

# Relationship Between Physical Exercise and Risk of Depression: An Assessment of Intermediate Variables Through Self-Assessed Health Status and Life Satisfaction in the Chinese Family Tracking Survey (CFPS) Data

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**Objective:** Depression is a potential health killer. As an important means of preventing various human diseases, physical exercise plays an important role in reducing the risk of depression. Using data from the Chinese Household Tracking Survey, this study analyzed the mechanisms by which physical exercise, self-rated health and life satisfaction reduce the risk of depression.

**Methods:** The data for this study comes from the China Family Panel Studies (CFPS) released by the China Social Science Survey Centre of Peking University. The 2020 survey data was used as the sample, which contained a total of 21,057 individuals. The study variables were analyzed in sequence for reliability and validity, correlation analysis, regression analysis, structural equation model testing, and bias-corrected percentile Bootstrap testing using SPSS 23.0 software and Hayes' (2013) Process plug-in.

**Results:** Physical exercise was significantly positively correlated with self-assessed health status and satisfaction of life ( $\beta = 0.049$ ,  $p < 0.01$ ;  $\beta = 0.075$ ,  $p < 0.01$ ), and significantly negatively correlated with risk of depression ( $\beta = -0.022$ ,  $p < 0.01$ ); self-assessed health status was significantly positively correlated with satisfaction of life ( $\beta = 0.440$ ,  $p < 0.01$ ), and significantly negatively correlated with risk of depression ( $\beta = -0.047$ ,  $p < 0.01$ ); satisfaction of life was significantly negatively correlated with risk of depression ( $\beta = -0.137$ ,  $p < 0.01$ ).

**Conclusion:** Physical exercise not only negatively predicted the risk of depression, but also indirectly predicted the risk of depression through the independent mediating effects of self-assessed health status and satisfaction of life, as well as chain mediating effects. There were no differences in the effects of physical exercise on depression risk by age, gender and marital status. Significant differences in the effect of physical exercise on depression risk were found among groups with different places of residence.

**Keywords:** physical exercise, risk of depression, self-assessed health status, life satisfaction, CFPS

## Introduction

In recent years, with the acceleration of the pace of life and work and the intensification of social competition, the prevalence of depression is on the rise, and the World Health Organization predicts that by 2030 depression will become the leading factor in triggering disease or death.<sup>1</sup> The 2023 China Psychiatric and Mental Health Survey shows that the mental health of the population is outstanding, with the detection rate of adults at risk of depression at 10.6%, and only 36% of the population considering themselves to be mental health is good<sup>2</sup>. Depression is a common mental disorder that manifests itself as a psychological state of persistent low mood and loss of interest and sense of pleasure; people suffering from depression feel chronically sad, hopeless and helpless, and lose their enthusiasm and motivation for life<sup>3</sup>. Whether and how physical activity, as an important way to prevent mental illness and improve health, has a positive

effect in reducing depression has received widespread attention.<sup>4</sup> Studies have argued from the perspective of psychological mechanisms and physiological mechanisms respectively. Among them, the cognitive-behavioral hypothesis suggests that physical activity produces positive cognitive behaviors and thus reduces depression<sup>5</sup>. The self-efficacy hypothesis suggests that physical activity is often viewed as a process of overcoming psychological and physiological inertia, and that self-efficacy is generated after physical activity, thus reducing depression.<sup>6</sup> Physiological studies have shown that physical activity can promote the increase of monoamine neurotransmitters in the brain, such as the secretion of amine metabolites and endorphins, which can reduce depressive mood.<sup>7</sup> The above studies provide a basis for physical exercise to reduce the occurrence of depression from a theoretical perspective, but there are fewer studies on the psychosocial mechanisms of the effects of physical exercise on depression, and no study has yet explored the role of physical exercise in reducing depression from the perspective of individual self-assessment of health status and life satisfaction. Based on this, this study will use data from the 2020 China Family Tracking Survey (CFPS) to examine the mechanisms of physical activity, life satisfaction, self-rated health status, and depression risk. It will provide theoretical and practical basis for reducing depression, improving health and promoting social participation among Chinese residents.

## Theoretical Background

### Physical Exercise and Depression Risk

Physical exercise refers to the process of engaging in physical activities by using a variety of physical means and combining natural forces to exercise the body for the purpose of improving health and strengthening physical fitness.<sup>8</sup> Physical exercise, as an important means of preventing disease and active health of human beings, is increasingly respected by people, especially in economically developed countries and regions, where physical exercise has become a part of daily life and the lifelong sports awareness of the residents is also increasing.<sup>9</sup> At present, the research on physical exercise is not only limited to the improvement of motor skills and physical function, but also expanding to the direction of physical exercise to improve mental health and alleviate psychological disorders. It has been shown that physical exercise not only improves cognitive behaviors and promotes mental health but is also a complementary and alternative means to medication and psychotherapy for depression<sup>10</sup> and may have similar effects or even more advantages than psychotherapy and pharmacological management.<sup>11,12</sup> Physical exercise has been included in clinical guidelines for the treatment of depression in the United States, the United Kingdom, and Australia.<sup>13,14</sup> A large number of cross-sectional studies have shown that there is a significant negative correlation between physical exercise and depression, the higher the frequency of physical exercise, the lower the depression score or the lower the detection rate.<sup>15,16</sup> Longitudinal studies have shown that regular exercisers have lower depression detection rates than non-exercisers and show stability over time span.<sup>17</sup> Recent meta-analyses have shown that physical exercise is an effective treatment for depression, especially vigorous exercise. Exercise was equally effective in individuals with comorbidities as well as different baseline levels of depression. Exercise can be considered a core treatment for depression along with psychotherapy and antidepressants.<sup>11,18</sup> Currently, studies have confirmed the existence of an effect of physical exercise on depression, but the specific mechanism of action between the two remains to be further developed. Therefore, this study will further explore the relationship and internal mechanisms between physical exercise and depression and propose the research hypothesis H1: physical exercise can negatively predict the risk of depression.

### Mediating Role of Self-Assessed Health Status

Self-assessed health status refers to the comprehensive assessment of one's own health status combining multi-dimensional subjective feelings and objective symptoms, which to a certain extent can reflect the individual's environmental influences on the performance of the objective health measurements cannot be reflected in the problem, not only reflects the physiological, psychological, and social dimensions of the health status, but also covers the current state of the health of the respondent and the expected.<sup>19</sup> Therefore, self-assessed health can reveal physiological and psychological conditions that are difficult to characterize by objective health indicators through an individual's comprehensive evaluation of his or her objective symptoms and subjective perceptions<sup>20</sup> The most direct benefit of participating in

physical exercise lies in the promotion of health, and health demand theory states that people invest time and money in physical exercise, which can be regarded as a kind of investment goods for health, in order to maintain the level of health to increase the time of health so as to create more social value.<sup>21</sup> Health is an important foundation for achieving comprehensive human development, and physical exercise is an important way to improve health. People who regularly engage in physical exercise have better health and higher levels of physical and mental health than those who do not. And physical exercise can reduce the probability of depression by improving health.<sup>4</sup> Accordingly, this study proposes the research hypothesis H2: self-assessed health status mediates the relationship between physical exercise and the risk of depression.

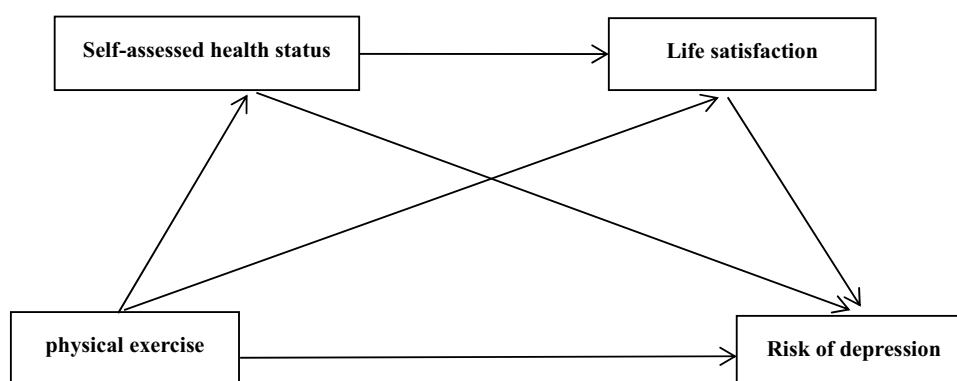
## Mediating Role of Life Satisfaction

Life satisfaction is an individual's overall cognitive assessment of his or her own life situation for most of the time or for a period of time according to his or her own standards.<sup>22</sup> Life satisfaction is not only the individual's evaluation of the objective material conditions of life, but also the subjective evaluation of the individual's psychological feelings such as happiness and satisfaction in life.<sup>23</sup> It has been shown that life satisfaction, as a rational cognitive component of subjective well-being, better reflects the specific condition of an individual's subjective well-being,<sup>24</sup> and better reflects the impact of social development as well as national policies on an individual's well-being.<sup>25</sup> Studies have shown that people who regularly participate in physical exercise have higher life satisfaction than those who do not<sup>26</sup> and all their life satisfaction is significantly higher after participating in physical exercise.<sup>27</sup> Life satisfaction not only affects daily behavioral performance, but also affects mental health and creates emotional problems such as depression.<sup>28</sup> In addition, life satisfaction may affect the individual's perception of people and things around them and the environment, and individuals with low life satisfaction are prone to show negative emotions such as depression, irritability, and anhedonia, and even trigger depression.<sup>29</sup> In contrast, individuals with high life satisfaction can experience the joy and happiness brought by life, thus generating positive emotional feedback and inhibiting the occurrence of depression. Therefore, physical exercise can increase individuals' life satisfaction, which in turn functions as a buffer against depression. Accordingly, this study proposes the research hypothesis H3: Life satisfaction mediates the relationship between physical exercise and the risk of depression.

## Chain Mediation of Self-Assessed Health Status and Life Satisfaction

Physical health is a prerequisite for quality of life, and life satisfaction reflects the quality of life of individuals from subjective feelings. Therefore, individual health status is closely related to life satisfaction, and individuals with good health status have higher life satisfaction.<sup>30</sup> Research has shown that whether individuals are satisfied with their lives is the premise and basis for measuring their psychological health, and the higher the individual's life satisfaction, the better the psychological health, which influences the individual's pursuit and satisfaction of life goals and the corresponding emotional experience.<sup>31</sup> Individuals with lower life satisfaction are more inclined to adopt negative coping styles and experience more negative emotions in daily life, which has an important impact on individual mental health status.<sup>32</sup> Research on the welfare effects of sport from the perspective of individual welfare suggests that the subject of physical demand enhances the level of welfare through participation in physical exercise.<sup>33</sup> Physical exercise enhances individual health, strengthens resistance to disease,<sup>34</sup> reduces negative emotions, brings positive experiences, and improves subjective well-being.<sup>35</sup> Therefore, physical exercise may affect the risk of depression through two mechanisms, namely self-assessed health status and life satisfaction. Accordingly, the research hypothesis H4: self-assessed health status and life satisfaction play a chain-mediated role between physical exercise and risk of depression is proposed.

In summary, based on the literature review of the relationships among the variables of physical exercise, self-assessed health status, life satisfaction, and risk of depression, this study will further explore the relationship between physical exercise and risk of depression and the chain mediating role of self-assessed health status and life satisfaction, and the hypothesized model of the study is shown in [Figure 1](#).



**Figure 1** Conceptual framework.

## Data and Methods

### Data Sources and Research Sample

The data for this study comes from the newly released China Family Panel Studies (CFPS) conducted by the China Centre for Social Science Research at Peking University. The CFPS is a nationally representative social tracking survey that collects information on dynamic changes in a number of research topics at the individual, household, and community levels, with a baseline in 2010 and a tracking survey every two years thereafter. 2020's tracking survey has a target sample size of 16,000 households, with all members of each household surveyed. The target sample size of the 2020 tracking survey is 16,000 households, including all members of each household. The target sample size for the 2020 Family Tracking Survey is 16,000 households, with all members of each household surveyed. The CFPS defines those under age 16 as children and those 16 and older as adults. The population selected for the study is the adult population, ie, the sample of people aged 16 years and older, which totaled 24,504 in the 2020 CFPS database. After removing the missing values and outliers, 21057 valid samples were formed.

### Description of Variables

#### Dependent Variables

The risk of depression was measured using the Centre for Epidemiologic Studies Depression (CES-D) scale. This scale was developed by Radloff of the National Institute of Mental Health (NIMH) in the United States and has been prominently used to assess levels of depression.<sup>36</sup> The CFPS2020 uses an 8-question version of the CES-D with the question "Indicate how often each of these feelings or behaviors has occurred in the past week", including: I feel that life is not going on, I feel sad, I am happy, I feel lonely, I feel happy, I do not sleep well, I find it hard to do anything, and I feel depressed. Assign a value of 0 to 3 to the answers "Almost never, Sometimes, Often, Most of the time" (reverse question transposed). The 8 question item scores were summed and ranged from 0 to 24, with a higher total score indicating a higher risk of depression. The internal consistency Cronbach's  $\alpha$  coefficient for the scale was 0.843, indicating that the internal consistency of the scale was good.

#### Independent Variables

In this study, the frequency of physical exercise was measured by the CFPS2020 adult questionnaire, which was based on the measurement method of Zhong Huamei et al<sup>37</sup> and the answer to the questionnaire "Frequency of physical exercise, excluding cycling and walking for the sole purpose of going off work" was selected. The answers "never, on average less than once a month, on average more than once a month, on average 1-2 times a week, on average 3-4 times a week, on average 5 times a week or more, once a day, twice a day or more" were assigned a value of 0–7, and the answer "in general, how many minutes did you/do you exercise each time in the past 12 months" was assigned a value of 0–7, while the answer "how many minutes did you/do you exercise each time in general" was assigned a value of 0–8. Measurement of exercise time according to "how many minutes you exercised each time in the past 12 months in general". The answer

“average frequency of exercise  $\geq 3$ -4 times per week and duration of exercise  $\geq 30$  min per time” is defined as participation in physical exercise and assigned a value of 2, otherwise assigned a value of 1.

### Intermediate Variables

Self-assessed health status is a better indicator of current health status and prediction of future health status, is a comprehensive indicator of personal health status, has been widely used in research.<sup>38</sup> The question is “How do you/do you think your health status?”, and the answers “unhealthy, average, relatively healthy, very healthy, very healthy” are assigned a value from 1 to 5 respectively.

Life satisfaction is reflected by the individual's subjective evaluation of the quality of life. The question “How satisfied are you with your life?” was selected from the CFPS questionnaire and measured by assigning the answers “very dissatisfied, not very satisfied, average, relatively satisfied, very satisfied” with a value of 1 to 5 respectively, and the higher the score, the higher the life satisfaction. The higher the score, the higher the satisfaction with life.

### Control Variables

Individuals' self-assessed health status is influenced by a variety of factors, such as gender, age, marriage, and place of residence. Therefore, to ensure the accuracy of the statistical results, the above factors were used as control variables.

### Multiple Covariance Test

The VIF values were used to evaluate the multicollinearity between the variables and the test of multicollinearity was performed using SPSS 23.0, if the value is greater than 10, it represents high multicollinearity.<sup>39</sup> The results showed that the VIF values of all the variables were less than 8, indicating no multicollinearity between the variables.

## Statistical Analysis

Statistical analyses were carried out using SPSS 23.0 software and plug-in procedures developed by Hayes' (2013) to conduct reliability, correlation, and regression analyses of the study variables in turn; with the help of model 4 in the SPSS macros developed by Hayes (2013) was used to test for mediation effects, and model 6 was used to test for the cascading mediation effects.

## Results

### Descriptive Statistics and Correlation Analysis

Descriptive statistics showed that the mean age of the sample is  $44.20 \pm 19.44$  years; 10,112 (48.02%) female and 10,945 (51.98%) male; 10,482 (49.78%) in rural areas and 10,575 (50.22%) in urban areas; 3,702 (17.58%) unmarried and 17,355 (82.42%) married. The results of the correlation analysis showed (Table 1) that the correlation coefficients between physical exercise and self-assessed health status, life satisfaction, and risk of depression were statistically significant. Physical exercise was significantly positively correlated with self-assessed health status and satisfaction of life ( $\beta = 0.049$ ,  $p < 0.01$ ;  $\beta = 0.075$ ,  $p < 0.01$ ), and significantly negatively correlated with risk of depression ( $\beta = -0.022$ ,  $p < 0.01$ ); self-assessed health status was significantly positively correlated with satisfaction of life ( $\beta = 0.440$ ,  $p < 0.01$ ), and significantly negatively correlated with risk of depression ( $\beta = -0.047$ ,  $p < 0.01$ ); satisfaction of life was significantly negatively correlated with risk of depression ( $\beta = -0.137$ ,  $p < 0.01$ ).

**Table 1** Descriptive Statistics and Correlation Analysis

	M	SD	1	2	3	4
1. Physical exercise	0.827	1.172	1			
2. Self-assessment health status	7.065	1.901	0.049**	1		
3. Life satisfaction	7.541	2.084	0.075**	0.440**	1	
4. Risk of depression	15.604	3.107	-0.022**	-0.047**	-0.137**	1

Note: \*  $p < 0.05$  \*\*  $p < 0.01$ .

**Table 2** Analysis of Regression Relationship Among Variables

Effect	Term	Effect	SE	t	p	LLCI	ULCI
Direct effect	Physical exercise $\Rightarrow$ Risk of depression	-0.033	0.017	-1.974	0.048	-0.066	-0.000
Indirect effect process	Physical exercise $\Rightarrow$ Self-assessment health status	0.080	0.010	7.728	0.000	0.060	0.100
	Physical exercise $\Rightarrow$ Life Satisfaction	0.095	0.010	9.268	0.000	0.075	0.115
	Self-assessed health status $\Rightarrow$ Life satisfaction	0.479	0.006	76.215	0.000	0.467	0.491
	Self-assessed health status $\Rightarrow$ Risk of depression	-0.028	0.012	2.432	0.015	-0.005	-0.051
	Life satisfaction $\Rightarrow$ Risk of depression	-0.214	0.011	-20.324	0.000	-0.234	-0.193
Total effect	Physical exercise $\Rightarrow$ Risk of depression	-0.059	0.017	-3.507	0.000	-0.093	-0.026

**Note:** LLCI refers to the lower limit of the 95% interval of the estimate, ULCI refers to the upper limit of the 95% interval of the estimate.

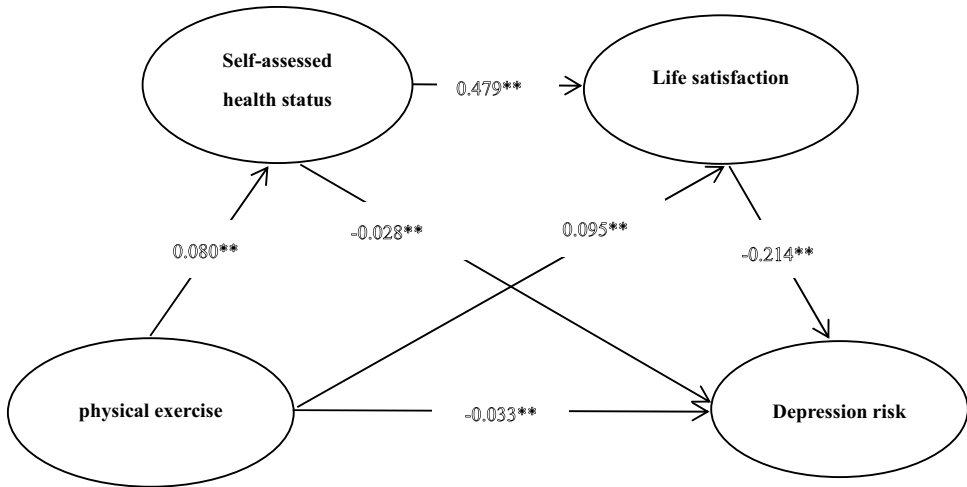
**Table 3** Mediation Effect Analysis of Self-Assessed Health Status and Life Satisfaction

Term	Effect	Boot SE	BootLLCI	BootULCI	z	p
Physical exercise $\Rightarrow$ Self-assessment health status $\Rightarrow$ Risk of depression	0.002	0.000	0.000	0.002	6.085	0.000
Physical exercise $\Rightarrow$ Life satisfaction $\Rightarrow$ Risk of depression	-0.020	0.001	-0.009	-0.005	-20.930	0.000
Physical exercise $\Rightarrow$ Self-assessment health status $\Rightarrow$ Life satisfaction $\Rightarrow$ Risk of depression	-0.008	0.000	-0.004	-0.002	-21.165	0.000

**Note:** LLCI refers to the lower limit of the 95% interval of the estimate, ULCI refers to the upper limit of the 95% interval of the estimate.

### Mediated Effects Test

The results of the correlation analyses met the statistical requirements for further testing the mediating effects of self-assessed health status and life satisfaction.<sup>40</sup> Then, gender, age, place of residence, and marital status were used as control variables for mediation effect tests based on Bootstrap using the SPSS macro program written by Hayes (2013), and chained mediation effect model tests were conducted using Model 6. As shown in Table 2, physical exercise significantly negatively predicted the risk of depression ( $\beta = -0.033$ ,  $p < 0.05$ ), and hypothesis 1 was established. After further inclusion of self-assessed health status and life satisfaction in the regression equation, physical exercise significantly positively predicted self-assessed health status ( $\beta = 0.080$ ,  $p < 0.01$ ) and life satisfaction ( $\beta = 0.095$ ,  $p < 0.01$ ). Self-assessed health status significantly positively predicted life satisfaction ( $\beta = 0.479$ ,  $p < 0.01$ ) and significantly negatively predicted risk of depression ( $\beta = -0.028$ ,  $p < 0.01$ ). Life satisfaction significantly negatively predicted risk of depression ( $\beta = -0.214$ ,  $p < 0.01$ ). At this point, physical exercise still significantly negatively predicted risk of depression ( $\beta = -0.059$ ,  $p < 0.01$ ). The results of the mediation effect test showed (Table 3 and Figure 2) that the mediation effect



**Figure 2** Chain-mediated model of physical activity and risk of depression.

**Note:** \* $p < 0.05$  and \*\* $p < 0.01$ .



study using Bootstrap sampling test with 5000 samples showed that for the mediation path “physical exercise  $\Rightarrow$  self-assessed health status  $\Rightarrow$  risk of depression”, the 95% confidence interval did not include the number 0 (95% CI: 0.000~0.002), thus indicating the existence of this mediating effect path. For the mediating path “physical exercise  $\Rightarrow$  life satisfaction  $\Rightarrow$  risk of depression”, the 95% confidence interval did not include the number 0 (95% CI: -0.009~-0.005), thus suggesting that this mediating effect path exists. Next, the chained mediated effect path was analyzed and for the mediated path “physical exercise  $\Rightarrow$  self-assessed health status  $\Rightarrow$  life satisfaction  $\Rightarrow$  risk of depression”, the 95% confidence interval did not include the number 0 (95% CI: -0.004~-0.002), which means that this mediated effect path exists. Therefore, hypothesis 2, hypothesis 3 and hypothesis 4 are all supported.

## Heterogeneity Analysis of Physical Exercise to Reduce the Risk of Depression

Whether there is heterogeneity in the reduction of risk of depression by physical exercise is tested by including different control variables. The mediating effect study is conducted using the Bootstrap sampling test method with 5000 samples. The results showed that there was no heterogeneity in the effect of physical exercise on the risk of depression by gender, age and marital status, but there was heterogeneity among residents living in different areas. When controlling for residence as city people, the mediating effects are shown in Table 4. The results indicate that for the mediation path “physical exercise  $\Rightarrow$  self-assessed health status  $\Rightarrow$  risk of depression” the 95% confidence intervals and include the number 0 (95% CI: -0.010~0.002), thus indicating that this mediation path does not exist. For the mediating path “physical exercise  $\Rightarrow$  life satisfaction  $\Rightarrow$  risk of depression”, the 95% confidence interval did not include the number 0 (95% CI: -0.031~-0.015), thus suggesting that this mediating effect path exists. Next, the chained mediation path was analyzed. For the mediation path “physical exercise  $\Rightarrow$  self-assessed health status  $\Rightarrow$  life satisfaction  $\Rightarrow$  risk of depression”, the 95% confidence interval did not include the number 0 (95% CI: -0.022~-0.012), which means that this mediation path exists. When controlling for residence as countryside people, all paths of mediation effects exist.

## Discussion

### Direct Effects of Physical Exercise on Depression Risk

The study showed that physical exercise significantly and negatively predicted depression risk, which is consistent with previous findings.<sup>41</sup> The present study tested the research hypotheses with data from a large-scale nationwide survey, further enriching the research on the psychological benefits of physical activity, as well as the theoretical results of research on the effects of physical activity on depression. The latest study reveals the mechanism of physical exercise's antidepressant effect at the cellular level. During aerobic exercise, muscles produce an enzyme called PGC-1 $\alpha$ , and this enzyme raises the level of PGC-1 $\alpha$ 's enzyme in the human body, which in turn helps the brain to fight depression. Thirty-five minutes of moderate-intensity aerobic exercise a day, six days a week, can help reduce symptoms of depression by 47%.<sup>42</sup> In addition, physical activity promotes the production of endorphins, hormones that help the body fight stress.<sup>7</sup> Physical activity also regulates the coordination of the body's systems and promotes metabolism, which often fails to function when the body is under stress or depressed. Physical exercise also promotes social interaction, friends together with the movement will make the mood happy, reducing the depression brought about by the feeling of loneliness and helplessness. After exercise, the body will produce a sense of fatigue so that the quality of sleep improves, helping to eliminate stress and reduce depression. Research shows that modern big city workers work

**Table 4** Mediation Effect Analysis of Self-Rated Health Status and Life Satisfaction (CITY)

Term	Effect	Boot SE	BootLLCI	BootULCI	z	p
Physical exercise $\Rightarrow$ Self-assessment health status $\Rightarrow$ Risk of depression	0.032	0.020	-0.010	0.002	6.085	0.032
Physical exercise $\Rightarrow$ Life satisfaction $\Rightarrow$ Risk of depression	-0.120	0.021	-0.031	-0.015	-10.010	0.000
Physical exercise $\Rightarrow$ Self-assessment health status $\Rightarrow$ Life satisfaction $\Rightarrow$ Risk of depression	-0.033	0.000	-0.022	-0.012	-11.155	0.000

**Note:** Boot LLCI refers to the lower limit of the 95% interval of Bootstrap sampling. BootULCI refers to the upper limit of the 95% interval of Bootstrap sampling. bootstrap type: percentile bootstrap method.

long hours in the office, lack of sunlight exposure, resulting in vitamin D deficiency, prone to depression and other mental illnesses, outdoor physical exercise can help people more exposure to sunlight, reducing the risk of depression. A Meta-analysis confirms that there is no significant difference in the effectiveness of physical exercise in treating depression compared to other treatments such as physical, psychological, and medication.<sup>43</sup> In China, drugs are still the main treatment for depression, and physical exercise should be more widely promoted as a positive and non-side-effective treatment.

## Direct Effects of Self-Rated Health and Life Satisfaction on Depression Risk

Studies have shown that poor self-assessed health status is a major risk factor for depression in older adults, and the risk of depression in older adults with poor self-assessed health status is 3.47 times higher than that in older adults with good self-assessed health status. This may be due to the fact that self-assessed health status largely reflects the objective health status of older adults, which has a significant impact on depression<sup>44</sup> and that compared to those with a negative and pessimistic outlook, those with a positive and optimistic personality tend to make a higher assessment of their own health status than they actually do. Positive people tend to rate their health higher than their actual health status compared to negative and pessimistic people<sup>45</sup> and optimistic personality is significantly negatively correlated with depression.<sup>46</sup> People with good self-assessed health are energized about their work life, while people with poor self-assessed health are constantly worried about their health and become pessimistic, which leads to depression. Therefore, it is important not only to pay attention to physical health and improve their objective health status, but also to pay attention to mental health and encourage them to maintain a positive and optimistic attitude towards life. Life satisfaction was found to be another key element affecting the risk of depression; the lower the life satisfaction, the more likely they are to develop negative emotions such as self-denial, and the higher the risk of developing depressive symptoms, consistent with previous research.<sup>47,48</sup> By increasing life satisfaction, it is possible to generate positive factors that benefit mental health, control negative emotions and reduce the risk of depression.

## Mediating Effects of Self-Assessed Health Status and Life Satisfaction

This study found that self-rated health mediated the relationship between physical activity and risk of depression. People who regularly participate in physical activity are more confident about their health status, thus avoiding depression due to concerns about their health. Studies have shown that college students' attitudes and behaviors, such as physical activity and healthy living habits, are largely influenced by judgments of their own physical health level, and correctly evaluating their physical health is a crucial foundation for it.<sup>49</sup> People who regularly engage in physical exercise have developed good physical exercise habits, have a more regular routine, have a deeper understanding of their own health, and have a lower incidence of depression and other psychological disorders.

This study found that life satisfaction mediates the relationship between physical activity and risk of depression. Physical activity not only allows you to spend time and relax, but also connects you more closely with your family and friends through enjoyable group exercise. It enhances our quality of life and increases life satisfaction, thus reducing negative emotions that arise from dissatisfaction with life. According to the "spillover theory", the positive emotional experiences, attitudes and behaviors induced by good physical activity habits have a direct impact on life satisfaction, leading to a more positive attitude towards life and a more stable mood, which further reduces the risk of depression.<sup>50</sup>

The present study found that self-rated health status did not mediate the effect of physical activity on depression risk in the group living in urban areas, whereas in the group living in rural areas, there was a mediating effect. The possible reason for this is that the urban group had better medical conditions, were more aware of their health status, and were more objective in their evaluation of their self-rated health status, and therefore they were more inclined to predict and ameliorate depression by medical means. The rural group, however, had poorer medical conditions and lower literacy levels, which led to a greater reliance on self-judgment of illness. However, studies have found that physical activity participation in rural groups in China is consistently lower than that in urban groups.<sup>51</sup> Therefore, on the one hand, we need to strengthen the improvement of medical conditions in rural areas, and scientifically assess and prevent diseases; on the other hand, we need to encourage rural groups to strengthen physical exercise and actively prevent diseases.



## Chain Mediation of Self-Assessed Health Status and Life Satisfaction

The present study further found that physical activity was able to predict the risk of depression through the chain-mediated effects of self-rated health and life satisfaction. It was found that with the development of society, individuals' awareness and concepts of health are increasing, gradually evolving from passive health in the past to active health. Physical exercise has been widely emphasized as an important means of active health.<sup>52</sup> People who regularly engage in physical exercise pay more attention to their own health status, which further improves their health level. Individuals with a high level of health status are more experienced in life and more able to overcome difficulties encountered in life.<sup>53</sup> If, for example, there is a pessimistic attitude towards their health status, then life satisfaction will drop sharply, triggering depression and other psychological disorders. Therefore, physical exercise should be widely promoted as a positive and active health tool in reducing the risk of depression. In the process of deeply promoting the national strategy of national fitness, residents should be guided and encouraged to reduce the risk of depression by participating in physical exercise. The government, schools and other relevant departments should further strengthen publicity and education to foster a lifelong awareness of physical exercise.

## Research Limitations and Prospects

This study examined the combined effects of physical exercise, self-rated health and life satisfaction on the risk of depression using a large national census sample. The results obtained provide a realistic basis for reducing depression risk. This study explored the mechanism of depression risk reduction from a subjective psychological perspective, but the causal relationship between variables needs to be further verified. Further experimental interventions could be conducted in the future. In addition, this study used self-assessed health status and life satisfaction as mediating variables, but there are other factors affecting depression, such as happiness and job satisfaction, which need to be further verified.

## Conclusion

Physical exercise not only negatively predicted the risk of depression, but also indirectly predicted the risk of depression through the independent mediating effects of self-rated health and life satisfaction, as well as chain mediating effects. There were no differences in the effects of physical exercise on depression risk across age, gender and marital status. Significant differences in the effect of physical exercise on depression risk were found among groups with different places of residence.

## Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Ethics Approval

This study involves human participants. The survey was reviewed and approved by the Peking University Biomedical Ethics Review Committee (approval number: IRB00001052-14010). Participants gave informed consent to participate in the study before taking part.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

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