

Association between healthy lifestyles and post-COVID-19 syndrome among college students

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Abstract:

BACKGROUND: Post-COVID-19 syndrome still occurs in some populations. A healthy lifestyle is widely recognized as a first-line treatment to increase the body's antiviral resistance and tissue repair, but it is unclear whether a healthy lifestyle can promote or alleviate the symptoms of post-COVID-19 syndrome.

METHODS: A stratified random sampling method was used to select 498 participants from three universities in Fujian as the target of the questionnaire survey. The survey focused on students' healthy lifestyles and the symptoms of fatigue, anxiety, dyspnea, and depression that are common in post-COVID-19 syndrome.

RESULTS: Two months after developing COVID-19, some students continued to experience fatigue, anxiety, dyspnea, and depression, with fatigue being the most prominent symptom. The results of the study showed that there was a significant negative correlation ($P < 0.01$) between a healthy lifestyle and fatigue, anxiety, dyspnea, and depression among university students. Furthermore, when analyzing the different subdimensions of healthy lifestyles among university students, it was found that all dimensions showed varying degrees of negative correlation with fatigue, anxiety, dyspnea, and depression, except for health-related behaviors and interpersonal behaviors, which showed no relationship with fatigue ($P < 0.01$).

CONCLUSIONS: By improving healthy lifestyles, long-term COVID-19 symptoms can be reduced and improved and contribute positively to patient recovery, providing a viable rehabilitation option for long-term COVID-19 patients.

Keywords:

Anxiety, college students, depression, dyspnea, fatigue, healthy lifestyle, post-COVID-19 syndrome

In late 2019, there was a sudden outbreak of a novel coronavirus pneumonia epidemic that spread rapidly around the world and became the largest public health crisis due to its high transmission capacity.^[1] According to the World Health Organization, more than 764 million confirmed cases and more than 6.9 million deaths have been reported worldwide as of 23 April 2023.^[2] The rapid development and effective use of COVID-19 vaccines have significantly reduced the risk of serious illness and death from COVID-19.^[3] At the same time,

more effective antiviral drugs have been produced or discovered for the treatment of COVID-19 infections, greatly improving therapeutic efficacy.^[4]

Most patients recover from COVID-19 infection, but there have been reports that over 70% of patients experience one or more complications after recovery, academically referred to as "Post-COVID-19 Syndrome" and "Long COVID-19."^[5] The most common symptoms are fatigue, dyspnea, anxiety, and depression,^[6-8] which are also common in young people.^[9] The majority (75%) of people with post-COVID-19 syndrome are then not admitted to hospital, and in

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most cases, interventions such as self-management are effective in promoting recovery.^[10]

A healthy lifestyle is widely recognized as a first-line treatment to improve the body's antiviral resistance and tissue repair.^[11,12] Research has shown that a healthy lifestyle can effectively prevent and reduce the risk of severe COVID-19^[13] while also reducing the mortality rate associated with COVID-19.^[14] Research has also shown that a healthy lifestyle is associated with a reduced risk of post-COVID-19 syndrome.^[15] However, there is currently little research on how a healthy lifestyle can promote recovery or alleviate symptoms of post-COVID-19 syndrome, especially from the perspective of university students. The university stage is a crucial time for students to develop a healthy lifestyle.^[16] Therefore, it is important to study the role of healthy lifestyle in the rehabilitation and symptom relief of patients with post-COVID-19 syndrome for the healthy development of college students.

The following questions will be explored in this study:

- Question 1: What is the level of healthy lifestyle among Chinese university students and do they have sequelae after COVID-19 infection?
- Question 2: Is there an association between healthy lifestyle and COVID-19 outcomes in college students?

Methods

Research design

Three colleges and universities in Fujian Province were selected for this study. Stratified random sampling was used to ensure a representative sample. In each school, 2–3 classes of pupils in each year group were randomly selected as the sample for the study. The sample was selected according to two principles: (1) voluntary participation in the survey after informed consent and (2) knowledge of healthy lifestyles.

After identifying the participants, the investigator obtained their consent and asked them to sign a consent form. Second, the terms and question patterns used in the questionnaire were explained in detail to the participants so that the research questions could be better understood by the research participants. Finally, the dimensions and scores of the relevant scales were interpreted.

A total of 540 students were recruited for this study in February 2023 and volunteered to take part in the survey. Subsequently, 42 questionnaires were excluded due to incomplete answers or repetition of the same answers, leaving 498 valid questionnaires (92.2% validity rate).

Data collection

Healthy lifestyle

In this study, we used the Healthy Lifestyle Scale for College Students developed by Wang *et al.*^[17] and later revised by Jiao and Wang.^[18] The scale contains 33 questions divided into 8 dimensions and is scored on a 5-point Likert scale, with higher scores indicating a higher level of healthy lifestyle among university students. The reliability and validity of this scale have been validated in previous studies, and in this study, the Cronbach's alpha coefficient for the scale was 0.945.

Dyspnea

The Modified Medical Research Council was used in this study to assess dyspnea in daily life.^[19,20] The scale consists of five narrative questions, with each statement representing a level (0–4) that almost completely describes the range of dyspnea. The higher the level, the greater the patient's respiratory distress.

Fatigue

This study used the modified ratings of the perceived exertion scale to assess how people rate their feelings of fatigue during exercise.^[21] The scale was invented by the Swedish scientist Borg and uses a scale of 0–10 to assess fatigue. Lower values indicate less fatigue. In this study, students give a rating based on their subjective feelings after 6 min of walking.

Depression

In this study, the Patient Health Questionnaire-9 (PHQ-9) scale was used to assess depression in patients with COVID-19.^[22] The PHQ-9 is an internationally recognized measure of depression that consists of nine items that assess how often a patient has experienced nine symptoms in the past 2 weeks. The scale is based on a 4-point Likert scale, with total scores ranging from 0 to 4 as normal, 5 to 9 as mild depression possible, 10 to 14 as moderate depression possible, 15 to 19 as moderately severe depression possible, and 20 to 27 as severe depression possible. The reliability and validity of this scale have been validated in previous studies, and the Cronbach's alpha coefficient for the PHQ-9 scale in this study was 0.903.

Anxiety

In this study, the General Anxiety Disorder Scale-7 (GAD-7) was used to assess anxiety in COVID-19 patients.^[23] The GAD-7 consists of seven items that assess how often a patient has experienced seven symptoms in the past 2 weeks. A 4-point Likert scale was used, with total scores ranging from 0 to 4 as normal, 5 to 9 as mild anxiety disorder, 10 to 14 as moderate anxiety disorder, and >15 as severe anxiety disorder. The reliability and validity of this scale have been validated in previous studies, and

the Cronbach's alpha coefficient for the GAD-7 scale in this study was 0.911.

Statistical analysis

The study was analyzed using IBM SPSS version 21 software (IBM Corporation, Armonk, NY, USA). In the first stage, descriptive statistics and correlation matrices were calculated for all study variables. In the second stage, scale scores for descriptive characteristics were compared using ANOVA analyses and *t*-tests, and differences between variables such as parental education level and self-rated health status and the measured variables were determined using the Mann-Whitney *U*-test corrected for Bonferroni. In the third stage, Pearson correlation analysis was used to examine the relationship between the variables.

Results

Of the invited respondents, 236 (47.4%) were male and 262 (52.6%) were female, aged between 18 and 20 years. There were 207 (41.6%) students from rural areas and 291 (58.4%) from urban areas. Most of the students' parents had a low level of education, with only 101 (20.3%) of the students' fathers and 102 (20.5%) of the students' mothers having a bachelor's degree or higher. In terms of self-rated health, 92 (19.5%) students reported that they were very healthy and 25 (5.0%) reported that they were unhealthy. In addition, 144 (28.9%) students reported suffering from chronic conditions such as rhinitis and gastritis [Table 1].

During COVID-19 [Table 2], the total healthy lifestyle score for the students was 113.65 ± 16.46 . Among the subdimensions, sports and exercise behavior had the lowest score of 7.53 ± 2.67 , followed by regular lifestyle behavior. The highest scores were for interpersonal behavior with a maximum score of 21.98 ± 4.47 , followed by health-responsible behavior.

In the 2 months following the COVID-19 cure, most students did not develop serious mental health problems [Table 3]. Only 142 students (28.5%) showed mild symptoms of anxiety, while only 8 students (1.6%) showed moderate anxiety. In addition, 126 students (6.6%) showed mild symptoms of depression, 17 students (3.4%) showed moderate symptoms of depression, and only one student (0.2%) showed moderate-to-high symptoms of depression. Similarly, the majority of students were not affected by COVID-19 resulting in dyspnea, with only three students (0.6%) experiencing moderate-to-high levels of dyspnea and one student (0.2%) experiencing high levels of dyspnea. However, COVID-19 did have an impact on the physical condition of the students, with most experiencing mild fatigue, 82 students (16.5%) experiencing moderate fatigue, and more seriously, 23

Table 1: Descriptive characteristics of the participating study population

Features	n (%)
Gender	
Male	236 (47.4)
Female	262 (52.6)
Age	
18	108 (21.7)
19	163 (32.7)
20	227 (45.6)
Place of residence	
Rural	207 (41.6)
City	291 (58.4)
Father's education level	
Elementary school	110 (22.1)
Middle school	148 (29.7)
High school	139 (27.9)
Bachelor's degree or above	101 (20.3)
Mother's education level	
Primary school	98 (19.7)
Junior high school	167 (33.5)
High school	131 (26.3)
Bachelor's degree or above	102 (20.5)
Self-assessed health status	
Relatively unhealthy	25 (5.0)
Fair	172 (34.5)
Healthier	209 (42.0)
Very healthy	92 (18.5)
Chronic disease	
None	284 (57.0)
Yes	214 (43.0)

Table 2: Healthy lifestyle behaviors in patients with post-COVID-19 syndrome

Variables	Mean±SD	Minimum	Maximum
HLCS	113.65±16.46	66	150
Sports exercise behavior	7.53±2.67	3	15
Regular life behavior	8.9±2.64	3	15
Dietary and nutritional behavior	12.14±3.07	4	20
Health injurious behavior	9.3±1.48	2	10
Health-responsible behavior	18.52±3.48	5	25
Stress management behaviors	17.69±3.57	6	25
Interpersonal behavior	21.98±4.47	7	30
Life appreciation behavior	17.61±3.94	5	25

SD=Standard Deviation, HLCS=Healthy Lifestyle for College Students

students (4.6%) experiencing moderate to severe fatigue after a 6-min walk.

It was found [Table 4] that there was a highly significant difference ($P < 0.01$) between the means of healthy lifestyle, anxiety, and depression in terms of gender, age, place of residence, father's education, mother's education, health status, and chronic diseases. There was a significant difference between dyspnea and the mean of sex, father's education, mother's education, health status, and chronic diseases ($P < 0.01$), but not with age and place of residence ($P > 0.05$).

Table 3: Anxiety, depression, subjective fatigue, and dyspnea in post-COVID-19 syndrome college students

Symptom	Range	n (%)
GAD-7		
No	0–4	348 (69.80)
Mild	5–9	142 (28.5)
Moderate	10–14	8 (1.6)
PHQ-9		
No	0–4	354 (71)
Mild	5–9	126 (6.6)
Moderate	10–14	17 (3.4)
Moderately severe	15–19	1 (0.2)
PRE		
No	0	147 (29.5)
Mild	1–2	246 (49.4)
Moderate	3–4	82 (16.5)
Moderately severe	5–7	23 (4.6)
mMRC		
No (Level 0)	0	365 (73.3)
Mild (Level 1)	1	98 (19.7)
Moderate (Level 2)	2	31 (6.2)
Moderately severe (Level 3)	3	3 (0.6)
Severe (Level 4)	4	1 (0.2)

GAD=General Anxiety Disorder Scale, PHQ-9= Patient Health Questionnaire-9 scale, RPE= Ratings of Perceived Exertion, mMRC= Modified Medical Research Council

According to the results of the correlation analysis Table 5, a healthy lifestyle among university students was moderately and significantly negatively correlated with anxiety ($r = -0.382^{**}$, $P < 0.01$) and depression ($r = -0.383^{**}$, $P < 0.01$), and weakly negatively correlated with fatigue ($r = 0.198^{**}$, $P < 0.01$). Among the subdimensions, except for health responsibility and interpersonal behavior, which were not associated with fatigue ($P > 0.05$), each of the other subdimensions was negatively associated with fatigue, dyspnea, anxiety, and depression to varying degrees ($P < 0.01$).

Discussion

The descriptive statistics of this study showed that college students in Fujian Province had an HLCS score of 113.65 ± 16.46 during the recovery period after COVID-19, which was overall lower than the healthy living level in all regions of the country before the epidemic.^[24] Among the subdimensions, the lowest scores were for exercise and regularity behaviors, followed by dietary and nutritional behaviors and health injury behaviors, with higher scores for each of the other subdimensions, a result that may be related to the COVID-19 on healthy lifestyles. Subjects in the COVID-19 Prevention and Control normative phase took measures to minimize leaving the house and significantly reduced the frequency of outdoor sports and exercise,^[25] resulting in a 21.4% increase in average daily sedentary time, a 10.7% increase in daily lying time, and a 63.9% decrease in weekly sports and exercise.^[26]

It is also possible that reduced physical activity may be associated with the post-COVID-19 syndrome, causing fatigue and dyspnea.^[27] In addition, an unbalanced diet and a sedentary lifestyle during COVID-19 lead to the development of overweight or malnutrition.^[28] In addition to being affected by COVID-19, lack of exercise, poor dietary, and lifestyle habits are the most likely to lead to unhealthy lifestyles during the college years, and these behaviors can have a negative impact on health.^[29] This study also examined the relationship between healthy lifestyles and demographic characteristics, and the results showed variability in healthy lifestyles and demographic characteristics such as gender, place of residence, parental education, self-rated health status, and presence of chronic diseases, which is consistent with previous studies.^[30]

Experts have investigated residual symptoms after 1 year of COVID-19, and the results of the study showed that a proportion of the population experienced fatigue (28%), dyspnea (18%), depression (23%), and anxiety (22%),^[31] which is consistent with the results of the present study. COVID-19 syndrome is long-lasting, with most patients recovering within 2 weeks and a subset of patients having persistent symptoms 3 months after infection and even multiple symptoms 6 months after infection.^[32] The persistence of such symptoms, especially fatigue symptoms, can have a direct impact on the academic, leisure, and daily life of university students.^[33] Fatigue is the most common symptom reported in post-COVID-19 syndrome, which negatively affects physical activity and physical function, leading to a vicious cycle of decreased physical strength and even muscle wasting and decreased cardiorespiratory capacity in college students,^[34] making it one of the most commonly reported post-COVID-19 syndromes. Dyspnea is not as common as depression and anxiety, but it affects the quality of life of students.^[35] Of course, the cause of persistent dyspnea in many patients is not an obvious pulmonary or cardiac consequence of COVID-19 but is related to whether the patient has a preexisting chronic disease or health status.^[14,36]

Post-COVID-19 syndrome was also associated with demographic variables. We found higher levels of fatigue, breathlessness, anxiety, and depression in university men than in women. In contrast, the literature has reported higher levels of fatigue, dyspnea, anxiety, and depression in women than in men in terms of severity, and also reported that the degree of post-COVID-19 syndrome was positively correlated with time to onset and severity of illness.^[37] This explains the more complex syndrome of post-COVID-19 syndrome, where not only gender is relevant to the severity of fatigue, anxiety, dyspnea, and depression. There is also a relationship with other factors, including patient age, health status, and chronic disease.^[38] Especially in patients with chronic diseases,

Table 4: Effect of demographic characteristics of college students on scores of healthy lifestyle centers, General Anxiety Disorder Scale-7, Patient Health Questionnaire-9, ratings of perceived exertion, and Modified British Medical Research Council

Features	n (%)	HLCS	GAD-7	PHQ-9	RPE	mMRC
Gender						
Male	236 (47.4)	104.69±14.40	3.11±3.29	3.62±3.87	1.82±1.69	0.41±0.69
Female	262 (52.6)	121.72±13.82	2.31±2.80	2.35±2.79	1.47±1.50	0.29±0.59
<i>t</i>		-13.452	2.953	4.207	2.481	2.106
<i>P</i>		0	0.003	0	0.013	0.036
Age						
18	108 (21.7)	97.52±13.27	3.52±3.29	3.95±3.90	1.97±1.77	0.43±0.75
19	163 (32.7)	108.6±9.54	3.31±3.14	3.58±3.47	1.79±1.59	0.33±0.58
20	227 (45.6)	124.95±13.26	1.85±2.67	2.03±2.83	1.36±1.48	0.32±0.63
<i>F</i>		206.702	16.706	16.896	6.673	1.043
<i>P</i>		0	0	0	0.001	0.353
Place of residence						
Rural	207 (41.6)	105.83±13.77	3.25±3.26	3.77±3.74	1.89±1.69	0.37±0.63
City	291 (58.4)	119.22±15.96	2.3±2.85	2.37±3.02	1.45±1.51	0.33±0.65
<i>t</i>		-9.761	3.453	4.595	3	0.72
<i>P</i>		0	0.001	0	0.003	0.472
Father's education level						
Elementary school	110 (22.1)	108.9±20.46	3.13±3.38	4.72±3.94	2.15±1.80	0.52±0.75
Middle school	148 (29.7)	115.21±21.79	2.58±3.11	3.37±3.31	1.84±1.64	0.39±0.66
High school	139 (27.9)	114.17±20.89	2.66±3.22	2.32±3.02	1.31±1.36	0.24±0.59
Bachelor's degree or above	101 (20.3)	115.06±27.85	2.3±3.12	1.3±2.23	1.21±1.40	0.24±0.51
<i>F</i>		416.888	22.612	22.88	9.426	5.127
<i>P</i>		0	0	0	0	0.002
Mother's education level						
Primary school	98 (19.7)	92.88±10.41	4.14±3.41	4.52±3.95	1.79±1.74	0.52±0.79
Junior high school	167 (33.5)	107.65±8.920	3.25±3.13	3.41±3.43	1.98±1.70	0.38±0.67
High school	131 (26.3)	120.63±7.44	2.12±2.65	2.49±2.99	1.44±1.42	0.22±0.53
Bachelor's degree or above	102 (20.5)	134.47±6.89	1.11±2.07	1.3±2.33	1.17±1.35	0.28±0.55
<i>F</i>		455.973	22.367	18.489	6.603	4.656
<i>P</i>		0	0	0	0	0.005
Self-assessed health status						
Relatively unhealthy	25 (5)	106.36±17.16	4.28±3.46	4.8±3.38	2.58±2.00	0.84±0.80
Fair	172 (34.5)	108.77±16.06	3.51±3.24	3.7±3.34	2.15±1.61	0.44±0.67
Healthier	209 (42)	115.74±15.97	2.28±2.79	2.55±3.27	1.43±1.48	0.23±0.53
Very healthy	92 (18.5)	120±14.96	1.65±2.66	1.98±3.40	0.89±1.29	0.30±0.69
<i>F</i>		13.278	11.867	9.121	18.298	9.045
<i>P</i>		0	0	0	0	0
Chronic disease						
None	354 (71.9)	116.93±15.63	2.35±2.89	2.50±3.26	1.50±1.51	0.28±0.55
Yes	144 (28.9)	105.59±15.69	3.53±3.31	4.06±3.50	1.95±1.77	0.51±0.81
<i>t</i>		7.33	-3.98	-4.737	-2.88	-3.74
<i>P</i>		0	0	0	0	0.004

GAD=General Anxiety Disorder Scale, PHQ=Patient Health Questionnaire, RPE=Ratings of Perceived Exertion, mMRC=Modified Medical Research Council, HLCS= Healthy Lifestyle for College Students

the severity of post-COVID-19 syndrome in this group is higher than in those without chronic diseases, even to the point of causing a risk of death.^[39]

Post-COVID-19 syndrome can lead to systemic dysfunction. As a result, medical experts have been actively investigating different treatment strategies. Current treatments for long-term COVID-19 are mainly pharmacological treatments such as

histamine antagonists,^[40] dietary supplements^[41] containing anti-inflammatory and antioxidant components (e.g. vitamins and minerals), antibiotics, and antiviral compounds.^[42] Of course, there is also access to outpatient rehabilitation^[43] and tele-rehabilitation^[44] modalities, which mainly include motor rehabilitation,^[45] psychological rehabilitation,^[46] and others. However, the survey of participants in this study found that students with COVID-19 syndrome did not go to

Table 5: Relationship between healthy lifestyles and General Anxiety Disorder Scale-7, Patient Health Questionnaire-9, ratings of perceived exertion, and Modified British Medical Research Council among college students

Variables	Indicators	PHQ-9	GAD-7	RPE	mMRC
HLCS	<i>r</i>	-0.382**	-0.383**	-0.198**	-0.204**
	<i>P</i>	0.000	0.000	0.000	0.000
Sports exercise behavior	<i>r</i>	-0.135**	-0.110*	-0.212**	-0.124**
	<i>P</i>	0.003	0.014	0.000	0.005
Regular life behavior	<i>P</i>	-0.231**	-0.249**	-0.146**	-0.107*
	<i>r</i>	0.000	0.000	0.001	0.017
Dietary and nutritional behavior	<i>P</i>	-0.229**	-0.210**	-0.176**	-0.161**
	<i>r</i>	0.000	0.000	0.000	0.000
Health injurious behavior	<i>P</i>	-0.160**	-0.248**	-0.135**	-0.164**
	<i>r</i>	0.000	0.000	0.003	0.000
Health-responsible behavior	<i>P</i>	-0.214**	-0.216**	-0.071	-0.114*
	<i>r</i>	0.000	0.000	0.112	0.011
Stress management behaviors	<i>P</i>	-0.330**	-0.332**	-0.153**	-0.133**
	<i>r</i>	0.000	0.000	0.001	0.003
Interpersonal behavior	<i>r</i>	-0.204**	-0.193**	-0.077	-0.088*
	<i>P</i>	0.000	0.000	0.084	0.049
Life appreciation behavior	<i>r</i>	-0.390**	-0.391**	-0.167**	-0.187**
	<i>P</i>	0.000	0.000	0.000	0.000

*Significantly correlated at the 0.05 level (bilateral), **Significantly correlated at the 0.01 level (bilateral). GAD=General Anxiety Disorder Scale, PHQ=Patient Health Questionnaire, RPE= Ratings of Perceived Exertion, mMRC=Modified Medical Research Council, HLCS= Healthy Lifestyle for College Students

hospital for effective rehabilitation, but rather opted for self-management and rehabilitation, which can be costly.

The results of this study are therefore particularly important. The study found that a healthy lifestyle among college students was negatively associated with fatigue, dyspnea, anxiety, and depression, This suggests that a good and healthy lifestyle can alleviate and reduce the symptoms of post COVID-19 syndrome. This finding has a positive effect on the recovery of patients with post COVID-19 syndrome. In fact, healthy lifestyles have long been studied in patients with fatigue, anxiety, and depression, but not in long-term COVID-19. Kelly *et al.* studied the healthy lifestyle of patients with early-stage breast cancer and found that a healthy lifestyle alleviated, reduced, and shortened the duration of fatigue, anxiety, and depression in breast cancer patients.^[47] Notably, among the dimensions, health-responsible behavior and interpersonal relationship behavior were not associated with fatigue. Each of the remaining subdimensions is associated with fatigue and, in particular, motor-exercise behavior is the main current treatment for fatigue.^[48,49] The more important finding is that a healthy lifestyle is associated with dyspnea, a significant finding that should be helpful and informative for future patients suffering from dyspnea.

Conclusions

This study found that Chinese college students had a low level of healthy lifestyle influenced by COVID-19. After 2 months of self-healing, some students continued

to experience fatigue, anxiety, dyspnea, and depression, with fatigue being the most prominent symptom. The results of the study showed a negative correlation between healthy lifestyle and fatigue, anxiety, dyspnea, and depression, suggesting that long-term COVID-19 symptoms can be alleviated and improved by improving healthy lifestyle, which may contribute positively to the recovery of long-term COVID-19 patients. Based on the results of the study, it is recommended that relevant departments formulate relevant policies and carry out health promotion activities to encourage college students to actively participate in physical exercise, maintain good dietary habits, regular work and rest schedules, and mental health management, adjust and improve the healthy lifestyle of college students, help college students in the long-term recovery process of COVID-19 patients, and promote the restoration of their physical and mental health.

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Conflicts of interest

There are no conflicts of interest.

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