

The Effect of Physical Exercise on Pilot Students' Emotional Regulation Ability: The Intermediary Role of Psychological Resilience

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Abstract. The aim of this research was to explore the relations between physical exercises and emotion regulation ability of pilot students in the aftermath of an epidemic, and also to investigate the intermediary role of psychological tolerance, with the aim of further finding measures to prevent and intervene in the development of emotional problems in pilot students, to promote pilot students' psychological well-being better, and to safeguard aviation safety. This study used a questionnaire to examine 391 flight cadets, and the measurement tools included Physical Exercise Rating Scale, psychological resilience scale, and Emotion Regulation Scale. The results showed that the amount of physical exercise was significantly and positively correlated with emotion regulation ability, and psychological resilience was substantially and positively in correlation to emotion regulation ability; psychological resilience mediated in part by physical activities and pilots' emotion regulation ability, and the effect percentage was 52.63%. In summary, it is concluded that: (1) Physical exercise positively predicts the emotional regulation skills of student pilots, physical exercise has a positive predictive effect on psychological resilience, and psychological resilience has a positive predictive effect on pilot students' emotion regulation ability; and (2) Psychological resilience plays a partially mediating role in the impact between physical exercise and pilot students' emotion regulation ability.

Keywords: Physical Exercise, Pilot Students, Emotional Regulation Ability, Psychological Resilience, Intermediary Role.

1. Introduction

Neocoronavirus pneumonia which outbreak in 2019 has severely impacted people's lives and socialisation, threatening their physical and mental health. The study found that both students and employees experienced varying degrees of psychological stress during the coronavirus pneumonia epidemic, with the student population showing more emotional reactions such as anxiety and depression [1]. Although the epidemic was effectively controlled in March 2020, the uncertainty and insecurity of the epidemic in the post-epidemic era continues to cause persistent tension, anxiety and panic among university students [2].

Civil aviation pilot students are the reserve team of pilots, which are different from ordinary college students, and their emotional problems cannot be ignored especially. The COVID-19 which burst out in 2020 has made a great influence on the civil aviation industry, and pilot students are also facing the pressure of training postponement [3]. According to the "Annual Report on the Development of Pilot Instruments for Civil Aviation in China (2022 Edition)" published by the Department of Flight Standards of CAAC, the growth rate of pilot licenses slowed down significantly in 2020 because of the effect on the epidemic on flight training activities, and the incremental growth of pilot licenses got a significant rebound in 2021, and the growth rate of pilots in the year 2022 recovered to about 65% of the pre-epidemic level, after digesting the backlogs of the training in the past two years. Compared to ordinary college students, pilot students have special learning tasks, heavy flight task loads, high pressure, and the problem of training delays due to the impact of the epidemic, all of which may lead to more serious emotional problems among pilot students.

Statistics show that human factors cause about 70% of flight accidents, of which psychological factors constitute the main part of human factors [4]. In the study of the relationship between driver's emotional state and traffic safety, drivers in the accident group had significantly more negative

emotions than drivers in the safety group, so the driver's emotional state is significantly related to traffic safety, and driving with a negative emotion may induce accidents [5]. The crash of Germanwings Airlines on March 27, 2015, was caused by the co-pilot, who suffered from depression and intentionally drove the plane into a mountain, which resulted in the crash. This accident resulted in the death of all 144 passengers and 6 crew members on board. Civilian pilots, as drivers of airliners, are responsible for the lives of hundreds of passengers, and in the event of a flight accident, the injuries and losses will be even more devastating.

The psychological health of pilot students is a key factor of aviation safety and an important mediating variable between the acquisition of flight skills and obtaining optimal training performance. The emotional well-being of pilots is directly related to flight safety [6]. Studies have indicated that the psychological health problems of pilots have the highest incidence of anxiety [7]. While existing mental health research is limited for civil aviation pilot students, their mental health status may also be quite different from that of pilots, and the factors affecting their mental health level may also be different, which needs to be further explored. In addition, some studies have shown that improving emotion regulation ability can diminish mental health problems caused by depression, anxiety, and stress [8]. Therefore, improving the emotion regulation ability of pilot students can have a positive impact on their mental health and enable them to better acquire flight skills, thereby enhancing flight safety and providing stronger protection for passengers. Therefore, it is particularly necessary to seek ways to ameliorate pilot students' emotional regulation ability.

There are many ways in which emotions can be regulated, among which, scientific and reasonable physical exercise can effectively regulate bad emotions. It has been found that short-duration exercise makes a significant improvement influence on emotion regulation, which is shown by attenuating the negative effects induced by negative emotions [9]. College students who exercised regularly were also significantly better at emotion regulation than students who did not exercise enough [10]. Physical exercise promotes interpersonal interactions and improves individual self-efficacy among pilot students, and then serves to improve the emotional stability of pilot students [4]. Therefore, the study proposed Hypothesis 1: Physical exercise plays an active role in the emotional regulation of pilot students.

Psychological resilience, which means one's ability to overcome difficulties to quickly recover from negative experiences and successfully cope with them when faced with a variety of negative impacts brought about by stressful events or unfavorable situations or positive personality qualities [11]. Studies have demonstrated that the development of psychological elasticity benefits from both the positive and negative effects of protective factors, and physical exercise is a protective factor that promotes individuals' mental development, and there is a positive association between it and psychological elasticity [12]. Individual physical activities can develop one's sense of control and sense of value, which is conducive to improving the standard of psychological resilience of individuals [13]. Foreign studies have also pointed out that physical exercise has a remarkable effect on the enhancement of individual subjective well-being [14], and individual subjective health and psychological elasticity have a highly correlated relationship. At the same time, emotion regulation and psychological elasticity are correlated, studies have shown that psychological elasticity can significantly predict emotion regulation. In light of this, Hypothesis 2 is proposed: Psychological elasticity has an important mediating role in the relations of physical activity and emotion regulation.

In prior research, no studies have defined the collective relationship between physical activity, psychological resilience, and emotion regulation ability, although there are specific relationships between the variables. There are many existing studies on the emotional problems of the college student population, but there are also few studies related to the civil aviation industry and the mental health of pilot students to provide a powerful and relevant reference for the industry. Therefore, this study takes flight students as the object of investigation and will contribute to the prevention and intervention of emotional problems arising in flight students. In summary, this study used civil aviation flight students as subjects to discuss the relationship between physical fitness and emotional regulation in pilot students (Hypothesis 1) and to investigate the intermediary effect on psychological

resilience (Hypothesis 2), aiming to enhance the improvement effect of physical exercise on flight students' emotion regulation ability and to improve the mental health of civil aviation flight students.

2. Subjects and methodology of the study

2.1. Subjects of study

In the present research, the questionnaire survey methodologies were used to survey the relationship among physical exercise, pilot students' emotion regulation ability and psychological resilience. The questionnaire survey object is civil aviation pilot students, using Questionnaire Star, in total, 392 responses were gathered finally, of which 391 were valid, the validity rate was 99.7%, all of them are male, majoring in flight technology; the number of people whose year of the enrollment is 2 people in 2016, 4 in 2017, 64 in 2018, 30 in 2019, 28 in 2020, 168 in 2021, and 95 in 2022; 270 people in the theoretical study phase, 90 in the practical training delivery phase, and 31 in the pending training delivery phase.

2.2. Research Methods

(1) Psychometric method

a. Physical Exercise Rating Scale

The Physical Activity Rating Scale (PARS-3) revised by Prof. Deqing Liang in 2004 was adopted in this study. This scale examines the amount of physical activity in terms of intensity, duration and frequency of participation. Scoring method: Each dimension is assigned into levels and has a rating from 1 to 5. Exercise volume = intensity*time*frequency. Intensity and frequency are graded from 1 to 5, with scores from 1 to 5, and time from 1 to 5, with scores from 0 to 4, with a maximum of 100 points and a minimum of 0 points. The criteria for the development of the amount of physical exercise were: 0-19 points means small exercise, points from 20 to 42 means medium exercise, and more than 43 points means large exercise. The re-test reliability of the PARS-3 was 0.82. In this study, the reliability was 0.883.

b. Psychological Resilience Scale

In this study, we used the "Psychological Resilience Scale (CD-RISC)" revised by Xiao Nan in 2007, which is the most commonly used scale in China to measure the psychological resilience of individuals. The scale is distributed into three aspects: optimism, strength and resilience. Among them, optimism is composed of question 2, 3, 4 and 6, which means that one person has faith in the outcome of things and is able to look at things positively; strength is composed of question 1, 5, 7, 8, 9, 10, 24 and 25, which refers to the self-confidence and vitality of the individual in the process of overcoming adversity; resilience is composed of question 1, 5, 7, 8, 9, 10, 24 and 25, which is thought of as the one's self-confidence and vitality during the process of overcoming adversity; passion and energy for self-improvement. Self-improvement passion and vitality; resilience is composed of question 11~23, which refers to the individual under physical or mental pressure, the performance of unremitting endurance, courage and backbone, etc.: the scale adopts a 5-point scale from "0 = never" to "4 = always", the higher the score, the higher the score indicates that the individual's confidence in the process of overcoming adversity. The scale is scored on a 5-point scale from "0 means never" to "4 means always", with higher scores indicating greater psychological resilience. The internal consistency coefficient and retest reliability of the English version of the scale were 0.89 and 0.87, and the Cronbach's coefficient of the Chinese revised version was 0.91. The scale's reliability in this study was 0.947.

c. Emotion Regulation Scale

The Emotion Regulation Questionnaire developed by Gross was adopted in this study, which consists of ten items on a five-point scale, with higher scores indicating more frequent use of emotion regulation strategies. The scale includes two dimensions: cognitive reassessment and expressive restraint. Cognitive reassessment refers to changing one's understanding of an emotional event and changing one's perception of its individual significance. Expressive inhibition is a form of response

modification that occurs after an emotional response and is the suppression of impending emotional expressive behavior. The cognitive reassessment dimension includes six items (1, 3, 5, 7, 8, and 10) and the expressive inhibition dimension consists of four items (2, 4, 6, and 9). The Chinese edition of the scale had excellent reliability and validity, with alpha coefficients of 0.77 and 0.83 for expression suppression and cognitive reappraisal, respectively. In this research, the scale's reliability was 0.842.

(2) Mathematical and statistical method

Simple screening and processing of data were performed using Excel, descriptive statistics, one-way ANOVA, Pearson's correlation analysis and regression analysis were performed using SPSS, and mediation effect analysis was performed using Model 4 with the PROCESSV4.2 Plugin.

3. Results

3.1. Common method bias test

In the present research, Harman's one-factor method was applied to test for the presence of common method bias. The outcomes reflected that there were six factors with eigenroots greater than 1, of which the first factor explained 33.957% of the variance, which was less than the critical value of 40%, so the common method bias was notable in this research.

3.2. General characteristics of physical exercise, psychological resilience and emotional regulation ability of pilot students

Table.1. General characteristics of physical exercise, psychological resilience and emotional regulation ability in pilot students

	Mean M	Standard deviation SD
physical exercise	36.92	24.925
psychological resilience	96.95	14.971
emotional regulation	36.33	6.477

As shown in Table 1, the average amount of physical exercise of the pilot students was 36.92, which is in the moderate amount of exercise, with a standard deviation of 24.925; the average psychological resilience score was 96.95, with a standard deviation of 14.971; and the average Emotional Regulation Score was 36.33, with a standard deviation of 6.477.

3.3. Relevant analysis of the amount of physical exercise, psychological resilience and emotional regulation ability in pilot students

Table.2. Pearson's correlation analysis

	physical exercise	psychological resilience	emotional regulation
physical exercise	1		
psychological resilience	0.255**	1	
emotional regulation	0.146**	0.314**	1

Note: ** means p less than 0.01, * means p less than 0.05.

Table 2 displays that the relevant analysis was adopted to test the relevance between the amount of physical exercise and psychological resilience, emotional regulation, and the strength of the correlation is expressed by the Pearson correlation coefficient. The correlation coefficient between the amount of physical exercise and psychological resilience is 0.255 and demonstrates an implication at the level of 0.01, which suggests that there is a distinct positive association between the amount of physical exercise and psychological resilience. The correlation coefficient between the amount of physical activity and emotional regulation was 0.146 and indicated implication at the 0.01 level, which means that there is a remarkable positive correlation between the amount of physical exercise and emotion regulation.

3.4. Predictive effects of amount of physical exercise on emotion regulation ability in pilot students

Table.3. Regression analysis of the amount of physical exercise and emotional regulation ability in pilot students

	Unstandardised coefficient		Standardised coefficient	t	p	R ²	ΔR ²
	B	standard error	Beta				
a constant (math.)	34.927	0.580	-	60.178	0.000*		
physical exercise	0.038	0.013	0.146	2.920	0.004*	0.021	0.019

Dependent variable: emotional regulation

Note: *p<0.05, **p<0.01

Table 3 suggests that using physical activity as an independent variable, while using the emotion regulation ability as the dependent variable in the linear regression analysis, as shown in the above table, the model formula is: emotion regulation ability = 0.038*physical exercise + 34.927, and the R2 value of the model is 0.021, which means that the amount of physical exercise explains the reason for 2.1% of the change in emotion regulation ability. Summarizing the analysis, it goes to show that the amount of physical exercise has a significant beneficial predictive effect on emotion regulation ability.

3.5. Predictive effect of amount of physical exercise on psychological resilience in pilot students

Table.4. Regression analysis of the amount of physical exercise and psychological resilience in pilot students

	Unstandardised coefficient		Standardised coefficient	t	p	R ²	ΔR ²
	B	standard error	Beta				
a constant (math.)	91.307	1.311	-	69.625	0.000*		
physical exercise	0.153	0.029	0.255	5.194	0.000*	0.065	0.062

Dependent variable: psychological resilience

Note: *p<0.05, **p<0.01

Table 4 illustrates that the amount of physical exercise was used as the independent variable, while psychological resilience was used as the dependent variable in the linear regression analysis, from the above table, the model formula is: psychological resilience = 0.153*physical exercise + 91.307, and the R2 value of the model is 0.065, it can be seen that the amount of physical exercise explains the reason for the change of psychological resilience by 6.5%. Summarizing the analysis, which means that the amount of physical exercise has a significant favourable predictive effect on psychological resilience.

3.6. Predictive effect of psychological resilience on emotion regulation ability in pilot students

Table.5. Regression analysis of psychological resilience and emotion regulation ability in pilot students

	Unstandardised coefficient		Standardised coefficient	t	p	R ²	ΔR ²
	B	standard error	Beta				
a constant (math.)	23.146	2.043	-	11.330	0.000*		
MZ	0.136	0.021	0.314	6.531	0.000*	0.099	0.097

Dependent variable: emotional regulation

Note: *p<0.05, **p<0.01

From Table 5, it is clear that psychological resilience is used as the independent variable while emotion regulation ability is used as the dependent variable for linear regression analysis. As can be seen from the above table, the model formula is: emotion regulation ability = 0.136*psychological resilience + 23.146, and the R² value of the model is 0.099, which means that psychological resilience explains the reason for 9.9% of the variation in emotion regulation ability. Summarizing the analysis, psychological resilience has a significant positive predictive effect on emotion regulation ability.

3.7. The mediating role of psychological resilience in the amount of physical exercise and emotional regulation ability in pilot students

Table.6. Mediated effects model test

	emotional regulation	psychological resilience	emotional regulation
a constant (math.)	34.927** (60.178)	91.307** (69.625)	23.223** (11.379)
physical exercise	0.038** (2.920)	0.153** (5.194)	0.018 (1.429)
psychological resilience			0.128** (5.960)
sample size	391	391	391
R ²	0.021	0.065	0.104
ΔR ²	0.019	0.062	0.099
F-value	F(1,389)=8.528,p=0.004	F (1,389)=26.973, p=0.000	F (2,388)=22.406, p=0.000

Note: * p<0.05, ** p<0.01, t-values in parentheses

From the above Table 6, we can see that mediation effect analysis involves 3 models, as follows: emotion regulation ability=0.038*physical exercise+34.927; psychological resilience=0.153*physical exercise+91.307; emotion regulation ability=0.136*psychological resilience+23.146.

Table.7. Mediating effects of psychological resilience

sports event	Effect	95% CI lower limit	95% CI upper limit	reach a verdict	Efficacy as a percentage of
Amount of physical activity => psychological resilience => emotional regulation	0.02	0.035	0.126	Partial mediation	52.63 per cent
Amount of physical activity => emotional regulation	0.018	0.007	0.044		
aggregate effect	0.038	0.013	0.064		

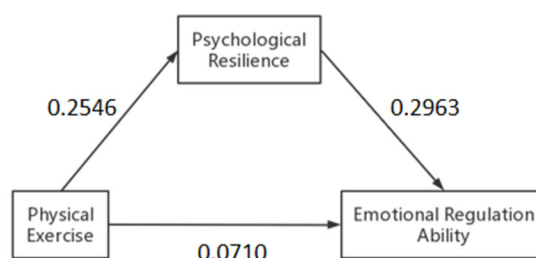


Figure 1. Model of mediating effect

Further validation of the mediating role of psychological flexibility, the Bootstrap method was applied with a confidence interval (CI) of 95% and 5000 repetitions of sampling, with a 95% CI not containing 0. From Table 7 and Figure 1, the mediating effect summed to 0.02, with 95% CI [0.035, 0.126], and the effect percentage was 52.63%, which concluded that psychological resilience partially mediates the association between physical exercise and pilot students' emotional regulation ability.

4. Discussion and analysis

4.1. The effect of physical exercise on emotional regulation ability

The results of this study show that the amount of physical exercise of pilot students is at the medium level, the psychological resilience is at the excellent level, and their emotional regulation ability is at the medium-high level. Factors affecting college students' participation in physical exercise include heavy study burden, lack of space and physical exercise equipment, and lack of time to exercise [15]. Contemporary college students' emotions are easily influenced by society and the surrounding environment, and they are prone to negative emotional experiences [12], and the higher level of psychological resilience of the pilot students can help them regulate their emotions better.

The results of this study showed a significant positive correlation between the amount of physical activity and emotion regulation and that the amount of physical exercise was a significant positive predictor of emotion regulation. Studies on humans and animals have shown that physical activity increases the release of β -endorphin and 5-hydroxytryptamine, and also reduces depression and anxiety symptoms and promotes mental health by providing social support and enhancing the exercise experience [15]. This provides a theoretical basis for the protective mechanism of physical exercise on the emotional regulation ability of pilot students. It has also been shown that college students usually choose to exercise with their peers, which promotes communication with each other [15], and physical exercise increases interpersonal interactions of flight students, provides effective social support, and positively promotes flight students' self-efficacy, which improves flight students' emotional stability [5]. Meanwhile, physical activity can reduce or abolish an individual's preoccupation with negative emotional experiences [16], and those who regularly participate in physical activity may be better able to regulate and recover from negative emotions when they arise

[17]. In addition, neurological-level studies have found that physical activity increases p-mTOR positive neurons in the entorhinal prefrontal cortex, striatum, hippocampus, hypothalamus, and amygdala, which produce antidepressant and anxiety resistance [18], as a means of maintaining emotional stability. Accordingly, Hypothesis 1: Physical exercise plays an active role in the emotional regulation of pilot students.

4.2. Mediator effect of psychological resilience

The results of regression analysis and structural equation modeling suggested that psychological resilience partially mediated the relationship between physical activity and pilots' emotion regulation ability. First, the amount of physical exercise was positively correlated with psychological resilience, validating the findings of previous studies [12]. It has been pointed out that physical activity is an important factor in the developmental process of psychological resilience, and that physical activity can improve physical and mental health and thus increase the level of psychological resilience of individuals [19], and that regular physical activity enhances the level of psychological resilience of individuals by reducing their physical and mental responses to external stresses, and by improving the pathways of their physiological and psychological states [20]. Secondly, previous studies have also shown that negative emotions and psychological resilience are negatively correlated [21], psychological resilience can effectively buffer the adverse effects of negative events, and individuals with high levels of psychological resilience can adopt more effective emotion regulation strategies to regulate their emotions when experiencing stressful events and have more positive emotions and mindsets [22]. Individuals with high levels of psychological resilience show fewer emotional problems and psychological resilience plays a protective role in emotional problems [23]. Rutter also pointed out four ways in which psychological resilience works in his research: (1) Reducing the impact of danger so that it has a less negative effect on the individual; (2) Reducing the negative chain reaction after an unfortunate experience; (3) Increasing self-esteem and self-efficacy; (4) Pointing out positive opportunities for the individual to help them to generate hope and access resources for success. Biologically relevant studies have also found that psychological resilience is modulated through adaptive changes in neural circuits and molecular pathways containing a large number of neurotransmitters, and that psychological resilience encompasses not only the pattern of neurochemical responses to acute stress and the neural mechanisms mediating reward, but also a series of cognitive appraisal, affective regulation, active adoption of strategies, and coping with difficulties as well as a series of psycho-behavioral responses during an individual's adaptation process [24]. Therefore, improving the psychological resilience of pilot students can enable them to have better strategies to cope with negative emotions and to dilute the impact of negative events, which also improves the individual's ability to regulate emotions. For pilot students, physical exercise enhances the level of psychological resilience, leading to better emotion regulation. Hypothesis 2: Psychological elasticity has an important mediating role in the relations of physical activity and emotion regulation.

5. Conclusions

The following findings were made in this study: (1) Physical exercise has a positive predictive effect on the emotion regulation ability of pilot students, physical activity has a positive predictive effect on psychological resilience, and psychological resilience has a positive predictive effect on the emotion regulation ability of pilot students; (2) Psychological resilience partially mediates the relationship between physical activity and the emotion regulation ability of pilot students, which means that physical exercise can affect flight student emotion regulation both directly and indirectly through psychological resilience.

6. Value and prospects of this study

In terms of theory, this study is relevant in summarizing and utilizing existing research findings to further enrichment of theoretical system between physical activity and mental health at the theoretical level. Understanding the role of psychological resilience in the relationship between physical exercise and pilot students' emotional regulation ability may help to promote the mental health of pilot students and has fundamental impact on school guidance counsellors and psychological professionals in the civil aviation industry. In terms of practice, the research in this paper will provide a reference for the civil aviation industry and related colleges and organizations in the background of the post-pandemic era, so as to better promote the mental health of pilots and lay a foundation for the development of the industry and flight safety. Future research should focus more on how to improve the psychological resilience of pilot students, and also explore whether there are other mediating variables between physical exercise and emotion regulation ability, such as self-esteem, self-efficacy, etc.

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