

Article

Gender and Age Association with Physical Activity and Mood States of Children and Adolescents in Social Isolation during the COVID-19 Pandemic

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Abstract: Background: The outbreak of COVID-19 had a huge impact on daily life. It greatly reduced our physical activity (PA) and caused an increase in negative emotions. The emotions of different ages and sexes were impacted during the pandemic but the most severely influenced were adolescents. Therefore, the study's main purpose was to explore the influence of age and gender on adolescent physical activity and emotions during the pandemic. Methods: The subjects of the present study were 14,045 adolescents aged 10–18 years from the Yan'an Shaanxi province. The International Physical Activity Questionnaire Short Form (IPAQ-SF) was used to investigate the PA and Profile of Mood States (POMS) was used to investigate adolescents' mood states. Results: we found that girls and boys have significant differences in total PA and moderate PA ($p < 0.01$). The adolescents' PA levels of different ages had significant differences ($p < 0.01$). Meanwhile, boys had higher negative emotion scores (anger, fatigue, depression, confusion) than girls. Girls, in contrast, had higher positive emotion scores (self-esteem, vigor) ($p < 0.01$). With increasing age, the increase in emotional states seems to diminish ($p < 0.01$). Conclusions: Results show long-term social isolation causes reduced PA and increased negative mood states. Girls' PA was higher than boys, and boys had higher levels of mood disturbances. PA and levels of mood disturbances were significantly associated with age from 10 to 18 years old. This research study aimed to help the correlation department understand the relationship between PA and mood states of adolescents of different ages and sexes during COVID-19. Providing health promotion and preventative advice for different sex and age groups has expanded globally.

Keywords: physical activity; mood states; adolescents; COVID-19

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1. Introduction

The coronavirus disease 2019 outbreak attracted unprecedented attention worldwide [1]. As of 20 January 2021, more than 96 million COVID-19 cases have been confirmed globally, with more than 2 million deaths [2]. The COVID-19 pandemic has been a global health crisis that has affected general health and everyday life [3,4]. To prevent the spread of COVID-19, the Chinese government enacted a series of restriction measures to delay the diffusion of the COVID-19 pandemic, including reducing outdoor time, closing elementary and secondary schools across the nation, and conducting all teaching activities virtually. People's physical activities were under limitations. Therefore, children's access to social support resources and PA may have been limited during isolation at home.

Physical activity (PA), defined as "any bodily movement generated by skeletal muscles that design in energy expenditure" [5], and low levels of sedentary time spent in front of screens and monitors (screen time, ST) have been associated with improved physical, psychosocial, and mental health [6–8]. The COVID-19 outbreak revealed a decrease in PA and an increase in screen time. Children and adolescents are one of the population groups that have been struck especially hard by the restrictive measures. They were still restricted from school, and leisure activities were temporarily closed. This limitation could

negatively affect children's physical and mental health, as they did not get to play with their friends, be active in their sports groups, or have regular exercise during school physical education (PE) lessons. At the same time, the Ministry of Education launched an emergency policy initiative called "Suspending Classes Without Stopping Learning" to switch teaching activities into large-scale online teaching while schools were closed [9]. Adolescents spent more time sitting than before. All around the world, adolescents should undertake at least 60 min of moderate to vigorous intensity physical activity (MVPA) per day according to the World Health Organization [10]. This is especially important as previous studies have shown that approximately 50% of adolescents achieved recommended weekly PA levels before the outbreak, while only 24% of them achieved sufficient PA levels during COVID-19 [11]. As we know, PA is an important determinant of adolescents' physical and psychological growth. It can help prevent and control disease, reduce risk factors, and maintain health. Physical inactivity and excessive sedentary behavior (SB) are significant problems among children. Health behavior established in childhood might well track into adulthood and can lead to increased risk of a number of serious health conditions (e.g., overweight/obesity, type II diabetes, and metabolic syndrome) in later childhood and adulthood [12]. Furthermore, gender and age play a key role in the behavioral regulation of PA. Regular exercise benefits health, but research has found that PA declines with age, especially in adolescence [1,13]. Gender also plays an important role in PA engagement, as motivation factors also seem to differ between males and females [14]. Boys may be more attracted to exertional characteristics, while girls may be more attracted to PE for other aspects, such as the popularity gained with their peers or the improvement of their body image. For boys, exercising was often perceived as being fun and something they wanted to do rather than something they needed to do for other reasons. This is consistent with studies in South Africa [15,16].

As the COVID-19 pandemic spread rapidly around the world, it caused social panic globally. Increased negative emotions and reduced positive emotions, especially fear and anger, are the main presentations of COVID-19 pandemic stress [17,18]. The COVID-19 pandemic has caused increased exposure to numerous health, economic, and social stressors for adolescents. Moreover, adolescence is a vulnerable period with an increased risk for internalizing problems [19,20]. Adolescents' exposure to stressful life events increases in adolescence, and adolescents are more vulnerable to depression, anxiety, and stress [21]; even anger emerges as events evolve [22].

Meanwhile, due to the Bayesian Mindsponge Framework (BMF) analytics, people of different sexes and ages tend to have different mindsets, which greatly influence their thinking processes and behaviors [23,24]. As a result, girls express more positive mood states and more negative internalizing emotions, such as sadness and anxiety, and boys express more externalizing emotions, such as anger [25]. Several studies have reported that emotion regulation does not decline with age but rather that reappraisal increases with age [26].

The COVID-19 pandemic has spread rapidly worldwide, adversely affecting children's physical and mental health. However, the current research has focused on emotions and PA during COVID-19. There has been a lack of research on different age stages and genders. As a result, this paper examined the influence of different age stages and genders on PA and mood states during the pandemic. Based on previous research, physical activity for boys was higher than girls before the outbreak [27]; therefore, we hypothesized that the students' PA dropped with increasing age during self-isolation, especially among boys. Additionally, boys' mood states are influenced to a greater extent than those of girls during the pandemic. These research findings will help provide exercise suggestions for adolescents to use when they must stay at home. The relevant department can develop different exercise measures for adolescents of different genders and ages.

2. Materials and Methods

2.1. Sample and Study Design

This is a cross-sectional study conducted during the outbreak. The survey was conducted in a city in Southern Shaanxi Province called Yan'an, a typical agricultural area. The object of this study is 14,045 students aged between 10 and 18 years who lived in Yan'an. A total of 7067 boys and 6978 girls participated in this study; 50.3% were boys, and 49.7 were girls. Adolescents with physical or intellectual disabilities or with psychological or neuroendocrine problems were excluded from this study. The parents or legal guardians of each child signed an informed consent form to enroll them in this study. Patients were divided into three age groups according to three points. The first age group was 10–12, the second age group was 13–15, and the last age group was 16–18. The total participants in each group were: 7001 from 10 to 12 years old (49.8%), 4447 from 13 to 15 years old (31.7%), and 2597 from 16 to 18 years old (18.5%). Most participants were concentrated in the 10–12 years category (Table 1).

Table 1. Descriptive characteristics of study subjects ($n = 14,045$) ($x \pm s$).

	Age (Years) $M \pm SD$	n	%
Sex			
Boys	13.05 \pm 2.26	7067	50.30%
Girls	13.23 \pm 2.36	6978	49.70%
Age (years)			
10–12 years	11.22 \pm 0.79	7001	49.80%
13–15 years	13.97 \pm 0.94	4447	31.70%
16–18 years	16.88 \pm 0.83	2597	18.50%
Wake up time			
Before 6:00		184	1.30%
6:00–8:00		10,251	73%
8:00–10:00		3422	24.40%
After 10:00		188	1.30%
Bedtime			
20:00–21:00		3167	22.50%
21:00–22:00		6801	48.50%
22:00–23:00		3462	24.60%
After 23:00		615	4.40%

2.2. Measures

During the pandemic, the survey was distributed between 8 and 15 March 2020. Therefore, the traditional mode of issuing questionnaires no longer holds. All questionnaires were given on the Wenjuanxing questionnaire platform (<https://www.wjx.cn/>), accessed on 21 March 2020. The questionnaire mainly included three aspects: basic information (gender, age, grade, living area), PA, and mood states. Adolescents' PA was examined using the Chinese version of the International Physical Activity Questionnaire [28]. The questionnaire has good reliability and validity [29]. IPAQ-SF scales investigated PA intensity, frequency, and duration in a week. The MET scores are 3.3 for walking, 4.0 for moderate intensity, and 8.0 for activity of vigorous intensity. MET-minutes per week (METs/wk) were calculated as duration (in minutes) \times frequency (days per week) \times MET intensity [29].

The profile of mood states (POMS) questionnaire was used to measure mood disturbance [28] and has a 65-item self-report of mood. The POMS scale includes seven subscales; each question was scored as 0–5 points (0 = no at all; 1 = a little; 2 = intermediate; 3 = more; 4 = extremely), which were interpreted as emotions ranging from good to bad. Subjects were selected based on their reported emotions. Counting each subscale score, tension, depression, anger, fatigue, and confusion, calculates the negative mood scale scores. From this is subtracted vigor and self-esteem, positive mood scale scores, yielding a total score of Total Mood Disturbance (TMD) [30]. Accordingly, the total results for TMD were obtained.

Scores can range from 0 to 200, where higher scores indicate a greater degree of mood disturbance [31]. To ensure validity and reliability, all patients signed written informed consent. Adolescents were required to fill out the questionnaire under the guidance of their parents.

2.3. Statistical Analysis

Data analysis was performed using SPSS25.0 statistical software. PA and emotions values were presented as mean \pm standard deviation (SD). Cronbach's alpha was used as the method of reliability test. The IPAQ-SF scales ($\alpha = 0.80$, Cronbach's alpha for each score range from 0.591 to 0.801) and POMS scale ($\alpha = 0.67$, Cronbach's alpha for each score range from 0.588 to 0.714) had excellent reliability and validity. PA and emotions did not follow a normal distribution; therefore, the Mann–Whitney U test was applied to compare the PA and emotional differences between sexes. Kruskal–Wallis nonparametric and post hoc tests were used to compare the PA and emotional differences across different age groups. The statistical significance was set at $p < 0.05$.

3. Results

The effect of gender on emotion and PA analyses is summarized in Table 2. The analysis presented in Table 2 shows that students with moderate and vigorous PA achieved 821 ± 1446.95 MET-min/week. Vigorous PA was 352.09 ± 806.29 MET-min/week, which was the largest. Moderate PA was 272.96 ± 584.71 MET-min/week, which was the second largest. Walking was 201.06 ± 522.59 MET-min/week, which was the lowest score. Through comparisons, we found that the moderate and vigorous activity of boys was 1191.45 ± 1673.30 MET-min/week, and the moderate and vigorous activity of girls was 1205.74 ± 1570.17 MET-min/week. The negative subscales of moderate physical activity in girls were significantly higher than in boys ($p < 0.01$). It was found that girls had greater total PA and moderate PA than boys. In contrast, no difference was observed between vigorous PA and walking ($p > 0.05$).

Table 2. Comparison of physical activity and mood states between different sexes ($n = 14,045$) ($x \pm s$).

	Boys ($n = 7067$)	Girls ($n = 6978$)	Total ($n = 14,045$)	U	Z	p
Physical activity (MET*-min/week)						
Moderate and Vigorous	1191.45 \pm 1673.30	1205.74 \pm 1570.17	821.62 \pm 1446.95	2.44×10^7	−1.818	0.187
Vigorous physical activity	529.80 \pm 979.66	495.93 \pm 886.63	352.09 \pm 806.29	2.44×10^7	−1.329	0.184
Moderate physical activity	375.87 \pm 687.28	415.32 \pm 662.27	272.96 \pm 584.71	2.30×10^7	−7.423	<0.01
Walking	285.78 \pm 610.35	294.48 \pm 616.79	201.06 \pm 522.61	2.45×10^7	−0.979	0.329
Profile of Mood States						
Tension	2.64 \pm 2.49	2.58 \pm 2.49	2.86 \pm 2.58	2.40×10^7	−2.868	<0.01
Anger	2.27 \pm 2.45	2.13 \pm 2.36	2.93 \pm 3.16	2.45×10^7	−0.524	0.600
Fatigue	2.04 \pm 2.26	1.90 \pm 2.19	2.28 \pm 2.41	2.46×10^7	−0.248	0.804
Depression	1.87 \pm 2.25	1.76 \pm 2.23	1.50 \pm 1.98	2.43×10^7	−1.591	0.112
Confusion	3.96 \pm 1.92	3.83 \pm 1.86	3.08 \pm 2.05	2.38×10^7	−3.419	<0.01
Vigor	4.03 \pm 2.11	4.04 \pm 2.08	3.35 \pm 2.08	2.44×10^7	−0.906	0.365
Self-esteem	4.23 \pm 1.96	4.25 \pm 1.94	3.47 \pm 2.04	2.43×10^7	−1.443	0.149
Total mood disturbance	104.52 \pm 10.19	103.90 \pm 10.16	103.74 \pm 10.33	2.44×10^7	−0.988	0.318

Notes: MET*-min/week: Metabolic Equivalent Task minutes per week. The MET assignments for each intensity of PA were walking (3.3 METs), moderate (4 METs), and vigorous (8 METs).

The analysis presented in Table 2 shows statistically significant differences in emotion among students of different sexes ($p < 0.01$). Girls had prominently lower negative emotion scores than boys, including tension and confusion ($p < 0.01$). It is without significant difference in positive emotion ($p > 0.05$). We can see in Table 2 that girls had higher vigor and self-esteem in their positive emotion scores than boys. Meanwhile, the boys had higher

tension scores than the girls ($p < 0.01$). No apparent difference was observed in other emotions ($p > 0.05$).

Table 3 indicates that age significantly affected mood states and PA. We found a statistically significant interaction between different age groups and moderate and vigorous, vigorous, moderate, and walking PA ($p < 0.01$). As age increased, a decreasing trend was observed in PA. At the same time, we also found a statistically significant interaction between different age groups and emotions ($p < 0.01$). The tension, anger, and fatigue score gradually decreased with age. With increasing age, depression, confusion, vigor, and self-esteem scores gradually diminished. TMD scores had statistically a significant interaction among the 10–12-year-olds and 13–15-year-olds ($p < 0.01$). The 10–12-year-olds had higher TMD scores than 13–15-year-olds. The study also found no significant interaction between different sexes and ages.

Table 3. The relationship between physical activity and mood states in different age groups ($n = 14,045$) ($x \pm s$).

	10–12 Years ($n = 7001$)	13–15 Years ($n = 4447$)	16–18 Years ($n = 2597$)	H	p
Physical activity (MET*-min/week)					
Moderate and vigorous	1210.01 \pm 1627.37 ##	676.12 \pm 1345.76 **	23.72 \pm 43.76 ^^	1262.62	<0.001
Vigorous physical activity	517.09 \pm 939.68 ##	291.91 \pm 740.23 **	10.30 \pm 24.25 ^^	356.20	<0.001
Moderate physical activity	399.65 \pm 679.21 ##	224.22 \pm 535.22 **	14.87 \pm 26.63 ^^	372.25	<0.001
Walking	293.27 \pm 612.90 ##	165.46 \pm 485.11 **	13.42 \pm 32.30 ^^	170.77	<0.001
Profile of Mood States					
Tension	2.63 \pm 2.48 ##	2.86 \pm 2.61 **	3.50 \pm 2.71 ^^	205.97	<0.001
Anger	2.22 \pm 2.39 ##	3.01 \pm 2.45 **	4.70 \pm 4.21 ^^	721.71	<0.001
Fatigue	1.94 \pm 2.19 ##	2.34 \pm 2.45 **	3.07 \pm 2.67 ^^	395.73	<0.001
Depression	1.81 \pm 2.20 ##	1.39 \pm 1.94 **	0.87 \pm 0.98 ^^	246.95	<0.001
Confusion	3.98 \pm 1.87 ##	2.61 \pm 2.02 **	1.44 \pm 1.05 ^^	3630.30	<0.001
Vigor	4.10 \pm 2.06 ##	3.05 \pm 2.02 **	1.81 \pm 0.96 ^^	2719.46	<0.001
Self-esteem	4.30 \pm 1.91 ##	3.15 \pm 2.00 **	1.80 \pm 0.93 ^^	3423.30	<0.001
Total mood disturbance	104.18 \pm 10.29	103.18 \pm 10.66 **	103.54 \pm 10.92	18.78	<0.001

Notes: MET*-min/week: metabolic equivalent task minutes per week. The MET assignments for each intensity of PA were walking (3.3 METs), moderate (4 METs), and vigorous (8 METs). ** represents a statistically significant difference between the 10–12-year-olds and 13–15-year-olds ($p < 0.01$). ## represents a statistically significant difference between the 10–12-year-olds and 16–18-year-olds ($p < 0.01$). ^^ represents a statistically significant difference between the 13–15-year-olds and 16–18-year-olds ($p < 0.01$).

4. Discussion

The principal purpose of this study was to analyze the PA and mood states of children and adolescents from 10 to 18 years old. The results from the questionnaire indicated that gender and age were shown to impact PA and mood states. During the COVID-19 pandemic, a greater number of girls than boys achieved moderate PA. The boys' scores on the negative mood scale (tension and confusion) were higher than the girls' score. By contrast, girls' positive mood scale (vigor and self-esteem) was higher than the boys' score. The increasing age of children and adolescents was associated with less PA, higher scores on the negative mood scale, and lower scores on the positive mood scale. This research uncovered the main effects of different age stages and gender on PA and mood states in the outbreak cohorts. This research focused on children and adolescents to promote their physical and mental health during COVID-19. Additionally, we hope to provide theoretical guidance and reference for the relevant departments' policy making.

Because of COVID-19, the self-isolation measures affected peoples' daily activities, resulting in limited PA and fewer opportunities to be active [32]. The results of a scoping review highlighted a decrease in physical activity during the pandemic, ranging between -10.8 min/day and -91 min/day [33]. A study also compared the physical activity and recreational screen time of a sample of 1711 4–17-year-olds before and during the strictest

time of the first COVID-19 lockdown in Germany. They found that sports activity declined, whereas recreational screen time increased [34]. Compared to the pre-COVID-19 lockdown period, adolescents' PA had a similar trend with age during the pandemic, but PA was significantly decreased. During the pandemic, results provided evidence of an age-related difference in actual PA levels. As expected, younger adolescents seemed to participate in more PA and sports, also entailing higher intensity levels of energy expenditure. A study showed that PA decrease was more accentuated during childhood, adolescence, and adulthood [35,36]. These results are consistent with our study findings that PA tends to decline with increasing age from 10 to 18 years old. It is possibly due to adolescents (10–18 years old) being in the stage of primary school to high school. With the increasing age, less time to exercise was linked with adolescents having to take the senior high school entrance and college entrance examinations. They were suffering the pressure of academic continuity. It can be seen that COVID-19 has substantially influenced adolescents' PA.

Meanwhile, a study showed that girls had lower levels of PA than boys and there was a prevalence of females with insufficient activity before the outbreak [37]. After the outbreak of COVID-19, the results of our study suggest that moderate PA was higher in girls than boys. During the pandemic, the PA level of males showed a greater decline than females [38,39]. This could be due to different exercise programs between girls and boys. Boys are more likely to participate in outdoor sports, such as volleyball, football and so on [40]. Girls are more likely to do some exercise at home, such as yoga, dancing, and so on [41]. The COVID-19 outbreak increased home isolation time and reduced outdoor sports, especially for boys. Thus, the PA of girls was less affected than that of boys during the pandemic. Moreover, results showed inequalities in involvement in household chores by females and males, females were more engaged in housework than males, and the perception of partner involvement was lower in females than in males [42]. Thus, girls were influenced slightly more by the pandemic spread as compared with boys.

From the point of view of mood states, adolescents are in the emotionally unstable stage of growth. They are more susceptible to wide mood fluctuations, emotionally labile, and have reduced impulse control. During the COVID-19 pandemic, long-term isolation had some adverse effects, such as increasing negative emotions and risk of obesity, diabetes, cardiovascular and other diseases in children [43–45]. Additionally, age and gender have also been suggested to play an essential role in emotions. From the findings of our study, boys obtained a higher score than girls for tension and confusion. In contrast, some studies have revealed that females have greater negative emotions than males, and females more easily experience a depressed mood and suicidal behaviors [46,47]. The reason might be due to the different target populations and areas. The previous studies' subjects were college students in China during the pandemic, or high school adolescents in the Commonwealth of the Northern Mariana Islands before the pandemic. Therefore, selecting children and adolescents as the subjects of this study had more academic significance.

Secondly, male–female emotional differences may also be associated with PA differences. Some evidence indicates that outdoor sports are beneficial for psychological health. This could reduce or prevent negative emotions such as tension and confusion [48,49]. It was well established that PA triggers the release of certain body chemicals (such as β -endorphins or dopamine), which consequently result in the improvement of mood and feelings of well-being. This can improve mood states and mental health [50,51]. During the pandemic, reduced activity was likely to have impacted mood [52], thus resulting in an increased negative mood. Girls were inclined to engage in housework, yoga, and dance at home during COVID-19, so PA and their mood states were less influenced than those of boys.

By contrast, boys can choose fewer exercise programs than girls at home. Additionally, adolescent sedentary time will increase during adolescence [53]. Furthermore, teenagers' most common sedentary behavior is time spent in front of the television, computer, tablet screens, etc. [54–56]. Playing online games is one of the most popular recreational activities [57]. Online games can influence all aspects of daily life, including academic

performance and well-being [58]. Boys also easily become addicted to playing internet games compared with girls [59]. In summary, reducing PA in boys could produce a negative emotional influence during the pandemic.

In this study, along with the increased age, the tension, anger, and fatigue scores increased, and the depression, confusion, vigor, and self-esteem scores reduced. This could be due to most subjects (10–18 years old) of this study reaching the age of puberty. With the increased age, adolescents would have greater negative emotional influence from early puberty to late puberty [60]. Therefore, the scores of anger, fatigue, and tension increased. Meanwhile, children and adolescents are in an educational phase from primary school to high school. With China's increasing school grade level, they face multiple examinations. High school and college entrance examinations became a major source of pressure in their daily lives [15]. This increases tension, anxiety, and other negative emotions [16].

Our study still had several limitations. First, the online questionnaire on PA and mood states might decrease the study's stability and reliability. Secondly, this paper only discussed the influence of age and sex, but many external factors can still affect PA and mood states, such as the changing environment and sleep quality.

5. Conclusions

During the COVID-19 pandemic, long-term social isolation causes reduced PA and negative mood states. Girls' PA was higher than boys', and boys had higher levels of mood disturbances. PA and levels of mood disturbances were significantly associated with age from 10 to 18 years old. The trends of PA showed gradual decrease. Meanwhile, the negative emotional states were also affected by increasing age. It is especially important to consider evidence regarding more outdoor activities before the home isolation. Therefore, children and adolescents should strengthen household-based physical exercise. Additionally, the relevant government departments should offer a policy to encourage PA in high school students and/or renew the evaluation system of PA to emphasize the importance of health.

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