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Effects of Physical Activity on Depression and Physical Fitness Among Shanghai Junior High School Students

Efectos de la actividad física en la depresión y la condición física entre los estudiantes de secundaria de Shanghái

Dan Bai, Asha Hasnimy Mohd Hashim, Zhiwei Chen, Maoqiang Xu

Universiti Teknologi Malaysia (Malaysia)

Abstract. This study explores the relationship between light physical activity (LPA) and moderate-vigorous physical activity (MVPA), depression and physical fitness among Shanghai junior high school students. A nationwide offline survey was conducted in Shanghai between August and December 2023 using a purposive sampling design. A total of 432 questionnaires were administered to six seventh-grade classes and eighth-grade classes from six schools in Shanghai; 416 responses were included in the final analysis. SPSS software version 29, the Correlation and Multiple Linear Regression techniques were employed to analyze the collected data. Higher levels of LPA and MVPA were correlated with lower levels of depression. However, only LPA was a significant positive predictor for depression among Shanghai junior high school students. MVPA did not show significant predictive power for depression. Only MVPA was positively correlated with 50 meters (50M), standing long jump (SLJ), 800/1000 meters (800/1000M), and total physical fitness (TPF), but not for sitting forward bend (FB) and vital capacity (VC); various measures of physical fitness were found highly correlated with each other. MVPA was also a significant positive predictor for 800/1000M, SLJ, 50M and TPF but not for VC and FB. LPA did not show significant predictive power for any physical fitness measures. The findings highlighted the importance of MVPA in enhancing physical fitness outcomes, while LPA primarily impacted depression levels. Various measures of physical fitness were highly interrelated. The results underscored the significance of promoting MVPA to improve physical fitness and reduce depressive symptoms in this population.
Keywords: physical activity, depression, physical fitness, junior high school students

Resumen. Este estudio explora la relación entre la actividad física ligera (AFL) y la actividad física moderada-vigorosa (AFMV), la depresión y la condición física entre los estudiantes de secundaria de Shanghái. Se realizó una encuesta presencial a nivel nacional en Shanghái entre agosto y diciembre de 2023 utilizando un diseño de muestreo intencional. Se administraron un total de 432 cuestionarios a seis clases de séptimo y octavo grado de seis escuelas en Shanghái; 416 respuestas fueron incluidas en el análisis final. Se emplearon la versión 29 del software SPSS, las técnicas de correlación y regresión lineal múltiple para analizar los datos recopilados. Niveles más altos de actividad física ligera (AFL) y actividad física moderada-vigorosa (AFMV) se correlacionaron con niveles más bajos de depresión. Sin embargo, solo la AFL fue un predictor positivo significativo para la depresión entre los estudiantes de secundaria de Shanghái. La AFMV no mostró un poder predictivo significativo para la depresión. Solo la AFMV se correlacionó positivamente con los 50 metros (50M), el salto de longitud (SLJ), los 800/1000 metros (800/1000M) y la condición física total (CFT), pero no con la flexión hacia adelante sentado (FB) y la capacidad vital (CV); se encontró que varias medidas de condición física estaban altamente correlacionadas entre sí. La AFMV también fue un predictor positivo significativo para los 800/1000M, SLJ, 50M y CFT, pero no para CV y FB. La AFL no mostró un poder predictivo significativo para ninguna medida de condición física. Los hallazgos destacaron la importancia de la AFMV para mejorar los resultados de la c ondición física, mientras que la AFL impactó principalmente en los niveles de depresión. Varias medidas de condición física estaban altamente interrelacionadas. Los resultados subrayaron la importancia de promover la AFMV para mejorar la condición física y reducir los síntomas depresivos en esta población.
Palabras clave: actividad física, depresión, condición física, estudiantes de secundaria

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Dan Bai
dan20@graduate.utm.my

Introduction

Children and adolescents formed an essential foundation of national prosperity and social progress. Children and adolescents focus on their physical fitness. Recently, the results of the National Student Physical Fitness Survey have shown that the decline in students' physical fitness has slowed down("Results of the 2014 National Student Physical Health Survey," 2015). However, the situation is still not optimistic; the rates of myopia, overweight, and obesity continue to decrease, while the rates of myopia, overweight, and obesity continue to increase (Cai, Zhu, & Wu, 2017). The physical fitness of Chinese school-aged children, including junior high school students in Shanghai, is a topic of interest. In 2016, about 3 in 10 Chinese children achieved an "excellent" or "good" fitness standard, while approximately 8% did not meet the Chinese National Student Physical Fitness Standard

(CNSPFS). Boys were more likely to not pass the fitness standards compared to girls, and children living in urban areas were also more likely to not meet minimum fitness performance levels. The Chinese Ministry of Education has emphasized the importance of physical health and fitness in schools, requiring at least two hours of exercise daily for students, with specific guidelines for different grade levels. This initiative aims to incorporate health and physical fitness into school curricula and standardized exams, highlighting the significance of PA for academic engagement and overall well-being among students (Wang et al., 2016; Wang et al., 2023; Zhu et al., 2017).

Exercise refers to a subset of PA that is planned, structured, and repetitive; it also has a final or intermediate objective of the improvement or maintenance of one or more components of physical fitness (Siscovick et al., 1985). Meanwhile, a concept analysis indicates that the definition of PA is "any bodily movement produced by skeletal muscles that results in energy expenditure". The positive effects of PA can be gained in different ways and do not necessarily include exercise (Siscovick et al., 1985).

Quantitative measurement of PA involves three basic parameters: intensity, frequency, and duration. The metabolic cost of PA is often expressed in Metabolic Equivalent (MET) units, which are often translated into Chinese as 'Metabolic Equivalent'(Goran & Treuth, 2001), with 1MET representing the rate of energy consumption of the human body during sedentary activities, which is measured at 3.5 mL of oxygen per minute per kilogram of body weight. The PA Guidelines for Chinese Children and Adolescents (2017) classify PA into three levels of intensity according to metabolic equivalents, which are light physical activity (LPA), including standing, slow walking, dishwashing, and stretching, with intensities ranging from 1.5-2.9 METs; moderate physical activity (MPA), including brisk walking, cycling, skating, etc., with an intensity of 3.0-5.9 METs; and vigorous physical activity (VPA), including heavy lifting, fast running, kicking a ball, etc., with an intensity of more than 6 METs. Total physical activity (TPA) indicates the sum of PA of each intensity (Schwarzfischer et al., 2017).

Depression is projected to be the second leading cause of global disease burden by 2030 (Mathers & Loncar, 2006). Despite its prevalence among teenagers, depression often goes unnoticed. Individuals grappling with depression manifest an array of symptoms, encompassing reduced energy levels, irritability, diminished interest, feelings of worthlessness and sadness, as well as contemplation of death or suicide. Consequently, the escalating rates of adolescent depression have evolved into a critical public health concern (Ali et al., 2010). Junior high school students exhibit concerning psychological tendencies in their academic pursuits, daily lives, and sports engagements. These tendencies encompass weak willpower, deficient social interaction skills, introverted personalities, lack of vitality, as well as feelings of depression and anxiety (Carpenter et al., 2013). The percentage of junior high school students in Jiading District, Shanghai, detected to have anxiety was 38.5% (Xiangchun, 2014), while in Songjiang District, Shanghai, the rate detected for junior high school students was 38.3% (Xiafang, 2013). In another study, Yaoyao (2021) conducted an anxiety and depression survey involving four junior high schools in the Fengxian District of Shanghai. The prevalence rates for anxiety and depressive symptoms were found to be 27.3% and 12.6%, respectively. Notably, as grade levels progressed, the prevalence of depressive symptoms among students exhibited a gradual increase (Yao Yao, 2021). The prevalence of depression among junior high school students in Shanghai, China, is a serious issue.

Mei et al. (2022) showed that shorter PA, physical education (PE) classes and sleep duration, as well as longer sedentary and screen time, were related to higher levels of depressive symptoms. Hierarchical regression analysed by Shields et al. (2010) suggested a moderating effect of depression on self-efficacy and PA, but more articles indicated that self-efficacy acts as a mediator between improvements in PA and self-efficacy (Johansson, Lundgren, Andersson, Svensson, & Mourad, 2022; Trumpeter, 2004). Lubans et al. (2016) proposed a conceptual model to hypothesize a psychosocial mechanism for understanding the relationship between PA and mental health outcomes (i.e., cognition, well-being, and ill-being) among children and adolescents. According to the psychosocial mechanism, PA engagement alters individuals' psychosocial views and, consequently, their mental health outcomes. In other words, social contact (i.e., increased perceived competence and self-efficacy) among youths may enhance the mental health advantages of PA. This aligns with the conclusions of Ersöz et al. (2017), who established that exercise yields positive effects on depression, self-efficacy, and psychological well-being. Man Xiang et al. (2020) investigated the direct and indirect relations of various doses of PA to depression through ASE among middle school students. They found that both LPA and MPA were associated with it, and ASE regulates adolescents' depression.

PA also plays an important role in improving the physical fitness problem among junior high school students. Some studies have found that the physical fitness of children and adolescents is related to the amount of PA. Most of the Kunshan people participate in PA one time or more than one time per week. They perform 30–60 minutes of MPA to improve physical fitness, recreation, and disease prevention (Saqib et al., 2020). The majority of the participants (32.0%) said that the national fitness plan helps promote sports environment and health. About 28.0% reported that the National Fitness Plan (NFP) helps promote cycling and walking environments for PA and health promotion and preventing non-communicable diseases (NCDs) (Menhas et al., 2021). The direct cause of the declining physical fitness in children and adolescents is insufficient PA (H. Li, Chen, & Zhuang, 2011). For children and adolescents in a critical period of growth and

development, participating in a sufficient amount of PA daily is a fundamental guarantee for promoting their physical and mental health development (Zhang et al., 2016).

With the support of many policies and regulations in China, improving PA and physical fitness, and reducing depression have become important issues of concern to junior high school students. This study commenced with a strong emphasis on PA, with the primary objective of enhancing physical fitness and mitigating depression among junior high school students in Shanghai. First, this study aims to investigate the relationship between PA, depression, and physical fitness among junior high school students in Shanghai. Specifically, it seeks to determine whether different types of PA, such as LPA and MVPA, influence depression and physical fitness in this population. This study's goal is not only to understand these relationships but also to provide insights that can guide the development of effective interventions for promoting healthy development.

In this study, Self-determination theory (SDT) and Bronfenbrenner's ecological systems theory (EST) are used in this research. SDT is the formal theory that describes intrinsic and extrinsic motivations (Deci & Ryan, 1985). SDT emphasized the importance of autonomy and competence. The study designed PAs that students could choose independently, allowing them to feel a greater sense of control and accomplishment during participation, thereby reducing depressive symptoms. EST is a widely accepted theory for explaining how various environmental systems influence human development. The EST considers the influence of multiple environmental factors on individuals' behavior. Using the EST, the researcher examines how the interactions between individual factors (e.g., BMI and PA), the microsystem (family and peers) and the macrosystem (cultural and societal norms) influence physical fitness.

Literature review

Physical Fitness

Corbin et al. (2000) proposed that physical fitness is a state of health involving participation in PAs and a low risk of discovering health problems. Latorre Román et al.(2017) believed that physical fitness, which refers to the ability to perform and enjoy active leisure activities without fatigue affecting daily activities, is an effective biomarker of health.

From a health-related physical perspective, physical fitness includes body composition, cardiorespiratory endurance, muscle strength and endurance, and flexibility, among others. From a skill-related physical perspective, it mainly has speed, strength, agility, balance, coordination, and reaction time, among others (Pate, 1988). A good physique is essential in maintaining health and is a crucial indicator of health status (Ortega, Ruiz, Castillo, & Sjöström, 2008). Siscovick et al. (1985) stated that physical fitness refers to the human body's ability to complete daily tasks with sufficient energy and to have enough energy to enjoy leisure and entertainment activities and cope with unforeseen emergencies in life. Even so, combined with previous views, the concept of "physique" appears to have a broad connotation, and it is challenging to involve all physical test variables in practical research. Therefore, this study was mainly based on the National Student Physical Fitness Standards (Revised in 2014) promulgated by our country, with physical fitness level divided into three parts: body shape, physical function, and physical fitness. This study also comprehensively evaluated the physical fitness level of middle school students based on the "Physical Fitness Standards". In junior high schools in Shanghai, physical fitness test items mainly include 800/1000 meters (800/1000M), sitting forward bend (SFB), standing long jump (SLJ), 50 meters (50M), and vital capacity (VC).

Relationship between PA and Physical Fitness

Regular PA has a significant effect on adolescent physical fitness. The WHO recommends that children accumulate an average of 60 min of PA daily, including aerobic, muscle-strengthening, and bone-strengthening exercises (Carriedo, Cecchini, Fernández-Álvarez, & González, 2022). Studies have observed relationships between PA and health in adolescents, with physical inactivity, sedentary behavior, and low cardiorespiratory fitness as strong risk factors for developing chronic diseases (Kumar, Robinson, & Till, 2015). The development of motor competence (MC) in childhood may both directly and indirectly augment health-related physical fitness (HRPF) and may serve to enhance the development of long-term health outcomes in children and adolescents (Cattuzzo et al., 2016). Additionally, adolescent physical inactivity likely contributes to critical global health problems, including cardiometabolic and mental health disorders (Sluijs et al., 2021). Therefore, this study proposes the following hypothesis:

H1: LPA will negatively influence the VC of junior high school students in Shanghai.

H2: LPA will positively influence the M50 of junior high school students in Shanghai.

H3: LPA will positively influence the FB of junior high school students in Shanghai.

H4: LPA will positively influence the SLJ of junior high school students in Shanghai.

H5: LPA will positively influence the 800/1000M of junior high school students in Shanghai.

H6: LPA will positively influence the TPF of junior high school students in Shanghai.

H7: MVPA will negatively influence the VC of junior high school students in Shanghai.

H8: MVPA will positively influence the M50 of junior high school students in Shanghai.

H9: MVPA will positively influence the FB of junior high school students in Shanghai.

H10: MVPA will positively influence the SLJ of junior high school students in Shanghai.

H11: MVPA will positively influence the 800/1000M of junior high school students in Shanghai.

H12: MVPA will positively influence the TPF of junior high school students in Shanghai.

Relationship between Physical Activity and Depression

PA appears to be an effective intervention for reducing depression/depressive symptoms and improving physical self-perceptions (Dale et al., 2019; Frömel et al., 2020; Li et al., 2022). Longitudinal and cross-sectional studies demonstrated significant associations between PA and lower levels of psychological ill-being (i.e., depression, stress, negative affect, and total psychological distress) and greater psychological well-being (i.e., self-image, satisfaction with life and happiness, and psychological well-being (Rodriguez-Ayllon et al., 2019). Sampasa-Kanyinga et al. (2020) found favorable associations between meeting all 3 movement behaviour recommendations in the 24-h guidelines and better mental health indicators among children and adolescents. Similarly, Hu et al. (2020) suggested that exercise interventions have a beneficial effect on depressive symptoms in the general population across a wide age range. Mei et al. (2022) showed that shorter PA, PE classes and sleep duration, as well as longer sedentary and screen time, were related to higher levels of depressive symptoms. The high use of social media and reduced PA of adolescents can affect mental health (Molina Fizi, Winarni, Dewanti, & Hartanto, 2024). PA interventions were effective in changing behavior and improving personality traits of children in both urban and rural areas (Chaeroni et al., 2024).

By assessing grade 8 students from 14 government-funded secondary schools in low socio-economic areas of Western Sydney (Australia), Costigan et al. (2019) concluded that light and moderate PA was not associated with well-being. Higher levels of vigorous physical activity (VPA) were associated with more positive affect, and negative affect was more pronounced in females than in males. Zhang et al. (2021) found an inverse bidirectional association between self-reported moderate-vigorous physical activity (MVPA) and depressive symptoms. In subsequent analyses stratified by intensity category, higher levels of vigorous-intensity physical activity were at the baseline, but moderate-intensity PA was associated with lower levels of depressive symptoms at the 10-year follow-up. Nevertheless, Pascoe et al. (2020) suggested that moderate-to-vigorous-intensity and light-intensity interventions may reduce anxiety symptoms.

Booth et al. (2023) assessed the behavioral and emotional problems among students between the ages of 11 and 13 using the strengths and difficulties questionnaire (SDQ). The researchers found that higher MVPA at age 11 was associated with decreased depressive symptoms in females aged 11 after adjusting for confounders. Among males, a positive change in MVPA between the ages of 11 and 13 was associated with a reduction in depressive symptoms. Heissel et al. (2023) found that exercise is effective in treating depression and depression symptoms. They suggested that it should be offered as an evidence-based therapy option, with a focus on supervised and group exercise of moderate intensity and aerobic exercise programs. Aerobic exercise is recommended at frequencies of 3 to 5 times per week with medium to high intensity (Ren & Xiao, 2023). Ren and Xiao (2023) also highlighted that exercise therapy has a significant promise for controlling depression, as evidenced by the molecular, neurological, and physiological mechanisms that underpin its antidepressant effects. Together, exercise should be considered as a therapeutic modality for improving health and psychological well-being (Blumenthal & Rozanski, 2023; Precht, Margraf, Stirnberg, & Brailovskaia, 2023; Wanjau et al., 2023). Therefore, this study proposes the following hypothesis:

H13: LPA will negatively influence the depression of junior high school students in Shanghai.

H14: MVPA will negatively influence the depression of junior high school students in Shanghai.

Method

Participants

This study focused on junior high school students in Shanghai during the first semester of 2023–2024. Participants were selected using the purposive sampling method. Three junior high schools in urban and suburban districts of Shanghai were selected; Jingan, Hongkou, and Xuhui in the urban district and Minghang, Qingpu and Jinshan in the suburban district. The researcher selected one junior high school from each district; one sixth-grade and one seventh-grade class were chosen to test the students' physical fitness, these students usually from the age of 12-14. Students from the selected classes completed the questionnaires on PA and depression. A total of 432 responses were received, with 416 questionnaires were completed and deemed fit for analysis. The participants comprised 216 male and 200 female students.

Data Quality Control

The staff responsible for conducting tests in the experiment were divided into two categories: a physical tester responsible for conducting physical fitness tests and a questionnaire surveyor responsible for conducting questionnaire surveys. The actual team consists of one team leader, three physical testers and one questionnaire surveyor. Physical fitness testers need to be trained before the test, and they must operate the physical fitness testing equipment and record and convert scores in strict accordance with the "National Student Physical and Health Standards (Revised in 2014)". The first fitness tests and questionnaire surveys began on 13 August 2023 and ended on 5 December 2023. A total of 432 questionnaires were collected, and 416 responses were included in the final analysis.

Measures

PA

Participants' PA was assessed by frequency in a typical week (ranging from 0 to 8) in which they engaged in light physical activity (LPA), moderate physical activity (MPA), and vigorous physical activity (VPA) during leisure time for at least 15 min. According to the scoring guidelines(Godin, 2011), the three intensity levels of PA were based on the corresponding metabolic equivalents of Task (MET) values (3 MET, MPA = 5 MET, and VPA = 9 MET). Precisely, the PA intensity level was calculated as follows: LPA = frequency × 3 metabolic equivalents (MET), MPA = frequency × 5 MET, and VPA = frequency ×9 MET. The calculated units of different intensity levels of PA were as flows: LPA (range, 0–24 units), MPA (range, 0–40 units), VPA (range, 0–72 units), and MVPA = MPA + VPA (range, 0–112 units). The calculated scores for LPA and MVPA were used for data analysis.

Depression

The depression anxiety stress scale (DASS), a depression subscale (Lovibond & Lovibond, 1995), was applied to assess the depressive symptoms among participants. In view of the situation and particularity of junior high school students in Shanghai, this research modified some of the questions. Participants responded to questionnaire items regarding the frequency of feelings during the past week, such as "I feel like life is meaningless, I feel like I have nothing to look forward to, I can't seem to experience any positive feelings, I can't be enthusiastic about anything, I feel like I have no value, I feel frustrated and depressed, I find it difficult to initiate things."The 4-point Likert scale was used to rate each statement, ranging from 0 (not at all) to 3 (all of the time). The total depression scores were used for data analysis. Through Smart-pls calculated that the reliability of the depression scale was adequate with a Cronbach a of 0.891, the factor loadings of all questions were above 0.6, composite reliability (CR) = 0.899, and the average extracted (AVE) = 0.611, indicating that the measured items well-represented students' depression.

Physical Fitness Items

The physical fitness (800/1000 M, FB, SLJ, 50 M, and VC) of participants were obtained through onsite measurements. The corresponding test scores (total score = 100 points) were calculated using the Shanghai Junior High School Physical Health Project Performance Evaluation Standards. The calculated test scores for 800/1000 M, FB, SLJ, 50 M, VC, and total physical fitness scores (TPF) were used for data analysis of this study.

Data Analysis Technique

This study employs the SPSS software, version 29, to perform the Correlation and Multiple Linear Regression. The primary objective is to explore the correlation between PA, depression, and physical fitness (800/1000M, FB, SLJ, 50M, VC, and TPF). The final objective is to investigate the impact of different intensities of PA on depression and physical fitness (800/1000M, FB, SLJ, 50M, VC, and TPF) among Shanghai junior high school students.

Results

Table 1 explains the demographic characteristics of respondents consisting of gender and age. It shows the detailed demographic variables analysis result. Frequency and percentage were used to analyse the respondents' profiles. As shown in Table 1, the samples comprised 216 males (51.9%) and 200 females (48.1%). In terms of age, 57 students (13.7%) were aged 12, 169 students (40.6%) were aged 13, 177 students (42.5%) aged 14, and 13 students (3.1%) were aged 15.

Table 1.
Demographic characteristics of the respondents of PA, depression, and physical fitness among Shanghai junior high school students

Demographic	Category	Frequency	Percentage (%)
Gender	Male	216	51.9
	Female	200	48.1
Age	12	57	13.7
	13	169	40.6
	14	177	42.5
	15	13	3.1

As shown in Table 2, higher levels of PA (LPA and MVPA) are associated with lower levels of depression; LPA ($r = -0.178$, $p < 0.01$) and MVPA ($r = -0.178$, $p < 0.01$) were negatively correlated with DP. There were significant positive correlations between MVPA and physical fitness measures, except for FB and VC. MVPA was positively correlated with 50M ($r = 0.198$, $p < 0.01$), SLJ ($r = 0.159$, $p < 0.01$), 800/1000M ($r = 0.186$, $p < 0.01$) and TPF ($r = 0.162$, $p < 0.01$), but LPA and depression had no significant correlations with physical fitness measures. In this research, VC was positively correlated with SLJ ($r = 0.199$, $p < 0.01$), 50M ($r = 0.153$, $p < 0.01$), FB ($r = 0.110$, $p < 0.05$), 800/1000M ($r = 0.128$, $p < 0.01$) and TPF ($r = 0.358$, $p < 0.01$). The 50M was positively correlated with SLJ ($r = 0.724$, $p < 0.01$), FB ($r = 0.189$, $p < 0.01$), 800/1000M ($r = 0.599$, $p < 0.01$) and TPF ($r = 0.786$, $p < 0.01$). In this research, the various measures of physical fitness were found to be highly interrelated, indicating that improvements in one area often correlate with improvements in other areas.

As shown in Table 3, taking depression as the dependent variable and MVPA and VPA as the independent variables, the results show the regression equation VIF value of = 1.041, indicating no multicollinearity between the model variables. The model indicates that LPA is a significant positive predictor for depression among Shanghai junior high school students. However, MVPA did not show significant predictive power for depression. LPA and MVPA explain 33% of the variance in the dependent variable (depression). This analysis highlights the importance of LPA in reducing junior high school students' depression.

Table 2.
Correlation Analysis of PA, depression, and physical fitness among Shanghai junior high school students

variables	1	2	3	4	5	6	7	8	9
LPA	1								
MVPA	.199**	1							
DP	-.178**	-.112*	1						
VC	-0.016	0.004	0.024	1					
M50	-0.003	.198**	0.004	.153**	1				
FB	0.017	0.078	0.02	.110*	.189**	1			
SLJ	0.012	.159**	0.065	.199**	.724**	.269**	1		
800/1000M	-0.05	.186**	0.002	.128**	.599**	.198**	.541**	1	
TPF	-0.02	.162**	0.001	.358**	.786**	.317**	.779**	.805**	1
Mean	17.3	51.7	4.3	90.0	79.3	77.9	76.4	71.5	79.0
SD	7.4	25.0	4.2	10.7	15.7	14.3	17.1	23.4	12.3

Notes: * $p < 0.05$; ** $p < 0.01$, DP = depression, LPA = light physical activity, MPVA= moderate-vigorous physical activity, 800/1000M = 800/100 meters, FB = sitting forward bend, SLJ = standing long jump, 50M = 50 meters, VC = vital capacity, TPF = total physical fitness

Table 3.
Regression analysis of PA on depression among Shanghai junior high school students

IVS	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	R2	Adj.R2	VIF
	B	SE	β					
Constant	6.588	0.608		10.832	<.001	0.038	0.033	
LPA	-0.092	0.028	-0.162	-3.296	0.001			1.041
MVPA	-0.013	0.008	-0.08	-1.619	0.106			1.041

Notes: IVS = Independent variables, B = unstandardized coefficient, β = standardized coefficient

Table 4.
Regression analysis of PA on physical fitness among Shanghai junior high school students

DVS	IVS	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	R^2	Adj.R^2	VIF
		B	SE	β					
1.VC	Constant	90.287	1.593		56.667	<.001	0	-0.005	
	LPA	-0.025	0.073	-0.017	-0.346	0.729			1.041
	MVPA	0.003	0.021	0.007	0.141	0.888			1.041
2.M50	Constant	74.171	2.294		32.333	<.001	0.041	0.036	
	LPA	-0.094	0.105	-0.044	-0.899	0.369			1.041
	MVPA	0.13	0.031	0.207	4.205	<.001			1.041
3.FB	Constant	75.528	2.12		35.624	<.001	0.006	0.001	
	LPA	0.002	0.097	0.001	0.024	0.981			1.041
	MVPA	0.044	0.029	0.077	1.548	0.122			1.041
4.SLJ	Constant	71.448	2.519		28.362	<.001	0.026	0.021	
	LPA	-0.048	0.115	-0.021	-0.414	0.679			1.041
	MVPA	0.112	0.034	0.163	3.299	0.001			1.041
5.800/1000M	Constant	66.606	3.416		19.497	<.001	0.042	0.038	
	LPA	-0.286	0.156	-0.09	-1.833	0.068			1.041
	MVPA	0.19	0.046	0.204	4.146	<.001			1.041
6.TPF	Constant	76.23	1.808		42.172	<.001	0.029	0.024	
	LPA	-0.091	0.083	-0.055	-1.102	0.271			1.041
	MVPA	0.085	0.024	0.173	3.492	<.001			1.041

Notes: DVS = Dependent variables, IVS = Independent variables, B = unstandardized coefficient, β = standardized coefficient, DP = depression, LPA = light physical activity, MPVA= moderate-vigorous physical activity, 800/1000M = 800/1000 meters, FB = sitting forward bend, SLJ = standing long jump, 50M = 50 meters, VC = vital capacity, TPF = total physical fitness

As shown in Table 4, taking 800/1000M, FB, SLJ, 50M, VC, and TPF as the dependent variables, the regression equation VIF value of = 1.041 indicates no multicollinearity between the variables. The 6 models indicate that MVPA is a significant positive predictor for several physical fitness measures, namely 800/1000M ($\beta = 0.204$, $p<0.001$), SLJ ($\beta = 0.163$, $p = 0.001$), 50M ($\beta = 0.207$, $p<0.001$) and TPF ($\beta = 0.173$, $p<0.001$), but not for VC and FB. However, LPA did not show significant predictive power for any physical fitness measures. For the four dependent variables of 800/1000M, SLJ, 50M, and TPF, LPA and MVPA explain 38% of the variance in P800/1000M; LPA and MVPA explain 21% of the variance in SLJ; LPA and MVPA explain 36% of the variance in 50M; LPA and MVPA explain 24% of the variance in TPF. This analysis highlights the importance of MVPA in improving physical fitness among students, whereas LPA appeared less impactful.

Conclusion

In this study, although both types of PA were associated with lower levels of depression, only LPA had a significant positive effect on depression; MVPA did not show any significant impact in this regard. Nevertheless, other research findings differ from the current research. For instance, Xiang et al. (2020) found no significant direct effects of the three doses of PA (LPA, MPA, VPA) on depression. Furthermore, the results supported that ASE served as a mediator in the three pathways of different doses of PA toward depression among adolescents. Giannotta et al. (2023) suggested that VPA has a potential positive influence on reducing depressive symptoms among adolescents. Another study found that physically active adolescents, including those engaged in VPA, experienced fewer psychosocial problems than their less active peers (Frömel et al., 2020). Booth et al. (2023) also suggested higher MVPA was associated with reduced depressive symptoms as well as behavioral and emotional difficulties in early adolescence. Zhou et al. (2024) used isotemporal substitution (IS) analysis, which revealed that substituting 30 min of SB with LPA was associated with improvements in depressive symptoms.

However, it is noteworthy that while LPA may have a positive influence in reducing depressive symptoms, the relationship between PA and depression is complex and can be influenced by various factors. While the literature on the specific relationship between different intensity levels of PA and depression in junior high school students is no more than about the relationship between PA and depression, some studies suggest that PA has a negative effect on depression among junior high school students. The search results suggest that PA has a potential negative influence in reducing depressive symptoms in junior high school students. Several other studies indicate that PA is associated with lower levels of depressive symptoms in adolescents (Andermo et al., 2020; Gu, 2022; Wang & Peiper, 2022; Wang et al., 2022). In nonclinical investigations, the most significant effects of physical exercise have been on self-concept and body image. Regular PA improves the functioning of the hypothalamus-pituitary-adrenal axis. Depression and anxiety appear to be influenced by PA but to a smaller extent in the community than in clinical patients. PA was found to help with sleep and treat several psychiatric problems (Mahindru, Patil, & Agrawal, 2023). These findings suggest that PA may have a negative influence on reducing depressive symptoms in junior high school students. However, in the current research, the findings indicate that LPA has a negative influence on depression among Shanghai junior high school students. For this study sample of junior high school students, the dose of exercise that affects and could improve their low mood is LPA. This

study emphasizes that MVPA is also a significant positive predictor for 800/1000M, SLJ, 50M and TPF, except for VC and FB. However, LPA did not show significant predictive power for any physical fitness measures, which suggests that higher levels of PA, especially moderate-to-vigorous intensity, are positively associated with better performance on various physical fitness tests, such as 50-meter sprints, standing long jump, and endurance runs. Conversely, sedentary behaviors like excessive screen time negatively impact physical fitness measures (Dong et al., 2021). Keesling et al. (2021) also conclude that the volume and intensity of the warm-up have a significant impact on 800m performance. A high-volume warm-up, such as a 10-minute jog followed by dynamic stretching exercises, has been shown to be superior to medium and low-volume warm-ups in improving 800m times.

The findings underscore the importance of promoting MVPA to enhance overall physical fitness and mitigate depressive symptoms in this adolescent population. The strong interrelationship among various physical fitness measures further highlighted the comprehensive benefits of engaging in MVPA regularly.

Limitations

A cross-sectional research design was used, and data were collected from different individuals at a single time. This design examines the relationships between variables at a specific moment. PA is a complex system that could influence students' depression and physical fitness. Quantitative research may struggle to fully capture students' overall depression and PA levels. Scholars must acknowledge this complexity and strive to incorporate these factors into the research design. Owing to the cross-sectional nature of this study, it may be challenging to determine the long-term PA effect on students' depression and physical fitness. Longitudinal tracking studies may be more effective in revealing these relationships. Considering these limitations, subsequent research efforts could enhance the credibility and effectiveness of this study by employing various research methods and incorporating qualitative research, among other approaches.

Conclusions

This study revealed several important insights into the relationship between LPA, MVPA, depression, and physical fitness among junior high school students in Shanghai. While both LPA and MVPA were correlated with lower levels of depression, only LPA had a significant positive influence on depression levels. MVPA, on the other hand, did not significantly predict depression, although it was strongly linked with better physical fitness outcomes, including performance in tests such as the 50M sprint, SLJ, and 800/1000M endurance runs.

The findings highlight the importance of encouraging different types of PA for different health outcomes. LPA appears to play a crucial role in reducing depressive symptoms, while MVPA is essential for improving physical fitness. Given the interrelationship between various physical fitness measures, promoting MVPA in schools could lead to widespread improvements in students' overall health and fitness.

However, the complex nature of the relationship between PA and mental health underscores the need for further research. Factors such as academic pressure, social dynamics, and individual differences may also influence how PA impacts depression, especially in adolescent populations. Schools and policymakers should consider these nuances when designing physical education programs aimed at improving both the mental and physical well-being of students.

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Datos de los/as autores/as y traductor/a:

Dan Bai	dan20@graduate.utm.my	Autor/a
Asha Hasnimy Mohd Hashim	asha@utm.my	Autor/a
Zhiwei Chen	chenzhiwei@graduate.utm.my	Autor/a
Maoqiang Xu	xumaoqiang@graduate.utm.my	Autor/a
Peng Jinxiu	1015326741@qq.com	Traductor/a