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Cross-Lagged Relationship between Physical Activity Time, Openness and Depression Symptoms among Adolescents: Evidence from China

Xiaojie Cao[1], Qinyu Zhang[2] and Xinqiao Liu[3,*]

[1]Graduate School of Education, Peking University, Beijing, 100871, China
[2]School of Medicine, Shanghai Jiao Tong University, Shanghai, 200025, China
[3]School of Education, Tianjin University, Tianjin, 300350, China
*Corresponding Author: Xinqiao Liu. Email: xinqiaoliu@pku.edu.cn

ABSTRACT

The relationship between physical activity time, openness and depression symptoms among adolescents is a cutting-edge research direction in the field, yet it remains unclear. This study is based on a sample of 7924 students from a nationally representative China Education Panel Survey database and examines the bidirectional relationships between physical activity time, openness and depression symptoms among Chinese adolescents. Descriptive analysis showed that during the 7th and 8th grades, the average physical activity time decreased to less than one hour per day, accompanied by a decreasing trend in openness and a slight worsening in depression symptoms. Correlation analysis showed a significant negative correlation between physical activity time and depression symptoms, a significant positive correlation between physical activity time and openness, and a significant negative correlation between depression symptoms and openness. The results from cross-lagged models indicated a bidirectional relationship between physical activity time and openness, with physical activity time significantly positively predicting openness in the following year and openness significantly positively predicting physical activity time in the following year. In addition, depression symptoms had a unidirectional negative predictive effect on openness. The conclusions provide empirical evidence for education administration and schools to promote the physical and mental health development of adolescents worldwide.

KEYWORDS

Physical activity time; depression; openness; adolescents

Introduction

Adequate physical activity time is essential for the development of adolescents' physical and mental health [1–4]. Unfortunately, the reality of physical activities globally is far from optimistic, particularly with regards to insufficient physical activity time. More than 80% of adolescents worldwide do not meet the World Health Organization recommendation of one hour of moderate-to-vigorous aerobic activity per day [5]. In Europe, only a quarter of boys and 15% of girls reach the recommended amount of time for physical activity [6]. The situation is even worse in sub-Saharan Africa, where only 13.8% of adolescents receive the recommended physical activity time [7]. In China, nearly 85% of young people face a lack of adequate physical activity [8], with only approximately one-fifth of students meeting the standard of one hour of physical activity per day. In addition, their physical activity levels tend to decrease as they get older [9]. Considering the pressing issue of adolescents lacking sufficient physical activity time and the importance of physical activity, it is necessary to investigate the key factors that influence adolescents' physical activity time.

Studies have suggested a close association between physical activity time and depression symptoms [10] and that physical activity may have potential benefits for

depression symptoms [11]. Adolescents are alarmingly susceptible to depression symptoms, with a sharp increase in onset occurring around the age of 13 [12–16]. The global prevalence of depression in adolescents has reached 4.5% [17,18], and the rate of depression symptoms in Chinese adolescents was 18.4% before 2000 and increased to 26.3% after 2016 [19]. During the COVID-19 pandemic, the overall prevalence of depression symptoms in children and adolescents increased to 28.6% [20], which is related to a decrease in physical activity time [21]. Moreover, depression symptoms in adolescents can have numerous adverse consequences [22–25], significantly increasing the risk of depression relapse in adulthood [26] and, in severe cases, leading to suicidal ideation and behavior [19]. Depression symptoms refer to a range of symptoms, including low mood, decreased interest in activities and appetite, which require clinical assessment for the diagnosis of depression disorder [27], a mood disorder characterized mainly by depressed mood and a range of severe depression symptoms [28]. In this study, we measured depression symptoms in adolescents using questionnaires. Meanwhile, recent studies indicate that lower openness is a significant predictor of depression symptoms [29–31]. In the Big Five personality traits, openness mainly describes traits of curiosity, open-mindedness, creativity and emotional richness, and highly open individuals are capable of employing creative coping strategies to address health issues [32,33]. Research suggests that openness may influence health behavior choices [5] and therefore time spent in physical activity. According to self-determination theory, individuals engage in certain behaviors to achieve intrinsic pleasure and satisfaction when driven by internal motivation [34,35]. High openness individuals are more likely to be internally motivated to engage in physical activity and are likely to voluntarily increase their physical activity time [36]. The principle of maturity in personality traits also reveals that these traits undergo predictable changes from adolescence [37], suggesting that openness may have a predictive relationship with both physical activity time and depression symptoms in adolescents. Unfortunately, although physical activity time, openness and depression symptoms have been proven correlated, the direction of their interaction remains unclear. The aim of this study is to investigate the cross-lagged relationship between physical activity time, openness and depression symptoms in Chinese adolescents using nationally representative longitudinal survey data. Clarifying the bidirectional relationship between these variables is valuable in providing guidance for the promotion of adolescent physical and mental health.

Literature Review

Physical activity time and openness
Physical activity time is correlated with openness [36,38–41], with most studies suggesting a positive relationship between the two [42,43]. Caille et al. found that openness plays a protective role in initiating and maintaining physical activity

[43]. Individuals with higher openness tend to be more curious and enjoy exploring new ideas and experiences, which may contribute to seeing physical activity as a way to experience new things [44]. In addition, self-determination theory posits that higher openness is associated with lower external regulation [36]. The motivational model suggests that openness has a positive impact on health motivation, increasing the likelihood of participating in physical activity [34]. However, a consensus has not yet been reached. Based on a meta-analysis of 33 studies, Rhodes et al. found no association between the personality traits of openness to experience/intellect and physical activity [45]. Lodewyk et al. discovered that women with higher openness were more likely to feel anxious and have low self-efficacy during physical activity, thereby diminishing the positive impact of physical activity [46]. Gacek et al.'s survey of Polish and Spanish students found a positive correlation between openness and physical activity only among Polish students [47]. It is worth noting that the relationship between physical activity time and openness might not be unidirectional [48]. Most studies are based on cross-sectional data, and there is little discussion of the bidirectional relationship between physical activity time and openness [43]. Data from adults show that openness has a significant effect on physical activity, but the effect of physical activity on openness is insignificant [42]. Furthermore, the relevant literature is mainly based on Western contexts such as Europe and the United States, and most of the evidence comes from adult populations. This encourages us to empirically analyze the bidirectional relationship between these variables in a Chinese context among adolescents.

Physical activity time and depression symptoms
Prior literature has revealed that prolonged moderate-intensity physical activity can help alleviate depression symptoms in adolescents [49]. Evidence from Canada and Iran suggests that regular physical activity time may reduce symptoms of depression by increasing confidence and self-esteem [50,51]. Moderate to vigorous aerobic exercise for prolonged periods has been shown to reduce the incidence of depression in adolescents [4]. Six months of moderate-intensity aerobic exercise has been shown to significantly increase gray matter volume in the prefrontal cortex and reduce symptoms of depression [52]. A longitudinal study of 4,257 adolescents in the United States found that a one-hour daily increase in light physical activity between the ages of 12 and 16 was associated with an 8%–11% reduction in depression symptom scores [53]. However, some studies have produced inconsistent results and suggested that physical activity may have no clinical benefit on depression symptoms [54,55]. The literature has focused more on the unidirectional relationship between physical activity time and depression symptoms in adolescents [1], but the effect of depression symptoms on physical activity time has received little attention. Therefore, the bidirectional relationship between physical activity time and depression symptoms remains unclear and merits further investigation.

Depression symptoms and openness
Previous literature has posited that there is a correlation between openness and depression symptoms [31,56,57]. Several studies have found that people with lower openness show more symptoms of depression [29–31]. People with lower levels of openness are less likely to derive pleasure from social relationships and activities [58] and lack appreciation for the arts, creativity, and curiosity about different emotional experiences and new ideas. This may reflect their lower ability to cope with depression symptoms and other negative emotions [59,60], thus making them more vulnerable to depression symptoms. At the cognitive level, rigid, closed-minded individuals (low openness) are less able to adapt to change than flexible, open-minded individuals (high openness), making them more vulnerable to depression symptoms [61]. However, current findings are not unambiguous. For example, Zhao et al., Klein et al., and Hayward et al. argue that openness and depression symptoms are not related [58,62,63]. Depression symptoms can have a transient effect on personality traits [64–67], particularly in children and adolescents [68]. In recent years, there has been increasing support for the malleability of personality traits [69,70]. This may be due to the joint influence of genetic and environmental factors on openness, with specific factors promoting changes in openness [68]. Longitudinal studies have shown that the average and individual levels of personality traits can change during adulthood, suggesting that personality is dynamic and can change across the lifespan [66]. Openness tends to increase in early adulthood, remain stable in mid-adulthood, and then decline in old age [71,72]. However, most current research focuses on the relationship between openness and depression symptoms in adults, so more evidence is needed to clarify the bidirectional relationship between depression symptoms and openness in adolescents, particularly in relation to developmental characteristics during adolescence.

Research hypothesis
In conclusion, discussions regarding the relationship between physical activity time, openness and depression symptoms among adolescents have yet to reach a consensus, leaving space for further exploration. In particular, there is a lack of empirical evidence based on the Chinese adolescent context. Additionally, adolescents around the age of 13 (typically the 7th grade of junior high school in China) are at a critical stage of mental health and personality development [12,13,16,37]. It is important to identify and address potential problems at this stage in a timely and proactive manner to promote positive future development. The research aims to investigate the bidirectional relationship between adolescents' physical activity time, openness, and depression symptoms in China. Using nationally representative longitudinal survey data, we empirically examine the cross-lagged relationship between physical activity time, openness and depression symptoms among Chinese adolescents. Based on the literature and the purpose of our research, we formulate the following hypotheses:

Hypothesis 1: Adolescents' physical activity time and openness decline while depression symptoms increase during the 7th and 8th grades.

Hypothesis 2: There is a significant negative correlation between physical activity time and depression symptoms, a significant positive correlation between physical activity time and openness, and a significant negative correlation between depression symptoms and openness. Moreover, these variables are hypothesized to demonstrate bidirectional relationships.

Methods

Participants
The data we use come from the China Education Panel Survey (CEPS) database. The survey was designed and implemented by the National Survey Research Center (NSRC) at Renmin University of China and is a large-scale, nationally representative tracking survey project. Currently, data from the two phases of 2013–2014 and 2014–2015 have been publicly released. The CEPS takes the 2013–2014 academic year as its baseline, with the 7th grade of junior high school and the 9th grade of junior high school as its starting point for the survey. Using a multistage probability proportional to size (PPS) and whole class sampling design, with the average educational level of the population and the proportion of mobile population as stratifying variables, 28 county-level units (counties, districts, and cities) were randomly selected from across the country as survey sites. The implementation of the survey is based on schools, and 112 schools and 438 classes were randomly selected from the selected county-level units. All students in the selected classes were included in the sample. The first follow-up survey was conducted in 2014–2015, but only students in grade 7 at baseline were followed up (i.e., they were in grade 8 in 2014–2015). Therefore, this study selected the same batch of students who participated in both surveys as research objects while deleting samples with missing values and finally retained a sample of 7924 students for empirical analysis. The mean age of the sample at baseline was 13.514 years (SD = 0.684) according to the data collected.

Measures

Physical activity time
In this study, the average daily physical activity time (in minutes) of adolescents was obtained by using the CEPS student questionnaire "How much time on average did you spend on the following extracurricular activities from Monday to Friday last week?" and "How much time on average did you spend on the following extracurricular activities last weekend?". Based on actual situations, we removed an average daily physical activity time of more than 300 min as an outlier.

Depression symptoms
In this study, depression symptoms were measured by averaging the scores obtained from four questions in the CEPS student questionnaire: "Did you feel blue in the past seven days?", "Did you feel unhappy in the past seven days?", "Did you feel that life was meaningless in the past seven days?", and "Did you feel sad in the past seven days?".

TABLE 1

Descriptive statistics of physical activity time, depression symptoms and openness

Variables	Year	N	M	SD	Min	Max	Skewness	Kurtosis
Physical activity time	Year 1	7924	50.886	54.736	0	300	1.56	5.884
	Year 2	7924	44.253	35.845	0	300	2.939	16.004
Depression symptoms	Year 1	7924	2.008	0.792	1	5	1.024	4.48
	Year 2	7924	2.145	0.923	1	5	0.896	3.69
Openness	Year 1	7924	3.233	0.576	1	4	−1.045	4.713
	Year 2	7924	2.89	0.647	1	4	−0.233	2.836

TABLE 2

Correlation analysis of physical activity time, depression symptoms and openness

Year	Variables	1	2	3	4	5	6
Year 1	1. Physical activity time	1.000					
	2. Depression symptoms	−0.058*	1.000				
	3. Openness	0.112*	−0.144*	1.000			
Year 2	4. Physical activity time	0.150*	−0.031*	0.064*	1.000		
	5. Depression symptoms	−0.031*	0.424*	−0.064*	−0.034*	1.000	
	6. Openness	0.088*	−0.233*	0.186*	0.077*	−0.319*	1.000

Note: *1% significance level.

Each question was rated on a 5-point scale ranging from "1 = never" to "5 = always". A higher average score indicates a higher level of depression symptoms among the students. The reliability coefficients α of the depression symptoms in the first and second year were 0.811 and 0.889, respectively.

Openness
In this study, the level of openness among students was measured using the CEPS student questionnaire. The following items were included: "I was able to express myself clearly", "I was able to give quick responses", and "I was curious about new stuff". Each item was evaluated using a 4-point scale (ranging from "1 = strongly disagree" to "4 = strongly agree"). The average of the scores of the three items was taken, with a higher average indicating a higher level of openness among the students. The reliability coefficients α of the openness in the first and second year were 0.596 and 0.593, respectively.

Data analysis
First, we conducted a descriptive statistical analysis on the variables of physical activity time, openness, and depression symptoms. Next, we explored the bivariate correlation between these variables using Pearson correlation analysis. Finally, we used the cross-lagged panel model to empirically investigate the bidirectional relationships between physical activity time, openness, and depression symptoms in Chinese adolescents. The cross-lagged panel model is typically employed to examine the relationship between two variables, X and Y, measured at different points in time (T1

and T2, respectively, where T1 precedes T2). Specifically, it examines the relationships between X at T1 and Y at T2, and Y at T1 and X at T2. The results can reveal the mutual relationship between the variables and their directionality, thereby providing insight into how these variables interact over time.

Results

Descriptive statistics and correlation analysis
Table 1 shows the mean, standard deviation, minimum, maximum, skewness, and kurtosis scores of physical activity time, openness and depression symptoms among Chinese adolescents. During the 7th and 8th grades, the average daily physical activity time of the adolescents decreased from 50.886 to 44.253 min, indicating a gradual decrease in the time spent on physical activity. In terms of depression symptoms, the average score increased from 2.008 to 2.145 between the 7th and 8th grades, indicating a slight increase in their level of depression symptoms. In terms of openness, the average score was 3.233 in grade 7 and 2.89 in grade 8. In summary, based on the descriptive data, the trend of physical activity time and openness among adolescents is decreasing, while their depression symptoms level is increasing, indicating a detrimental trend in the level of physical activity and mental health among Chinese adolescents, which deserves great attention and immediate improvement.
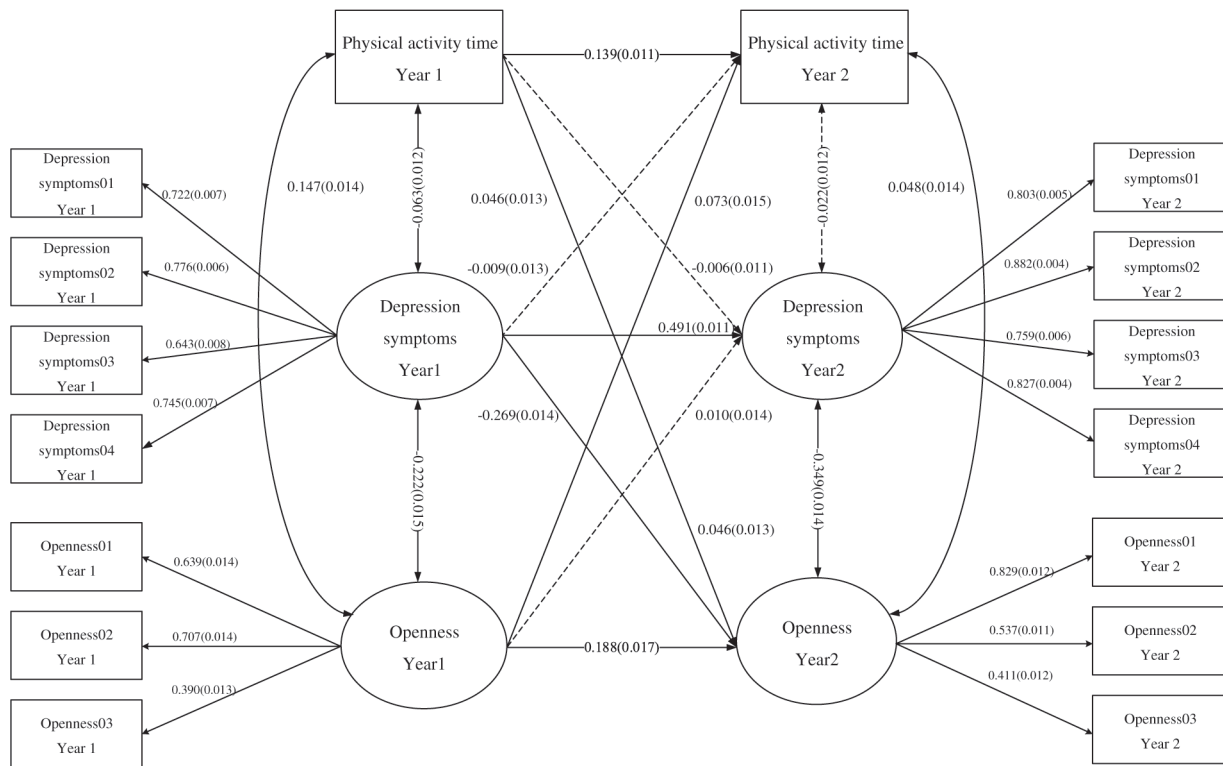
FIGURE 1. Cross-lagged model of physical activity time, depression symptoms and openness.

Table 2 shows the correlation coefficients between physical activity time, openness and depression symptoms among adolescents. In each year, a significant negative correlation ($p < 0.01$) was found between physical activity time and depression symptoms, a significant positive correlation ($p < 0.01$) was found between physical activity time and openness, and a significant negative correlation ($p < 0.01$) was found between openness and depression symptoms. As seen, there is a relatively stable negative correlation between physical activity time and depression symptoms and between depression symptoms and openness, as well as a relatively stable positive correlation between physical activity time and openness. In addition, significant positive correlations ($p < 0.01$) were found between physical activity time in different years, between depression symptoms levels in different years, and between openness levels in different years. This suggests that there is a certain degree of stability in physical activity time, openness and depression symptoms among Chinese adolescents over the two-year period of 7th and 8th grade.

Cross-lagged model
According to the characteristics of the variables, we build a cross-lagged model, as shown in Fig. 1. A two-wave cross-lagged model was constructed to examine the relationship between the variables of physical activity time, openness and depression symptoms. Fig. 1 shows the model structure for the full sample. The model fit indices are favorable, with RMSEA = 0.036, 90% CI = [0.034, 0.038]; CFI = 0.975, TLI = 0.967; SRMR = 0.021. As illustrated in Fig. 1, the standardized autoregressive path coefficient for physical

activity time was 0.139 ($p < 0.01$); for openness, it was 0.188 ($p < 0.01$); and for depression symptoms, it was 0.491 ($p < 0.01$). After controlling for autoregression, adolescents' physical activity time in the first year significantly positively predicted their openness in the second year (standardized path coefficient = 0.046; $p < 0.01$), and adolescents' openness in the first year significantly positively predicted their physical activity time in the second year (standardized path coefficient = 0.073; $p < 0.01$). Additionally, adolescents' depression symptoms in the first year significantly negatively predicted their openness in the second year (standardized path coefficient = −0.269; $p < 0.01$), but the effect of openness in the first year on depression symptoms in the second year was not significant (standardized path coefficient = 0.010; $p > 0.1$). Adolescents' physical activity time in the first year was found to have a negative effect on depression symptoms in the second year, but it was not significant (standardized path coefficient = −0.006; $p > 0.1$). Meanwhile, depression symptoms in the first year had a negative effect on physical activity time in the second year, but this was also not significant (standardized path coefficient = −0.009; $p > 0.1$). In conclusion, there is a bidirectional relationship between physical activity time and openness and a unidirectional predictive relationship between depression symptoms and openness among Chinese adolescents.

Discussion

This study examined a cross-lagged relationship between physical activity time, openness and depression symptoms

among Chinese adolescents based on survey data collected from the same cohort of adolescents during 7th and 8th grade. The conclusion adds new evidence from the Chinese context to the literature and deepens our understanding of the relationship between the aforementioned variables.

According to the results of the descriptive analysis, the average physical activity time among Chinese adolescents in grades 7 and 8 has decreased, falling short of the World Health Organization's recommendation of one hour of physical activity per day. This trend is consistent with previous findings [5–7], which indicate that four out of five adolescents worldwide do not meet the minimum requirements for physical activity and that physical activity time decreases with age [72]. This may be due to the increasing levels of tiredness, laziness, and lack of time as adolescents get older [73]. Meanwhile, the average level of openness among Chinese adolescents showed a decreasing trend, which contrasts with the results of a study of Estonian adolescents aged 12 to 18 [74]. This may be due to the nonlinear development of openness among adolescents, with opposing dynamic changes at different stages, with most improvements in openness occurring in the later stages of adolescence [75]. Furthermore, there are significant cultural differences in the development of adolescent openness [76], and our study presents the changes in openness among Chinese adolescents in a cultural context. In addition, there has been a slight increase in depression symptoms among Chinese adolescents in grades 7 and 8, which may be related to pubertal problems and the increasing burden of education [77–79]. These phenomena deserve close attention from education administration, schools and parents.

The results of the correlation analysis indicate that, first, there is a significant negative correlation between physical activity time and depression symptoms among Chinese adolescents. This is consistent with previous findings [10,11] and has been confirmed in both clinical and nonclinical samples of depression [11,80]. Second, there is a significant positive correlation between physical activity time and openness. This finding is consistent with prior literature [42,43]. However, it is in contrast to a previous meta-analysis that found no correlation between physical activity and openness [45], which may be because the previous study mostly involved adults and the correlation between physical activity and openness varies regionally [47]. Third, our study also found a significant negative correlation between depression symptoms and openness, which is consistent with previous research and suggests that higher levels of openness may be associated with improved mental health [56,57].

This study further clarified the bidirectional relationship between physical activity time, openness and depression symptoms among Chinese adolescents by using cross-lagged models.

First, physical activity time and openness had a reciprocal predictive relationship. Adolescents' physical activity time could significantly positively predict openness in the following year, and openness could significantly positively predict physical activity time in the following year. Our findings align with previous studies by Caille et al.

and Allen et al., who found that openness has a unidirectional effect on physical activity time [42,43]. Importantly, our research provides further evidence for the reciprocal predictive relationship between physical activity time and openness. Individuals with higher openness are more likely to initiate and maintain physical activity [43], which might be because they are more accepting of new ideas and experiences and are more willing to try new things, making them more likely to initiate physical activity as a way of experiencing new things [44]. This conclusion concurs with the pertinent outlooks espoused by both self-determination theory [34–36] and the overarching motivational model [34], implying that individuals possessing a higher degree of openness exhibit greater self-regulation and a more potent drive toward promoting health, thereby obviating the need for excessive external intervention to sustain their physical fitness regimen. These individuals also exhibit a greater proclivity to initiate and engage in physical activity of their own accord. Moreover, our study reveals that physical activity time also has a positive predictive effect on openness, which is consistent with a longitudinal study of adults and elderly individuals [48], which may be because physical activity can mitigate cognitive decline [81], increase cognitive flexibility [82] and thus mitigate the decline in openness in adulthood. It is worth noting that openness is more likely to change in adolescents than in adults [68], and our conclusions clearly show that increasing time spent in physical activity at this stage of life may help to increase openness, which in turn may play a protective role in preventing depression symptoms.

Second, we found that depression symptoms can negatively predict openness, with depression symptoms significantly negatively predicting openness in the following year but openness not predicting depression symptoms in the following year. Previous research has typically assumed that openness is relatively stable and unaffected by symptoms of depression [64], but increasingly more recent studies have suggested that personality is not fixed and that changes in life stressors and significant social roles and relationships can have reshaping effects on personality [63]. The cross-lagged model results further highlight that depression symptoms are a significant predictive signal that can have detrimental effects on personality development, such as future openness, among adolescents [63]. Therefore, it is crucial to pay special attention to adolescents' mental health development and to avoid the long-term negative consequences of depression. Previously, some studies have suggested that lower openness may predict the onset of depression symptoms [29–31], but our findings are inconsistent with these conclusions, as openness does not have statistically significant negative predictive effects on depression symptoms among Chinese adolescents.

Third, we did not find a bidirectional relationship between time spent in physical activity and depression symptoms. This finding is consistent with the two previous randomized control trials, which suggested that physical activity does not have a statistically significant effect on depression symptoms [54,55]. This may be because regular

engagement in physical activity alone does not prevent depression symptoms, and only an appropriate increase in physical activity can alleviate depressive symptoms [83,84]. However, our conclusion does not agree with some previous studies [49–51,53,83]. These previous studies have mainly focused on the relationship between nonmindful physical activity (e.g., brisk walking, running) and depression, and there have been few systematic studies of the relationship between mindful physical activity (e.g., qigong, tai chi, yoga) and depression. However, compared with popular nonmindful physical activities prevalent in the West, Chinese adolescents are more likely to be exposed to mindful physical activities [85,86], and the effects of such activities on depression symptoms need to be further investigated.

In summary, the conclusions of this study have practical and theoretical implications. On a practical level, education administration and schools should establish conditions for physical activity, encourage appropriate extension of adolescents' physical activity time, strengthen monitoring of their emotional status, and promote their overall healthy development. For instance, education administration should implement policies that ensure adolescents receive sufficient daily physical education in schools and promote openness during key stages of personality development. Schools should regularly organize mental health courses for adolescents, take prompt action with those exhibiting symptoms of depression, and strengthen cooperation with parents to focus on fostering openness, thereby promoting the physical and mental health of adolescents. On a theoretical level, this study provides new evidence that sheds light on the direction and nature of the relationship between adolescent's physical activity time, openness, and depression symptoms. The explanation for the bidirectional relationship between these variables has not yet reached a sufficient level of theoretical depth. Future research should propose a more specific theoretical framework to facilitate a more in-depth understanding of the dynamic relationship between these variables.

Limitations

First, due to database limitations, our current analysis of the bidirectional relationship between physical activity time, openness and depression symptoms is based on two waves of data. Future access to additional longitudinal data could further explore the dynamic changes in these variables over more waves. Additionally, the data used in this study is from the CEPS which was conducted seven to eight years ago, with only the first and second waves currently available. However, given the ongoing nature of the project, we will endeavor to update the study with the latest data as soon as it is officially released.

Second, the relationship between physical activity time and depression symptoms may be influenced by the intensity of physical activity. This study did not differentiate between the intensity of physical activity due to limitations in the database and questionnaire items, which may have underestimated the effect of physical activity time on depression symptoms.

Third, future researchers could consider using additional data to further refine their analysis of the heterogeneous effects that different aspects of openness may have on depression symptoms levels [61].

Fourth, the measures used in our study were based on students' self-report questionnaire scores, which may introduce some measurement error. In the future, interviews with students' parents, teachers, and peers will be conducted to validate our findings.

Conclusions

First, the levels of physical activity and psychological wellbeing of Chinese adolescents show an unfavorable trend. During grades 7 and 8, the average amount of physical activity among Chinese adolescents decreased, falling below the daily minimum of one hour. Meanwhile, their openness decreased, and there was a marked upward trend in the prevalence of depression symptoms.

Second, there is a significant negative correlation between physical activity time and depression symptoms and a significant positive correlation between physical activity time and openness and between depression symptoms and openness among Chinese adolescents.

Third, there is a bidirectional relationship between physical activity time and openness among Chinese adolescents, with physical activity in grade 7 significantly predicting openness in grade 8 and openness in grade 7 significantly predicting physical activity in grade 8. No bidirectional relationship was found between physical activity and depression symptoms, and there was a negative unidirectional predictive relationship between depression symptoms and openness.

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

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