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"Lifting More" is Associated with Lower Risks of Depression in University Students

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ABSTRACT

Research on the population in western world showed that, MSE (muscle-strengthening exercise) is beneficial to the treatment of mental disorders. However, the situation in Chinese adults is little known. For this reason, the study is performed to understand the connection between depression and MSE among college and university students in China aged between 18 to 24.1793 college students have been recruited, and their average age is 20.67. A questionnaire has been developed and it is self-reported and designed to collect information about MSE and participants, including body mass index and sex and so on. Sleep and physical activity have been evaluated by introducing two scales, that is, Pittsburgh Sleep Quality Index and International Physical Activity Questionnaire-Short Form, respectively. Moreover, Patient Health Questionnaire-9 has been adopted to indicate the severity of depression of participants. The link between depression and MSE has been studied by introducing multilevel linear regression. Among all these study participants, just 24.87% of them met the MSE standards of World Health Organization, that is, more than 2 days every week. The average depression score was 6.80 ($\pm$5.19). Greater number of days for MSE shows negative association with the depression, with beta = -0.17, 95% CI: -0.31 to -0.03, $p = 0.015$). Those students failing to meet MSE standards are more susceptible to the depression risk (beta = 0.63, 95% CI: 0.09–0.19, $p = 0.027$). The results show that, there is a relationship between MSE participation and relieved status of depression among young adults in China. Interventions designed to relieve depression can be developed on the basis of MSE.

KEYWORDS

College students; depression; mental health; muscle strengthening activity

1 Background

The symptoms of depression include poor concentration, tiredness, loss of appetite, poor quality of sleep, low self-worth, feelings of guilt, loss of interest and sadness [1,2]. Depression is one of health problems in the world [2,3], and there are over 264 million people with depression in the whole world [2]. Depression is a frequently-occurring disease, and it is detrimental to people's physical health and mental wellbeing [4–6], and a considerable number of people with depression tend to commit suicide [2]. According to a data released more recently, depression is one of three major and frequently-occurring disease burden in the world, and it ranks 1st in developed countries. It is expected that, by the year 2030, it will become the greatest disease burden in the world, and the rate of suicide related to depression is likely to go up [7]. A report of World Health Organization (WHO) shows that, depression is associated with greatest morbidity just next to cancer [2]. A lot of young adults are diagnosed as having depressive symptoms in the world, and depression is one of major diseases that lead to death among young adults [8–10]. The interaction between a number of multidimensional elements makes young adults even more susceptible to the depression [11,12]. Much attention has been paid to the depression prevalence among college students in China [13,14]. As a health problem and public health threat, depression is widely concerned by practitioners, scholars and policy makers. Among them, an effort is "Working Plan for Exploring Special Services for the Prevention and Treatment of Depression" issued by the Chinese General Office of the National Health Commission. It is provided that, the screening of depression shall be carried among college students in China.

As the prevalence of depression and the harmfulness of depression as health burden increases, researchers are motivated to study risk factors associated with depression [15,16], with an eye to developing effective measures to control the morbidity of depression. A number of research show that, enough physical activity (PA) helps prevent young adults from having depression [17–20]. However, most of the research are more concerned with PA as a whole, rather than showing special interest on one PA modality, for example, muscle-strengthening exercise, that is, MSE. To gain deep understanding of PA in relieving depression, more specific research is needed. World Health Organization (WHO) gave advises to worldwide adults to do aerobic PA of moderate intensify for more than 150 min every week or more than 75 min of aerobic PA of great-intensify every week. What's more, it is worth nothing that, according to the advises of WHO, the amount of PA should be distributed to more than 2 days within a week. However, the evidence showing the benefit of PA in preventing and relieving depression is mostly obtained from the research on aerobic PA, while the specific connection between anti-depression effect and MSE remains unknown. Lately, several studies have been carried to reveal the connection between depression and MSE as the role of MSE in promoting health has been recognized [21]. Bennie et al. [22] has released the results of a cross-sectional study, which is conducted among adults in Germany, and these adults are representative in this respect. The result shows that MSE is considered as a likely protective factor against the symptoms of depression. Meanwhile, the epidemiological study also shows that, the positive role of MSE in preventing adults from having depression cannot be underestimated. However, there is no strong evidence supporting the relationship between the indicators of mental health and MSE, and some negative evidence is found among some age and ethnic groups [23].

Although some achievement has been made by prior research, there are a number of limitations with them. One limitation lies in that, most of past studies are conducted based on the populations in western countries, while few research has been done to study the population in China with respect to the influence of MSE on depression. Another limitation is that there is no explanation or measurement of confounders when studying the relationship between depression and MSE. For example, two researched did not allow for two major confounders, that is, sleep duration and sedentary behaviors, as they are considered as two important correlative factors of depression among young adults. Sedentary behavior and sleep are major factors that help reveal the potential moderators for the association between depression and MSE [24].

The current research is designed to identify the literature gap and reveal the relationship between depression and MSE among young adults in China. By doing the research, the similarity of past research can be addressed, and the research also provides theoretical basis for the development of effective policies aimed at preventing and controlling depression among young adults in China.

2 Methods

2.1 Study Design and Participants

The current research is inspired by an ongoing longitudinal survey designed to evaluate the influence of COVID-19 pandemic on the mental health of college students in China [25]. The research plan includes four consecutive surveys on college students of ten colleges in Southern China, and the survey is started in February 2020, and it is performed every three months. During Wave 3, MSE is evaluated based on the survey result. The questionnaire has been distributed to the respondents who gave their consent of joining in Wave 3 during Wave 2. A total of 1,942 respondents completed and returned the questionnaire during Wave 3, that is, during the period from August 21 to 31, 2020. Among these respondents, 1,793 of them submitted valid data on the variables included in the questionnaire with the rate of response reaching 92.3%. The consent has been obtained from the respondents joining in the study before the data is collected.

2.2 Procedure and Data Collection

For the safety concern, and also providing convenience to the respondence, the survey is conducted online during the pandemic of COVID-19. Within 10 days, the college students were instructed to fill out the questionnaires distributed online through Weibo, WeChat, QQ and other college website (including bulletin board, forums, and websites of college societies), and the survey is hosted by wenjuanxing [wjx.cn], Ranxing Information and Tech Company, Changsha, China. It costs the respondents about 15 min to complete the questionnaire, and the respondents would receive 10 yuan as a reward for participants, which is $1.5 dollars. The process of data collection and recruitment have been approved by Human Research Ethics Committee (No. 2020005) at Shenzhen University.

2.3 Measures

2.3.1 Muscle-Strengthening Exercise (MSE)

Every respondent is instructed to describe their MSE engagement by answering questions of "how long did you do MSE during the past week?" For this purpose, the definition of MSE is "activity that involves major muscle groups [26], such as pull-ups, curl-ups, or weightlifting". The answers given by the respondents ranges from 0 to 7 days. Similar questions are included in the questionnaires adopted in research on the population in US [27–29] , Australia [30–32] and China [33], and the data is shown to be reliable. By referring to guidelines of WHO and past research [26], the respondents are considered to meet the guidelines of MSE if they answer that they do MSE twice or more times every week. When conducting statistical analysis, MSE days as a variable has been considered as continuous, while weather the respondent meet MSE guidelines or not (as a variable) has been regarded as a binary outcome.

2.3.2 Depression (PHQ-9)

The depressive symptoms of respondents have been evaluated based on the results of Patient Health Questionnaire-9, and the questionnaire consists of nine items. The depressive symptoms reported by the respondents and their conditions during last weeks have been compared, and their answers vary from 0 (not at all) to 3 (almost every day) [34]. According to a past research, the validity and reliability of PHQ-9 among college students are acceptable [35], so they are useful to the epidemiological survey. For the purpose of current study, the score of PHQ-9 as a variable is considered continuous.

2.3.3 Socio-Demographic Variables and other Control Variables

Based on past research that have been published [22,23], a number of variables have been evaluated, including PA behavior and perceived family affluence, number of close friends, educational background of parents, family composition (one parent or two parents), residence (rural or urban), siblings (only child, or have sisters or brothers), body mass index (measured by weight [kg] and height [cm]), age and sex. The perceived family affluence is measured using a scale developed by Adler et al. [36], and the higher the score, the greater the perceived family affluence.

PA behavior is measured based on International Physical Activity Questionnaire-Short Form (IPAQ-SF), as its validity and reliability are recognized when it is applied to Chinese population [37], which means that the sedentary behaviors and physical activity of adults in China can be measured by the scale. Generally, the respondents are instructed to recall their sedentary behaviours (including sitting time) and PA of different intensity during the past week. The sedentary time and the time of physical activity every week have been worked out according to the guidelines published by the expert group of IPAQ [38]. The sleep duration of respondents is evaluated using Pittsburgh Sleep Quality Index (PSQI) which proves to be valid among Chinese populations [39]. For the purpose of statistical analysis, variables such as sleep duration, sedentary behaviors, physical activity, physical activity, BMI and age are considered as continuous while variables including moderating and potential confounding ones are considered as categorical.

2.4 Statistical Analyses

The statistical analysis is performed using SPSS version 25.0. Descriptive statistics are conducted by calculating standard and mean deviation of continuous variables such as BMI and age, the percentage (%) and frequencies of categorical variables such as MSE days, residence and sex. Sex difference across the categorical variables is examined using Pearson's chi square, and sex difference across continuous variables is examined using student t test. The bivariate relationship between involved variables is determined using Pearson correlation coefficients. The relationship between depression and MSE is estimated by introducing a multilevel linear model. As to the techniques, the observatory dependency within a number of clusters is considered (that is, individual characteristics). On the basis of data composition of current study, the data is fitted as a two-level structure (Level 1 stands for individuals, while Level 2 stands for city), and then the relationship between depression and MSE is examined using the Linear Mixed Models function and Restricted Maximum Likelihood Estimation (REML). To reveal the relationship between depression and MSE, we have built two model (Model 1 refers to the days of MSE as independent variables, while Model 2 refers to The guidelines of MSE as independent variable), and they are controlled for control and sociodemographic variables. The beta estimate adjusted with corresponding 95% confidence intervals (95% CI) have been stated in the results. The statistical significance has been defined as as $p < 0.05$ (two-sided).

3 Results

Table 1 shows the socio-demographic characteristics of variable and study sample. Generally, 1793 respondents (63.58% female) have been recruited, and the mean value of BMI is 20.27 ± 2.86 kg/m². There are 34.18% of respondents are only-child, and respondents from the urban area account for 69.21%. As to the educational background, most of respondents' parents belong to high school or below (M: 82.48%, F: 89.18%). 52.2 of respondents answered that they have 3 or 5 close friends. Generally, total time that respondents spent in physical activity is 126.98 ± 120.98 minutes every week, and the sedentary time they spend is 384.53 ± 222.20 minutes every day, and they sleep 443.57 ± 91.52 minutes every day. Meanwhile, 72.6% of respondents do not do any MSE every week, and the proportions that male and female respondents account for are 58.04% and 80.09%, respectively. Generally, among all the respondents, 24.8% of them meet the standards of MSE guidelines, and the number of males meeting the standards are twice of female respondents. Moreover, with respect to the score of depression, the average result of female respondent is much higher than that of male respondents.

Table 1: Sample characteristics of this study

		Total		Male		Female		*p for sex difference*
		mean ± SD		mean ± SD		mean ± SD		
Age [years]		20.67 ± 1.61		20.75 ± 1.63		20.63 ± 1.60		0.110
Perceived family affluence		5.71 ± 1.64		5.46 ± 1.69		5.86 ± 1.59		<0.001
Body mass index [kg/m^2]		20.27 ± 2.86		21.44 ± 3.12		19.60 ± 2.46		<0.001
Physical activity [min/week]		126.98 ± 120.98		152.82 ± 132.17		112.18 ± 110.01		<0.001
Sedentary behavior [min/day]		384.53 ± 222.20		360.13 ± 224.47		298.51 ± 219.76		<0.001
Sleep duration [min/day]		443.57 ± 91.52		436.39 ± 98.25		447.69 ± 87.21		0.012
Depression		6.80 ± 5.19		6.04 ± 5.13		7.24 ± 5.17		<0.001
		n (%)		n (%)		n (%)		
Sex		1793	100	653	36.42	1140	63.58	–
Siblings								
	Single	613	34.18	277	42.42	336	29.47	<0.001
	Two or more	1180	65.81	376	57.58	804	70.53	
Residence								
	Urban	1241	69.21	430	65.85	811	71.14	0.020
	Rural	552	30.79	223	34.15	329	28.86	
Family structure								
	Full	1261	90.41	593	90.81	1028	90.18	0.600
	Divorced	109	6.08	39	5.97	70	6.14	
	Other	63	3.51	21	3.22	42	3.70	
Father education level								
	Middle school or below	867	48.35	328	50.23	539	47.29	0.291
	High school	612	34.13	221	33.84	391	34.30	
	College or university	250	13.94	76	11.64	174	15.26	
	Master or above	64	3.57	28	4.29	36	3.16	
Mother education level								
	Middle school or below	1055	58.84	403	61.72	652	57.19	0.245
	High school	544	30.34	182	27.87	362	31.75	
	College or university	152	8.48	49	7.5	103	9.04	
	Master or above	42	2.34	19	2.91	23	2.02	

Table 1 (continued).

		Total		Male		Female		p for sex difference
		mean ± SD		mean ± SD		mean ± SD		
Number of friends								
	None	29	1.62	10	1.53	19	1.67	0.052
	1–2	590	32.91	209	32.01	381	33.42	
	3–5	936	52.2	327	50.08	609	53.42	
	6 or more	238	13.27	107	16.39	131	11.49	
MSE days								
	0 days	1292	72.06	379	58.04	913	80.09	<0.001
	1 day	55	3.07	31	4.75	24	2.11	
	2 days	104	5.80	54	8.27	50	4.39	
	3 days	142	7.92	73	11.18	69	6.05	
	4 days	77	4.29	39	5.97	38	3.33	
	5 days	63	3.51	39	5.97	24	2.11	
	6 days	25	1.39	18	2.76	7	0.61	
	7 days	35	1.95	20	3.06	15	1.32	
MSE guidelines								
	Not met	1347	75.13	410	62.79	937	82.19	<0.001
	Met	446	24.87	243	37.21	203	17.81	

Note: MSE: muscle-strengthening exercise; MSE guidelines: reporting at least 2 days was regarded as meeting the guidelines; SD: standard deviation.

The bivariate correlation coefficients among the involved variables are shown in Tables 2 and 3. The relationship between MSE days and depression ($r = -0.11$, $p < 0.001$) and the relationship between MSE guidelines and depression are found to be significant ($r = -0.11$, $p < 0.001$). The relationship between depression and MSE days is determined using multilevel regression models (Table 4). Overall, the relationship between depression and MSE days ($\beta = -0.17$, 95% CI = -0.31 to -0.03) is found to be negative. The association between depression and meeting the guidelines of MSE is shown in Table 5. Compared to the relationship between depression and meeting MSE guidelines ($\beta = 0.63$, 95% CI = 0.07 to 1.19), the relationship between meeting the guidelines of MSE and depression is found to be positive.

4 Discussion

The research is designed to study the relationship between depression and MSE among young adults in China, and major confounders such as sedentary behaviors and sleep are considered. It is found that a quarter of young adults (24.87%) and college students in China engage in MSE at least 2 days every week. What's more, meeting the MSE guidelines and more time spent in MSE show significant relationship with the severity of depression (evaluated by PHQ-9). So far as we know, the present research fills the gap in the domain of MSE and its possible influence on the prevention of depression among young adults in China, which provides reference for better understanding of mental well-being.

Table 2: Correlation matrix among the variables included in this study (for muscle-strengthening exercise days)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1														
2	-0.04	1													
3	-0.31**	0.09***	1												
4	0.13***	0.003	-0.15***	1											
5	-0.06*	0.10***	0.02	0.21***	1										
6	0.12***	-0.10***	-0.04	-0.04	-0.19***	1									
7	0.01	0.02	0.03	-0.09***	-0.04	-0.11***	1								
8	0.03	-0.13***	0.03	-0.26***	-0.33***	0.20***	0.01	1							
9	0.03	-0.18***	0.03	-0.31***	-0.33***	0.20***	0.03	0.61***	1						
10	-0.05	0.004	-0.001	-0.05*	-0.03	0.09***	-0.002	0.02	0.07**	1					
11	-0.16***	-0.05	0.11***	-0.06*	-0.05*	0.09***	-0.01	0.04	0.06**	0.06*	1				
12	0.08***	0.005	-0.06*	-0.02	-0.06**	-0.02	-0.05	0.05*	0.04	-0.004	-0.18***	1			
13	0.06*	-0.08***	-0.07**	-0.002	-0.02	0.06**	0.02	-0.01	0.02	0.04	0.02	0.06*	1		
14	-0.22***	-0.10***	0.11***	-0.12***	-0.06**	0.05*	-0.01	0.08**	0.12***	0.05*	0.27***	-0.11***	-0.04	1	
15	0.11***	0.000	-0.05*	0.07**	-0.01	-0.14***	0.06*	0.01	-0.02	-0.22***	-0.12***	0.14***	-0.13***	-0.11***	1

Note: $* p < 0.05$; $** p < 0.01$; $*** p < 0.001$; 1: Sex; 2: Age; 3: Body mass index; 4: Siblings; 5: Residence; 6: Family structure; 7: Perceived family affluence; 8: Father education level; 9: Mother education level; 10: Number of friends; 11: Physical activity; 12: Sedentary time; 13: Sleep duration; 14: Muscle-strengthening exercise days; 15: Depression.

Table 3: Correlation matrix among the variables included in this study (for muscle-strengthening exercise guidelines)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1														
2	−0.04	1													
3	−0.31***	0.09***	1												
4	0.13***	0.003	−0.15***	1											
5	−0.06*	0.09***	0.02	0.27***	1										
6	0.12***	−0.10***	−0.04	−0.04	−0.19***	1									
7	0.01	0.02	0.03	−0.09***	−0.04	−0.11***	1								
8	0.03	−0.13**	0.03	−0.26***	−0.33***	0.20***	0.01	1							
9	0.03	−0.18***	0.03	−0.31***	−0.33***	0.20***	0.03	0.61***	1						
10	−0.05	0.004	−0.001	−0.05*	−0.03	0.09***	−0.002	0.02	0.07*	1					
11	−0.16***	−0.05	0.11***	−0.06*	−0.05*	0.09***	−0.01	0.04	0.06**	0.06*	1				
12	0.09***	0.01	−0.06*	−0.02	−0.06**	−0.02	−0.05	0.05*	0.04	−0.004	−0.18***	1			
13	0.06*	−0.08***	−0.07**	−0.002	−0.02	0.06**	0.02	−0.01	0.02	0.04	0.02	0.06*	1		
14	−0.22***	−0.08**	0.10***	−0.11***	−0.06*	0.03	0.002	0.06*	0.10***	0.05*	0.28***	0.12***	−0.01	1	
15	0.11***	0.0004	−0.05*	0.07**	−0.01	−0.14***	0.06*	0.01	−0.02	−0.22***	−0.12***	0.14***	0.13***	−0.11***	1

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; 1: Sex; 2: Age; 3: Body mass index; 4: Siblings; 5: Residence; 6: Family structure; 7: Perceived family affluence; 8: Father education level; 9: Mother education level; 10: Number of friends; 11: Physical activity; 12: Sedentary time; 13: Sleep duration; 14: Muscle-strengthening exercise days (MSE guidelines: reporting at least 2 days was regarded as meeting the guidelines); 15: Depression.

Table 4: Multilevel regression model results between MSE days and depression

		Beta	95% CI		p value
Intercept		13.55	9.32	17.78	0.000
Sex					
	Male	−0.86	−1.38	−0.35	0.001
	Female	Ref			
Siblings					
	Single	−0.45	−0.97	0.08	0.099
	Two or more	Ref			
Residence					
	Urban	0.26	−2.92	0.81	0.356
	Rural	Ref			
Family structure					
	Full	−2.18	−3.42	−0.94	0.001
	Divorced	−2.56	−4.08	−1.03	0.001
	Other	Ref			
Father education level					
	Middle school or below	−0.15	−1.63	1.34	0.847
	High school	0.09	−1.36	1.55	0.903
	College or university	0.28	−1.21	1.77	0.714
	Master or above	Ref			
Mother education level					
	Middle school or below	0.18	−1.63	1.98	0.848
	High school	0.21	−1.56	1.98	0.815
	College or university	0.30	−1.56	2.16	0.749
	Master or above	Ref			
Number of friends					
	None	6.66	4.77	8.55	0.000
	1–2	2.52	1.78	3.26	0.000
	3–5	1.20	0.50	1.90	0.001
	6 or more	Ref			
Age		−0.06	−0.20	0.09	0.427
Perceived family affluence		−0.35	−0.50	−0.21	0.000
Body mass index		−0.01	−0.10	0.07	0.805
Physical activity		−0.001	−0.004	0.0002	0.085
Sedentary time		0.002	0.002	0.003	0.000
Sleep time		−0.01	−0.01	−0.005	0.000
MSE days (0–7 days)		**−0.17**	**−0.31**	**−0.03**	**0.015**

Note: MSE: muscle-strengthening exercise.

Table 5: The association between MSE guidelines and depression by multilevel regression model

		Beta	95% CI		*p* value
Intercept		12.75	8.52	16.97	0.000
Sex					
	Male	−0.88	−1.39	−0.36	0.001
	Female	Ref			
Siblings					
	Single	−0.46	−0.99	0.07	0.089
	Two or more	Ref			
Residence					
	Urban	0.26	−0.29	0.82	0.353
	Rural	Ref			
Family structure					
	Full	−2.18	−3.42	−0.94	0.001
	Divorced	−2.53	−4.06	−1.01	0.001
	Other	Ref			
Father education level					
	Middle school or below	−0.17	−1.65	1.32	0.825
	High school	0.07	−1.39	1.53	0.924
	College or university	0.24	−1.25	1.73	0.756
	Master or above	Ref			
Mother education level					
	Middle school or below	0.26	−1.54	2.06	0.777
	High school	0.31	−1.46	2.07	0.734
	College or university	0.41	−1.45	2.26	0.666
	Master or above	Ref			
Number of friends					
	None	6.59	4.70	8.48	0.000
	1–2	2.53	1.79	3.27	0.000
	3–5	1.20	0.50	1.90	0.001
	6 or more	Ref			
Age		−0.05	−0.20	0.09	0.467
Perceived family affluence		−0.36	−0.50	−0.21	0.000
Body mass index		−0.01	−0.10	0.07	0.785
Physical activity		−0.002	0.00	0.00	0.084
Sedentary time		0.002	0.00	0.00	0.000
Sleep time		−0.01	−0.01	0.00	0.000
MSE Guidelines					
	Not meeting	**0.63**	**0.07**	**1.19**	**0.027**
	Meeting	**Ref**			

Note: MSE: muscle-strengthening exercise (MSE guidelines: reporting at least 2 days was regarded as meeting the guidelines).

As an important component of PA guidelines published by WHO and recognized by national departments of public health in United States and Canada. There is very few research on MSE and its benefits to mental health in different populations [21]. In this respect, such gap remains as a problem that prevent us from gaining deep understanding of physical activity in an inclusive and comprehensive way. Compared to a past research that focuses on the adults aged above 30, the focus of current research is put on young adults, and the proportion of meeting the guidelines of MSE is lower than that of the past research (24.87% vs. 28.50%). The difference in this respect might be a result of different characteristics of samples, such as survey time and age. Compared to the status of MSE in western countries such as Australia and the United States, among the young adults in China, the proportion of meeting the guidelines of MSE is lower. According to Bennie et al. [31], in Australia, about 29.2% of adults aged between 18 and 24 years meet the standards of the MSE guidelines. There is a study of data trend from 2011 to 2017 in the United States, and the result show that, more than 40% adults aged between 18 and 24 meet the standards of MSE guidelines [29]. Compared to the western respondents, the proportion of meeting the guidelines of MSE among young adults in China is lower. For this reason, to early intervention should be made to the young adults in China to promote the health behaviors in Chinese population [40–45].

No matter how MSE is measured in present research, there is independent relationship between longer participation of MSE and lower risk of depression and between meeting the guidelines of MSE and the lower risk of depression. Therefore, longer time spent in MSE might be a protective measure against depression. The findings of current research are identical with past research conducted by Bennie et al. [22,23]. According to a Germany study focusing on adults aged over 18 (N = 23,635), it is found that increased participation of MSE serves as a effective measure to treat depression. When it comes to the mechanism that MSE helps relieve the symptoms or severity of depression, there are some explanations provided by some researchers. First, greater involvement in MSE helps promote the muscle strength which is closely related with health status and fitness, and it also helps enhance people's physical status and quality of life [46–48], and all of these contribute to the relieved depression. Another explanation is that, by doing MSE, the human body would produce a substance called myokines, which is a biological inhibitor against the symptoms of depression [49]. Besides the biological mechanisms, people's neurobiological (such as blood flow in the brain) and psychosocial status (such as self-esteem) can also be improved by doing MSE [50]. However, it is suggested that the mechanism that MSE helps relieves depression can be further studied in the future. Moreover, a cross sectional design is adopted in the current study, there is no basis to draw conclusions on the causality. It is also suggested that further effort should be made to conduct experimental and longitudinal trials so as to determine the relationship between depression and MSE among young adults. Generally, it is found that MSE is a factor likely to help relieve the depression among young adults in China.

The findings of current research provide some useful implications for the prevention of depression and serves as a basis for prevention of depression. MSE provides effective methods for prevention of depression among young adults in China. When doing MSE, there is not much requirement on the environmental supports such as physical activity or equipment. That is to say, MSE can be done without any sports equipment, and it does not require large space. A number of stern shutdown policies implemented in different countries to control the pandemic of COVID-19 presents people from using gym, and in such condition, MSE becomes a desired form of exercise that can be promoted nowadays. The advantages of PA lie in its good accessibility compared to other physical activities such as playing footballs or basket ball or swimming. Moreover, MSE determinants or correlates among young adults in China [33] are important basis for large-scale campaign promoting MSE among young adults. It is suggested that further efforts should be made to develop effective measures to promote MSE among young adults.

The strength of current research lies in that large number of respondents have been recruited to create a large sample size, so the evidence that we have found in this respect becomes quite valid and reliable. Another strength is that a number of variables have been examined and compared to the results of past studies, such as behavioural variables, socioeconomic parameters and family members. Nevertheless, there are some limitations with the study. As a cross-sectional study, the cause-and-effect relationship between depression and MSE cannot be explained or revealed in the current study. The next limitation is that the questionnaires are answered in a self-reported manner, so recall and response bias might be generated. Moreover, the samples are collected from Southern China, so whether the result applies to the population of other districts remains unknown. What's more, when completing the questionnaire, the respondents are not required to point out the intensity of MSE they engage in, and it is also a limitation that needs to be overcome. However, the correlation coefficient between physical activity of middle-to-high intensity and MSE is 0.28, which is week, and it means that the things they measure isn't the same one. The types of physical activity should be distinguished in future studies.

5 Conclusions

The current research is among earliest effort to study the relationship between depression and MSE among young adults in China. Only a small portion of young adults in China meet the standards of MSE guidelines, that is, 2 days and longer every week. It is found that greater involvement in MSE is associated with relieved depression. It is also suggested that future research focus on finding more evidence that either support or go against the current research findings, such as experimental or follow-up study. Nevertheless, the current study provides evidence that helps prevent and control depression among young adults in China.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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