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Association between lifestyle factors and mental health in apparently healthy young men

Yue Feng[1†], Yanpu Jia[2†], Jialin Jiang[3†], Ruwen Wang[1], Cheng Liu[1], Weizhi Liu[2*] and Ru Wang[1*]

Abstract

Objective The study aims to explore the relationship between modifiable lifestyle factors (physical activity, sedentary time, body composition, muscle strength) and mental health, and predict future changes in mental health.

Methods A cross-sectional survey was conducted on 133 men (age: 29.03 ± 6.605 years, BMI: 23.58 ± 2.688 kg/m^2) to assess baseline body composition, muscle strength, sedentary time, and mental health, with follow-up at 3 months. F-tests were employed to compare the differences in mental health on sedentary time and body composition variables. Spearman correlation analysis was used to examine correlations between variables.

Results Spearman's correlation analysis showed that sedentary time, muscle strength and mental health of the subjects were significantly correlated. BMI, BFM, BFMI, PBF were higher in subjects with ≥ 4 h of sedentary time than in the other two shorter sedentary time groups. Subjects with higher PBF ($p = 0.047$, $\eta^2 = 0.030$) and BFM ($p = 0.032$, $\eta^2 = 0.035$) had severer depression. Subjects who sat for ≥ 4 h at a time were more severely depressed than those who sat for 2–4 h ($p = 0.020$). Change in depression was significantly negatively correlated with BMI, BFM, BFMI and PBF. Subjects with higher PBF ($p = 0.023$, $\eta^2 = 0.050$) and BFM ($p = 0.005$, $\eta^2 = 0.075$) at the baseline had less change in depression.

Conclusion A Significant correlation was found between sedentary time, body composition and mental health, and baseline body composition predicted changes in mood three months later.

Keywords Physical activity, Sedentary, Body composition, Muscle strength, Mental health

†Yue Feng, Yanpu Jia and Jialin Jiang contributed equal to this work.

*Correspondence:
Weizhi Liu
13024141970@163.com
Ru Wang
wangru@sus.edu.cn
[1]School of Exercise and Health, Shanghai University of Sport, Shanghai 200438, China
[2]The Emotion & Cognition Lab, Faculty of Psychology and Mental Health, Naval Medical University, Shanghai 200433, China
[3]Otorhinolaryngology Head and Neck Surgery, The First Affiliated Hospital of Naval Medical University, Shanghai 200433, China

Introduction

Mental health problems are mainly caused by anxiety and depression, the global prevalence of which has increased significantly after the COVID-19 epidemic. Specifically, the number of patients with anxiety and depression disorders reached 374 million and 246 million, respectively, making them major contributors to the global burden of disease [1]. According to the latest report, the detection rates of depression risk and anxiety risk in China are 10.6% and 15.8%, respectively, with young people constituting the high-risk group of anxiety and depression [2]. Moreover, the financial loss induced by anxiety and depression is enormous. The global cost of depression and anxiety is expected to reach $1 trillion a year and double by the year 2030 [3, 4]. Therefore, anxiety and depression have become significant public health concerns that require timely identification of modifiable risk factors for prevention.

Exercise training for health promotion is one of the most significant global trends in health and fitness [5, 6]. Various exercise training methods have been shown to have positive effects on the body and mental health [7, 8]. One of the risk factors for developing anxiety and depression is a lack of exercise. By contrast, regular exercise has been shown to improve health in both healthy people and those with mild to moderate illnesses [9, 10]. The current research mainly focuses on exploring the potential effects of exercise intensity, duration, and variety on anxiety and depression [11, 12]. Regular long-term exercise is beneficial to reduced depression and anxiety, while acute exercise generally enhances mood and cognitive performance in healthy individuals [13]. The mechanism underlying this phenomenon may be the regulation of the functional balance of the hypothalamic-pituitary-adrenal axis, the secretion of brain-derived neurotrophic factor, and an increase in the level of inflammation in the body [14–16]. Despite a wealth of potential explanations, the findings on the positive correlation between exercise and anxiety and depression are inconsistent in terms of prevention and treatment, which could result from the ignorance of the effects of body composition and sedentary time.

Although body composition indicators such as BMI and waist circumference have been widely used to evaluate overweight or obesity, more precise measures of body composition are needed to differentiate between the components of skeletal muscles and fat. Furthermore, there are inconsistent research findings in adult populations regarding the separate relationship between sedentary behaviour and obesity. However, there is inconsistent research in adult populations regarding the separate relationship between sedentary behavior and obesity [17]. In another study of sedentary time, positive associations with BMI and waist circumference were found to be significant only among participants with inadequate levels of physical activity [18]. Studies have shown an independent positive correlation between sedentary time and BMI, waist circumference and body fat mass [19–21]. Meanwhile, increased physical activity levels have been found to be associated with improved mental health [22, 23], while sedentary time have been found to be related to the risk of depression and anxiety [24]. Despite the interaction between exercise and sedentary, higher levels of physical activity may counteract the negative effects of sedentary lifestyles on body composition. Still, it is unclear whether the association between sedentary lifestyles, physical fitness, and mental health has long-term effects as it is poorly studied. Therefore, prioritising strategies to prevent depression and anxiety requires clarifying the association between sedentary lifestyles, physical fitness, and mental health.

The main objectives of this study include further exploring the association between modifiable lifestyle factors (i.e. body composition, muscle strength, and sedentary time) and mental health, predicting future changes in mental health, and providing a theoretical basis for early prevention and identification of emotional problems.

Methods

Study population

In this study, 133 healthy Chinese men were recruited from the community to volunteer for research. Conducted between January 2023 and December 2023, it involves the following inclusion criteria: (1) males exclusively, aged from 18 to 45; (2) cooperation in the collection of psychological and physical fitness measures. Meanwhile, the exclusion criteria for selecting the study sample are as follows: (1) Traumatic brain injury, organic brain disease, and other major systemic diseases, (2) Psychiatric disorders (3) Skeletal and muscular diseases, cardiovascular and cerebrovascular diseases, and immunological diseases; (4) a history of significant trauma and surgery. This study was ethically approved by the Ethics Committee of the Naval Medical University, with all participants fully informed and having signed an informed consent.

Measure

Anthropometric measurement

A mechanical stadiometer was used to measure height in metres (m). An Inbody 120 (BioSpace, Seoul, Korea) body composition analyser was used to monitor Fat and muscle composition parameters [20]. Measurement indicators include body weight, body fat mass (BFM), skeletal muscle mass (SMM), and percentage of body fat (PBF, based on which body mass index (BMI) = weight (kg)/height^2 (m^2), fat mass index (BFMI) = fat mass (kg)/height^2 (m^2), and skeletal muscle mass index (SMI) = skeletal muscle mass (kg)/height^2 (m^2) were calculated. During the measurement, the subjects wore light, short-sleeved sportswear without any metal accessories, such as watches, necklaces, and belts, as well as shoes or socks.

Muscle strength measurement

In order to measure muscle strength, hand grip strength was chosen to reflect upper limb static strength, while vertical jump height was used to reflect lower limb strength. Qualified staff were trained to assess hand grip strength using the K-Force® Grip device (Kinvent™, Montpellier, France). In the hand grip strength test, the subject was required to stand with the arm straight and slightly away from the body, with the wrist in a neutral position, and exert maximum force with the dominant hand three times. The best of the three times was taken as the final score. If the subject's dominant hand was injured, the test was performed using the non-dominant hand. The longitudinal jump test system (Techguide TZCS-3, China) was used to measure the lower limb strength based on the longitudinal jump height. Subjects were asked to flex their hips, knees and ankles, perform a downward reverse extension movement and then jump as high as possible, keeping their lower limbs fully extended during the post-jump release process. Subjects were tested three times for each movement, with a 1-minute rest between each test, and the data from the highest jump of the three tests were taken for subsequent analysis.

International Physical Activity Questionnaire-Short Form (IPAQ-SF)

The IPAQ-SF consists of seven questions, with questions 1–6 collecting time at physical activity levels (light physical activity level, moderate physical activity level, and vigorous physical activity level, and question 7 collecting average daily sedentary time in the most recent week. Sedentary time was used in subsequent statistical analyses.

Table 1 Demographic information

		M	SD
Age		29.03	6.605
Sedentary time		1.77	0.795
	≤ 2 (N, %)	52	37.1
	2-4 (N, %)	37	26.4
	≥ 4 (N, %)	26	18.6
Inbody information			
	BMI	23.58	2.688
	BFM	12.86	5.485
	BFMI	4.23	1.781
	SMM	33.36	3.420
	SMI	10.96	0.842
	PBF	17.42	5.707
Muscle strength			
	Max hand grip strength	41.10	8.449
	Handgrip strength body mass index	57.99	12.569
	Vertical jump height	29.76	9.000
Mental health			
	Depression- T1	3.75	3.844
	Depression- T2	5.01	3.440
	Anxiety- T1	2.63	3.633
	Anxiety- T2	3.16	3.285

Assessment of anxiety and depressive states

The subjects' anxiety and depression scales were collected the two separate points in time, with T1 being the baseline and T2 being 3 months later. Depression and were assessed using the Patient Health Questionnaire-9 (PHQ9) questionnaire and the Generalised Anxiety Disorder 7 (GAD-7) item questionnaire, respectively.

Data availability

The datasets analysed during the current study are not publicly available due unpublished but are available from the corresponding author on reasonable request.

Statistical analyses

The data of this study were analysed using SPSS 20.00 statistical software. Continuous variables were expressed as mean ± standard deviation (mean ± SD). F-tests were used to assess differences in mental health on sedentary time and body composition variables. A nonparametric Spearman correlation test was performed to examine the relationships among the variables of body composition, sedentary time, muscle strength and mental health. The significance level p was set to <0.05 (two-tailed).

Result

Demographic information

The demographic characteristics of the participants were reported respectively in Table 1. There were 133 males included. The average age was 29.03 ± 6.605 years. Participants with sedentary time ≤ 2, 2–4, and ≥ 4 were 37.1%, 26.4% and 18.6%, respectively. The inbody information including BMI, BFM, BFMI, SMM, SMI and PBF were indicated in Table 1. The average max hand grip strength, handgrip strength body mass index and vertical jump height were also presented. The average depression in T1 and T2 were 3.75 ± 3.844 and 5.01 ± 3.440 respectively, while anxiety in T1 and T2 were 2.63 ± 3.633 and 3.16 ± 3.285, respectively.

Correlations between sedentary time, inbody factors, muscle strength and mental health at T1

As indicated in Table 2, spearman correlation analysis revealed that depression was significantly correlated with inbody factors including BMI ($r=0.192$, $p=0.028$), BFM ($r=0.218$, $p=0.012$), BFMI ($r=0.216$, $p=0.013$) and PBF ($r=0.213$, $p=0.015$). Anxiety was positively correlated with sedentary time ($r=0.194$, $p=0.040$), suggesting that longer sitting may be detrimental to mood. In addition, longer sedentary time was correlated with inbody factors and muscle strength. Therefore, there are significant positive correlations between sedentary time, muscle strength and mental health of participants, revealing the vital role of body exercise in the process.

Table 2 The correlations between sedentary time, inbody factors, muscle strength and mental health at T1

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	1.000												
2. BMI	0.288***	1.000											
3. Sedentary time	0.144	0.218*	1.000										
4. BFM	0.391***	0.887***	0.242*	1.000									
5. BFMI	0.412***	0.886***	0.232*	0.991***	1.000								
6. SMM	-0.030	0.636***	0.115	0.406***	0.320***	1.000							
7. SMI	0.014	0.783***	0.113	0.425***	0.407***	0.833***	1.000						
8. PBF	0.444***	0.810***	0.236*	0.971***	0.984***	0.213*	0.281***	1.000					
9. Handgrip strength body mass index	-0.349***	-0.384***	-0.144	-0.472***	-0.468***	-0.190*	-0.136	-0.461***	1.000				
10. Max hand grip strength	-0.238**	0.154	-0.007	0.012	-0.022	0.349***	0.330***	-0.055	0.803***	1.000			
11. Vertical jump height	-0.304***	-0.145	0.010	-0.142	-0.146	-0.083	-0.082	-0.139	0.189*	0.091	1.000		
12. Depression-T1	0.205*	0.192*	0.173	0.218*	0.216*	0.088	0.093	0.213*	-0.155	-0.055	-0.127	1.000	
13. Anxiety-T1	0.228**	0.131	0.194*	0.138	0.135	0.064	0.078	0.134	-0.099	-0.032	-0.132	0.851***	1.000

Note: *** p<0.001; ** p<0.01; * p<0.05

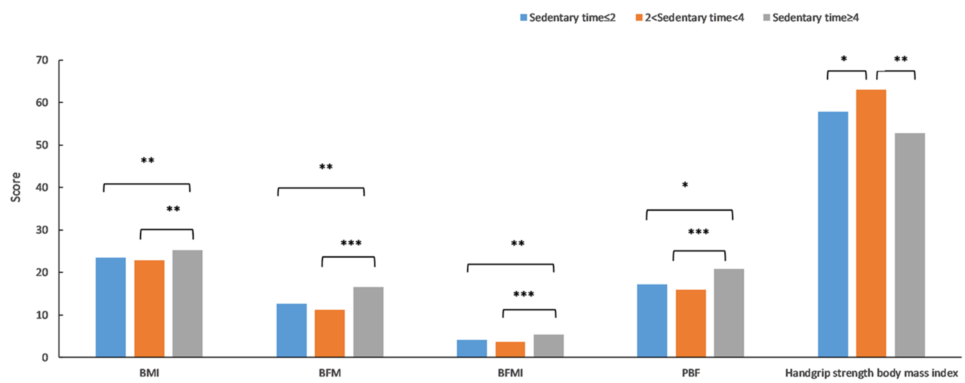

Fig. 1 The effect of sedentary time on the inbody and muscle strength

The influence of sedentary time on the inbody and muscle strength

The influence of sedentary time on the inbody and muscle strength is shown in Fig. 1. Significant differences were found in BMI (F=5.935, p=0.004,η^2=0.100), BFM (F=7.625, p<0.001, η^2=0.125), BFMI (F=6.326, p=0.003, η^2=0.106), and PBF (F=5.723, p=0.004, η^2=0.097) of inbody factors, and handgrip strength body mass index (F=5.697, p=0.004, η^2=0.097) of muscle strength. Furthermore, according to the pairwise test, the participants with sedentary time≥4 presented higher BMI, BFM, BFMI and PBF than those with sedentary time≤2 and 2–4. Therefore, given the effects of sedentary time on the inbody and muscle strength, the study then suspects that there may be an influence on mental health; therefore, another F-test was then conducted.

The influence of inbody factors and sedentary time on mental health

As indicated in Fig. 2, inbody factors and sedentary time exerted effects on mental health. First, four inbody factors were divided into two groups (high vs. low) based on their average level so as to explore the influence of inbody index on mental health. Results showed that PBF and BFM exerted significant effects on mental health. Specifically speaking, participants with higher PBF (F=4.010, p=0.047, η^2=0.030) and BFM (F=4.712, p=0.032, η^2=0.035) had severer depression. As for the sedentary time, there was no significant effect of sedentary time on no matter depression (F=2.777, p=0.067, η^2=0.050) or anxiety (F=1.726, p=0.183, η^2=0.032). However, the pairwise test found that the participants with sedentary time≥4 at a time (p=0.020) had severer depression than that of 2–4, indicating the negative effects of sedentary time on mental health.

The relationship between the change in mental health and other factors

In order to further explore the changes in mental health, a correlation analysis was first conducted. The changes were represented by the difference between anxiety or depression levels at baseline (T1) and anxiety or depression levels three months later (T2) in the present study. According to Table 3 revealed that the change of depression (T2 - T1) was negatively correlated with inbody factors including BMI (r = -0.257, p=0.009), BFM (r = -0.282, p=0.004), BFMI (r = -0.273, p=0.005) and PBF (r = -0.247, p=0.012). The relationship between inbody factors and depression suggests that physical conditions may predict changes in mental health.

The predictive effect of inbody factors on mental health

F-test was used to further explore the predictive effects of inbody factors on mental health, as shown in Fig. 3. The results indicated that PBF and BFM at the baseline exerted significant effects on the change in mental

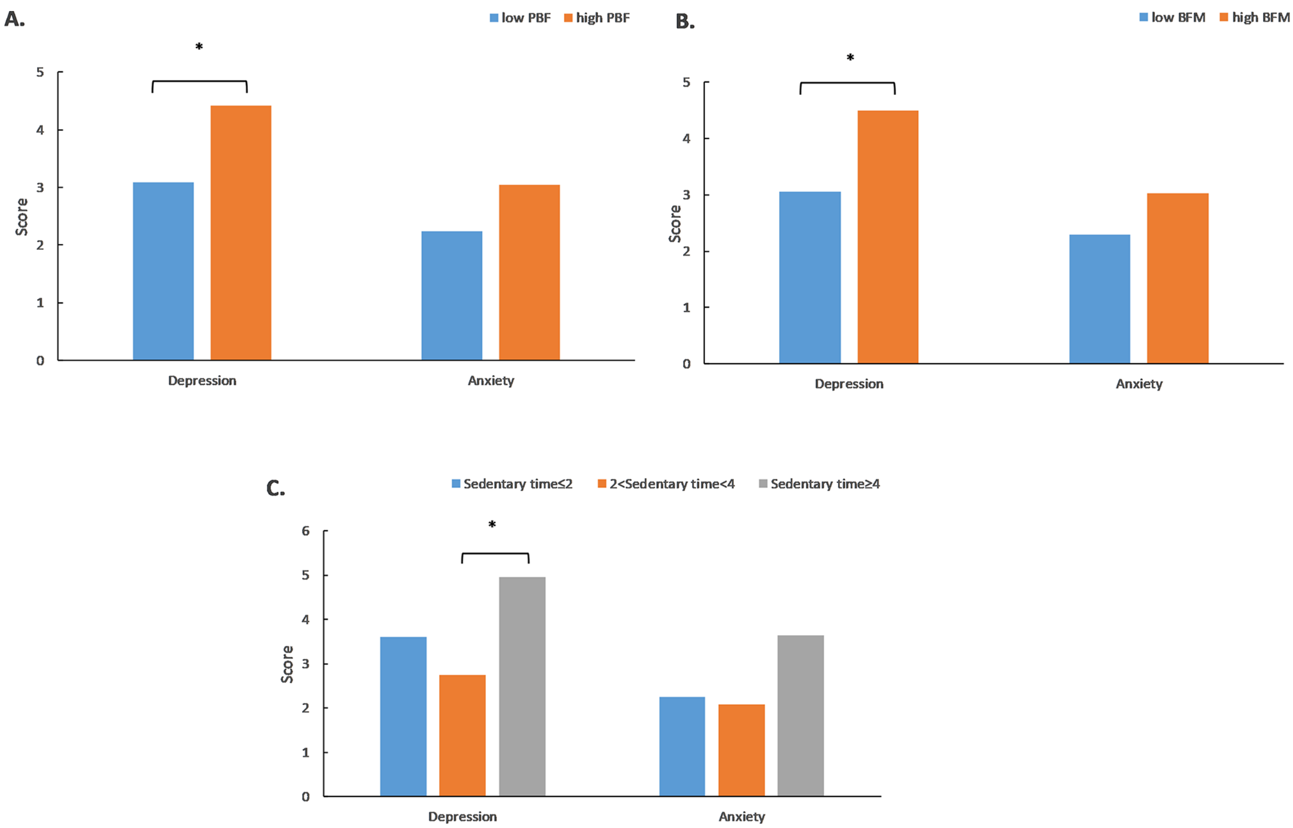

Fig. 2 The effect of inbody factors and sitting hours on the mental health

Table 3 The correlations between sedentary time, inbody factors, muscle strength and the change of mental health

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	1.000												
2. BMI	0.288***	1.000											
3. Sedentary time	0.144	0.218*	1.000										
4. BFM	0.391***	0.887***	0.242*	1.000									
5. BFMI	0.412***	0.886***	0.232*	0.991***	1.000								
6. SMM	-0.030	0.636***	0.115	0.406***	0.320***	1.000							
7. SMI	0.014	0.783***	0.113	0.425***	0.407***	0.833***	1.000						
8. PBF	0.444***	0.810***	0.236*	0.971***	0.984***	0.213*	0.281**	1.000					
9. Handgrip strength body mass index	-0.349***	-0.384***	-0.145	-0.472***	-0.468***	-0.190*	-0.136	-0.461***	1.000				
10. Max hand grip strength	-0.238**	0.154	-0.007	0.012	-0.022	0.349***	0.330***	-0.055	0.803***	1.000			
11. Vertical jump height	-0.304***	-0.145	0.010	-0.142	-0.146	-0.083	-0.082	-0.139	0.188*	0.090	1.000		
12. Depression (T2-T1)	-0.163	-0.257**	-0.191	-0.282**	-0.273**	-0.167	-0.153	-0.247*	0.175	0.029	0.137	1.000	
13. Anxiety (T2-T1)	-0.054	-0.144	-0.095	-0.111	-0.103	-0.138	-0.144	-0.081	0.001	-0.078	0.065	0.575***	1.000

Note: *** p<0.001; ** p<0.01; * p<0.05

health. Specifically speaking, the participants with higher PBF (F=5.318, p=0.023, η^2=0.050) and BFM (F=8.244, p=0.005, η^2=0.075) at the baseline had less change in depression (T2 - T1). The results suggest that physical conditions at baseline to some extent predict psychological changes three months later.

Discussion

Existing studies have focused on the effects of different exercise types, duration, and intensity on mental health, while fewer studies have examined the relationship between physical activity levels, sedentary time, body composition, and mental health. Therefore, the present study focuses on the effects of body composition, muscle strength, and sedentary time on men's mental health, especially the changes in subjects' mental health after 3 months of baseline prediction. The main findings suggest that there is a significant correlation between sedentary time, body composition, muscle strength, and mental health, with longer sedentary time associated with higher body fat content, and more severe depression. Notably, body composition at baseline somewhat predicted psychological changes three months later.

Recent studies on physical activity levels, sedentary time, body composition and muscle strength have all mentioned gender differences. There are anatomical

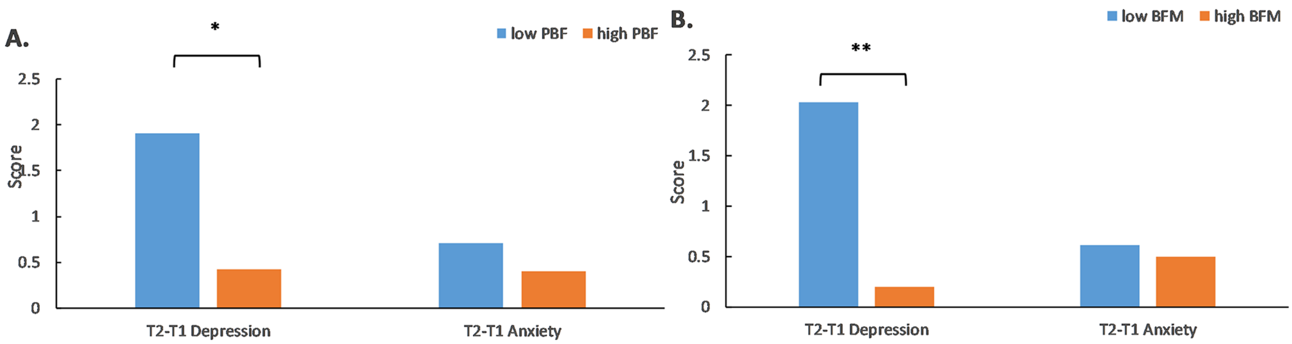

Fig. 3 The predictive effect of inbody factors on the change of mental health

and physiological differences between the sexes, and the decline with age may be different [25]. Prolonged sedentary behaviour was significantly correlated with total body fat distribution (especially abdominal fat accumulation), independent of physical activity levels, and a higher percentage of fat in women than in men. In addition, differences in hormone levels also contribute to the fact that men tend to have greater muscle mass and strength than women [26]. In addition to differences in fitness levels, there are also gender differences in the neural basis associated with the ability to regulate emotions, with males having a higher ability to regulate emotions than females. Given these gender differences, this study will place its focus on male subjects for further exploration [27].

Age-related degenerative changes in body tissues (muscle, fat and bone) that reduce overall strength and function can result in disease [28, 29]. The body composition phenotypes of the organism can be studied using the relationship between BMI, grip strength, skeletal muscle mass and fat mass [30, 31]. As shown in the research results, although the mean BMI and mean body fat percentage were within the normal range for Chinese men, age was significantly negatively correlated with HGS and jump height, and significantly positively correlated with BFM, BFMI and PBF, in line with the correlation between age and body composition. In addition, BMI was significantly correlated with sedentary time, fat mass index and grip strength body mass index, suggesting a link between body composition and sedentary behaviour. The research results, then, revealed that the longer the sedentary time, the higher the fat-related index of the subjects, suggesting that sedentary behaviour influences body composition and promotes the development of obesity. It is also found that indicators of body composition (BMI, body fat percentage, FMI, muscle mass, MMI) are significantly correlated with grip strength [32]. Hand grip strength serves as an indicator of individuals' overall muscular strength, but some parameters can significantly reduce hand grip strength, such as increased fat mass index, increased age, etc. [33]. In a study on the normative values of grip strength in a large sample of Chinese people, the mean grip strength for men aged 30+was 42.12 kg [32]. In the study, the mean grip strength was slightly lower, probably due to differences in body composition (fat mass and muscle mass). The research findings showed that grip strength was significantly positively correlated with SMM and SMI, and grip body mass index was significantly negatively correlated with BFM, BFMI and PBF, suggesting that increasing skeletal muscle content can increase upper limb strength, but it is necessary to control the generation of fat content. Therefore, it can be seen that there is a relationship between body composition, sedentary time and muscle strength. It is hypothesised that prolonged sedentary time alters body composition, exerting effects on muscle strength. However, the specific mechanisms involved need to be investigated further.

Regular exercise can not only change body composition and increase muscle strength but also improve mental health and reduce negative emotions such as anxiety and depression, thus promoting physiological or psychological changes [34]. The relationship between physical activity and sedentary behaviour has been controversial in recent years. The study suggests that there may be no direct relationship between levels of physical activity and sedentary behaviour, namely, the effects of sedentary behaviour on health are not related to physical activity [35]. In addition, the effects of sedentary behaviour on mental health are currently less well understood, with anecdotal evidence found in short- and long-term intervention trials, and no conclusive evidence on the specific mechanisms of sedentary behaviour. Previous studies have correlated different physical fitness indicators with mental health risk separately and found that obesity and sedentary time were positively correlated with the risk of anxiety and depression, and grip strength was negatively correlated with the risk of depression and anxiety [36]. This is consistent with the findings of the present study that body fat indicators and sedentary time were positively correlated with depression, and sedentary time was positively correlated with anxiety. In addition, longer sedentary time and higher body fat are associated with more severe levels of depression at baseline. It is worth noting that the change in depression levels after three months remained significantly negatively correlated with inbody factors, whereas higher body fat was associated with smaller changes in depression, presumably due to the fact the subjects with higher baseline depression levels have higher body fat, while the subjects with lower body fat have more room for depression levels to rise. The available evidence suggests that different forms of exercise training, including yoga, Pilates and High-Intensity Interval Training, positively influence body composition and psychological adaptation [37–40]. Therefore, future studies could consider designing comparative interventions of different exercise forms to further explore the direct effects and underlying mechanisms of these exercise modalities on body composition and mental health.

Limitations

Nevertheless, the study also has some limitations. Firstly, the study employed a cross-sectional design with only a 3-month follow-up on mental health, which may not adequately reflect long-term trends and causal relationships between variables. Future studies should adopt a longer-term longitudinal design to more accurately observe changes in mental health. Secondly, this study only included male subjects and did not compare differences across age groups or genders. Further research needs to expand the range of subjects to improve the generalizability of the findings. Lastly, this study lacked intervention measures, which may prevent direct assessment of how changes in lifestyle factors affect mental health. Future research could design exercise intervention programs based on factors such as exercise type, intensity, and duration to assess the impact of exercise on improving mental health, and further explore the potential biological mechanisms.

Conclusions

There is a significant correlation between sedentary time, body fat-related index, grip strength and anxiety and depression. The longer the sedentary time and the higher the body fat content, the more severe the depression. Notably, body composition at baseline is somewhat predictive of mood change three months later, providing a new perspective for predicting future mental health. These findings emphasize the significant impact of lifestyle factors on mental health, providing empirical evidence for developing targeted mental health intervention strategies. Future research could design and implement targeted exercise intervention measures based on this study to improve modifiable lifestyle factors, while also exploring in depth the specific mechanisms by which these interventions affect mental health.

Abbreviations

BFM	Body fat mass
SMM	Skeletal muscle mass
PBF	Percentage body fat
BMI	Body mass index
BFMI	Fat mass index
SMI	Skeletal muscle mass index
IPAQ-SF	International Physical Activity Questionnaire-Short Form
PHQ9	Patient Health Questionnaire-9
GAD-7	Generalised Anxiety Disorder 7
SD	Standard deviation

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Author contributions

YF, YJ and JJ contributed to the writing of this article and are the co-first authors. RW and CL contributed to the data collection and article revised. WL and RW led the whole study, including putting this study forward and carrying out the study; they are the co-corresponding authors.

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Data availability

The datasets analysed during the current study are not publicly available due unpublished but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All procedures were conducted in accordance with the relevant guidelines, regulations, and the ethical standards set forth in the Declaration of Helsinki. Ethical approval was granted by the Committee on Ethics of Medicine of Naval Medical University on 03/03/2022(No: AF-HEC-012). All participants were fully informed and signed an informed consent form.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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