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Research Article

Study on the Relationship Between Moderate - to - Vigorous Physical Activity and Psychological Sub - Health in Adolescents

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Received: November 25, 2024 Revised: November 30, 2024 Accepted: December 15, 2024 Published: December 19, 2024

Abstract

Objective: To understand the level of moderate - to - vigorous physical activity (MVPA) and the psychological health of adolescents, explore the relationship between MVPA and psychological health, and provide a theoretical basis for the formulation of relevant policies and measures.

Methods: In five regions of Shanghai, Kunming, Urumqi, Suzhou, and Changsha, 10,327 (male: 5,231, female: 5,096) middle school students aged 12-17 were selected as the research subjects to investigate their MVPA and psychological sub - health. Data analysis uses chi - square test, non - parametric test, and logistic regression analysis.

Results: The study revealed that 30.4% of adolescents faced psychological sub - health symptoms and 22.4% met the criteria for psychological sub - health status, with significant disparities. MVPA standards declined with age, and girls were more likely to have substandard MVPA levels (68.1%) than boys (56.4%). Notably, senior high school girls had a 1.303 (OR=1.303, 95% CI: 1.054-1.611, $P<0.05$) times higher detection rate of psychological sub - health symptoms than their MVPA level, junior high school boys had a 1.286 (OR=1.286, 95% CI: 1.041-1.589, $P<0.05$) times higher rate, and junior high school girls had a 1.367 (OR=1.367, 95% CI: 1.126-1.661, $P<0.01$) times higher rate. Additionally, there were significant differences in MVPA levels and psychological sub - health detection rates between junior and senior high school students.

Conclusion: MVPA substandard is more likely to cause the prevalence of mental sub - health in female students. Focus on the mental health status of girls and junior high school students, and strengthen the psychological counseling of teenagers.

Keywords: teenagers, MVPA physical activity, psychological sub - health

Citation: Li Y, Liu Z, Yu X, Yu H, Li M, Ye G, Shi B, Ma L. Study on the Relationship Between Moderate - to - Vigorous Physical Activity and Psychological Sub - Health in Adolescents. *Phys Health Educ*, 2024; 1: 3. DOI:10.53964/phe.2024003.

1 INTRODUCTION

In today's society with highly developed intelligence and information technology, the demand for mental work has gradually replaced the traditional physical labor demand, which may lead to the deficiency of people's physical activity

level and the increase of static behavior time, especially the deficiency of moderate - to - vigorous physical activity (MVPA). Adolescence is an important stage in the transition to adulthood, according to reports published by the World Health Organization (WHO)^[1], Less than a quarter of adolescents globally get enough exercise, and some countries are as high as one in three. Physical inactivity is a major risk factor for noncommunicable diseases, with a negative impact on mental health and quality of life, and physical inactivity has become the fourth largest mortality risk factor worldwide^[2]. Decades of epidemiological studies on millions of people in the United States have shown that regular and intense physical activity on weekdays can effectively reduce the risk of a variety of cancers, including colon and breast cancer^[3]. Physical inactivity not only causes a range of physical health hazards but also causes adverse psychological effects. Xiao Cheng^[4] found that the mental health level of college students in the middle and low physical activity groups was significantly lower than that of those in the middle and high physical activity groups. The 2008 American Physical Activity Guidelines describe the relationship between physical activity and mental health, clarifying that regular moderate to high - intensity physical activity can be effective in preventing mental illness^[5]. Hao Jiahu et al.^[6] found that the level of physical activity in college students was generally low, and sufficient high - intensity physical activity and regular weekly exercise could reduce the risk of depressive symptoms among college students.

Adolescence is a critical transition period from childhood growth to adulthood, in which adolescents need to address many developmental challenges^[7]. In this period, all kinds of psychological activities are very active, and all kinds of psychological qualities are in the process of formation, but they are not mature and stable, and there is strong plasticity and degeneration, so the adolescent period is considered the risk period of the onset of mental health problems^[8]. With the continuous development of the social economy, our country has entered the development of a new period, since the reform and opening up of the masses' living standards have made very big improvements, accelerating the urbanization and the popularization of education, and the process of widening the gap between rich and poor, the crime rate and divorce rate rise in imperceptible in the influence of adolescent mental health. WHO^[9] recommends that adolescents aged 5-17 years should accumulate at least 60min of moderate to vigorous physical activity per day, with more than 60min per day providing additional health benefits^[10]. This study aims to study the basic situation of adolescent MVPA and psychological sub - health in adolescents and the relationship between each index and psychological sub - health, to provide a scientific basis for individual activity behavior for solving the psychological sub - health problems encountered in real life.

2 METHOD

2.1 Research

The object from August 2021 to April 2022, in Shanghai, Kunming, Urumqi, Suzhou city, and Changsha five regions, take stratified group random sampling method in the test point each extract 4-8 classes of middle school students as subjects, the class within the research qualified students health fitness project test and questionnaire survey. The total number of participants in the test was 10,824. After excluding the invalid questionnaire, 10,327 (male: 5,231, female: 5,096) were analyzed.

2.2 Study Methods

2.2.1 Youth 24h Activity Behavior Survey

Using the "Evaluation of physical activity level of children and adolescents aged 7-18 years old" questionnaire^[11] to survey physical activity, which divides adolescent physical activity into 27 items plus 3 self - filled items. The unit of physical activity is metabolic equivalents (METs), categorized into vigorous - intensity activity ($>6\text{METs}$), moderate - intensity activity ($3\text{METs} \leq \text{PA} \leq 6\text{METs}$), and light - intensity activity ($1.5\text{METs} < \text{PA} < 3\text{METs}$). The questionnaire has been well - validated for reliability and validity. The questionnaire's reliability, as measured by Cronbach's alpha, was 0.695, and its correlation with MVPA measured by an accelerometer was 0.689, indicating good reliability and validity. Participants were required to have normal physical health without any disease or mental health history. Informed consent was obtained from all participants' parents before conducting the survey.

This study was based on the WHO physical activity guidelines^[3] for the recommended criteria of adolescent MVPA, the calculated $\text{MVPA} < 60\text{min/d}$ can be judged as insufficient MVPA.

2.2.2 Survey on Psychological Sub - Health of Adolescents

Professor Tao Fangbiao adopted^[12] the psychological sub - health part of the adolescent sub - dimensional assessment questionnaire, a total of 39 items. The questionnaire used level 6 evaluation criteria to investigate the psychological sub - health status in the last three months, with the duration of symptoms as the criterion, Option 1 was

Table 1. Detection Rates of Psychological Sub - Health by Gender and Age in Adolescents (%)

Sex	Classification	Age						Total
		12	13	14	15	16	17	
Boy	mental health	526(59.8)	494(57.4)	427(49.3)	398(45.3)	402(45.1)	392(45.9)	2639(50.4)
	Psychological sub - health symptoms	239(27.1)	224(26.0)	259(29.9)	283(32.2)	305(34.2)	285(33.4)	1595(30.5)
	Mental sub - health state	115(13.1)	143(16.6)	180(20.8)	198(22.5)	184(20.7)	177(20.7)	997(19.1)
	statistic χ^2							81.567
	P							<0.01
Girl	mental health	417(50.5)	405(48.7)	373(43.4)	332(37.8)	349(40.8)	360(42.6)	2236(43.9)
	Psychological sub - health symptoms	206(24.9)	209(25.1)	270(31.4)	289(32.9)	285(33.3)	285(33.7)	1544(30.3)
	Mental sub - health state	203(24.6)	218(26.2)	216(25.2)	258(29.3)	221(25.9)	200(23.7)	1316(25.8)
	statistic χ^2							52.055
	P							<0.01
Total	mental health	943(55.3)	899(53.1)	800(46.4)	730(41.5)	751(43.0)	752(44.3)	4875(47.2)
	Psychological sub - health symptoms	445(26.1)	433(25.6)	529(30.6)	572(32.6)	590(33.8)	570(33.5)	3139(30.4)
	Mental sub - health state	318(18.6)	361(21.3)	396(23.0)	456(25.9)	405(23.2)	377(22.2)	2313(22.4)
	statistic χ^2							118.379
	P							<0.01

>3 months, with 6 points; 2 for >2 months, 5 points; 3 was >1 month, 4 points; 4 for >2 weeks, 3 points; 5 for >1 week, 2 points; 6 for none or time, 1 week, and 1 point. The total score on the scale was 234, with a minimum score of 39. The lower the score, the better the mental health of the subjects. Evaluation of psychological sub - health: duration >1 month (options 1,2,3); when 8 items of psychological sub - health symptoms, for mental sub - health state, or mental sub - health; when the number of items is 0, for mental health. The questionnaire^[13] Cronbachs α coefficient was 0.957, taking the symptom self - evaluation scale (SCL-90) as the effect criterion, and the correlation validity of the effect criterion was 0.636, which shows good reliability and validity in the psychological statistical evaluation. Therefore, the questionnaire is considered credible and effective and can be used as an evaluation tool for the psychological sub - health of adolescents.

2.3 Mathematical Statistics

The questionnaire data were initially entered using the EXCEL form, and the statistical analysis software was transformed using SPSS23.0. By chi - square test compares mental health and 24h activity differences between the indicators, because the PA variables are not a normal distribution, the non - parametric test method to compare the strength and each type of PA status difference, finally using logistics regression analysis caused different factors of psychological sub - health, the full - text analysis results $P<0.05$ with statistical significance.

3 RESULTS

3.1 Basic Situation of Psychological Sub - Health Detection in Adolescents

Table 1 shows that, in terms of age, the detection rate of psychological sub - health symptoms was 16 (33.8%)>17 (33.5%)>15 (32.6%)>14 (30.6%)>12 (26.1%)>13 (25.6%); the detection rate of psychological sub - health status was 15 (25.9%)>16 (23.2%)>14 (23.0%)>17 (22.2%)>13 (21.3%)>12 years (18.6%). In terms of gender, the overall detection rate of psychological sub - health symptoms in boys (30.5%) was slightly higher than that of girls (30.3%), but the detection rate of psychological sub - health status (25.8%) was higher than that of boys (19.1%), and the comparative results were significantly different ($P<0.001$). In general, the detection rates of psychological sub - health

Table 2. MVPA Compliance Rates by Gender and Age in Adolescents (%)

Sex	Classification	Age						Total
		12	13	14	15	16	17	
Boy	MVPA standard	480(54.5)	412(47.9)	406(46.9)	337(38.3)	344(38.6)	302(35.4)	2281(43.6)
	MVPA substandard	400(45.5)	449(52.1)	460(53.1)	542(61.7)	547(61.4)	552(64.6)	2950(56.4)
	statistic χ^2							95.478
	P							<0.01
Girl	MVPA standard	358(43.3)	332(39.9)	293(34.1)	235(26.7)	216(25.3)	193(22.8)	1627(31.9)
	MVPA substandard	468(56.7)	500(60.1)	566(65.9)	644(73.3)	639(74.7)	652(77.2)	3469(68.1)
	statistic χ^2							136.233
	P							<0.01
Total	MVPA standard	838(49.1)	744(43.9)	699(40.5)	572(32.5)	560(32.1)	495(29.1)	3908(37.8)
	MVPA substandard	868(50.9)	949(56.1)	1026(59.5)	1186(67.5)	1186(67.9)	1204(70.9)	6419(62.2)
	statistic χ^2							224.841
	P							<0.01

symptoms and psychological sub - health status among adolescents were 30.4% and 22.4%, and the results were significantly different ($P<0.001$).

3.2 Analysis of MVPA Standards Among Adolescents

As shown in Table 2, in terms of age, the substandard detection rate of MVPA was 17 years (70.9%)>16 years (67.9%)>15 years (67.5%)>14 years (59.5%)>13 years (56.1%)>12 years (50.9%). In terms of gender, overall MVPA failure was higher than boys (56.4%) among girls (<6.01), 14 (63 (60.1%), 14 (65.9%), 65.3%), 16 (74.7%), 17 (77.7%), 12 (45.5%), 14 (15.14.14), 14 (53.1%), 15 (61.7%), and 17 (64.6%).

3.3 Analysis of the MVPA Compliance Rate and the Detection Rate of Psychological Sub - Health Among Adolescents

As shown in Table 3, the prevalence of psychological sub - health symptoms (27.8%) and 33.3%) was slightly higher than girls (27.4%) and 33.2%), the prevalence of psychological sub - health status (25.4%) and girls (26.3%) were significantly higher than boys (16.9%) and middle school (21.4%). There were significant differences between the MVPA in junior high school and the MVPA in senior high school and the detection rate of psychological sub - health of adolescents ($P<0.05$).

3.4 Juvenile MVPA Compliance Rate and Psychological Sub - Health Detection Rate Logistic Regression Analysis

With the MVPA standard group as a reference and MVPA standard attainment rate as an independent variable, logistic regression analysis of mental sub - health symptoms and mental sub - health status were carried out respectively (Tables 4 and 5). The detection rate of MVPA substandard mental sub - health symptoms in high school girls was 1.303 times that of MVPA standards mental sub - health symptoms ($P<0.05$). The detection rate of MVPA substandard mental sub - health state in junior middle school boys was 1.286 times that of MVPA standards mental sub - health state ($P<0.05$). The detection rate of MVPA sub-standard mental sub - health state in junior middle school girls was 1.367 times that of MVPA standards mental sub - health state ($P<0.01$).

4 DISCUSSION

The results of this study showed that the detection rate of psychological sub - health symptoms and psychological sub - health status in adolescents was 30.4% and 22.4%, higher than that of Zhao Zhiya^[14] detection rate of

Table 3. MVPA Compliance and Psychological Sub - Health Detection Rates Among Adolescents (%)

Sex	School stage	MVPA Grouping	Classification		P
			Psychological sub - health symptoms	Psychological sub - health state	
Boy	junior middle school	substandard	385(28.4)	247(18.2)	0.08
		standard	366(27.3)	208(15.5)	
	Total	751(27.8)	455(16.9)	0.719	
	senior middle school	substandard	299(32.3)		200(21.6)
		standard	545(33.9)		342(21.3)
	Total	844(33.3)	542(21.4)		
Girl	junior middle school	substandard	264(26.4)	290(28.8)	<0.01
		standard	437(28.2)	358(23.1)	
	Total	701(27.4)	648(25.4)	<0.05	
	senior middle school	substandard	226(36.4)		169(27.2)
		standard	617(32.1)		499(26.0)
	Total	843(33.2)	668(26.3)		

Table 4. Logistic Regression of MVPA and Psychological Subhealth Symptoms in Adolescents

Classification			OR	95% CI	P
junior middle school	Boy	MVPA standard	1		0.177
		MVPA substandard	1.129	0.947-1.346	
	Girl	MVPA standard	1		0.751
		MVPA substandard	1.032	0.851-1.252	
senior middle school	Boy	MVPA standard	1		0.432
		MVPA substandard	0.929	0.772-1.117	
	Girl	MVPA standard	1		<0.05
		MVPA substandard	1.303	1.054-1.611	

Table 5. Logistic Regression of MVPA and Mental Sub - Health Status in Adolescents

Classification			OR	95% CI	P
junior middle school	Boy	MVPA standard	1		<0.05
		MVPA substandard	1.286	1.041-1.589	
	Girl	MVPA standard	1		<0.01
		MVPA substandard	1.367	1.126-1.661	
senior middle school	Boy	MVPA standard	1		0.924
		MVPA substandard	0.99	0.801-1.233	
	Girl	MVPA standard	1		0.11
		MVPA substandard	1.205	0.959-1.514	

psychological sub - health of junior high school students and Ni Shigangs^[15] detection rate of the survey, which may be affected by different psychometric tools and different evaluation methods, may also be related to the academic pressure and different regions between the economic level and other social factors related to. In terms of the detection rate of psychological sub - health state, girls (25.8%) is higher than that of boys (19.1%), which may be because the detection rate of psychological sub - health state of girls (25.8%) is higher than that of boys (19.1%)^[16]. The incidence of psychological sub - health state among girls was significantly higher than that of boys, and more social support was related to the occurrence of psychological sub - health state, suggesting that improving the social support for adolescents may reduce their psychological sub - health state^[17].

Globally, about 28% of adults and 81% of adolescents still do not meet the WHO's recommendations for the recommended amount of physical activity^[18], and studies show that only 26% of U.S. men and 19% of U.S. women

meet the recommendations of the 2018 Physical Activity Guidelines for the United States^[19]. The results of this study showed that the MVPA deficiency in adolescents reached 62.2%, and varied between gender and age. WenXian Yang^[20] The PA measurement analysis of children in Nanjing by accelerometer found that the MVPA of boys is greater than that of girls at all ages. The reason for the analysis is that boys are naturally active and have strong physical strength, while girls prefer quiet, which means that the MVPA of boys is greater than that of girls. High school teenagers in China are facing the pressure of college entrance examinations, so their academic time is higher than that of junior middle school, which inevitably leads to an increase in static behavior and a decrease in MVPA. The results of this study also show that the MVPA standard of high school teenagers is significantly lower than that of junior middle school teenagers.

The results of this study showed that female MVPA compliance status was associated with adolescent psychological sub - health, but not with boys. The detection rate of substandard MVPA symptoms was related among high school girls; the substandard MVPA was related to the detection rate of psychological sub - health status. To some extent, it suggests that it can appropriately improve the physical activity time of teenagers, especially high school girls, which may be helpful to their mental health. Zhang Qiang et al.^[21] also found that poor physical fitness, poor lifestyle, and insufficient MVPA were the main factors contributing to the rising rate of adolescents' mental sub - health. Jiang et al.^[22] found in the study of 6176 college students that insufficient physical activity and other reasons would significantly increase the detection rate of mental sub - health among college students. This may be because PA was early pointed out as a protective factor for mental health^[23], Adolescents with poor mental health may lack the motivation to be physically active and may switch to video - based static behaviors that can be achieved with little self - effort, so that substandard MVPA also loses this protective effect. Itani et al.^[24], in a two - year follow - up survey of Japanese adolescents, found that the factor related to poor mental health among junior high school students was the substandard MVPA. Sun Xiang et al.^[25] found that physical activity can help reduce the level of psychological stress and relieve psychological stress. Other studies have found that physical activity has a two - way relationship with emotion, physical activity can produce good emotional benefits, and positive emotional benefits can further stimulate individuals to actively participate in physical activity and encourage them to insist on exercise^[26]. Sun Haiyan^[27] In a study of 930 students in higher vocational colleges found that the proportion of boys' exercise habits was significantly higher than girls, the mental health problems such as depression, hostility, and terror scores found, compared with non - sports groups, sports group depression, terror of mental health dimension scores significantly reduced, shows that participate in sports activities has a good role in promoting adolescent mental health.

5 CONCLUSION

The detection rate of adolescent mental sub - health was higher among girls than boys. The overall MVPA deficiency rate of adolescents is poor, which mainly reflects girls and senior students. The prevalence of mental sub - health was higher in high school girls and middle school students whose MVPA was substandard. We found that female students had a higher MVPA substandard and a higher mental sub - health detection rate than male students, which may be because MVPA substandard is more likely to cause the prevalence of mental sub - health in female students. Therefore, we suggest that we should focus on the mental health status of girls and junior high school students, strengthen the psychological counseling of teenagers, and intervene in time if psychological problems occur. The daily life and exercise habits of young people should be correctly guided, especially female young people should be encouraged to strengthen their physical activity, and schools should formulate corresponding physical education teaching plans according to students of different ages and genders.

Acknowledgements

Not applicable.

Conflicts of Interest

The authors declared no conflict of interest.

Author Contribution

The authors contributed to the manuscript and approved the final version.

Abbreviation List

MVPA, moderate - to - vigorous physical activity

METs, Metabolic equivalents

WHO, World Health Organization

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