



ARTICLE

Associations between Physical Activity, Depression, Self-Esteem, and Suicide Ideation in Adolescents

Dojin An¹, Nguyen Hoang Minh Thuan² and Youngho Kim^{1,*}

¹Department of Sport Science, Seoul National University of Science and Technology, Seoul, 01811, Republic of Korea

²Department of Sports Management, Ho Chi Minh City University of Physical Education and Sport, Ho Chi Minh City, 749000, Vietnam

*Corresponding Author: Youngho Kim. Email: yk01@seoultech.ac.kr

Received: 01 July 2024 Accepted: 11 October 2024 Published: 31 October 2024

ABSTRACT

Background: In contemporary society, it has been widely witnessed that a surprising number of adolescents suffer emotional and mental health problems, and such turmoil is very often carried over into adulthood with serious implications for adjustment during the post-adolescent years. The purpose of the current study is to investigate the associations of physical activity with self-esteem, depression, and suicidal ideation. In addition, this study examined whether self-esteem and depression mediate the relationship between physical activity and suicide ideation in adolescents. **Methods:** The study participants were 946 (male: 527, female: 419) who attended junior high and high schools in Seoul, Korea. The self-esteem scale, leisure time physical activity scale, the self-rating depression scale, and the suicide ideation scale were used to identify adolescents' mental health and physical activity. Descriptive analysis, correlation analysis, and Structural Equation Modeling were conducted to test the study hypothesis. **Results:** Results indicated that physical activity was significantly correlated with depression, self-esteem, and suicide ideation. Based on each variable's correlations, the finding revealed that physical activity was significantly associated with self-esteem, depression, and suicide ideation. In addition, depression and self-esteem had significant mediating effects on the relationship between physical activity and suicide ideation. **Conclusion:** The study suggests that the suicide prevention intervention should incorporate physical activity involvement with self-esteem and depression to strengthen the protective combined effect of the intervention on suicide ideation and suicide attempts.

KEYWORDS

Physical activity; depression; self-esteem; suicide ideation; adolescents

Introduction

Adolescence has been generally defined as a stage integrating biological development, enhancement of socialization, and psychological skills. This synergic transition is important for health-related behaviors and health states in adolescents [1–3].

Mental health (MH) is a significant health issue for adolescents [4,5]. MH is divided into two psychological states: positive (i.e., self-esteem and self-concept, etc.) and

negative (i.e., depression, anxiety, and suicidal ideation, etc.) [6–8].

Recently, it has been broadly witnessed that many adolescents are suffering from MH problems [9]. Especially, during COVID-19, a large number of studies have indicated that many adolescents reported higher levels of depression and even suicidal ideation due to family isolation and school closures [10–12]. More seriously, the prevalence of depression and its caused suicide attempts are continuously increasing in the post-COVID-19 [13].



At this point, it has been paid concerted attention to focus on MH and its treatment practices with adolescents in developed countries in developed countries [5]. Furthermore, the current research has been directed toward theoretically based and empirically supported MH care that aimed at identifying the relation to physical activity (PA) in adolescents [14].

PA is one of the health-promoting behaviors and regular PA is significant in preventing negative MH problems [15,16]. It is well documented that regular PA can help promote physical and psychological health for adolescents [17]. Physical activity and mental health are theoretically and empirically associated [18–19]. For example, some studies indicated that a lack of PA is significantly associated with high levels of anxiety, and suicide ideation in adolescents [13,18]. Moreover, other studies reported that regular PA is positively effective in enhancing self-esteem and self-concept [14,19].

A large volume of studies has reported that engaging in PA positively changes negative MH and that PA is a significant predictor to explain depression and suicidal ideation [13,20]. However, some studies indicated that there are no substantial relationships between PA and suicidal ideation [21] as well as suicidal attempts [22]. With such mixed findings, Lester and colleagues argued that the association between PA and suicide ideation could be mediated by further MH variables [23].

If it has been widely agreed that PA is significant in reducing depression and increasing self-esteem, it can be assumed that depression and self-esteem mediate the association between PA and suicide ideation. Some studies have investigated a mediating effect of self-esteem and depression between physical activity and suicide ideation [24,25]. Yu and colleagues indicated that depression and self-esteem have a significant mediating effect in explaining the relationship between PA and suicidal ideation [26]. Additionally, Xiong and the colleagues revealed that PA is significant in reducing depressive symptoms and modulating depression via the mediation of self-esteem [27].

According to these studies, physical activity is directly associated with depression, self-esteem, and suicide ideation, and self-esteem and depression are significant mediators of the relationship between PA and suicide ideation. However, there is limited research that has been carried out to investigate the association between PA, depression, self-esteem, and suicide ideation in Korean adolescents. Most of the previous studies have been conducted in Western countries, while such research is lacking in Korea, where adolescents' MH promotion through PA participation has been recently paid much attention. Hence, the current study investigated the associations of PA with self-esteem, depression, and suicidal ideation. In addition, this study examined whether self-esteem and depression mediate the link between PA and suicide ideation in adolescents. Fig. 1 is the hypothesized model set in this study, and the research hypotheses were set as follows:

Hypothesis 1. PA will be significantly related to self-esteem, depression, and suicide ideation.

Hypothesis 2. Self-esteem and depression will significantly mediate the relationship between PA and suicide ideation.

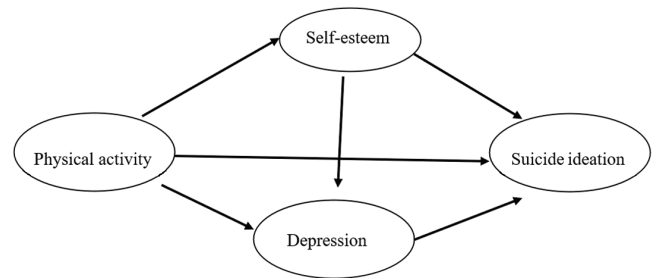


FIGURE 1. Hypothesized model for explaining the relationship between physical activity, depression, self-esteem, and suicide ideation in adolescents.

Materials and Methods

Study participant

A total of 946 adolescents (male: 527, female: 419) aged from 14–19 years old (Mage = 15.78, SD = 2.53) voluntarily participated in this study. In the initial stage of the study, permission from the principal and parents was given. Then, the objectives and procedures of the study were provided through newsletters and the student bulletin board in schools. Through these processes, 998 adolescents completed the survey form. Of these, 52 adolescents were excluded because they did not properly respond. All remaining 946 participants provide their informed consent in compliance with the approval of the Institute of Review Board of Seoul National University of Science and Technology.

Measures

The self-esteem scale, developed by Rosenberg [28], was used in the study. This measure consists of two high-ordered sub-factors with 10 items (positive self-esteem and negative self-esteem with 5 items each). The participants were asked to indicate on a 5-point Likert scale from “not at all” (1) to “very much so” (5), a two-week test-retest reliability was 0.83.

The leisure time physical activity scale (LTEQ), originally developed by Godin et al. [29], was applied in the study to evaluate participants' habitual weekly PA. Participants were asked to report how many times they engaged in high-intensity (i.e., running and strenuous cycling, etc.), moderate (i.e., fast walking and easy swimming, etc.), and mild (i.e., yoga and golf, etc.) PA for more than 15 min during a typical week. The score was calculated by multiplying each activity session using the following equation. A two-week test-rest reliability was 0.86.

$$\text{Metabolic equivalent (MET)} = [\text{high intensity} \times 9] + [\text{Moderate} \times 5] + [\text{Mild} \times 3].$$

*MET stands for the metabolic equivalent of task. One MET is the amount of energy used while sitting quietly. Physical activity may be rated using METs to indicate their intensity. For example, reading may use about 1.3 METs while running may use 8–9 METs

The depression scale (SDS), originally developed by Zung [30], was applied to measure adolescents' depression. The measure consists of two high-ordered sub-factors with 20 items (positive and negative with 10 items each). The participants responded with a 5-point Likert scale ranging from “not at all” (1) to “repeatedly” (5) for statements such

TABLE 1

The study variables of the participants

Variables		M ± SD	Case (n)	Percent (%)
Physical activity (METs)	Total physical activity	9.66 ± 9.05		
	Mild physical activity	5.63 ± 5.24		
	Moderate physical activity	8.09 ± 8.25		
	Vigorous physical activity	12.72 ± 9.24		
Self-esteem		3.04 ± 0.47		
Depression	Experienced		642	67.9
	Never experienced		304	32.1
Suicide ideation	Experienced		205	21.7
	Never experienced		741	78.3

Note: METs = [Strenuousx9] + [Moderatex5] + [Mildx3]. Cut-off point: Never experienced: not at all (1); Experienced: Seldom (2), Occasionally (3), Often (4) and Repeatedly (5).

as “I feel best in the morning when I am in the best mood of the day,” (positive) or “I suddenly burst into tears or feel like crying for a long time,” (negative). A two-week test-retest reliability was 0.79.

The suicide ideation scale (SIS) developed by Harlow et al. [31] was applied to measure suicidal ideation in Korean adolescents. This measure consists of 5 questions with a 5-point Likert scale from “not at all” (1) to “repeatedly” (5) for statements such as “I have ever had thoughts about suicide”. The scale asks respondents to rate the frequency of suicidal thoughts and considerations of dying, predictions of future suicidal behavior, experiences of telling others they would kill themselves, and experiences of suicidal prayers. Higher total scores are associated with higher levels of suicidal ideation. A two-week test-retest reliability was 0.89.

Data analysis

The collected data were analyzed by using the SPSS 28. First, descriptive statistics were conducted to summarize the study variables of the participants. Second, a bivariate correlation analysis was conducted to evaluate the degree of relationship between all study variables. Third, Structural Equation Modeling (SEM) was conducted to identify the influences of PA, self-esteem, and depression on suicide ideation. Additionally, SEM was applied to examine the mediating effect of self-esteem and depression in predicting the relationship between PA and suicide ideation. To establish the model fit of the proposed model, some global indexes were applied: a χ^2/df ratio less than 3, a relative fit index (RFI), a comparative fit index (CFI), the adjusted goodness of fit index (AGFI) values greater than 0.90, and the root mean square error of approximation (RMSEA) values less than 0.05 [32,33]. All statistical significance was tested at $\alpha = 0.05$.

Results

Descriptive analysis

Table 1 shows the descriptive statistics (i.e., Mean, Standard Deviation, and Percentage) for the study variables of the

participants. According to Table 1. The PA (Mean score of METs) of the study participants was 9.66, adding up mild PA (5.63), moderate (8.09), and vigorous (12.72). In addition, for MH, the mean with SD of self-esteem was 3.04 ± 0.47 67.9% of the study participants experienced depression and 21.7% had suicide ideation.

Correlation analysis

Table 2 presents the bivariate correlation coefficients and descriptive statistics between all study variables. The correlation coefficients between all variables range from 0.20 to 0.71, indicating that they are all statistically significant. In specific, PA was substantially correlated with self-esteem ($r = 0.33$), depression ($r = -0.42$), and suicide ideation ($r = -0.20$). Based on the correlation coefficient, the association among PA, depression, self-esteem, and suicide ideation were considered.

Structural equation model analysis

SEM was conducted to verify the association among PA, depression, self-esteem, and suicide ideation in Hypothesis 1 and 2. As Shown in Table 3, PA is significantly related to self-esteem ($\beta = 0.68$, $p = 0.001$), depression ($\beta = -0.37$, $p = 0.001$), and suicide ideation ($\beta = -0.19$, $p = 0.001$). The relationships between self-esteem esteem and suicide ideation ($\beta = -0.31$, $p = 0.001$) and between depression and

TABLE 2

Correlations among study variables

Variable	1	2	3	4
Self-esteem (1)	1	-0.71**	-0.54**	0.33**
Depression (2)		1	0.47**	-0.42**
Suicidal ideation (3)			1	-0.20*
Physical activity (4)				1
Mean	3.69	2.31	2.69	10.21
SD	0.67	0.57	0.81	6.02

Note: * $p < 0.05$, ** $p < 0.001$.

TABLE 3

The relationships between physical activity, self-esteem, depression, and suicide ideation

	Path	β	S.E.	<i>t</i>	<i>p</i>
Physical activity	→ Self-esteem	0.68	0.025	14.36	0.001
Self-esteem	→ Suicide ideation	-0.31	0.079	3.40	0.001
Depression	→ Suicide ideation	0.46	0.053	3.96	0.001
Physical activity	→ Suicide ideation	-0.19			
Physical activity	→ Suicide ideation (total effect)	-0.31	0.045	6.95	0.001
Bootstrap results for mediating effect		Effect	S.E.	LL 95% BC	UL 95% BC
Physical activity→Self-esteem→Suicide ideation		0.23	0.028	0.043	0.155
Physical activity→Depression→Suicide ideation		0.35	0.028	0.043	0.155

Note: Bootstrap sample size = 1000, LL = Lower level, UL = Upper level, BC = Bias-corrected confidence intervals.

TABLE 4

Fit index values of structural equation models

Indexes	χ^2	Df	RFI	CFI	AGFI	RMSEA
	137.41	6	0.990	0.992	0.940	0.04

suicide ideation ($\beta = 0.46$, $p = 0.001$) were statistically significant. In addition, self-esteem ($\beta = 0.23$, CI [0.043, 0.155], $p = 0.001$) and depression ($\beta = 0.35$, CI [0.043, 0.155], $p = 0.001$) significantly mediated the relationship between PA and suicide ideation.

The current study estimated and tested the relationships among PA, depression, self-esteem, and suicide ideation to establish a model fit. Based on the findings, the proposed model of the present study was suitable for the data with indices of global model fit presented in Table 4. Fig. 2 shows the standardized path coefficients among PA, self-esteem, depression, and suicide ideation.

Discussion

To well understand the current findings, it is essential to be aware that investigating the role of PA on adolescents' mental health (i.e., depression and suicide ideation) is significant for several reasons. First, adolescents can contribute to successfully changing their own negative MH through participation in regular PA [34]. Second, by

understanding the association between PA and MH processes, more effective PA strategies for adolescent groups that are at high MH risk—may be developed and implemented [35].

To accomplish a deeper understanding of the processes that lead to MH promotion among adolescents, the current study examined the hypothesized model that PA would be associated with self-esteem, depression, and suicide ideation—and that self-esteem and depression would mediate the associations between physical activity and suicide ideation.

The current findings showed that adolescents' PA had a clear association with self-esteem, depression, and suicidal ideation. This was supported by previous studies, demonstrating that PA reduces depression and suicide ideation and promotes self-esteem [36,37]. Gu conducted a pre- and post-study of adolescents participating in aerobic exercise three times a week for 16 weeks and found that there were statistically substantial differences in MH, with lower levels of depression and anxiety [38]. Mayer found that adolescents who engaged in PA for a longer period had higher self-esteem and lower depression [39]. Moreover, Lee et al. [40] also reported that adolescents who engaged in low- to moderate-intensity regular PA had higher self-esteem and lower depression.

Based on the association of PA with depression and self-esteem identified from the current findings, it can be plausible to suggest that adolescents should be encouraged to be involved in regular PA and provided with more opportunities to participate in various types of PA. Furthermore, it is important to understand that regular PA in adolescents prevents not only physiological and physical problems such as metabolic syndrome (i.e., obesity, type-2 diabetes, high blood pressure, etc.), which are often

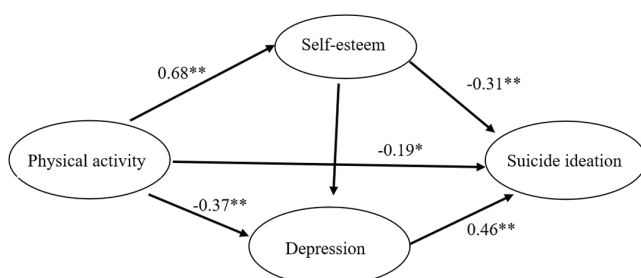


FIGURE 2. Relationship of physical activity with depression, self-esteem, and suicide ideation in adolescents (* $p < 0.05$; ** $p < 0.01$).

triggered by excessive study time, but also a variety of MH problems (i.e., stress, depression, and anxiety, etc.).

Moreover, the current findings indicated that PA is statistically significantly related to suicide ideation. This was supported by previous studies, indicating that adolescents who participated in PA reported lower suicidal ideation than non-participants, and the longer they participated in PA, the lower their suicidal ideation [41,42]. However, such a relationship between PA and suicide ideation has not been consistently supported by previous studies [21,22]. Lester et al. argued that the identification of potential mediators of the association between PA and suicide ideation [23]. In this regard, some studies indicated that factors that belong to the negative dimension of MH such as depression, and the positive dimension of MH such as self-esteem may serve as crucial mediators in this relationship [43,44].

The current study from an adolescent population contributes to the clarification of the MH issue. In this study, PA and self-esteem were negatively related to depression and suicide ideation. Moreover, depression and self-esteem significantly mediated the association between PA and suicide ideation, and this finding is supported by previous studies [26,45]. Ha and colleagues reported that PA is significantly related to suicidal ideation through self-esteem and depression demonstrating that self-esteem harmed depression, and depression had a positive effect on suicidal ideation in the PA group compared to the non-PA group [46]. Brailovskaia et al. also indicated that the association between higher PA and lower suicide-related outcomes was substantially mediated by higher self-esteem [43].

Limitations and implications

Several limitations should be considered for further study. The study participants were recruited from three secondary schools in Nowon-gu located in northern Seoul. Therefore, these data may not be representative of all Korean adolescents. The study applied a cross-sectional design, and hence we cannot guarantee a causal relationship among the study variables. Moreover, because the data was obtained from self-reported measures, some biases or prejudices may occur to interpret and recall the items.

Despite these limitations, the current findings clarify that it can be significant to account both for the presence of PA and self-esteem in addition to awareness of risks due to depression, when assessing individuals at risk for suicide. It is a fact that regular PA can not only help the experience of positive feelings and increase the sense of control that individuals with enhanced suicide risk often overlook but also mitigate depression which may significantly influence suicidal ideation and attempts. Therefore, the study suggests that the suicide prevention intervention should incorporate PA involvement with self-esteem and depression to strengthen the protective combined effect of the intervention on suicidal ideation and suicide attempts.

Conclusion

The current study attempted to test the association of PA with depression, self-esteem, and suicide ideation. The findings indicated that adolescents' PA is significantly associated

with self-esteem, depression, and suicidal ideation- and that depression and self-esteem are significantly mediated by the relationship between PA and suicide ideation. These results could not only emphasize the importance of the PA as a protective health behavior against depression and suicide ideation but also accelerate the effective PA intervention targeting adolescents suffering from negative MH problems.

Acknowledgement: We acknowledge all participants involved in this research and those who helped in recruiting.

Funding Statement: This study was supported by the Research Program funded by the SeoulTech (Seoul National University of Science and Technology).

Author Contributions: Youngho Kim designed the study. Nguyen Hoang Minh Thuan and Dojin An collected data. All authors analyzed the data and wrote the manuscript. All authors reviewed the results and approved the final version of the manuscript.

Availability of Data and Materials: The raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

Ethics Approval: The studies involving human participants were reviewed and approved by the Research Ethics Committee of Seoul National University of Science and Technology (2023-0024-01). Written informed consent to participate in this study was provided by the participant's legal guardian.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

References

- Hogarth CR. Adolescent psychiatric nursing (mental health series). In: Mosby year book. St. Louis; 1991.
- Hurrelmann K, Losel F. Health hazards in adolescence. Berlin: De Gruyter; 1990. doi:10.1515/9783110847659.
- Kim YH. Correlation of mental health problems with psychological constructs in adolescence: final results from a 2-year study. *Int J Nur Stud.* 2003;40:115–24. doi:10.1016/s0020-7489(02)00037-8.
- Vigo D, Thornicroft G, Atun R. Estimating the true global burden of mental illness. *Lancet Psychiatr.* 2016;3(2):171–8. doi:10.1016/S2215-0366(15)00505-2.
- Peng S, Luo X, Liang S, Deng F, Liu Y, Zeng H, et al. Psychological and emotional responses during different stages of the COVID-19 pandemic based on a survey of a mental health hotline. *Int J Ment Health Promot.* 2022;24(5):711–24. doi:10.32604/ijmhp.2022.020556.
- Ryff CD, Love GD, Urry HL, Muller D, Rosenkranz MA, Friedman EM, et al. Psychological well-being and ill-being: do they have distinct or mirrored biological correlates? *Psychother Psychosom.* 2006;75(2):85–95. doi:10.1159/000090892.
- Huppert FA, Whittington JE. Evidence for the independence of positive and negative well-being: implications for quality of life assessment. *Br J Health Psychol.* 2003;8(1):107–22. doi:10.1348/135910703762879246.

8. Kharel M, Sakamoto JL, Carandang RR, Ulambayar S, Shibanuma A, Yarotskaya E, et al. Impact of COVID-19 pandemic lockdown on movement behaviors of children and adolescents: a systematic review. *BMJ Glob Health*. 2022;7(1):e007190. doi:10.1136/bmjgh-2021-007190.
9. Li B, Ng K, Tong X, Zhou X, Ye J, Yu JJ. Physical activity and mental health in children and youth during COVID-19: a systematic review and meta-analysis. *Child Adolesc Psychiatr Ment Health*. 2023;17(1):92. doi:10.1186/s13034-023-00629-4.
10. Jakovljevic M, Bjedov S, Jaksic N, Jakovljevic I. COVID-19 pandemic and public and global mental health from the perspective of global health security. *Psychiatr Danub*. 2020;32(1):6–14. doi:10.24869/psyd.2020.6.
11. Samji H, Wu J, Ladak A, Vossen C, Stewart E, Dove N, et al. Review: mental health impacts of the COVID-19 pandemic on children and youth—a systematic review. *Child Adolesc Ment Health*. 2022;27(2):173–89. doi:10.1111/camh.12501.
12. Singh S, Roy D, Sinha K, Parveen S, Sharma G, Joshi G. Impact of COVID-19 and lockdown on mental health of children and adolescents: a narrative review with recommendations. *Psychiatr Res*. 2020;293(5):113429. doi:10.1016/j.psychres.2020.113429.
13. Feng W, Zhao L, Ge Z, Zhao X, Li T, Zhu Q. Association between physical activity and adolescent mental health in the post COVID-19: the chain mediating effect of self-esteem and social anxiety. *PLoS One*. 2024;19(5):e0301617. doi:10.1371/journal.pone.0301617.
14. Kopp PM, Möhler E, Gröpel P. Physical activity and mental health in school-aged children: a prospective two-wave study during the easing of the COVID-19 restrictions. *Child Adolesc Psychiatry Ment Health*. 2024;18(1):4. doi:10.1186/s13034-023-00695-8.
15. Marconcin P, Werneck AO, Peralta M, Ihle A, Gouveia ER, Ferrari G, et al. The association between physical activity and mental health during the first year of the COVID-19 pandemic: a systematic review. *BMC Public Health*. 2022;22(1):209. doi:10.1186/s12889-022-12590-6.
16. Warburton DER, Bredin SSD. Health benefits of physical activity: a systematic review of current systematic reviews. *Curr Opin Cardiol*. 2017;32(5):541–56. doi:10.1097/HCO.0000000000000437.
17. World Health Organization. Benefits and risks of physical activity and sedentary behavior. Available from: <https://www.who.int/news-room/factsheets/detail/physical-activity>. [Accessed 2022].
18. Sampasa-Kanyinga H, Colman I, Goldfield GS, Janssen I, Wang JL, Podinic I, et al. Combinations of physical activity, sedentary time, and sleep duration and their associations with depressive symptoms and other mental health problems in children and adolescents: a systematic review. *Int J Behav Nutr Phys Act*. 2020;17(1):72. doi:10.1186/s12966-020-00976-x.
19. Andermo S, Hallgren M, Nguyen TTD, Jonsson S, Petersen S, Friberg M, et al. School-related physical activity interventions and mental health among children: a systematic review and meta-analysis. *Sports Med Open*. 2020;6(1):25. doi:10.1186/s40798-020-00254-x.
20. Congsheng L, Kayani S, Khalid A. An empirical study of physical activity and sports affecting mental health of university students. *Front Psychol*. 2022;13:917503. doi:10.3389/fpsyg.2022.917503.
21. Choquet M, Kovess V, Poutignat N. Suicidal thoughts among adolescents: an intercultural approach. *Adolescence*. 1993;28(111):649–59.
22. Sabo D, Miller KE, Melnick MJ, Farrell MP, Barnes GM. High school athlete participation and adolescent suicide. *Int Rev Sociol Sport*. 2005;40(1):5–23. doi:10.1177/1012690205052160.
23. Lester D, Battuelo M, Innamorati M, Falcone I, DeSimoni E, Del Bono SD, et al. Participation in sport activities and suicide prevention. *Int J Sport Psychol*. 2010;41(1):58–72.
24. Babiss LA, Gangwisch JE. Sports participation as a protective factor against depression and suicidal ideation in adolescents as mediated by self-esteem and social support. *J Dev Behav Pediatr*. 2009;30(5):376–84. doi:10.1097/DBP.0b013e3181b33659.
25. Kayani S, Kiyani T, Wang J, Zagalaz Sánchez ML, Kayani S, Qurban H. Physical activity and academic performance: the mediating effect of self-esteem and depression. *Sustainability*. 2018;10(10):3633. doi:10.3390/su10103633.
26. Yu H, Mu Q, Li K. Effects of physical exercise on non-suicidal self-injury in adolescents: the chain mediating role of perceived social support and self-concept. *Front Psychiatry*. 2023;14:1201863. doi:10.3389/fpsyg.2023.1201863.
27. Xiong G, Wang C, Ma X. The relationship between physical activity and mental depression in older adults during the prevention and control of COVID-19: a mixed model with mediating and moderating effects. *Int J Environ Res Public Health*. 2023;20(4):3225. doi:10.3390/ijerph20043225.
28. Rosenberg M. Society and the adolescent self-image. In: Princeton. NJ: Princeton University Press; 1965. Available from: <https://www.jstor.org/stable/j.ctt183pjhh>. [Accessed 2024].
29. Godin G, Shephard RJ. Importance of type of attitude to the study of exercise behavior. *Psychol Rep*. 1986;58(3):991–1000. doi:10.2466/pr0.1986.58.3.991.
30. Zung WW. A self-rating depression scale. *Arch Gen Psychiatry*. 1965;12(1):63–70. doi:10.1001/archpsyc.1965.01720310065008.
31. Harlow LL, Newcomb MD, Bentler PM. Depression, self-derogation, substance use, and suicide ideation: lack of purpose in life as a mediational factor. *J Clin Psychol*. 1986;42(1):5–21. doi:10.1002/(ISSN)1097-4679.
32. Banville D, Desrosiers P, Genet-Volet Y. Translating questionnaires and inventories using a cross-cultural translation technique. *J Teach Phys Edu*. 2000;19(3):374–87. doi:10.1123/jtpe.19.3.374.
33. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equation Model*. 1999;6(1):1–55. doi:10.1080/10705519909540118.
34. Booth N, Ness AR, Joinson C, Tomporowski PD, Boyle JME, Leary SD, et al. Associations between physical activity and mental health and behavior in early adolescence. *Ment Health Phys Act*. 2023;24(1):1–10. doi:10.1016/j.mhpa.2022.100497.
35. Crichton M, Bigelow H, Fenes B. Physical activity and mental health in children and youth: clinician perspectives and practices. *Child Youth Care Forum*. 2023;53(4):981–1001. doi:10.1007/s10566-023-09782-5.
36. Park SH, Han KS, Kang CB, Park ES. Effects of an exercise program on depression symptom, self-esteem and stress in adolescents: a systematic review. *J Korean Acad Psychiatr Ment Health Nurs*. 2013;22(1):22–33. doi:10.12934/jkpmhn.2013.22.1.22.
37. Bang H, Won D, Park S. School engagement, self-esteem, and depression of adolescents: the role of sport participation and volunteering activity and gender differences. *Child Youth Serv Rev*. 2020;113:105012. doi:10.1016/j.childyouth.2020.105012.
38. Gu J. Physical activity and depression in adolescents: evidence from China family panel studies. *Behav Sci*. 2022;12(3):71. doi:10.3390/bs12030071.
39. Mayer JS, Hees K, Medda J, Grimm O, Asherson P, Bellina M, et al. Bright light therapy versus physical exercise to prevent

- co-morbid depression and obesity in adolescents and young adults with attention-deficit/hyperactivity disorder: study protocol for a randomized controlled trial. *Trials*. 2018;19(1):140. doi:10.1186/s13063-017-2426-1.
40. Lee HK, Kim YH. Association of physical activity stage and intensity with psychological variables in adolescent. *J Korean Acad Kinesiol*. 2017;19(1):17–26. doi:10.15758/jkak.2017.19.1.17.
 41. Kim MS, Jeon HJ, Kim HI, Kang HH. The influence of the participation in the fitness type leisure activities on ego-resilience and suicidal ideation of college students. *Korean J Leis, Recr Park*. 2018;42(3):71–82. doi:10.26446/kjlrp.2018.9.42.3.71.
 42. Nam SK, Jeong KH, Lee ES. A study on the bullying, suicidal thoughts and positive effect of participation in leisure sports among the Adolescent. *Korean J Sport Sociol*. 2007;20(3): 403–23. doi:10.22173/JKSSS.2007.20.3.403.
 43. Brailovskaia J, Teismann T, Margraf J. Positive mental health mediates the relationship between physical activity and suicide-related outcomes: a three-year follow-up study. *Current Psychol*. 2022;41(9):6543–8. doi:10.1007/s12144-020-01152-x.
 44. Schuch FB, Vancampfort D, Richards J, Rosenbaum S, Ward PB, Stubbs B. Exercise as a treatment for depression: a meta-analysis adjusting for publication bias. *J Psychiatr Res*. 2016;77:42–51. doi:10.1016/j.jpsychires.2016.02.023.
 45. Wunsch K, Kasten N, Fuchs R. The effect of physical activity on sleep quality, well-being, and affect in academic stress periods. *Nat Sci Sleep*. 2017;9:117–26. doi:10.2147/NSS.
 46. Ha JY, Cho HI, So YH. The relationship among body image, physical attractiveness, self-esteem, hopelessness depression and suicidal ideation according to exercise participation in high school students. *J Sport Leis Stud*. 2011;46:843–58. doi:10.51979/KSSLS.2011.11.46.843.