



Effects of Physical Exercise Motives on Physical Health and Aerobic Fitness of Teenagers

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Abstract

Background: A good level of physical fitness helps teenagers maintain a good state in daily study and life and enables them to cope well with emergencies. We aimed to explore the influences of physical exercise motives on the physical health and aerobic fitness of teenagers.

Methods: A total of 982 teenagers aged between 13 and 16 years in the four districts of Guangzhou City, China from January to December 2019 were selected randomly with the assistance of communities. Their physical exercise motives and exercise behaviors were investigated using a questionnaire survey, and their physical health indexes and aerobic fitness were assessed. The relationships of physical exercise motives and behaviors with physical health and aerobic fitness were analyzed.

Results: Teenagers who have higher physical health scores show significantly increasing trends in their scores in exercise motives and different dimensions, exercise behaviors, and aerobic fitness scores ($P<0.05$). Physical exercise motives show significant correlations with exercise behaviors, physical health, and aerobic fitness. Moreover, exercise behaviors show significantly positive correlations with physical health and aerobic fitness ($P<0.05$). Physical exercise motives have a positive effect on exercise behaviors, physical health, and aerobic activities, and exercise behaviors have a positive effect on physical health and aerobic activities ($P<0.05$).

Conclusion: The physical exercise motives of teenagers have positive and prediction effects on exercise behaviors, physical health, and aerobic fitness. Exciting physical exercise motives can promote the physical exercise behaviors of teenagers and improve their physical health and aerobic fitness.

Keywords: Teenagers; Physical exercise; Motives; Behaviors; Physical health

Introduction

According to statistical data of the Ministry of Education of China (1), the vital capacities of Chinese students have been decreasing in the past 25 years, whereas the detection rates of poor vision and obesity increase annually and exceed international standards. Moreover, the endurance of Chinese students has decreased considerably. Although speed and strength have improved to some extent in recent years, they generally decline

continuously. Physique is an important index that runs through the life-long health of individuals. During adolescence, a relatively high physical fitness level is conducive to increasing learning efficiency and decreasing morbidity. By contrast, reduction in physical fitness level increases the incidence risks of chronic diseases, such as type 2 diabetes, obesity, hypertension, fatty liver, and



cardiovascular diseases. It is an important risk factor that causes health issues and deaths (2). Since the COVID-19 outbreak, schools in different countries have postponed the opening of classes, launched online teaching and reduced the time of outdoor activities for teenagers. This situation undoubtedly has adverse effects on the health of teenagers, whose physical fitness levels continue to decline. Recently, decline in teenagers' physical health has attracted the attention of all sectors of society and even has become a focus of public health research.

Although physical health has profound impacts on the physical and psychological health of teenagers, the degree of participation of Chinese teenagers in physical exercises remains low. A series of China's policy regulations that encourages teenagers to participate in physical exercises, such as "*Suggestions on Strengthening Physical Health of Teenagers*", has increased the degree of participation of Chinese teenagers in physical exercises. However, the general participation of teenagers in physical exercises is still not ideal, and insufficient physical exercises are major influencing factors of physical health (3).

Thus, we aimed to explore the influences of physical exercise motives on the physical health and aerobic fitness of teenagers.

Literature Review

Although improvements in external environments in the form of policies, regulations, and economic input can bring positive impacts on individual participation in physical exercises, external factors have limited effects. Many studies pointed out that internal psychological factors, such as the strengthened fitness consciousness of individuals (4-5) and stimulated exercise motives (6), are decisive factors in effectively increasing the degree of individual participation in physical exercises (7). Physical exercise motives refer to internal psychological incentives that encourage individuals to participate in physical exercises and meet their needs or demands, which are also important factors for guiding physical exercise behaviors (8). Gao (9) conducted a multilevel logistic regression analysis on the level of physical

activity of adolescents and health-related quality of life and verified that strengthening guidance for adolescents' sports expectations and motivations can increase their beliefs in sports expectations and promote their participation in daily physical activities. Health beliefs can encourage college students to develop physical exercise habits, strengthen the self-consciousness of individual physical exercise behaviors, and enhance the perseverance of physical exercise behaviors, without physical exercise providing intrinsic motivation (10). Hu (11) stated that autonomous motivation has a positive impact on children and adolescents' physical activity, physical learning pleasure, participation, effort, and willingness to continue participating in physical activities in the future. In addition to external factors affecting the participation of individuals in physical exercises, internal factors, such as beliefs and motivations, should not be ignored. Aerobic fitness refers to the ability of individuals to regulate oxygen intake and use and it is the basis of aerobic activities or work. Hence, aerobic fitness is also called aerobic working competence. Aerobic fitness can increase cardiac pump function and blood vessel performance and improve pulmonary ventilation functions. Hence, individuals who have high aerobic fitness levels have good cardio-pulmonary functions or have high capacities for aerobic activities, and their physical health is good (12).

Maximal oxygen uptake (VO_2 max) is one of the major indexes for evaluating aerobic fitness level. The value of VO_2 max is mainly influenced by congenital genetic factors. However, acquired scientific exercises can greatly increase aerobic fitness level (7).. Physical exercise motivation has a certain reference value in predicting the physical fitness levels of adolescents, and pointed out cultivating and strengthening the physical exercise motivation of adolescents can help them meet their psychological needs, highlight the internalization of external motivation, and adopt intrinsic motivation (pleasure and interest) (13).

Currently, whether physical exercise motives are related to the physical health and aerobic fitness of teenagers is unclear. Based on an objective

evaluation of physical health and aerobic fitness of teenage students, the indexes of physical exercise motives and exercise behaviors were introduced for correlation analysis.

The internal influences of physical exercise motives and behaviors on physical health and aerobic fitness were analyzed in this study.

Methods

Research objects

A total of 982 teenagers aged between 13 and 16 years in the four districts of Guangzhou City, China was selected by group random sampling from January to December 2019.

Before the investigation, we introduced the purpose and content of the investigation to each guardian and participant, and clarified the confidentiality of the investigation. After each guardian and participant signed the informed consent form, they filled in the questionnaire anonymously under the one-to-one guidance. This study passed the ethical review of the author's organization.

The inclusion criteria were as follows: first, teenagers with good physical conditions in daily life; second, teenagers aged 13–18 years, without gender limitation.

The exclusion criteria were as follows: 1) respondents who are unfit to take aerobic fitness for having limb dysfunction, cardio-pulmonary dysfunction, and lesions or severe diseases of other organs. 2) Respondents with bad habits of smoking, alcoholism, and drug dependence. 3) Respondents with a family history of severe anxiety, depression, obsessive-compulsive disorder, or mental disease. 4) Respondents who have difficulty in complying with the survey for complications of cognitive disorder and audiovisual dysfunction. A total of 1068 questionnaires were sent, and invalid questionnaires were deleted. Finally, 982 valid questionnaires were obtained, showing an effective collecting rate of 91.95%. It covered 501 males and 481 females who were 13–18 years old, with an average of 16.21 ± 1.43 years.

Procedures

Questionnaire survey

The questionnaire survey was divided into physical exercise motives and exercise behaviors. Both parts implemented the uniform field survey in the unit of classes. The researchers used functional uniform instructions to introduce the objective and significance of the survey and scale filling method. The respondents were asked to fill in the questionnaire on-site in anonymity, and the questionnaires were collected on-site.

Physical exercise motives survey (MPAM): this scale was compiled by Ryan et al (14), and its reliability and validity were tested. It covers 30 items of five dimensions from the perspective of internal motivations (pleasure, feeling of competence and social relevance) and external motivations (appearance and health). Single item was evaluated by the Likert 7-level (1–7 scores), which transmits from “completely disagree” to “completely agree.” A high score indicates strong physical exercise motives. The reliability and validity of the scale were good. The Cronbach's α coefficient of the subscales is 0.676–0.748, and the Cronbach's α coefficient of the total scale was 0.890.

Physical exercise behaviors

The universal physical activity grade scale which was translated and revised by Liang et al (15) from the physical activity grade scale was used for evaluation. It covers three items of exercise intensity, exercise time, and exercise frequency, and the scores ranged from 1 to 5. Exercise behaviors = Exercise Intensity * (Exercise Time-1) * Exercise Frequency. The scale shows good reliability and validity, with an internal consistency coefficient of 0.856 and test-retest reliability of 0.82.

Physical health and aerobic fitness test

The respondents took physical health tests during physical education (PE) class. Professional testers were assigned tests according to the relevant requirements of *China's Physical Health Standards for Students* (revised in 2014) (16). Test items included:

Body shape: height and body weight. It is calculated using the formula body mass index (BMI) = body weight (kg)/height² (m²). The score weight ratio was 15%.

Somatic function: forced vital capacity (FVC). The score weight ratio was 15%.

Physical fitness: 50 m sprint, standing board jump, sit-and-reach, 1000 m (boy) or 800 m (girl), and 1 min sit-ups. The score weight ratios were 20%, 10%, 10%, 20%, and 10%, respectively. The sum of the three aspects was the total physical health score and ranged from 0 to 100. The students were categorized according to their scores: <60, failed; 60–79, qualified; 80–89, good; and ≥90, excellent.

Aerobic fitness: the VO₂ max was tested with a RUNRACE-1200 aerobic treadmill made in Italy. The running speed and slope were set at 15 kg/h and 6%, and the running time was set at 15 min. The relative value (mL/ (kg·min)) was recorded as the final score.

Quality control

Relevant physical health test instruments use the uniform mode of instruments for measurement. Professionals who had received special training were invited to conduct the tests or surveys and data recording. Two researchers were invited for double-blind data input to establish a database. After data input was completed, 20% of ques-

tionnaires were selected randomly in 1 week for re-checking and ensuring the accuracy and reliability of the input data.

Statistical analysis

Measurement data were expressed by mean ± standard deviation ($\bar{x} \pm s$), and *t*-test was used for the comparison. The enumeration data were expressed by percentages (%), and χ^2 test was used for the comparison. A *P*-value of <0.05 indicated statistically significant difference.

Results

Evaluation results of physical health and aerobic fitness

According to the survey data, male teenagers achieved better scores in FVC, standing board jump, sit-ups, sprint, and VO₂ max, whereas female teenagers showed higher scores in BMI and sit-and-reach, and the differences were statistically significant (*P*<0.001). According to the test scores, the physical health scores of teenagers were all higher than 75. The body shape and somatic function scores were higher than 80 (100 scores in total) and were slightly higher than the moderate level. Of all the respondents, 125 failed, 661 passed, and 196 were excellent. The test results are listed in Table 1.

Table 1: Evaluation results of physical health and aerobic fitness of teenagers ($\bar{x} \pm s$)

Items	Total (n=982)	Male (n=501)	Female (n=481)	t	P
Physical health test results					
BMI (kg/m ²)	20.58±1.27	20.01±1.23	21.16±1.32	14.131	<0.001
FVC	39.92±6.13	43.62±6.55	36.12±5.31	19.664	<0.001
Standing board jump (cm)	178.62±12.59	187.21±13.32	170.03±10.25	22.586	<0.001
Sit-and-reach (cm)	15.51±2.11	14.21±2.04	16.78±2.12	19.359	<0.001
Sit-ups	40.43±10.59	48.72±11.03	29.32±6.85	32.952	<0.001
50 m sprint	8.11±1.15	7.65±1.13	8.69±0.62	17.778	<0.001
Girl 800 m running (min)	—	—	3.81±0.13	—	—
Body 1500 m running (min)	—	3.55±0.22	—	—	—
Physical health (scores)	82.74±8.19	86.21±8.14	80.43±6.69	12.129	<0.001
Body shape	93.12±6.74	92.85±5.21	94.01±5.23	3.481	0.001
Somatic function	90.14±6.82	91.42±6.19	88.02±6.04	8.707	<0.001
Physical fitness	78.21±5.69	84.23±6.85	77.01±6.47	16.966	<0.001
VO ₂ max (mL/[kg·min])	42.79±7.23	44.32±5.12	41.18±4.71	9.991	<0.001

Survey results of physical exercise motives and exercise behaviors of teenagers

Male respondents showed significantly lower scores in appearance in exercise motives and

body shape in physical health ($P<0.001$). However, male respondents showed significantly higher scores in the rest items than male respondents ($P<0.05$). The results are shown in Table 2.

Table 2: Survey results of physical exercise motives and exercise behaviors of teenagers ($\bar{x} \pm s$, scores)

Items	Total (n=982)	Males (n=501)	Females (n=481)	t	P
Exercise motives	3.59±0.63	3.65±0.66	3.52±0.61	3.202	0.001
Pleasure	4.88±0.77	4.95±0.78	4.76±0.77	3.840	<0.001
Feeling of competence	4.69±0.85	4.77±0.91	4.61±0.83	2.875	0.004
Social relevance	4.22±0.97	4.44±1.05	4.01±0.94	6.752	<0.001
Appearance	4.10±0.82	3.87±0.81	4.35±0.86	9.007	<0.001
Health	5.03±0.69	5.16±0.72	4.89±0.68	6.036	<0.001
Exercise behaviors	30.92±4.25	39.73±7.91	22.01±5.03	41.699	<0.001
Exercise time	3.50±0.52	3.82±0.54	3.17±0.49	19.729	<0.001
Exercise intensity	3.40±0.56	3.65±0.62	3.15±0.53	13.559	<0.001
Exercise frequency	3.55±0.59	3.86±0.64	3.22±0.55	16.776	<0.001

Comparison of exercise motives, exercise behaviors, and aerobic fitness among teenagers with different physical health grades

According to the graded evaluation of physical health, scores for exercise motives and different

dimensions, exercise behaviors, and aerobic fitness increased significantly with physical health grade ($P<0.05$) (Table 3).

Table 3: Comparison of exercise motives, exercise behaviors, and aerobic fitness among teenagers with different physical health grades ($\bar{x} \pm s$, scores)

Items	Case number	Exercise motives	Interests & Pleasure	Feeling of Competence	Social Relevance	Appearance	Health	Exercise behaviors	Aerobic fitness
Failed	125	3.89±0.54	3.78±0.52	3.53±0.41	3.68±0.42	3.82±0.45	4.65±0.64	24.32±3.19	64.21±3.43
Passed	661	4.42±0.60	4.33±0.69	4.28±0.54	4.22±0.59	4.06±0.49	5.21±0.67	29.97±4.05	78.31±6.85
Excellent	196	4.96±0.67	5.06±1.21	4.96±1.03	4.59±0.64	4.55±0.56	5.65±0.77	39.21±10.43	90.79±9.21
F		6.069	8.673	10.657	4.192	4.013	10.065	5.932	19.521
P		0.003	<0.001	<0.001	0.015	0.019	<0.001	0.004	<0.001

Correlation analysis between physical exercise motives and exercise behaviors of teenagers

According to correlation analysis, the physical exercise motives of teenagers showed significant-

ly positive correlations with scores of all the dimensions of exercise behaviors ($P<0.05$). Moreover, all the dimensions of exercise behaviors had significantly positive correlations ($P<0.05$) (Table 4).

Table 4: Correlation analysis between physical exercise motives of teenagers and exercise behaviors

<i>Projects</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
1. Exercise motives	1									
2. Interests & pleasure	0.599**	1								
3. Feeling of competence	0.562**	0.625**	1							
4. Social relevance	0.431**	0.521**	0.541**	1						
5. Appearance	0.412**	0.275**	0.412**	0.312**	1					
6. Health	0.643**	0.492**	0.596**	0.455**	0.369**	1				
7. exercise behaviors	0.421**	0.318**	0.327**	0.291**	0.161*	0.275**	1			
8. Exercise time	0.336**	0.263**	0.231**	0.235**	0.126*	0.224**	0.727**	1		
9. Exercise intensity	0.201**	0.215**	0.265**	0.192**	0.192**	0.241**	0.639**	0.249**	1	
10. Exercise frequency	0.245**	0.281**	0.192**	0.152*	0.142*	0.201**	0.491**	0.093	0.121*	1

Notes: * $P < 0.05$, ** $P < 0.01$

Correlation analyses of physical exercise motives and exercise behaviors of teenagers with physical health and aerobic fitness

According to correlation analysis, the physical exercise motives and exercise behaviors of teenagers

were positively correlated with physical health and aerobic fitness (VO_2 max; $P < 0.05$) (Table 5).

Table 5: Correlation analysis of physical exercise motives and exercise behaviors of teenagers with physical health and aerobic fitness

<i>Items</i>	<i>Aerobic fitness</i>	<i>Physical health</i>	<i>Body shape</i>	<i>Somatic function</i>	<i>Physical fitness</i>
1. Exercise motives	0.226**	0.562**	0.279**	0.206**	0.118*
2. Interests & pleasure	0.209**	0.591**	0.178**	0.187**	0.112*
3. Feeling of competence	0.154	0.321**	0.202**	0.194**	0.124*
4. Social relevance	0.186**	0.403**	0.165*	0.169**	0.106*
5. Appearance	0.102*	0.413**	0.362**	0.125**	0.101*
6. Health	0.192**	0.422**	0.465**	0.213**	0.206**
7. Exercise behaviors	0.181**	0.594**	0.367**	0.241**	0.213**
8. Exercise time	0.132*	0.512**	0.237**	0.165**	0.161*
9. Exercise intensity	0.113*	0.326**	0.161*	0.102*	0.142*
10. Exercise frequency	0.145*	0.431**	0.212**	0.129**	0.135*
11. Aerobic fitness (VO_2 max)	1	0.282**	0.294**	0.223**	0.407**

Notes: * $P < 0.05$, ** $P < 0.01$

Regression analysis of the relationships of exercise motives and exercise behaviors with physical health and aerobic fitness

The predictive effects of the dimensions of physical exercise motives to exercise behaviors, physical health, and aerobic fitness was verified through stepwise multiple regression analysis. Three models were designed for analysis. Model

1: dimensions of physical exercise motives were included in the regression model for the prediction of physical exercise behaviors. Model 2: the dimensions of physical exercise motives were included in the regression model to predict physical health and aerobic fitness. Model 3: physical exercise behaviors were included in the regression model for the prediction of physical health and

aerobic fitness. The results showed that exercise motives had a predictive ability for exercise behaviors and physical health. In exercise motives, all the dimensions, except appearance, can be

used in predicting aerobic fitness. Moreover, exercise behaviors can be used in predicting the physical health and aerobic fitness. The results are shown in Table 6.

Table 6: Regression analysis of relations of exercise motives and exercise behaviors with physical health and aerobic fitness

Items	Exercise behaviors				Physical health				Aerobic fitness			
	β	P	R ²	F	β	P	R ²	F	β	P	R ²	F
Model 1	Exercise motives		0.121	11.043								
	Pleasure	0.312	<0.001	0.093								
	Feeling of competence	0.321	<0.001	0.099								
	Social relevance	0.290	<0.001	0.081								
	Appearance	0.159	0.005	0.023								
	Health	0.271	<0.001	0.069								
Model 2	Exercise motives						0.069	12.149			0.051	3.937
	Pleasure				0.269	<0.001	0.069		0.227	<0.001	0.043	
	Feeling of competence				0.221	<0.001	0.064		0.149	0.011	0.020	
	Social relevance				0.214	<0.001	0.062		0.185	0.001	0.033	
	Appearance				0.132	0.011	0.020		0.019	0.770	0.002	
	Health				0.264	<0.001	0.057		0.104	0.041	0.017	
Model 3	Exercise behaviors				0.201	<0.001	0.032	11.231	0.180	0.001	0.030	10.023

Discussions

As shown in Table 1, teenage students had scored higher than 75 in all the dimensions of physical health and scores higher than 80 (100 scores in total) in body shape and somatic function, which were slightly higher than the moderate level. According to test results of aerobic fitness, VO₂ max reached 42.79±7.23 mL/(kg·min), which was also in a good state but still had room for improvement. This result is generally better than expected and indicates that although the outdoor activities of the majority of young students had been significantly reduced because of the COVID-19 pandemic, most students could actively respond to schools' call to exercise at home. According to gender comparison of physical health and aerobic fitness, the test scores of female teenagers were lower in terms of FVC, standing board jump, sit-ups, and sprint and low-

er VO₂ max, indicating that females need to improve in terms of physical fitness and somatic function. This result is consistent with the conclusions of Song et al (17) and might be related to differences between the physiological features of men and women.

According to the results in Table 2, the mean score of a single item of the exercise motives of teenagers was >3.5 (1–7 scores), and the mean score of exercise behaviors was >3 scores (1–5 scores), which were higher than the upper limit of the theoretical score (≥50%) and slightly higher at the moderate level. Specifically, health, pleasure, and feeling of competence were the top three dimensions. According to the gender comparison of scores, the scores of pleasure, feeling of competence, social relevance, and health of male teenagers were significantly higher than those of female teenagers, whereas the scores of

female teenagers for appearance were significantly higher ($P < 0.05$).

Table 3 shows significant differences in exercise motives, exercise behaviors, and aerobic fitness among teenagers with different physical health grades. Scores for exercise motives and different dimensions, exercise behaviors, and aerobic fitness had significantly increasing trends ($P < 0.05$) with increasing physical health grade. Respondents with high scores for physical exercise behaviors had high scores for physical health and aerobic fitness. This result explains the high scores for physical health and aerobic fitness under strong physical exercise motives to some extent. Training the physical health belief and self-efficacy of teenagers is beneficial to the improvement of their attention or concerns to physical health and encourages them to participate in sports and improve their physical health conditions (18).

According to the results of Tables 4 and 5, the exercise behaviors of teenagers had significantly positive correlations with physical health and aerobic fitness. Physical exercise motives had positive correlations with exercise behaviors, physical health, and aerobic fitness ($P < 0.05$). Patients that perform exercises for long periods and at high intensities and frequencies often had high scores for physical health and aerobic fitness possibly because high-frequency and long-term insistence on physical exercises could produce an accumulation effect that facilitates the maintenance of physical health. The positive participation of teenagers in extracurricular athletics was closely related to their exercise motives (19). This result is consistent with the results of the present study. The main goal of physical exercise is to improve physical fitness and maintain or promote health. Physical exercise frequency, time, and intensity and insistence to exercise habits are important influencing factors for exercise effect and physical health. Motivation is an internal impetus that excites or maintains individual behaviors (20) and an implicit behavior closely related to external behaviors. Physical exercise motives are important psychological motivations that influence the physical exercise behaviors of indi-

viduals (21). Therefore, exercise motives might have direct impacts on exercise behaviors from the perspective of logic and might influence physical health indirectly through exercise behaviors.

The stepwise multiple regression analysis results in Table 6 show that physical exercise motives generally had positive impacts on exercise behaviors, physical health, and aerobic fitness ($P < 0.05$), especially internal motivations (pleasure, feeling of competence, and social relevance). In other words, exercise interests or getting pleasure experiences and meeting new friends through exercises could promote and predict physical exercise behaviors effectively (22). The possible reason is that when individuals have strong exercise motives in the physical exercise process, their enthusiasm and initiation in participating and finishing various physical exercises are strong. By contrast, individuals who have low exercise motives are often passive or finish physical exercises perfunctorily. Such difference influences their exercise intensity, time, and frequency, thus influencing exercise effect.

Conclusion

The physical exercise motives of teenagers are closely related to exercise behaviors, physical health, and aerobic fitness. There are significant gender differences in exercise motives (boys are better than girls). With the increase of physical health grade, exercise motives, exercise behaviors and aerobic fitness are significantly increased. Physical exercise motives can promote the exercise behaviors of teenagers and have positive effects on the prediction of their aerobic fitness and physical health.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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