

Prevalence of Sub-health Status among College Students in Guangzhou Baiyun Technician College Business during the Coronavirus Pandemic

Yan-Qi Liao¹, Ming-Ming Li¹, Wan-Xian Lu^{1,*}, Yan-Bin Pan¹, Jian-Rong Gong², Miao-Hang Shan¹

ABSTRACT

Background: Sub-health status (SHS) is an intermediate status between health and disease. We aimed to investigate the prevalence of sub-health status among college students during the coronavirus disease (COVID-19) pandemic and analyze its influencing factors in order to provide basic information to increase the health level of college students. **Methods:** College students were selected as subjects from Guangzhou Baiyun Technician College Business using convenience sampling. The inclusion criteria was informed consent, current college students who voluntarily participated in this survey. Exclusion criteria were to complete the questionnaire in less than two minutes. General data questionnaire, daily lifestyle questionnaire, and SHS measurement scale were used to survey college students. The SHS measurement scale consists of three subscales covering the physiological (1-14 items), psychological (16-27 items), and social (29-37 items) dimensions, with 39 items in total. The items 15, 28, 38 and 39 were used for the overall evaluation of the health status within each dimension and would not be taken into account for the score rating. A commonly used 5-point Likert scale was developed to incorporate the positive items, including questions 1-3, 13-19, and 26-39 with a scaled score equal to the raw score at 1-5; while negative items including questions 4-12 and 20-25 with a scaled score equal to 6 minus the raw score. For each subscale, the sum of all item scores was the raw score. The total raw score was calculated as the sum of raw scores derived from all 3 sub-scales. For any individual dimension, a lower score indicated higher severity of SHS. For sub-scales and the whole scale, raw scores were converted into percentile scores for statistical analysis. Converted score = (raw score - minimum theoretical score) / (maximum theoretical score - minimum theoretical score) × 100. The highest and lowest converted scores of the three subscales were 0 and 100 respectively. In this study, analysis of sub-health was performed using converted scores for all subscales and the whole scale. Based on the sub-health measurement scale, the health condition of subjects would be assessed as disease status (scored < 54), SHS (scored 54 to 79) and health status. From March 6 to 16, 2020, an online survey was conducted via wxj.cn (an online platform available for questionnaire sources). A total of 16,163 students filled out the questionnaire. **Results:** During the COVID-19 pandemic, the detected prevalence of sub-health among college students was 64.4%. the total SHS score was 73.356 ± 11.115 points, the physiological SHS score was 81.284 ± 11.034 points, the psychological SHS score was 68.691 ± 12.559 points, and the social SHS score was 67.242 ± 17.112 points. Multiple linear regression analysis showed that eating irregular meals, exercising fewer times per week, sleeping fewer hours per night, sleeping after 11 PM more often, spending more time on electronic devices, exercising for fewer minutes each time, and skipping breakfast had the significant negative impact on the SHS scores of college students during the COVID-19 pandemic (P<0.05), while being the only child had a significant positive impact on the SHS scores of college students during the COVID-19 pandemic (P<0.05). **Conclusion:** During the COVID-19 pandemic, the detected prevalence of sub-health was high among college students. Society and schools should pay more attention to the health of college students during the COVID-19 pandemic and take pertinence action to solve the problem base on influencing factors.

Key words: Coronavirus Disease, Sub-health Status, College Students, Coronavirus Pandemic, Influencing factors.

Yan-Qi Liao¹, Ming-Ming Li¹, Wan-Xian Lu^{1,*}, Yan-Bin Pan¹, Jian-Rong Gong², Miao-Hang Shan¹

¹The First Affiliated Hospital of Jinan University, Intensive Care Unit, Guangzhou, CHINA.

²Department of Gastroenterology, The First Affiliated Hospital of Jinan University, Guangzhou, CHINA.

#Yan-Qi Liao and Ming-Ming Li were cofirst authors, they contributed equally to this study.

Correspondence

Mrs. Wan-Xian Lu

The First Affiliated Hospital of Jinan University, Intensive Care Unit, Guangzhou-510630, CHINA.
Mobile no: +86-13392691952
Email: zzyxk20@yeah.net

History

- Submission Date: 17-10-2020;
- Revised Date: 05-12-2020;
- Accepted Date: 22-02-2021;

DOI : 10.5530/ijmedph.2021.2.17

Article Available online

<http://www.ijmedph.org/v11/12>

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INTRODUCTION

The coronavirus disease (COVID-19) is caused by a new type of β coronavirus.¹ It has the characteristics of rapid transmission, strong contagion, and general susceptibility to the population. On 30 January

2020, the Director-General of the World Health Organization (WHO) declared the outbreak of COVID-19 to be a Public Health Emergency of International Concern.² As of 09:36 on September 8,

Cite this article : Liao Y, Li M, Lu W, Pan Y, Gong J, Shan M. Prevalence of Sub-health Status among College Students in Guangzhou Baiyun Technician College Business during the Coronavirus Pandemic. Int J Med Public Health. 2021;11(2):96-102.

2020, there were 27,378,811 total confirmed cases worldwide. Faced with the outbreak of the pandemic, the Chinese government has implemented a series of effective prevention and control measures, such as strict isolation measures, cancellation of public gatherings and events, and travel restrictions. In particular, the education system issued a notice to postpone the spring semester for schools, shifting to online learning. In the presence of sudden outbreak and subsequent changes in study and daily lifestyle, college students would inevitably be subject to negative emotions such as anxiety and fear, which can affect their physiological and mental health and easily lead to suboptimal health status.

In the mid-1980s, Professor N. Buchman, a former Soviet scholar, discovered through research that in addition to health and disease, the human body also has an intermediate state between health and disease, called the third status,³ while the Chinese call it Sub-health status (SHS). The "Sub-health TCM Clinical Guideline"⁴ points out that people in a SHS cannot meet the health standard, which is manifested by a certain degree of reduced vitality, decreased function and adaptability. The clinical manifestations of the SHS are divided into the following categories: ① Fatigue, or sleep disturbance, or pain and other physical symptoms; ② Depression, restlessness, irritability, or fear and timidity, or short-term memory loss, inability to concentrate and other mental and psychological symptoms; ③ Interpersonal Communication often decreases, or social adaptability decreases, such as interpersonal tension. Any one of the above 3 items has been onset for more than 3 months, and the disease that may cause the above performance is excluded by the system examination, it can be judged to be in the state of skeletal muscle SHS, mental SHS, and social communication SHS. Although there is no concept of "sub-health" outside China, but a lot of research has been done on "Chronic Fatigue Syndrome (CFS)", and diagnostic criteria have been formulated one after another. Although the diagnostic criteria and conceptual descriptions of SHS and CFS are not exactly the same, the research contents of the two are basically the same, and both are studies on fatigue. Today, SHS has become one of the focuses of the medical community in the 21st century. According to a global survey by WHO, only 5% of the world's population are truly healthy, diseases are identified in only 20%, and the remaining 75% are suffering from SHS.⁵ According to relevant Chinese studies,⁶⁻¹¹ the detected prevalence of SHS among college students is 42.8% to 65.2%, indicating that it is a common problem that cannot be ignored among college students.

There are still no studies on SHS among college students during the pandemic. Therefore, this study was intended to investigate SHS and its influencing factors among college students during the pandemic through a questionnaire survey, so as to provide a theoretical basis for promoting the health of college students.

MATERIALS AND METHODS

We conducted a cross-sectional study to investigate the prevalence of SHS among college students in Guangzhou Baiyun Technician College Business during the COVID-19 pandemic using a self-administered questionnaire. College students were selected as subjects using the convenience sampling. The inclusion criteria was informed consent, current college students who voluntarily participated in this survey. The exclusion criteria were to complete the questionnaire in less than two minutes. From March 6 to 16, 2020, an online survey was conducted via wx.cn (an online platform available for questionnaire sources). A unified instruction was used to explain the research objective to the subjects. To ensure the quality of the filled questionnaire, those finished in less than two minutes were excluded. Because we did a preliminary survey and it was not enough to complete the questionnaire in less than two minutes. This study had been approved by the Hospital Medical Ethics Committee (Grant No: KY-2020-016).

The questionnaire was divided into three sections. Section I is general data questionnaire designed by the researcher, including gender, age, place of family residence, education level, whether being the only child or not, etc. Section II is daily lifestyle questionnaire, including the usage of electronic devices, sleep, exercise, diet, smoking, and drinking. Section III is the Sub-health Measurement Scale Version 1.0 (SHMS V 1.0) developed by Xu Jun.^{12,13} The scale consists of three subscales covering the physiological (1-14 items), psychological (16-27 items), and social (29-37 items) dimensions, with 39 items in total. The items 15, 28, 38 and 39 were used for the overall evaluation of the health status within each dimension and would not be taken into account for the score rating. A commonly used 5-point Likert scale was developed to incorporate the positive items, including questions 1-3, 13-19, and 26-39 with a scaled score equal to the raw score at 1-5; while negative items including questions 4-12 and 20-25 with a scaled score equal to 6 minus the raw score. For each subscale, the sum of all item scores was the raw score. The total raw score was calculated as the sum of raw scores derived from all 3 sub-scales. For any individual dimension, a lower score indicated higher severity of SHS. For sub-scales and the whole scale, raw scores were converted into percentile scores for statistical analysis. Converted score = (raw score - minimum theoretical score) / (maximum theoretical score - minimum theoretical score) × 100. The highest and lowest converted scores of the three subscales were 0 and 100 respectively. In this study, analysis of sub-health was performed using converted scores for all subscales and the whole scale. Based on the sub-health measurement scale developed by Xu Jun, the health condition of subjects would be assessed as disease status (scored < 54), SHS (scored 54 to 79) and health status (scored > 79).¹² This questionnaire exhibited a content validity index Kaiser-Meyer-Olkin (KMO) of 0.945 and a Cronbach's α coefficient of 0.913, indicating good reliability and validity.

SPSS20.0 software was used for data processing and analysis. Frequency, composition ratio, and mean \pm standard deviation were used for statistical description. The t test and one-way analysis of variance were used to compare the differences in various SHS scores among college students during the COVID-19 pandemic. Multiple linear regression was used to analyze the factors influencing SHS scores. The SHS scores of college students during the COVID-19 pandemic were taken as the dependent variables, and items including gender, place of family residence, and whether being the only child or not were taken as the independent variables (see Table 1 for assignments), to conduct regression analysis (α inclusion=0.1, α exclusion=0.15).

$P < 0.05$ was considered a statistically significant difference.

RESULTS

A total of 16,163 students filled out the questionnaire, and there were 13,501 valid questionnaires, with a valid collection rate of 83.5%, including 5,080 (37.6%) males and 8,421 (62.4%) females, aged (20.830 \pm 1.663) years old. Among them, 301 students (2.2%) were technology high school students, 13,181 (97.6%) were college or undergraduate students, and 19 (0.2%) were master students. There were 2,849 (21.1%) the only

Table 1: SHS scores of college students during the COVID-19 pandemic (points).

Project	n	Min	Max	$\bar{x} \pm s$
Physical dimensions	13501	8.93	100	81.284 \pm 11.034
Psychological dimensions	13501	8.33	100	68.691 \pm 12.559
Social dimension	13501	0.00	100	67.242 \pm 17.112
Total	13501	19.29	100	73.356 \pm 11.115

child and 10,652 (78.9%) non-only child in this survey, 575 (4.3%) were in illness, 8,696 (64.4%) in SHS, and 4,230 (31.3%) in good health.

In this study, the total SHS score averaged (73.356 ± 11.115) points. Among the three subscales, the physiological score of (81.284 ± 11.034) was the highest, followed by the psychological score of (68.691 ± 12.559) points, and the social score of (67.242 ± 17.112) was the lowest. Higher scores suggested better health status, that is, the physiological SHS was the best, followed by the psychological dimension, and the social dimension was the worst Table 2.

The survey showed that during the COVID-19 pandemic, the three items with the lowest physiological SHS scores of college students were hair growth, sleep quality, and appetite, the scores were 3.329 ± 1.076 , 3.700 ± 0.887 , and 3.808 ± 0.827 , respectively; the three items with the lowest psychological SHS scores of college students were anxiety, memory, and thinking, scores were 1.999 ± 0.923 , 3.422 ± 0.823 , and 3.526 ± 0.816 , respectively; the three items with the lowest social SHS scores of college students were seeking help actively, receiving material or emotional support from classmates and families, and keeping in touch

Table 2: Comparison of SHS scores among college students with various factors during the COVID-19 pandemic. (n=13501, $\bar{x} \pm s$)

Project	Physiological dimension score			Psychological dimension score			Social dimension score			Total sub-health score		
	score	t or F	P	score	t or F	P	score	t or F	P	score	t or F	P
Gender												
Male	78.545±8.715	3.813	<0.001	64.886±9.031	6.376	<0.001	58.675±12.693	13.213	<0.001	68.753±6.479	1.522	0.128
Female	77.807±8.413			63.611±8.653			62.378±12.044			68.972±6.325		
Place of family residence												
Rural	81.885±10.748	4.842	<0.001	68.589±12.287	0.723	0.469	65.762±16.925	7.642	<0.001	73.181±10.908	1.396	0.163
Non-rural	80.940±11.180			68.750±12.713			68.088±17.162			73.456±11.231		
Whether being the only child or not												
yes	81.287±11.397	0.020	0.984	69.688±13.068	4.627	<0.001	69.551±17.784	7.885	<0.001	74.292±11.563	4.919	<0.001
no	81.283±10.935			68.425±12.407			66.624±16.876			73.105±10.979		
Whether smoking or not												
yes	79.715±12.294	2.664	0.008	67.569±13.923	1.683	0.093	67.064±18.750	1.99	0.843	72.298±12.392	1.783	0.075
no	81.334±10.988			68.728±12.512			67.248±17.058			73.390±11.071		
Whether drinking or not												
yes	79.662±12.006	3.653	<0.001	67.460±14.111	2.363	0.018	66.586±18.944	0.937	0.349	72.116±12.328	2.721	0.007
no	81.370±10.973			68.758±12.468			67.277±17.008			73.422±11.043		
Usage of electronic devices												
<6h	83.297±10.513Δ	211.650	<0.001	70.816±12.287Δ	151.672	<0.001	69.182±17.028Δ	70.702	<0.001	75.388±10.867Δ	192.715	<0.001
6~12h	80.536±10.884*			67.74±12.272*			66.422±16.727*			72.522±10.839*		
≥12h	76.276±12.427*Δ			64.568±14.103*Δ			63.158±0.605*Δ			68.889±12.256*Δ		
Whether sleeping after 11 PM or not												
never or seldom	84.290±11.060#	159.249	<0.001	72.939±12.790Δ#	177.194	<0.001	70.617±18.839#	65.494	<0.001	76.882±11.607#	178.476	<0.001
sometimes	83.644±10.009#			71.243±11.825*#			69.612±16.280#			75.784±10.400#		
often	80.557±10.408*Δ			67.552±11.745*Δ			65.992±15.945*Δ			72.353±10.322*Δ		
always	78.841±12.019*Δ#			66.104±13.311*Δ#			65.388±18.139*Δ			71.015±11.787*Δ#		
Hours of sleep per night												
<8h	79.204±11.599Δ	76.678	<0.001	66.802±12.563Δ	48.964	<0.001	65.080±17.418Δ	34.514	<0.001	71.320±11.289Δ	71.944	<0.001
8~10h	81.989±10.637*			69.350±12.410*			67.841±16.727*			74.018±10.856*		
≥10h	81.691±11.353*			68.986±12.559*			68.285±17.987*			73.888±11.546*		
Times of exercise per week												
0times	77.867±12.226Δ	200.289	<0.001	64.533±13.574Δ	216.591	<0.001	61.535±18.061Δ	215.601	<0.001	69.096±11.740Δ	297.052	<0.001
1~2times	80.810±10.622*			68.230±11.800*			66.661±16.295*			72.858±10.509*		
≥3times	83.255±10.557*Δ			70.959±12.466*Δ			70.293±16.945*Δ			75.706±10.924*Δ		

Duration of exercise each time												
<30min	80.067±11.041Δ	90.481	<0.001	67.321±12.355Δ	92.783	<0.001	65.356±16.927Δ	107.846	<0.001	71.914±10.899Δ	134.335	<0.001
30min~1h	82.803±10.594*			70.523±12.239*			70.099±16.462*			75.326±10.791*		
>1h	81.958±11.504*Δ			69.179±13.385*Δ			67.137±18.275*Δ			73.766±11.834*Δ		
Whether skipping breakfast or not												
never or occasionally	78.261±11.637Δ	276.904	<0.001	65.955±12.856Δ	182.418	<0.001	64.260±17.539Δ	108.312	<0.001	70.441±11.380Δ	256.545	<0.001
sometimes	80.911±10.445*			68.146±11.642*			66.917±15.944*			72.936±10.240*		
often or always	83.345±10.444*Δ			70.655±12.437*Δ			69.256±17.085*Δ			75.371±10.911*Δ		
Whether eating regular meals or not												
never or seldom	75.181±12.614Δ	472.252	<0.001	63.257±13.425Δ	299.066	<0.001	60.435±18.118Δ	214.639	<0.001	67.301±11.875Δ	452.800	<0.001
occasionally	78.029±11.148*			65.595±12.118*			64.008±16.255*			70.161±10.622*		
often or always	83.075±10.225*Δ			70.346±12.180*Δ			69.123±16.841*Δ			75.123±10.641*Δ		

with friends, the scores were 3.311 ± 0.966 , 3.521 ± 1.098 , and 3.568 ± 0.976 , respectively.

The t test showed that the physiological, psychological, and social scores differed among different genders; the physiological and social scores differed among those with different places of family residence; the psychological, social, and total scores differed among those being the only child or not; the physiological scores differed among those smoking or not; the physiological, psychological, and total scores differed among those drinking or not. LSD method pairwise comparison showed the SHS scores differed in terms of usage of electronic devices, whether sleeping after 11 PM or not, hours of sleep per night, times of exercise per week, duration of exercise each time, whether skipping breakfast or not, and whether eating regular meals or not. The differences were statistically significant ($P<0.05$). Table 3.

Multiple linear regression analysis showed that eating irregular meals, exercising fewer times per week, sleeping fewer hours per night, sleeping after 11 PM more often, spending more time on electronic devices, exercising for fewer minutes each time, and skipping breakfast had the significant negative impact on the SHS scores of college students during the COVID-19 pandemic ($P<0.05$). Being the only child had a significant

positive impact on the SHS scores of college students during the COVID-19 pandemic ($P<0.05$). The standardized regression coefficients were -0.165 (whether eating regular meals or not), -0.116 (times of exercise per week), -0.086 (hours of sleep per night), -0.081 (whether sleeping after 11 PM or not), -0.078 (usage of electronic devices), -0.057 (duration of exercise each time), -0.055 (whether skipping breakfast or not), and 0.032 (whether being the only child or not) Table 4.

DISCUSSION

The survey showed that the detected prevalence of sub-health status among college students was 64.4%, which was similar to the results of many related studies in China⁶⁻¹¹. The Figure was lower than the detected SHS prevalence of 75% in the WHO report,⁵ which may be explained by the fact that college students are in their young age, with good physical conditions and strong health awareness. However, the detected prevalence of sub-health was still fairly high among college students, which might be related to the social life stress incidents in this major outbreak.

SHS primarily manifests as changes in the physiological, psychological, and social dimensions.¹⁴ Given the rapid outbreak, strong infectiousness, and severe symptoms, special medicine against the virus still remains unavailable. This situation is likely to induce public anxiety and panic and easily affect the physical and mental health of college students to varying degrees. The results of this study showed that the physiological SHS was the best, followed by the psychological SHS, suggesting that the college students were generally in good physical conditions during the pandemic. A study¹⁵ showed that college students staying home exhibited various levels of emotional problems during the pandemic. For example, bored and upset students accounted for 72.87%, and anxious and worried ones accounted for 65.69%. The postponed semester of colleges and universities, the unscheduled date of school reopening, and the stress of academics and career during the graduation season all have varying degrees of impacts on the mental health of college students. In addition, with relatively higher education levels, college students tend to be quick to acquire and grasp information. A survey¹⁶ showed that 73.3% of college students frequently or always checked on the updates about COVID-19. Excessive attention paid to the pandemic may also induce the occurrence of psychological SHS. The results of this study showed that social SHS was the worst among the three subscales. This might be related to the college students' boredom of learning at home, lack of learning atmosphere, inadequate self-discipline, and difficulty with adapting to a new learning mode. The discomfort caused by staying indoors too long, tedious environment and routines, and changes in

Table 3: Assignment of independent variables.

Independent Variable	Assignment method
Gender	male=0; female=1
Place of family residence	non-Rural=0; Rural=1
Whether being the only child or not	non-only children =0; only children =1
Whether smoking or not	non-smoking=0; smoking =1
Whether drinking or not	non-drinking=0; drinking=1
Usage of electronic devices	<6h=0; 6~12h=1; ≥12h=2
Whether sleeping after 11 PM or not	never or seldom =0; sometimes =1; often=2; always =3
Hours of sleep per night	≥10h=0; 8~10h=1; <8h=2
Times of exercise per week	more than 3 times =0; 1~2 times =1; 0 times =2
Duration of exercise each time	>1h=0; 30min~1h=1; <30min=2
Whether skipping breakfast or not	often or always =0; sometimes =1; never or occasionally =2
Whether eating regular meals or not	often or always =0; occasionally =1; never or seldom =2

Table 4: Multiple-factor analysis of SHS scores among college students during the COVID-19 pandemic.

variable	B	Standard error	β	t	P
Constant	82.069	0.308		266.606	0.000
Whether eating regular meals or not	-2.806	0.161	-0.165	-17.419	0.000
Times of exercise per week	-1.829	0.134	-0.116	-13.609	0.000
Hours of sleep per night	-1.576	0.151	-0.086	-10.439	0.000
Whether sleeping after 11 PM or not	-0.935	0.102	-0.081	-9.189	0.000
Usage of electronic devices	-1.316	0.146	-0.078	-9.038	0.000
Duration of exercise each time	-0.867	0.125	-0.057	-6.916	0.000
Whether skipping breakfast or not	-0.710	0.124	-0.055	-5.709	0.000
Whether being the only child or not	0.860	0.221	0.032	3.896	0.000

Note: $R^2=0.118$, Adjust $R^2=0.117$, $F=225.068$, $P<0.001$.

lifestyle may also be relevant. Further analysis of the questionnaire items showed that college students had the lowest scores in seeking help actively, keeping in touch with friends, and receiving material or emotional support from classmates and families. This may be explained by the fact that college students usually live in the campus and spend less time at home, and now they have to get along with their family members all day long during the pandemic but only to find that they share few common topics. Moreover, college students may have a strong ego perception and are not good at interacting with others,¹⁷ and they tend to communicate with the outside world less while staying home.

The above is the current status of SHS of college students during the COVID-19 epidemic. At the same time, this study shows that there are differences in SHS of college students with different characteristics during the COVID-19 epidemic.

Being the only child was the protective factor for SHS scores of college students during the COVID-19 pandemic ($P<0.05$), as only children had better SHS scores than non-only children. Contrary to the results of Lian Guixiong *et al.*¹⁰ who believed that only children generally had worse sub-health symptoms than non-only children, this might be related to the particularity in the pandemic period of COVID-19. Some studies¹⁸⁻²⁰ showed that only children had higher levels of psychological health than non-only children, which was consistent with the results of this study. This might be explained by the fact that only children normally have a small family size, which is more financially affluent. When staying home, they can receive sufficient attention from families, fully satisfied both spiritually and materially. As a result, their enhanced sense of well-being would be unlikely to induce panic or helplessness. In addition, only children may be more proactive in interacting with people²¹ and more willing to talk to others during the pandemic.

Spending more time on electronic devices was the risk factors for SHS scores of college students during the COVID-19 pandemic ($P<0.05$). The less usage of electronic devices, the higher the SHS scores, and the closer to health status. According to the Proposed Diagnostic Criteria for Internet Addiction published by Tao Ran *et al.*²² the Internet addiction was diagnosed by daily internet use for at least six hours per day, lasting for at least 3 months. In this survey, college students who spent no less than six hours on electronic devices accounted for 61.6%. The underlying reason might be that the tedious daily routine heavily relied on spending time on the Internet, such as playing games, watching series, or browsing news¹⁵ Meanwhile, online learning at home should also be taken into consideration, as they would need to use their computers to watch videos, search papers, or use their smart phones or tablets to read course materials and learn vocabulary. The impact of extended use of electronic devices on health should not be underestimated. Multiple studies have shown that extended use of electronic devices can have harmful effects on the physical health of college students,²³⁻²⁵ causing headache, neck and

shoulder discomfort, visual fatigue, and dry eyes. Studies have also shown that prolonged exposure to the screens of electronic devices can reduce cognitive and sensory capabilities.²⁶ Properly controlled use of electronic devices would be conducive to lowering the occurrence of SHS. When scheduling online courses, schools should be careful to balance between study and rest. As far as college students are concerned, the top priority is to improve self-discipline, especially in using electronic devices. In addition, they should make good plans of daily life and learning with activities such as practicing brush writing, learning embroidery, or painting, which can effectively regulate boredom and irritability.

Sleeping after 11 PM more often and sleeping fewer hours per night were the risk factors for SHS scores during the COVID-19 pandemic ($P<0.05$), which was consistent with the findings of Xi Junyan *et al.*²⁷ Students who slept before 11 PM had better SHS, but they only accounted for 12.4%. In other words, 87.6% of college students kept staying up late during the pandemic. College students who slept less than eight hours per night had the lowest SHS scores, that is, the worst SHS, accounting for 23.9%. Students who slept eight to ten hours had the highest SHS scores, that is, the best SHS, accounting for 62.5%. In this regard, most students had enough sleep, possibly because they had more rest time due to the postponement of school reopening. In 2015, the National Sleep Foundation (NSF) issued its recommendations for appropriate sleep recommendations. It recommends sleep range of 7 to 9 hours per night for younger adults (18 to 25). The optimal time to fall asleep is before 10 PM and no later than 11 PM. Poor sleep quality directly affects the efficiency and safety of people's daily behaviors, as well as the physical and mental health. It may result in decreased immunity, depression, and even a variety of diseases.²⁸ The analysis of questionnaire items showed that college students tended to have poorer sleep quality, partly because they became less motivated for studying at home, concerned about their progress, and worried about the public health emergency. Good sleep quality promotes physical and mental health and improves learning efficiency.²⁹ Schools can take the following measures: 1. Make plans of daily routine and study programs for the students' reference, guiding them to develop good discipline. 2. Maintain contact and communication with students, track their learning progress at home, and pay attention to students' physical and mental health, so as to provide psychological guidance in a timely manner. 3. Use the school's online platform to inform students of the true news about the pandemic in real time, and share scientific tips to guide them to actively and effectively deal with the situation. In the other hand, the college students can improve their sleep quality by incorporating appropriate exercise and balancing diet, so as to prevent the occurrence of SHS.

Exercising fewer times per week and exercising for fewer minutes each time were the risk factors for SHS scores during the COVID-19 pandemic ($P<0.05$). Those took more times of exercise per week had

higher SHS scores. Those who exercised more than three times per week had the highest scores and were closer to being healthy. For different durations of exercise each time, 34.2% of college students exercised for 30 min to one hour, and they had the highest SHS scores and were closer to being healthy. This was consistent with Liu Jie,³⁰ who suggested that college students should exercise for 20 to 45 min each time, three times or more each week. In this survey, students who exercised more than three times per week accounted for 14.7%, while those exercising one or two times accounted for 44.8%. In other words, the majority of students still kept exercising while at home. Proper exercise can not only promote blood circulation, eliminate fatigue, improve cardiorespiratory capacity, but also cultivate one's moral character, hone the power of will, and enhance self-confidence. A study¹⁶ has shown that moderate exercise on a regular basis can significantly increase saliva IgA concerns and secretion rate, reduce the risk of upper respiratory tract infections, and enhance the body's immune function. Therefore, in the outbreak of the highly infectious 2019-nCoV, it is particularly necessary to strengthen prevention by improving physical conditions. During the pandemic, college students can enrich their daily routine through yoga, aerobics, and Tai Chi.

Skipping breakfast and eating irregular meals were the risk factors for SHS among college students during the COVID-19 pandemic ($P < 0.05$). Those eating breakfast and regular meals had higher scores and were closer to being healthy. In this study, 31.9% of college students never or occasionally ate breakfast, which could easily lead to SHS. In the other hand, 69.8% of college students always had regular meals and developed good eating habits. As the most important meal of the day, breakfast should account for 30% of the total food intake throughout the day.³¹ Often skipping breakfast can easily result in low blood sugar, which seriously affects the efficiency of learning, while increasing the risks of diseases such as gastrointestinal diseases and gallstones. Regular diet is conducive to physical supplementation, provides various nutrients required by the body, and maintains the functional vital activities. Analysis of the questionnaire items showed that college students tended to have poorer appetite during the pandemic. The underlying reason might be the reduced activity and consumption when staying home. It may also be related to mental stress. College students should apply the following measures: 1. Improve their appetite and relieve stress by cooking at home. 2. Increase the amount of activities and promote appetite by doing housework or working as a community volunteer.

CONCLUSION

The detected prevalence of sub-health among college students was as high as 64.4% during the COVID-19 pandemic. Particularly, unhealthy eating habits, lack of exercise, and declined sleep quality were the risk factors for SHS scores. Interventions should be made for the risk factors of college students' SHS scores during the COVID-19 epidemic to promote SHS to health.

ACKNOWLEDGEMENT

The authors would like to thank the college students who participated in this study.

Authors' contributions

Yan-Qi Liao and Ming-Ming Li conceived of the study and drafted the manuscript. Jian-Rong Gong performed the statistical analysis. Wan-Xian Lu, Yan-Bin Pan and Miao-Hang Shan conceived of the study and participated in its design and coordination. The authors read and approved the final manuscript.

Ethics approval and consent to participate

The research protocol was approved by the Hospital Medical Ethics Committee, The First Affiliated Hospital of Jinan University, with the approval number KY-2020-016.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest

ABBREVIATIONS

COVID-19: The Coronavirus disease; **SHS:** Sub-health status; **WHO:** World Health Organization; **CFS:** Chronic Fatigue Syndrome.

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Cite this article : Liao Y, Li M, Lu W, Pan Y, Gong J, Shan M. Prevalence of Sub-health Status among College Students in Guangzhou Baiyun Technician College Business during the Coronavirus Pandemic. *Int J Med Public Health*. 2021;11(2):96-102.