



Participation in Physical Education Classes, Psychological Well-Being, and Sleep Satisfaction Among South Korean Adolescents

Yoonkyung Song¹ PhD, Eun-Young Lee² PhD, Justin Y. Jeon^{1,3,4} PhD

¹Department of Sport Industry Studies, Yonsei University, Seoul, Korea; ²School of Kinesiology and Health Studies, Queen's University, Kingston, Canada; ³Exercise Medicine Center for Diabetes and Cancer Patients, ICONS, Seoul; ⁴Cancer Prevention Center, Severance Hospital, Seoul, Korea

PURPOSE: This study aimed to examine the associations between participation in physical education (PE) classes and the psychological well-being and sleep satisfaction of Korean adolescents.

METHODS: Cross-sectional data from 127,804 Korean adolescents (aged 12–18 years) who participated in the 2016 and 2017 Korea Youth Risk Behavior Web-based Surveys (KYRBS) were analyzed. The exploratory variable was the frequency of participation in PE classes every week, while the dependent variables included the psychological well-being and sleep satisfaction, as assessed by the KYRBS questionnaire. Sex- and grade-stratified logistic regression analyses were conducted to generate the odds ratios (ORs) and 95% confidence intervals (CI).

RESULTS: Overall 16.9% of adolescents reported that they did not participate in PE classes while 33.0% reported participating for more than three times a week. After adjusting for the academic achievements, family's economic status, consumption frequency of breakfast and highly caffeinated drinks, and physical activity level, a greater participation in the PE classes was found to be associated with happiness in a dose-response fashion in both sexes and grades ($p < .05$). As for stress, participation in the PE classes for more than three times a week was associated with less/no stress in boys (OR: 1.16, 95% CI: 1.02–1.31, $p < .05$) and high school students (OR: 1.22, 95% CI: 1.03–1.44, $p < .05$). Moreover, greater participation in the PE classes was associated with a lower odds of reporting sleep satisfaction in a linear fashion among high school students.

CONCLUSIONS: More frequent participation in PE classes was associated with the psychological well-being and sleep satisfaction in a large sample of Korean adolescents. Increasing the number of mandatory PE sessions is a promising strategy for promoting the psychological well-being of Korean adolescents.

Key words: Physical activity, Happiness, Stress, Sleep quality, KYRBS

INTRODUCTION

It is well-established that participating in physical activity (PA) is associated with better mental and psychosocial health among adolescents [1,2]. Specifically, regularly participating in PA is inversely associated with depression, anxiety, stress, and behavioral issues while favorably associated with self-esteem and cognitive functioning [2]. PA is also associated with better sleep quality among adolescents [3,4].

Despite the potential benefits of PA on psychological well-being and

sleep among adolescents, PA levels among South Korean (Korean thereafter) adolescents are low compared to their peers in other countries [5, 6]. For example, in the Global Matrix 3.0 where report cards on children and youth PA from 49 countries were compared, overall PA among Korean children and adolescents were graded “F”, with only 5.8% of them engaging in 60 minutes of moderate- to vigorous-intensity physical activity (MVPA) daily [6]. In addition, adherence to the World Health Organization's PA guidelines (i.e., accumulating at least 60 minutes of MVPA daily) was only 5.9% among a national sample of Korean adoles-

Corresponding author: Justin Y. Jeon Tel +82-2-2123-6197 Fax +82-2-2123-8648 E-mail jjeon@yonsei.ac.kr

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cents aged 12 to 18 years based on self-reported data [7].

The PA of adolescents occurs in school, and schools is a place of PA for adolescents who spend most of their time [8]. Particularly, Korean adolescents depend on school-related PA [9]. The number of steps at school accounts for 40% of the total number of PA per day [10]. PA through physical education (PE) classes provide more than 50% of daily MVPA [11,12]. Moreover, after-school PAs at school are found to provide up to 50% of PAs to adolescents [10]. In addition, participating in PE classes and psychological well-being among Korean adolescents showed positive relationships. The more active students participated in PE classes, the lower their mental health problems were [13]. More school PA activities (e.g., PE classes, organized sports clubs, after-school programs, etc.) are positive for mental health such as stress, depression, and suicidal attempt [14].

However, given that Korean students spend most of their waking hours in schools or private institutions with highly structured daily schedules [15], it is important to examine the potential benefits of the frequency of participating in PE classes, rather than overall PA per se, to the well-being of adolescents. This is also important in that schools can provide all students (either active or not) with an equal opportunity to be physically active [15,16].

With regard to sleep satisfaction, to date, one study reported that participating in MVPA is associated with sleep satisfaction among Korean adolescents [17]. However, no study has examined associations between PE participation and sleep satisfaction in the Korean adolescent population. This inquiry is particularly important in the Korean context given that Korean adolescents studied most of their waking hours and generally lack sleep due to important academic workload [18]. For example, in typical weekdays, Korean adolescents spend an average 49 hours per week (about 40% of their waking hours in a 24-hour period) in school or private institution studying [18]. As for sleep, on average 13-15-year-olds sleep 7.6 hours and 16-18-year-olds sleep only 5.8 hours per day [18], while the recommendation is 8-10 hours per night. When the maximum sleep duration is fixed along with other academic schedules within a 24-hour period for Korean adolescents, it may be more important to target the quality of sleep rather than the quantity.

As the awareness and consensus on the effectiveness of school PE such as improving health and harmonious personality through various sports activities has been established, school PE curriculum were organized into 272 hours per year for middle schools, 10 units or more and 6 semesters for high schools from 2016 [20]. Therefore, the purpose of this

study was to examine associations between participation in PE classes and psychological well-being and sleep satisfaction among a national sample of Korean adolescents. We hypothesized that greater participation in PE classes would be associated with positive psychological well-being and sleep satisfaction.

METHODS

1. Participants

This observational, cross-sectional study used the 2016 and 2017 Korea Youth Risk Behavior web-based Survey (KYRBS) data from a nationally representative sample of Korean middle- and high-school students aged between 12 and 18 years. The KYRBS is an annual epidemiological surveillance conducted by the collaboration among the Korea Disease Control and Prevention Agency (KDCA), Ministry of Education, and Ministry of Health and Welfare to monitor the health and behavior of adolescents [21,22].

The KYRBS sampling process is divided into population stratification, sample allocation, and sampling stages in order to minimize the sampling error. In the first step, the multistage cluster sampling obtains nationally representative data. Second, students from 400 middle schools and 400 high schools including all the public, private and specialized schools in 17 provinces participate in the KYRBS. In the last sampling process, stratification variables were used with the primary extraction unit as a school and the secondary extraction unit as a class [21,22].

Schools recruited using a multiple stratified cluster sampling design proceed with the survey as follows: Identification (ID) numbers were assigned to each student by their classroom teachers. Using the assigned ID number, each student accessed and completed the self-administered, anonymous, web-based survey during a regular class period on the KYRBS web page. Online informed consent was obtained from all participating students and all data were de-identified. The survey consisted of 107 indicators of 117 and 123 questions assessing health and health-related behaviors and students took approximately 50 minutes to complete.

The survey protocol was approved by the KDCA Review Board according to the Enforcement Rule of the Bioethics and Safety Act. The KYRBS questionnaire and detailed methods are available on the KYRBS website (<http://yhs.cdc.go.kr>).

2. Instruments

1) Frequency of PE classes

The frequency of participating in PE classes during the past week was measured by asking students the following question: “During the past seven days, how many times did you participate in PE class?” The four response options included “none”, “1 time/week”, “2 times/week”, and “≥ 3 times/week”.

2) Psychological well-being

Perceived happiness and stress were used to measure psychological well-being by asking students the following questions: “On regular days, how happy are you?”, and “How stressed are you?” The response options ranged from “1” (very happy/very often feel stressed) to “5” (very unhappy/not at all stressed). Happiness variable was reverse coded so that lower scores reflect being unhappy and higher scores reflect being happy. The scores for happiness and stress were then converted into a dichotomous variable (“1” = very happy/happy or less/not stressed and “0” = neutral/unhappy/very unhappy/or neutral/stressed/very stressed).

3) Sleep satisfaction

Sleep satisfaction was measured by asking students the following question: “During the past seven days, did you obtain sufficient sleep in order to recover from fatigue?” The response options ranged from “1” (very sufficient) to “5” (very insufficient). Consistent with psychological well-being variables, the scores were converted into a dichotomous variable (“1” = very sufficient/sufficient and “0” = neutral/insufficient/very insufficient).

4) Covariates

Covariates included age, family economic status, academic achievement, the frequency of breakfast and high-caffeine drink consumption, and PA level. These covariates were chosen based on availability in the survey and its association with the outcomes [23-27]. An indicator of adiposity was not included as a covariate in this study based on a previous study reporting that PA was associated with psychological well-being regardless of body mass index among Korean adolescents [17].

3. Statistical analysis

All analyses were accounted for the sampling weights with the consideration of response rates, clustering, and sampling rates provided within the KYRBS dataset. Descriptive statistics were calculated to estimate

means and standard deviations ($M \pm SD$) for continuous variables, and percentages (%) for categorical variables. A ‘participation in PE class’ interaction was tested as the associations between PE classes, psychological well-being, and sleep satisfaction may vary by gender and grades [28,29]. Indeed, the ‘participation in PE class*gender’ and ‘participation in PE class*grades’ interaction on dependent variables was significant (happiness, $p = .000$; stress, $p = .000$; sleep satisfaction, $p = .000$); thus, subsequent analyses were stratified by gender and grades. The gender and grade differences were used a complex sample analysis for general linear model and Rao-Scott chi-square test. Complex sample logistic regression analyses were conducted to generate the odds ratio (OR) and 95% confidence interval (CI) with unadjusted and adjusted for psychological well-being and sleep satisfaction of the frequencies in PE classes as a reference category for those who did not participate in PE classes. All statistical inferences were based on a significance level of $p < .05$. A p value for a linear trend was also calculated to determine if a dose-response association exists between participation in PE classes, psychological well-being, and sleep satisfaction (p -for-trend $< .001$). All analyses were conducted using Complex Samples Procedures in SPSS version 25 (IBM Corp., Chicago, IL, USA).

RESULTS

Of the eligible 132,974, a total of 127,804 adolescents (response rate, 96.1%) had complete data and included in the analyses. Descriptive characteristics of the participants were shown in Table 1. The mean age of the participants was 15.18 ± 0.08 years, with 65,427 boys (51.5%) and 55,466 middle school students (43.4%).

Overall, 16.9% of students (13.7% in boys and 20.3% in girls; 14.2% of middle school students and 19.0% of high school students) did not participate in any PE classes. 33.0% of students were participated in PE classes for more than 3 times per week (Fig. 1). Among them, 38.8% of boys and 26.7% of girls participated in PE classes for more than 3 times per week, indicating a significant gender difference ($\chi^2 = 1,534.857$, $p < .001$). 55.6% of middle school students and 15.6% of high school students were participated in PE classes for more than 3 times per week ($\chi^2 = 12,690.161$, $p < .001$). Proportions of participants feeling happy and less/no stress, and sleep satisfaction were 66.2%, 20.0%, and 25.1%. The proportion of participants who participated in PA at least 60 minutes for more than five days a week was 13.5%. The mean breakfast frequency was 5.31 days per week, the high caffeine drink consumption was 1.30

Table 1. Subject characteristics

	Total (n=127,804)	Boys (n=65,427, 51.5%)	Girls (n=62,337, 48.5%)	χ^2	<i>p</i>
Age (yr) (M ± SD)	15.18 ± 0.08	15.13 ± 0.10	15.22 ± 0.09	68.796	.471
School grade				47.506	.457
Middle school	43.4	44.7	42.1		
High school	56.6	55.3	57.9		
Participation in PE class				1,534.857	< .001
None	16.9	13.7	20.3		
Once a week	20.0	17.1	23.1		
Twice a week	30.1	30.4	29.8		
≥ 3 times a week	33.0	38.8	26.7		
Happiness				334.986	< .001
Very happy/happy	66.2	69.4	62.8		
Very unhappy/unhappy/neutral	33.8	30.6	37.2		
Stress				1,566.667	< .001
Not/less stressed	20.0	25.9	13.8		
Very stressed/stressed/neutral	80.0	74.1	86.2		
Sleep satisfaction				1,486.906	< .001
Very sufficient/ sufficient	25.1	31.2	18.5		
Insufficient/very insufficient/neutral	74.9	68.8	81.5		
Family economic status				253.63	< .001
High	38.2	41.0	35.4		
Middle	46.6	44.0	49.4		
Low	15.1	15.0	15.3		
Academic achievement				48.552	.014
High	38.4	39.4	37.4		
Middle	28.6	27.5	29.7		
Low	33.0	33.1	32.9		
PA level				2,060.199	< .001
< 5 days/week	86.9	81.2	92.9		
≥ 5 days/week	13.1	18.8	7.1		
Breakfast (days/week) (M ± SD)	5.31 ± 0.03	5.43 ± 0.04	5.20 ± 0.04	553.12	< .001
High-caffeine drink	1.30 ± 0.01	1.33 ± 0.01	1.26 ± 0.01	201.283	< .001
Consumption (times/week) (M ± SD)					
Sleep duration (hr) (M ± SD)	6.27 ± 0.04	6.53 ± 0.06	6.01 ± 0.05	2,390.181	< .001

Data are presented as means and standard deviations (M ± SD) or percentages (%). PE, physical education; PA, physical activity; PA level.

times per week, and the mean sleep duration was about 6.27 hours.

Table 2 shows the gender-stratified associations between participation in PE classes, psychological well-being, and sleep satisfaction before and after adjusting for covariates. Overall, we observed dose-dependent patterns on the associations between participation in PE classes and happiness. After adjusting for covariates, participating in PE classes for more than three times per week was associated with happiness in both boys (OR: 1.59, 95% CI=1.42-1.77, $p < .05$) and girls (OR: 1.32, 95% CI=1.19-1.46, $p < .05$). Moreover, greater participation in PE classes was associated with higher odds of reporting happiness in a linear fashion in both boys and girls (p -for-trend = .000). Participating in PE classes for more than three times per week was associated with less/no stress in boys (OR: 1.16,

95% CI=1.02-1.31, $p < .05$). The associations between PE classes and sleep satisfaction were primarily null.

Table 3 shows the associations between participation in PE classes, psychological well-being, and sleep satisfaction by grade. After adjusting for covariates, participating in PE classes for more than three times per week was associated with happiness in middle school students (OR: 1.30, 95% CI=1.16-1.47, $p < .05$) and high school students (OR: 1.60, 95% CI=1.43-1.80, $p < .05$). Moreover, greater participation in PE classes was associated with higher odds of reporting happiness in a linear fashion in high school students (p -for-trend = .000). Participating in PE classes for more than three times per week was associated with less/no stress in high school students (OR: 1.22, 95% CI=1.03-1.44, $p < .05$). Additionally,

Table 2. Associations between participation in physical education classes, psychological well-being and sleep satisfaction among Korean adolescents by gender

	Happiness		Less/no stress		Sleep satisfaction	
	Crude OR (95% CI)	Adjusted OR (95% CI) [‡]	Crude OR (95% CI)	Adjusted OR (95% CI) [‡]	Crude OR (95% CI)	Adjusted OR (95% CI) [‡]
Boys						
PE [†] participation						
None	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
1 time/week	1.27 (1.11-1.47)*	1.26 (1.09-1.45)*	0.92 (0.77-1.09)	0.94 (0.79-1.12)	0.87 (0.77-0.98)*	0.96 (0.85-1.09)
2 times/week	1.52 (1.38-1.67)*	1.41 (1.26-1.57)*	0.97 (0.85-1.11)	0.98 (0.86-1.11)	0.83 (0.74-0.94)*	0.88 (0.78-0.98)*
≥ 3 times/week	2.03 (1.85-2.23)*	1.59 (1.42-1.77)*	1.21 (1.06-1.37)*	1.16 (1.02-1.31)*	1.08 (0.95-1.23)	0.89 (0.78-1.01)
Girls						
PE [†] participation						
None	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
1 time/week	1.19 (1.06-1.35)*	1.19 (1.06-1.34)*	1.00 (0.87-1.14)	1.04 (0.90-1.20)	0.88 (0.76-1.02)	0.95 (0.82-1.10)
2 times/week	1.26 (1.12-1.41)*	1.16 (1.03-1.30)*	1.05 (0.91-1.21)	1.02 (0.88-1.18)	0.90 (0.78-1.04)	0.89 (0.76-1.02)
≥ 3 times/week	1.62 (1.47-1.79)*	1.32 (1.19-1.46)*	1.19 (1.05-1.34)*	1.02 (0.88-1.17)	1.29 (1.13-1.47)*	0.95 (0.84-1.08)

OR, Odds Ratio; 95% CI, 95% Confidence Interval.

[†]PE = Physical education.

[‡]Adjusted for age, academic achievement and family economic status, the frequency of breakfast and high caffeine drink consumption, and physical activity level.

**p* < .05.

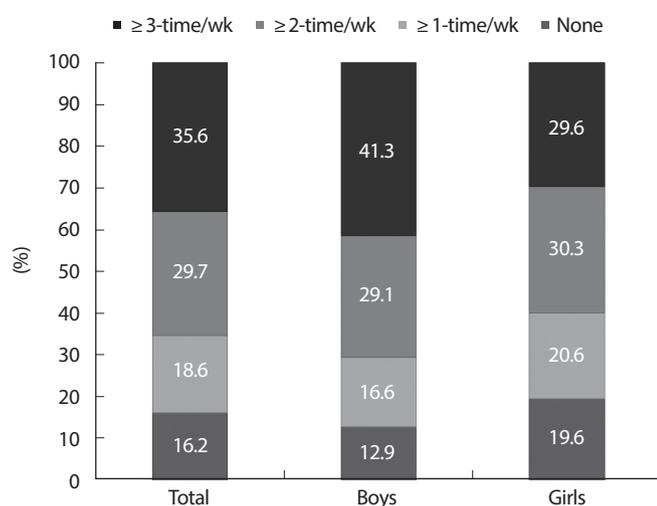


Fig. 1. Proportions of Korean adolescents participating in physical education classes per week (n=127,804).

greater participation in PE classes was associated with lower odds of reporting sleep satisfaction in a linear fashion in high school students (*p*-for-trend = .000).

DISCUSSION

This study demonstrated that participation in PE classes is associated with positive psychological well-being among Korean adolescents. Compared to students who did not participate in any PE classes, those who

participated in PE classes at least one time per week were more likely to be happy and less likely to feel stressed. Further, these associations were slightly stronger in boys than girls, and high school students than middle school students; however, the strength of the associations was small. Overall, our findings suggest that the more PE classes Korean students report participating in the better the associations are with psychological well-being. That being said, no relationships existed between participation in PE classes and sleep satisfaction except high school students.

Positive associations between PE and psychological well-being have previously been reported. For example, participation in PE classes was associated with higher levels of happiness and lower levels of perceived stress and depression in the Korean adolescent population [15,18,30,31]. The present study adds to the available evidence on the topic by providing contextual information on which PA setting may be beneficial to psychological well-being among Korean adolescents. School-based PA programs can provide the equal opportunity for students to engage in structured PA that may supplement to achieve the overall recommended PA for numerous health benefits [32]. Furthermore, beyond educational benefits such as the acquisition and development of movement skills and physical competence, PE can provide a space where students can feel enjoyment, relatedness, and social support while interacting with a supportive PE teacher and among students themselves [32,33]. Such social interactions within PE classes may play a role in the psychological well-being of adolescents.

Table 3. Associations between participation in physical education classes, psychological well-being and sleep satisfaction among Korean adolescents by grade

	Happiness		Less/no stress		Sleep satisfaction	
	Crude OR (95% CI)	Adjusted OR (95% CI) [‡]	Crude OR (95% CI)	Adjusted OR (95% CI) [‡]	Crude OR (95% CI)	Adjusted OR (95% CI) [‡]
Middle school students						
PE [†] participation						
None	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
1 time/week	1.26 (1.11-1.42)*	1.23 (1.08-1.40)*	0.99 (0.83-1.18)	0.98 (0.82-1.17)	0.87 (0.77-0.98)	1.21 (1.06-1.39)
2 times/week	1.21 (1.07-1.37)*	1.11 (0.99-1.26)	1.02 (0.88-1.18)	1.00 (0.87-1.14)	0.83 (0.74-0.94)	1.09 (0.98-1.22)
≥ 3 times/week	1.48 (1.33-1.65)*	1.30 (1.16-1.47)*	1.17 (1.04-1.32)*	1.09 (0.97-1.22)	1.08 (0.95-1.23)	1.00 (0.91-1.11)
High school students						
PE [†] participation						
None	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
1 time/week	1.29 (1.15-1.45)*	1.23 (1.09-1.38)*	1.00 (0.86-1.16)	0.99 (0.87-1.13)	0.86 (0.75-0.97)*	0.84 (0.74-0.95)*
2 times/week	1.48 (1.34-1.63)*	1.35 (1.21-1.49)*	1.15 (1.01-1.29)*	1.04 (0.93-1.17)	0.90 (0.79-1.04)	0.83 (0.72-0.96)*
≥ 3 times/week	1.81 (1.63-2.01)*	1.60 (1.43-1.80)*	1.52 (1.32-1.75)*	1.22 (1.03-1.44)*	0.97 (0.85-1.10)	0.81 (0.71-0.93)*

OR, Odds Ratio; 95% CI, 95% Confidence Interval.

[†]PE = Physical education.

[‡]Adjusted for gender, academic achievement and family economic status, the frequency of breakfast and high caffeine drink consumption, and physical activity level.

* $p < .05$.

Another explanation for the better psychological well-being among participants reporting greater participation in PE classes could be due to the PA-associated changes in the central catecholamine system, that is, changes in β -endorphins and/or norepinephrine levels that can lead to more positive emotions while reducing pain [34-37]. These neurotransmitters, which produce feelings of well-being, may act as a mood enhancer during and post PA [37]. Given these, we may speculate that participation in PE classes is mediated by a psychological function and in turn acts as a buffer against stressful events [38] such as studying for prolonged hours. Indeed, recent evidence suggests that breaking up prolonged sitting can be beneficial to health and well-being [39]. However, it is important to note that, in our study, only a high dose of PE classes participation was associated with the less/no stress indicator. These results may indicate that whereas a minimum dose of PE can be beneficial to adolescents feeling happy, more doses of the PE exposure would be required for adolescents to attenuate their daily stress level.

No associations were observed in the relationship between participation in PE classes and sleep satisfaction after adjusting for covariates in our study except high school students. The decrease in sleep satisfaction in high school students as the frequency of participants in physical education classes increases could be interpreted as high school students have relatively less sleep time and less time in physical education classes than middle school students. In addition to the covariates selected in this study, more in-depth analysis is needed, such as selecting and modifying

additional variables-smoking and drinking that are more suitable for adolescents. It may also be suggested that the physical activity through PE classes strength, type, and participation time presented in the survey in this study fell short of the threshold level for a positive change in subjective sleep satisfaction [40]. This is contradictory to the majority of studies that have suggested that PA is associated with sleep satisfaction among adolescents in different countries [40-42] as well as in Korea [18,43]. The previous studies showed that high-intensity and/or vigorous physical activity (VPA) was associated with favorable sleep patterns and less sleep complaints [41,42]. Furthermore, even if the frequency of participating in school PE classes was high, the degree of fatigue recovery through sleep had been negative [43]. According to the literature, associations between VPA and sleep satisfaction could be explained by two mechanisms-physiological and biological changes. First, VPA has been shown to increase cortical blood flow, endorphin release, and epinephrine and norepinephrine synthesis in the short term [44]. Second, VPA may positively contribute to increasing the volume of slow-wave sleep while reducing stage-2 sleep, and decreasing sleep-onset latency, which all may result in better efficiency of sleep [18,41]. No association between PE participation and sleep satisfaction may be due to the fact that in PE classes most PAs occur at moderate-to vigorous intensity rather than vigorous intensity [18,42]. Another possible explanation of our findings between PE participation and sleep satisfaction is that perhaps sleep satisfaction may be more closely related to PA outside of PE and/or screen

time behaviors rather than PE [42,45]. Given this, future researches on PE/PA and sleep satisfaction are needed because sleep is affected by various factors such as depression, anxiety, screen time, smoking and drinking [44,46].

Regardless of potential benefits of PE participation on psychological well-being shown in our study, PE classes often get replaced by self-directed study time for other important subjects in the competitive education environment of Korea [17]. In addition, Korea adolescents do not exercise hard even during insufficient PE classes [45]. Given that Korean children scored the lowest in the happiness scale among children in 22 countries for the past seven years [47,48], our findings on the potential benefits of participating in PE classes on psychological well-being provides further justification for increasing mandatory PE classes per week. According to the most current regulation associated with PE in Korea, middle schools are mandated to deliver 4 hours of PE per week while compulsory PE for middle school students is 272 hours per year. That being said, it is unknown if these regulations associated with mandatory PE are actually being delivered in schools [49].

In addition to increasing quantity, improving the quality of PE should also be considered simultaneously. In particular, gender is a major correlate of PA among Korean adolescents [50]. In a systematic review on correlates of PA among girls, gender discrimination and gender stereotypes by PE educators, and gender-biased teaching and evaluation methods have been identified as major barriers to PA [51]. This may explain the stronger associations between PE classes, psychological well-being, and sleep satisfaction in boys than girls shown in our study. It is also noted that the current PE programs in Korea may not appropriately represent the needs of female students [52]. Therefore, the development of future PA promotion strategies within a PE setting should be gender-specific. Furthermore, like gender differences, grade differences were also clearly indicated in this study, with high school students participating in school PE classes having higher subjective happiness and less stress than middle school students. This special nature of Korean education system, which values academic performance, could be explained as trying to get rid of the stress of high school students, especially through PAs in PE classes in school [29]. Securing high school PE classes, which are replaced by self-study hours or other major subjects - Korean, English, and math classes, is especially essential in high schools, where the burden of studying is heavier than in middle schools [29].

The major strength of our study is the use of a large and nationally representative sample. However, this study has limitations that should be

acknowledged. We were unable to test causality due to the nature of the cross-sectional design of the KYRBS. Research with stronger study designs and/or more robust measures is required to confirm our findings. Another limitation is the use of self-administered questionnaires. The questions are subjective and simple, and the measurement errors that occur in the response process cannot be excluded [25]; however, the KYRBS questionnaire is known to be valid and reliable over time [53]. Nonetheless, the association between PE participation and sleep satisfaction observed in our study may be due to the fact that sleep satisfaction was measured using a single item. Given the importance of sleep that makes up healthy 24-hour movement behavioral patterns [54], and its significant implications to overall health and well-being [55], comprehensively measuring different aspects of sleep behavior. Furthermore, it is unknown how much PA was performed by students during PE classes; thus, we are not able to confirm whether the observed associations are due to actual PA or other factors. It is also noteworthy that residual confounding by unmeasured variables (e.g., diet quality, screen time) is always a possibility in observational studies.

CONCLUSION

Our findings suggest that, primarily, participating in PE classes more frequently is positively associated with psychological well-being among Korean adolescents, regardless of family economic status, academic achievement, the frequency of breakfast and high-caffeine drink consumption, and PA level. School is a key environment in which most Korean adolescents spend a large portion of their waking hours during weekdays [52,56]. Not only PE classes in school plays a key role in improving adolescents' health, but also PE classes could lead adolescents to be active and establish physically active lifestyle [30].

Given this, emphasizing the importance of PE and increasing mandatory PE classes per week, as well as providing quality PE may be a first step toward promoting psychological well-being among Korean adolescents. In addition, more research is required to elucidate whether participating in PE classes do not have any implications to sleep satisfaction that either confirms or rejects our findings.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare for this study.

AUTHOR CONTRIBUTIONS

Conceptualization: Y Song; Data curation: Y Song; Formal analysis: Y Song, E Lee; Methodology: Y Song, E Lee; Visualization: Y Song; Writing-original draft: Y Song; Writing-review & editing: Y Song, E Lee, JY Jeon.

ORCID

Yoonkyung Song <https://orcid.org/0000-0002-8034-8212>
 Eun-Young Lee <https://orcid.org/0000-0001-9580-8974>
 Justin Y. Jeon <https://orcid.org/0000-0001-7978-4271>

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