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Complete List of Authors:	<p>Bi, Jianlu; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Huang, Ying; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Xiao, Ya; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Cheng, Jingru; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Li, Fei; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Wang, Tian; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Liu, Yanyan; The First Affiliated Hospital of Guangzhou University of Chinese Medicine, Department of Rheumatic diseases</p> <p>Chen, Jieyu; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital; Southern Medical University, School of Traditional Chinese Medicine</p> <p>Wu, Liuguo; Southern Medical University, School of Traditional Chinese Medicine; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital</p> <p>Luo, Ren; Southern Medical University, School of Traditional Chinese Medicine; Southern Medical University, Department of Traditional Chinese Medicine, Nanfang Hospital</p> <p>Zhao, Xiaoshan; Southern Medical University, School of Traditional Chinese Medicine,</p>
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The relationship between lifestyle factors and sub-health status: a cross-sectional study of Chinese students

Jianlu Bi^{1,2#}, Ying Huang^{1,2#}, Ya Xiao^{1,2}, Jingru Cheng^{1,2}, Fei Li^{1,2}, Tian Wang^{1,2}, Jieyu Chen^{1,2}, Liuguo Wu^{1,2}, Yanyan Liu³, Ren Luo^{1,2*}, Xiaoshan Zhao^{1,2*}

1. Department of Traditional Chinese Medicine, Nanfang Hospital, Southern Medical University, Guangzhou, Guangdong, 510515, China.

2. School of Traditional Chinese Medicine, Southern Medical University, Guangzhou, Guangdong, 510515, China.

3. Department of Rheumatic diseases, The First Affiliated Hospital of Guangzhou University of Chinese Medicine, Guangzhou, 510405, China

Jianlu Bi and Ying Huang contributed equally to this work.

* Corresponding author 1: Luo Ren, Department of Traditional Chinese Medicine, Nanfang Hospital, Southern Medical University, Guangzhou Avenue North 1838, Guangzhou, 510515, China. E-mail: luoren41671@aliyun.com

* Corresponding author 2: Xiaoshan Zhao, School of Traditional Chinese Medicine, Southern Medical University, Guangzhou Avenue North 1838, Guangzhou, 510515, China. E-mail: zhaoxs0609@163.com.

ABSTRACT

Objectives: Sub-health status (SHS) is considered an intermediate state between disease and health, and characterized with declines in vitality, physiological function, and capacity for adaptation. Although the prevalence rate of SHS is high, the causes of sub-health are unclear. Lifestyle is one of the most important factors affecting health state. However, the relationship between the SHS and lifestyle has not been clarified.

Design: Cross-sectional survey.

Setting: An anonymous questionnaire was sent to four colleges in four districts (Guangzhou, Foshan, Zhanjiang, Shaoguan) in China from May 2013 to July 2013..

Participants: A total of 12,429 questionnaires were distributed during the study period, and 11,144 completed responses were received

Results: The prevalence rates of health, SHS, and disease were 22.81% (2542), 55.90% (6234), and 21.25% (2368), respectively. Most students reported a moderate and good lifestyle. There were significant differences in lifestyle and health state between the two genders. Notably, health state was significantly positively correlated with lifestyle ($r=0.563$). The mean values for every dimension of the HPLP-II were lower for subjects who reported SHS and disease than those who were healthy. In HPLP-II dimensions, including spiritual growth, health responsibility, physical activity, interpersonal relations, and stress management were all related with SHS.

Conclusion: Health state was significantly positively correlated with lifestyle. Poor lifestyle was a risk factor for SHS. Conversely, adopting a healthier lifestyle can improve SHS.

Keywords: lifestyle; sub-health; questionnaire; HPLP- II; student

Strengths and limitations of this study

Lifestyle is one of the most important factors affecting health status. However, the relationship between the Sub-health status (SHS) and lifestyle has not been clarified. We designed the cross-sectional study to assess the relationship between lifestyle and health status. The results revealed that health status was significantly positively correlated with lifestyle. Poor lifestyle was a risk factor for SHS. Conversely, adopting a healthier lifestyle can improve SHS.

Introduction

Sub-health status (SHS) is considered an intermediate state between disease and health and characterized in the traditional Chinese medicine (TCM) guidelines released by the China Association of Chinese Medicine as declines in vitality, physiological function, and capacity for adaptation^{1,2}. Over the years, the concept of sub-health has been widely accepted in many other countries, including Japan³, Canada, and Australia^{4,5}. According to our survey of civil servants, 65.1% of the total survey population was in a SHS⁶. Although the prevalence rate of SHS is high, the causes of sub-health are unclear.

Lifestyle is one of the most important factors affecting health⁷⁻¹⁰. The goal of healthy people is worldwide disease prevention and health promotion. Health promotion lifestyles are a “multidimensional pattern of self-initiated actions and perceptions that serve to maintain or enhance the level of wellness, self-actualization, and fulfillment of the individual.”¹¹ As a result, Walker and colleagues developed the Health Promoting Lifestyle Profile (HPLP) to describe an individual’s health promotion lifestyle¹¹. HPLP has been translated into several languages and is used to study lifestyle and health state¹²⁻¹⁷. Previous studies proposed that SHS may be related to poor lifestyle habits, such as staying up late, stress related to work and study, physical inactivity, and poor diet pattern^{1, 18-22}. Here, we studied the relationship between SHS and lifestyle factors using the Chinese version of the HPLP-II translated by Yen¹⁴.

Method

Instruments

A cross-sectional study was conducted among four colleges in four districts in China (Guangzhou, Foshan, Zhanjiang, Shaoguan). Data were collected between May 2013 and July 2013. A self-reported questionnaire containing information on socio-demographic indicators and psychosomatic symptoms was used to assess the respondents’ health status. The questionnaire was completed within 20–30 min. Verbal consent was deemed sufficient because the students volunteered for the study. They could refuse if they did not want to take part in the questionnaire survey. Our purpose was to study the students’ health status rather than to intervene. All student data were strictly confidential. The study was approved by the Ethics Committee of Nanfang Hospital in Guangzhou, China [2012]

LunShenZi (No. 035). The ethics committee also approved the consent procedure.

Sub-health status evaluation

The evaluation of sub-health was performed according to the clinical guideline of sub-health published by the China Association of Chinese Medicine². Subjects completed the Sub-Health Measurement Scale Version 1.0 (SHMS V1.0), which is a multidimensional, self-report symptom inventory that was developed by our research group in China²³. SHMS V1.0 consists of 39 items in total, which are divided into 3 symptom dimensions (physiological, psychological, society), 9 factors: physiological aspect: physical condition (3 items), organ function (6 items), body movement function (3 items), vigor (2 items); psychological aspect: positive emotion (4 items), psychological symptoms (6 items), cognitive function (2 items); society aspect: social adjustment (4 items), social resources(3 items) and social support (2 items); healthy evaluation (4 items).(Table 1) Each item has five answer categories in accordance with the degree of each symptom (none, occasionally, sometimes, constantly, and always). In the data analysis, none was assigned to 1, occasionally to 2, sometimes to 3, constantly to 4, and always to 5. We asked participants about uncomfortable symptoms experienced in the previous month. Total scores were calculated. A low score represents lower SHS (poor health). After excluding participants who were diagnosed with clinical disease, the cut-offs for physiological, psychological, and society sub-health on SHMS V1.0 were <68, <67, and <67, respectively. If subjects were not in physiological, psychological, or society SHS, they were considered healthy. The cut-off points were determined by the sub-health branch of the Chinese Medical Association in Guangdong. The validity and reliability of the SHMS V1.0 has been confirmed, with a Cronbach alpha coefficient and split-half reliability coefficient of 0.917 and 0.831, respectively²³.

Table 1 Theoretical Framework of Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)

dimension	factors	items	item distribution
physiological	physical condition	3	1,2,3
	organ function	6	4,5,6,7,8,9
	body movement function	3	10,11,12
	vigor	2	13,14
psychological	positive emotion	4	16,17,18,19
	psychological symptoms	6	20,21,22,23,24,25
	cognitive function	2	26,27
society	social adjustment	4	29,30,31,32

	social resources	3	33,34,35
	social support	2	36,37
healthy evaluation		4	15,28,38,39
total		39	

Lifestyle evaluation

The Chinese version of the HPLP-II was translated by Yen¹⁴. The Chinese version of HPLP-II is a revised 52-item instrument that includes 6 dimensions: health responsibility (9 items), physical activity (8 items), nutrition (9 items), spiritual growth (9 items), interpersonal relations (9 items), and stress management (8 items). The names were changed for three of the six original dimensions (self-actualization to spiritual growth, interpersonal support to interpersonal relations, and exercise to physical activity¹⁴). Respondents were asked to report their behaviors on a 4-point Likert scale (1 = never, 2 = sometimes, 3 = often, and 4 = routinely). As the original authors of the scale recommended, the total HPLP-II score was obtained by calculating a mean of the responses to all 52 items. HPLP-II scores range from 52–208. The health-promoting lifestyle score was divided into four grades: 52–90, poor; 91–129, moderate; 130–168, good; and 169–208, excellent. Higher scores indicated a greater frequency of health-promoting behaviors.

2.4. Statistical Analyses

Data are reported as mean \pm standard deviation (SD) for continuous variables or frequencies for categorical variables. Descriptive statistics and univariate analyses were carried out using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). Pearson chi-square (χ^2) tests and independent-sample t tests were used to compare the independent variables versus dependent variables, and the corresponding 95% confidence intervals (CI) were calculated. $P < 0.05$ was considered significant for all tests.

Results

A total of 12,429 questionnaires were distributed during the study period, and 11,144 completed responses were received (89.66% response rate).

Lifestyle condition by gender

A total of 11,144 students aged 18 to 26 years (mean age 20.70 years, SD=1.58) were analyzed. There are 4780 males and 6363 females. Table 2 shows the Student's t test

results of different levels of HPLP-II by gender. The numbers of students with poor, moderate, good, and excellent levels are 309, 5814, 4587, and 434, respectively. Most students reported moderate and good lifestyles. There were significant differences between males and females in the HPLP-II levels of poor, moderate, and good, but no significant difference in the excellent level. The mean values of females in poor and moderate health were higher than those in males, and those of females in good and excellent health were lower than those calculated for males ($P=0.000$).

Table 2 lifestyle condition by gender

HPLP-II level	HPLP-II scores		t	P
	Male	Female		
Poor	81.42±7.82	83.67±6.79	2.598	0.010
Moderate	113.90±9.97	115.65±9.63	6.736	0.000
Good	143.47±10.06	142.85±9.83	-2.075	0.038
Excellent	182.6±11.74	180.80±11.09	-1.651	0.099

Overall student health state

We evaluated a total of 11,144 students, and the numbers of students in the health, sub-health, and disease groups were 2542, 6234, and 2368, respectively. The prevalence rate of sub-health was 55.90% (6234). The major diseases affected the respiratory and digestive systems, such as chronic rhinitis (1074), chronic gastritis (320), chronic pharyngitis (317), piles (109), chronic bronchitis (76), and gastroduodenal ulcer (75). The mean and SD of the subscale and total SHMS V1.0 scale are shown in Table 2. There were significant differences among health, sub-health, and disease groups in physiological, psychological, and society aspects ($P=0.000$). We found that the mean values of subjects in the health state were significantly higher than those in subjects with sub-health and disease states ($P=0.000$).

The numbers of males in health, sub-health and disease states were 1169, 2698, and 913, while those of females were 1373, 3536, and 1454, respectively. The subscale mean values of SHMS V1.0 in males were higher than those in females (Table 3). There were statistically significant differences between males and females ($P=0.000$). Our results suggest that the health status of female students is poorer than their male counterparts.

Table 3 SHMSV1.0 scores by health status

	Health	Sub-health	Disease	F	P
Dimensions of SHMS V1.0					

Physiological	82.3±6.91	70.91±9.55	69.84±10.34	1592.251	0.000
Psychological	78.27±7.00	60.73±10.27	62.29±12.61	2784.864	0.000
Society	79.47±7.30	60.73±11.85	64.95±13.73	2434.389	0.000
Gender					
Male	81.16±5.60	65.45±8.03	66.45±10.60	1616.441	0.000
Female	79.36±4.98	64.31±7.45	65.71±9.53	2043.924	0.000
Total	80.19±5.35	64.8±7.73	65.99±9.96	3666.607	0.000

The health state of students by HPLP-II level

As shown in Table 4, the mean values of SHMS V1.0 gradually increased from poor to excellent levels on the HPLP-II. They were significantly positively correlated (Spearman's $r=0.563$, $P=0.000$) (Figure 1). The statistics in Table 5 show that most students in the good HPLP level were healthy students, while those in the moderate HPLP level were in the sub-health and disease categories, and this difference was statistically significant ($\chi^2=1640.444$, $P=0.000$).

Table 4 SHMS V1.0 scores by HPLP-II level

HPLP-II level	SHMS V1.0 scores (Mean ±SD)
Poor	57.18±11.28
Moderate	64.8±8.93
Good	72.9±8.25
Excellent	81.28±8.75

Table 5 Frequency in different health status by HPLP-II level

HPLP-II level	Health	SHS	Disease	χ^2	P
Poor	11	237	61	1640.444	0.000
Moderate	579	3960	1275		
Good	1663	1957	967		
Excellent	289	80	65		

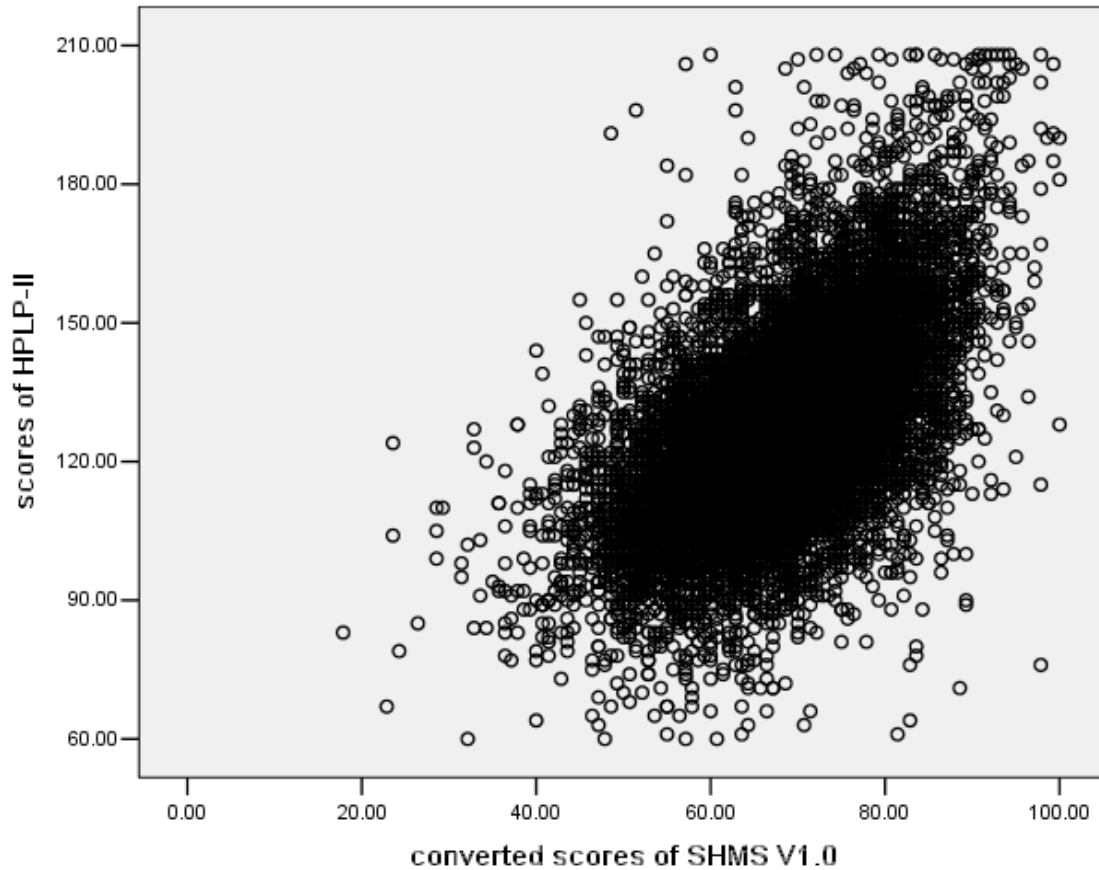


Fig. 1. Scatter plot of SHMS V1.0 and HPLP-II

Comparative analysis of HPLP-II scores by health state

Table 6 shows the mean and standard deviation for each HPLP-II subscale. There were statistically significant differences among the health, sub-health, and disease groups ($P=0.000$). The mean values in the sub-health and disease groups were lower than those in the health group on every HPLP-II dimension, indicating that students in the sub-health and disease groups had poorer lifestyles.

Table 6 HPLP-II subscale scores by health status

HPLP-II dimensions	No. of items	Health Mean \pm SD	SHS Mean \pm SD	Disease Mean \pm SD	F	P
Spiritual growth	9	29.10 \pm 4.33	23.97 \pm 4.74	25.34 \pm 4.92	1081.539	0.000
Health responsibility	9	19.91 \pm 5.09	16.68 \pm 3.95	17.39 \pm 4.11	520.067	0.000
Physical activity	8	19.88 \pm 4.4.99	16.58 \pm 4.35	16.88 \pm 4.47	498.864	0.000
Nutrition	9	23.23 \pm 4.64	20.40 \pm 4.14	21.18 \pm 4.25	392.236	0.000
Interpersonal relations	9	27.87 \pm 4.14	23.75 \pm 4.19	25.11 \pm 4.33	866.506	0.000
Stress management	8	24.33 \pm 3.74	20.59 \pm 3.61	21.41 \pm 3.81	935.300	0.000
Total scale	52	144.31 \pm 20.58	121.96 \pm 18.61	127.29 \pm 19.44	1219.263	0.000

Logistic regression analysis of sub-health status and lifestyle

Table 7 shows the regression analysis parameter estimates and standard errors for lifestyle and health and SHS. In HPLP-II dimensions, including spiritual growth, health responsibility, physical activity, interpersonal relations, and stress management were entered into the stepwise regression equation.

Table 7 Stepwise regression variables

Variables	B	S.E.	P	OR	95.0% C.I. for OR	
					Lower	Upper
Spiritual growth	-0.142	0.008	0.000	0.867	0.854	0.881
Health responsibility	-0.017	0.008	0.034	0.983	0.968	0.999
Physical activity	-0.032	0.007	0.000	0.969	0.955	0.983
Interpersonal relations	-0.062	0.009	0.000	0.94	0.923	0.958
Stress management	-0.099	0.011	0.000	0.905	0.886	0.925

Discussion

This study aimed to examine the relationship between health status and lifestyles in order to obtain a more complete profile of students' well-being and identify more effective intervention measures. We found that the prevalence rate of sub-health was 55.90% (6234/11,494). This result is similar to other reports in China^{24,25}. Most students reported a moderate lifestyle. Notably, health status was significantly positively correlated with lifestyle ($r=0.563$). The mean values of sub-health and disease were lower than those for health on every dimension of the HPLP-II. Our findings also revealed that physical activity, health responsibility, spiritual growth, interpersonal relations, and stress management are related to SHS.

Unhealthy behaviors and lifestyles are 2 important factors associated with 10 major causes of death⁷⁻¹⁰. Lifestyle is reportedly associated with increased risk of gastroduodenal ulcer²⁶, chronic rhinitis²⁷, obesity²⁸, neck cancer²⁹, breast cancer³⁰, and coronary heart disease³¹. Comprehensive lifestyle changes may have therapeutic potential in early cancers³², diabetes³³, and stroke³⁴. "Lifestyle diseases" are an increasing threat to health. Our findings suggested that students with disease have poor lifestyles. The diseases largely affected the respiratory and digestive systems, which are closely related to lifestyle^{27,28}. As a result, individuals can change poor lifestyle factors

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3 to improve their health status.

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5 Previous studies proposed that SHS may be related to poor lifestyle factors, such as
6 staying up late, stress related to work and study, physical inactivity, and poor diet ^{1, 18-22}.
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8 We designed the present study to assess the relationship between lifestyle and health
9 status. The statistical analysis revealed that health state was significantly positively
10 correlated with lifestyle. SHS and disease students both reported poor lifestyles. In fact,
11 lifestyle factors could affect the physiological, psychological, and society aspects of
12 health status. In HPLP-II, physical activity and nutrition may affect physiological health,
13 spiritual growth and stress management influence psychological health, and interpersonal
14 relations impact societal health. In addition, our results indicated that SHMS V1.0 score
15 and HPLP-II score of sub-health were the lowest in the different health state. Students
16 with diseases may worry about their health state and do their best to improve the
17 symptoms and physical signs. They may change their lifestyle, exercise more, and
18 actively treat the disease, which can improve their health status. However, SHS students
19 did not pay increased attention to their lifestyle, which continued to harm their health.
20 Due to heavy study loads and anxiety, most students do not eat regularly, get sufficient
21 sleep, or exercise enough. As a result, they may suffer from headache, insomnia, fatigue,
22 and forgetfulness. Therefore, it is important to focus attention on SHS and lifestyle
23 factors that threaten the health of young people.

24
25 Our study also revealed that men and women show significant differences in both
26 lifestyle and health status. Men and women have different morphologic, physiologic,
27 metabolic, and genetic characteristics. It is reported that women are more prone to
28 depression, anxiety, and other neuropsychiatric disorders ^{35, 36}. This may be because
29 women are more influenced by pressure and their surroundings and experiences, which
30 might make them more prone to SHS. Poor lifestyle is detrimental to individual health.
31 Students' current health status may provide a glimpse into their performances as future
32 professionals. Therefore, understanding the variables that could affect students' health
33 profiles warrants serious attention.

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35 Conclusion: Health state was significantly positively correlated with lifestyle. Poor
36 lifestyle was a risk factor for SHS. Conversely, adopting a healthier lifestyle can improve
37 SHS.
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Limitations

Some limitations should be noted. First of all, this was a cross-sectional design, which did not allow us to assess causality or the directionality of relationships. Second, all information was obtained from self-reported questionnaires, which could result in potential information bias. Multiple assessments and informants may provide a richer and more thorough understanding of SHS.

For peer review only

Please read the questions below and fill in your answers referring to the previous 4 weeks.

1. How about your appetite?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
2. How about your sleep?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
3. Are you satisfied with your hair growth? (e.g., early white hair, yellow hair or hair loss, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
4. Do you suffer from palpitations, chest tightness, or shortness of breath?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
5. Do you suffer from gastrointestinal discomfort? (e.g.: acid reflux, belching, nausea, abdominal pain, bloating, diarrhea, constipation, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
6. Do you suffer from abnormal urine? (e.g.: dark urine, dysuria, oliguria, urinary frequency, nocturia, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
7. Do you suffer from head discomfort? (e.g.: dizziness, headache, heavy head, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
8. Are you suffering from eye discomfort? (e.g.: soreness, dryness, more tears, fuzzy, fatigue, and more bloodshot eyes, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
9. Do you suffer hearing system abnormalities? (e.g., tinnitus, hearing loss, earache, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
10. Do you have difficulty with your knees or with bending over?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard
11. Do you have any difficulty in climbing 3-5 floors?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard
12. Do you have any difficulty in walking 1500 m?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard
13. Could the fatigue be alleviated by rest?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
14. Do you have enough energy to cope with everyday life, work, and learn?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
15. You think you are in what physiological (physical) health state?	<input type="checkbox"/> health	<input type="checkbox"/> sub-health	<input type="checkbox"/> disease		
	if you are in sub-health, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe				
16. Do you have confidence?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite
17. Are you satisfied with your living conditions?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
18. Are you optimistic about the future?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite
19. Are you feeling happy?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
20. Do you feel nervous?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
21. Do you experience bad moods or depression?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
22. Do you feel insecure?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
23. Do you have no reason to feel afraid?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
24. Do you feel lonely?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite
25. Are you sensitive or suspicious?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
26. How is your memory?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
27. What about your ability to think and solve problems?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
28. How is your psychological health (e.g., emotional, cognitive ability) state?	<input type="checkbox"/> health	<input type="checkbox"/> sub-health	<input type="checkbox"/> disease		
	if you are in sub-health, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe				
29. Can you appropriately deal with unhappy events in your life, work, and school?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
30. Are you satisfied with your social relationships?	<input type="checkbox"/> never	<input type="checkbox"/> rarely	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
31. Are you satisfied with your performance in your life, work, and school?	<input type="checkbox"/> never	<input type="checkbox"/> rarely	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
32. Can you quickly adapt to new living, working, and learning environments?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
33. Do you always keep in touch with friends and family (e.g., visits, phone calls, other communications)?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
34. Do you have friends to share your happiness and	<input type="checkbox"/> never	<input type="checkbox"/> few	<input type="checkbox"/> some	<input type="checkbox"/> many	<input type="checkbox"/> very many,

sadness?					more than 5
35. Do you have many colleagues, classmates, neighbors, relatives or friends close to you?	<input type="checkbox"/> never	<input type="checkbox"/> few	<input type="checkbox"/> some	<input type="checkbox"/> many	<input type="checkbox"/> very many, more than 5
36. When you need help, would your family, colleagues, or friends provide physical or emotional support or help?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
37. When you are in trouble, would you seek support and help from others?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
38. What is the state of your social health (e.g., interpersonal relationships, social interactions)?	<input type="checkbox"/> health	<input type="checkbox"/> sub-health	<input type="checkbox"/> disease	if you are in sub-health, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe	
39. What is the state of your health (including physiological, psychological, and social aspects)?	<input type="checkbox"/> health	<input type="checkbox"/> sub-health	<input type="checkbox"/> disease	if you are in sub-health, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe	

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Contributors Study concept and design: Ren Luo, Xiaoshan Zhao; acquisition of data: Jianlu Bi, Ying Huang, Ya Xiao, Jingru Cheng, Fei Li, Tian Wang, Jieyu Chen, Liuguo Wu, and Yanyan Liu; analysis and interpretation of data: Jianlu Bi and Ying Huang; drafting of the manuscript: Jianlu Bi and Ying Huang; critical revision of the manuscript for important intellectual content: Ren Luo, Xiaoshan Zhao; study supervision: Ren Luo and Xiaoshan Zhao. All authors were involved in the formulation of the research questions.

Competing interests The authors declare that there is no conflict of interests.

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Checklist

	Item No	Recommendation	Page
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract <hr/> (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants <hr/> (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding <hr/> (b) Describe any methods used to examine subgroups and interactions <hr/> (c) Explain how missing data were addressed <hr/> (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy <hr/> (e) Describe any sensitivity analyses	5

Continued on next page

Results		Page	
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5-6
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	5-6
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-9
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Association of lifestyle factors and suboptimal health status: a cross-sectional study of Chinese students

Jianlu Bi^{1,2#}, Ying Huang^{1,2#}, Ya Xiao^{1,2}, Jingru Cheng^{1,2}, Fei Li^{1,2}, Tian Wang^{1,2}, Jieyu Chen^{1,2}, Liuguo Wu^{1,2}, Yanyan Liu³, Ren Luo^{1,2*}, Xiaoshan Zhao^{1,2*}

1. Department of Traditional Chinese Medicine, Nanfang Hospital, Southern Medical University, Guangzhou, Guangdong, 510515, China.

2. School of Traditional Chinese Medicine, Southern Medical University, Guangzhou, Guangdong, 510515, China.

3. Department of Rheumatic diseases, The First Affiliated Hospital of Guangzhou University of Chinese Medicine, Guangzhou, 510405, China

Jianlu Bi and Ying Huang contributed equally to this work.

* Corresponding author 1: Luo Ren, Department of Traditional Chinese Medicine, Nanfang Hospital, Southern Medical University, Guangzhou Avenue North 1838, Guangzhou, 510515, China. E-mail: luoren41671@aliyun.com

* Corresponding author 2: Xiaoshan Zhao, School of Traditional Chinese Medicine, Southern Medical University, Guangzhou Avenue North 1838, Guangzhou, 510515, China. E-mail: zhaoxs0609@163.com.

ABSTRACT

Objectives: Suboptimal health status (SHS) is considered to be an intermediate status between disease and health, and is characterized by a decline in vitality, in physiological function, and in the capacity for adaptation. Although the incidence of SHS is high, the underlying causes remain unclear. Lifestyle is one of the most important factors affecting health status; however, the relationship between SHS and lifestyle has not been elucidated.

Design: Cross-sectional survey

Setting: A questionnaire, based on 'Health Promoting Lifestyle Profile-II (HPLP-II)' and 'Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)', was sent to four colleges in four districts (Guangzhou, Foshan, Zhanjiang, Shaoguan) of China between May and July, 2013.

Participants: A total of 12,429 questionnaires were distributed during the study period, and 11,144 completed responses were received.

Results: The prevalence rates for the 'healthy', 'SHS', and 'disease' groups of respondents (students) were 22.81% (2,542), 55.90% (6,234), and 21.25% (2,368), respectively. Most of the students reported a 'moderate' or 'good' lifestyle. There were significant differences in lifestyle and health status between the two genders. It was notable that health status was significantly positively correlated with lifestyle ($r=0.563$). For every dimension of the HPLP-II model, the mean values were lower for those subjects who reported as 'SHS' or 'disease' than for those who reported that they were 'healthy'. The individual dimensions of the HPLP-II model, including 'spiritual growth', 'health responsibility', 'physical activity', 'interpersonal relations', and 'stress management' were all related to SHS.

Conclusion: Health status is significantly positively correlated with lifestyle. Poor lifestyle is a risk factor for SHS. Conversely, adopting a healthier lifestyle can improve SHS.

Keywords: lifestyle; suboptimal health status (SHS); questionnaire; HPLP-II; student

Strengths and limitations of this study

- The prevalence rate of SHS is 55.90% in Chinese students by a cross-sectional study.
- Health status is significantly positively correlated with lifestyle.
- Poor lifestyle is a risk factor for SHS; conversely, adopting a healthier lifestyle can improve SHS.

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Introduction

Suboptimal health status (SHS) is considered to be an intermediate status between disease and health. In the traditional Chinese medicine (TCM) guidelines released by the China Association of Chinese Medicine, it is characterized by a decline in vitality, in physiological function, and in the capacity for adaptation¹⁻³. Over the years, the concept of suboptimal health status has been widely accepted in many other countries, including Japan⁴, Canada, and Australia^{5,6}. According to a survey of civil servants undertaken by ourselves, SHS was applicable to 65.1% of the total survey population⁷; although the incidence of SHS is high, nevertheless the causes remain unclear.

Lifestyle is one of the most important factors affecting health⁸⁻¹¹. To achieve the goal of a healthy population worldwide requires action in both disease prevention and health promotion. Health-promoting lifestyles are a “multidimensional pattern of self-initiated actions and perceptions that serve to maintain or enhance the level of wellness, self-actualization, and fulfillment of the individual.”¹² Working on this basis, Walker and colleagues developed the Health Promoting Lifestyle Profile (HPLP) to describe an individual’s health promotion lifestyle¹². HPLP has since been translated into several languages, and it is used widely to study lifestyle and health status¹³⁻¹⁸.

A number of previous studies have proposed that SHS may be related to poor lifestyle habits, such as going to bed late, work- and study-related stress, physical inactivity, and poor diet pattern^{1,7,19-22}. In the work reported here, we have studied the relationship between SHS and lifestyle factors using the Chinese version of HPLP-II (translated by Yen)¹⁵.

Methods

Survey instruments

A cross-sectional study was conducted among four colleges in four areas of China (Guangzhou, Foshan, Zhanjiang, Shaoguan). Data were collected between May and July, 2013. A questionnaire, which sought information on socio-demographic indicators and which included ‘Health Promoting Lifestyle Profile-II (HPLP-II)’ and ‘Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)’, was used to assess the respondents’ health status and lifestyle. The questionnaire was completed by each volunteer within 30 min. Verbal consents were deemed to be sufficient because the students had volunteered

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for the study and could refuse to take part if they wished. The objective of the survey was to study the students' health status rather than to intervene. All student data were kept strictly confidential. The study was approved by the Ethics Committee of Nanfang Hospital in Guangzhou, China [2012] LunShenZi (No. 035). The ethics committee also approved the consent procedure.

SHS evaluation

The evaluation of SHS was performed according to the clinical guidelines for SHS published by the China Association of Chinese Medicine². Subjects completed the Sub-Health Measurement Scale Version 1.0 (SHMS V1.0), which is a multidimensional, self-report symptom inventory that has been developed by our research group in China²³. SHMS V1.0 consists of 39 items in total, 35 of which are divided amongst 3 symptom dimensions (*physiological*, *psychological*, and *social*) and 10 factors, as indicated in Table 1. Thus, the *physiological* dimension comprises the following factors: physical condition (3 items), organ function (6 items), body movement function (3 items), and vigor (2 items); the *psychological* dimension comprises: positive emotion (4 items), psychological symptoms (6 items), and cognitive function (2 items); and the *society* dimension comprises: social adjustment (4 items), social resources (3 items) and social support (2 items). A final dimension, *healthy evaluation*, comprises 4 further items. For each item, there are five response categories (defined as: 'none', 'occasionally', 'sometimes', 'constantly', and 'always') corresponding, respectively, to the frequency of occurrence of each symptom. In the data analysis, 'none' was assigned a score of 1, 'occasionally', 2, 'sometimes', 3, 'constantly', 4, and 'always', 5. Participants were asked about uncomfortable symptoms that they had experienced during the previous month. The total scores were then calculated. A low total score represents a low estimate of SHS (*i.e.* poor health).

Before the survey, the students had attended an annual school health examination in hospital. The health examination included medical history, a physical examination, blood hematology and biochemistry analyses, rest electrocardiography, and chest radiography. After excluding any participants who were diagnosed with clinical disease in the health examination, the threshold values for SHS in the physiological, psychological, and society dimensions of SHMS V1.0 were 68, 67 and 67, respectively. If subjects were not

in SHS with respect to any of these three dimensions (physiological, psychological, and society), they were considered healthy. The threshold values were determined by the SHS Branch of the CACM in Guangdong. The validity and reliability of SHMS V1.0 has been confirmed, with a Cronbach alpha coefficient and split-half reliability coefficient of 0.917 and 0.831, respectively²³.

Table 1 Theoretical Framework of Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)

dimension	factors	items	item distribution
physiological	physical condition	3	1,2,3
	organ function	6	4,5,6,7,8,9
	body movement function	3	10,11,12
	vigor	2	13,14
psychological	positive emotion	4	16,17,18,19
	psychological symptoms	6	20,21,22,23,24,25
	cognitive function	2	26,27
social	social adjustment	4	29,30,31,32
	social resources	3	33,34,35
	social support	2	36,37
healthy evaluation		4	15,28,38,39
total		39	

Lifestyle evaluation

The Chinese version of HPLP-II is a translation from the English undertaken by Yen¹⁵; it is a revised 52-item instrument that includes 6 dimensions: ‘health responsibility’ (9 items), ‘physical activity’ (8 items), ‘nutrition’ (9 items), ‘spiritual growth’ (9 items), ‘interpersonal relations’ (9 items), and ‘stress management’ (8 items). The names of three of the six original dimensions have been altered (thus, ‘self-actualization’ has been altered to ‘spiritual growth’, ‘interpersonal support’ to ‘interpersonal relations’, and ‘exercise’ to ‘physical activity’)¹⁵. Respondents were asked to report their behaviors on a 4-point Likert scale (1 = never, 2 = sometimes, 3 = often, and 4 = routinely). Following the recommendations of the original authors of the scale, the overall HPLP-II score was obtained by calculating the mean of the responses to all 52 items. HPLP-II scores therefore ranged between 52 and 208. The health-promoting lifestyle score were divided into four levels: 52–90, designated ‘poor’; 91–129, ‘moderate’; 130–168, ‘good’; and 169–208, ‘excellent’. Higher scores indicated a greater frequency of health-promoting behaviors.

2.4. Statistical Analyses

Data are reported as the mean \pm standard deviation (SD) for continuous variables, or as frequencies in the case of categorical variables. Descriptive statistics and univariate analyses were carried out using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). Pearson chi-square (χ^2) tests and independent-sample t tests were used to compare the independent variables versus dependent variables, and the corresponding 95% confidence intervals (CI) were calculated. $P < 0.05$ was considered significant for all tests.

Results

A total of 12,429 questionnaires (including requests for socio-demographic information, and the documents HPLP-II and SHMS V1.0) were distributed during the study period, and 11,144 completed responses were received (a response rate of 89.66%).

Lifestyle condition by gender

A total of 11,144 students aged 18 to 26 years (mean age 20.70 years, SD=1.58) were analyzed. There were 4,780 males and 6,363 females. Table 2 shows the Student's t test results of different levels of HPLP-II by gender. The numbers of students at the 'poor', 'moderate', 'good' and 'excellent' levels were 309, 5,814, 4,587 and 434, respectively. Most students reported 'moderate' or 'good' lifestyles. There were significant differences between males and females at the 'poor', 'moderate' and 'good' levels, but no significant difference at the 'excellent' level. The mean scores for females at the 'poor' and 'moderate' levels were higher than the corresponding scores for males, and the mean scores for females at the 'good' and 'excellent' levels were lower than those calculated for males ($P=0.000$).

Table 2 Lifestyle condition by gender

HPLP-II level	HPLP-II scores		t	P
	Male	Female		
Poor	81.42 \pm 7.82	83.67 \pm 6.79	2.598	0.010
Moderate	113.90 \pm 9.97	115.65 \pm 9.63	6.736	0.000
Good	143.47 \pm 10.06	142.85 \pm 9.83	-2.075	0.038
Excellent	182.6 \pm 11.74	180.80 \pm 11.09	-1.651	0.099

Overall student health status

A total of 11,144 students were evaluated, and the numbers of students in the 'healthy', 'SHS', and 'disease' groups were 2,542, 6,234, and 2,368, respectively. The prevalence rate of SHS was 55.90% (6,234). The major diseases that were reported

affected the respiratory and digestive systems, such as chronic rhinitis (1,074), chronic gastritis (320), chronic pharyngitis (317), piles (109), chronic bronchitis (76) and gastro-duodenal ulcer (75). The mean scores and SD values for the individual dimensions of SHMS V1.0, and for the SHMS V1.0 data overall, are shown in Table 3. There were significant differences between the 'healthy', 'SHS' and 'disease' groups with respect to the physiological, psychological, and society dimensions ($P=0.000$). The mean scores of the subjects in the 'healthy' group were significantly higher than those of the subjects in the 'SHS' and 'disease' groups ($P=0.000$).

The numbers of males in the 'healthy', 'SHS' and 'disease' groups were 1,169, 2,698, and 913, whereas the numbers of females were 1,373, 3,536, and 1,454, respectively. The mean scores for the individual dimensions of SHMS V1.0 were higher in males than in females (Table 3); and there were statistically significant differences between males and females ($P=0.000$). The results suggest that the health status of female students is poorer than that of their male counterparts.

Table 3 SHMS V1.0 scores by health status

	Healthy	SHS	Disease	F	P
Dimensions of SHMS V1.0					
Physiological	82.3±6.91	70.91±9.55	69.84±10.34	1592.251	0.000
Psychological	78.27±7.00	60.73±10.27	62.29±12.61	2784.864	0.000
Society	79.47±7.30	60.73±11.85	64.95±13.73	2434.389	0.000
Gender					
Male	81.16±5.60	65.45±8.03	66.45±10.60	1616.441	0.000
Female	79.36±4.98	64.31±7.45	65.71±9.53	2043.924	0.000
Total	80.19±5.35	64.8±7.73	65.99±9.96	3666.607	0.000

The health status of students by HPLP-II level

As shown in Table 4, the mean scores as determined using SHMS V1.0 increased in line with the transition from the 'poor' level to the 'excellent' level according to HPLP-II; they were significantly positively correlated (Spearman's $r=0.563$, $P=0.000$) (Figure 1). The statistics in Table 5 show that most students at the 'good' HPLP-II level were 'healthy' students, while those at the 'moderate' HPLP-II level were in the 'SHS' and 'disease' categories, and this difference was statistically significant ($\chi^2=1640.444$, $P=0.000$).

Table 4 SHMS V1.0 scores for each HPLP-II level

HPLP-II level	SHMS V1.0 scores (Mean \pm SD)
Poor	57.18 \pm 11.28
Moderate	64.8 \pm 8.93
Good	72.9 \pm 8.25
Excellent	81.28 \pm 8.75

Table 5 Frequencies of health status categories, for each HPLP-II level

HPLP-II level	Healthy	SHS	Disease	χ^2	P
Poor	11	237	61	1640.444	0.000
Moderate	579	3960	1275		
Good	1663	1957	967		
Excellent	289	80	65		

Comparative analysis of HPLP-II scores by health status

Table 6 shows the mean score and standard deviation for each HPLP-II dimension. There were statistically significant differences between the 'healthy', 'SHS', and 'disease' groups ($P=0.000$). For each of the HPLP-II dimensions, the mean scores for the 'SHS' and 'disease' groups were lower than those for the 'healthy' group, indicating that students in the two former groups had poorer lifestyles.

Table 6 Scores for each HPLP-II dimension, according to health status

HPLP-II dimensions	No. of items	Healthy Mean \pm SD	SHS Mean \pm SD	Disease Mean \pm SD	F	P
Spiritual growth	9	29.10 \pm 4.33	23.97 \pm 4.74	25.34 \pm 4.92	1081.539	0.000
Health responsibility	9	19.91 \pm 5.09	16.68 \pm 3.95	17.39 \pm 4.11	520.067	0.000
Physical activity	8	19.88 \pm 4.4.99	16.58 \pm 4.35	16.88 \pm 4.47	498.864	0.000
Nutrition	9	23.23 \pm 4.64	20.40 \pm 4.14	21.18 \pm 4.25	392.236	0.000
Interpersonal relations	9	27.87 \pm 4.14	23.75 \pm 4.19	25.11 \pm 4.33	866.506	0.000
Stress management	8	24.33 \pm 3.74	20.59 \pm 3.61	21.41 \pm 3.81	935.300	0.000
Total scale	52	144.31 \pm 20.58	121.96 \pm 18.61	127.29 \pm 19.44	1219.263	0.000

Logistic regression analysis of SHS and lifestyle

Table 7 shows the regression analysis parameter estimates and standard errors for

lifestyle and healthy and SHS. For HPLP-II, five of the dimensions ('spiritual growth', 'health responsibility', 'physical activity', 'interpersonal relations', and 'stress management') were entered into the stepwise regression equation.

Table 7 Stepwise regression variables

Variables	B	S.E.	P	OR	95.0% C.I. for OR	
					Lower	Upper
Spiritual growth	-0.142	0.008	0.000	0.867	0.854	0.881
Health responsibility	-0.017	0.008	0.034	0.983	0.968	0.999
Physical activity	-0.032	0.007	0.000	0.969	0.955	0.983
Interpersonal relations	-0.062	0.009	0.000	0.94	0.923	0.958
Stress management	-0.099	0.011	0.000	0.905	0.886	0.925

Discussion

The aim of this study was to examine the relationship between health status and lifestyles so as to obtain a more complete profile of the well-being of students and to identify more effective intervention measures. We found that the prevalence rate of SHS was 55.90% (6234/11,494). This result is similar to other reports from China^{24, 25}. Most students reported a 'moderate' lifestyle. Notably, health status was significantly positively correlated with lifestyle ($r=0.563$). The mean values for the 'SHS' and 'disease' groups were lower than those for the 'healthy' group for every dimension of the HPLP-II model. Our findings also revealed that 'physical activity', 'health responsibility', 'spiritual growth', 'interpersonal relations', and 'stress management' are all related to SHS.

In 1946, the World Health Organization (WHO) defined health in its broader sense as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity"²⁶. With greater understanding of health, the definition has deepened to take account of suboptimal health status (SHS), which is an intermediate state between disease and health, as proposed by Wang^{1, 3, 27}. Prevention and intervention strategies aimed at SHS are similar to the concept of preventive, predictive and personalized medicine (PPPM), which is an effective approach to the improvement of health, the prevention of disease and the treatment of early-stage illness^{1, 3}. The results presented in this study revealed that the prevalence rate of SHS was high (55.90%). Although the prevalence of suboptimal health is high, there has been a lack of objective clinical diagnostics for SHS. A number of SHS questionnaires have been established and

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evaluated in China, such as SHSQ-25 and MSQA^{20,28}; however, SHSQ-25 is targeted at physiological and psychological SHS and MSQA is aimed at adolescents. SHMS V1.0, on the other hand, is a multidimensional questionnaire that includes physiological, psychological and social dimensions²³. As they enter young adulthood, a number of students appear with physical, psychological and social problems; hence, SHMS V1.0 is very suitable for the assessment of the health status of students.

Unhealthy behaviors and lifestyles are two important factors that are associated with 10 major causes of death⁸⁻¹¹. Lifestyle is reportedly associated with increased risks of gastro-duodenal ulcer²⁹, chronic rhinitis³⁰, obesity³¹, neck cancer³², breast cancer³³, and coronary heart disease³⁴ and “lifestyle diseases” are an increasing threat to health. Comprehensive lifestyle changes may have therapeutic potential in early cancers³⁵, diabetes³⁶, and stroke³⁷. The findings of the present study suggested that students affected by disease had poor lifestyles. The types of diseases in question largely affected the respiratory and digestive systems, which are closely related to lifestyle^{30,31}. There are therefore opportunities for individuals to make changes to poor lifestyle factors and to improve their health status as a result.

Previous studies have proposed that SHS may be related to poor lifestyle factors, such as going to bed late, work- and study-related stress, physical inactivity, and poor diet^{1, 7, 19-22, 38}. This study was designed to assess the relationship between lifestyle and health status. The statistical analysis revealed that health status was significantly positively correlated with lifestyle. SHS and disease students both reported poor lifestyles. Lifestyle factors affect a range of aspects of health status – physiological, psychological and social. Within the framework of HPLP-II, ‘physical activity’ and ‘nutrition’ may affect physiological health, ‘spiritual growth’ and ‘stress management’ influence psychological health, and interpersonal relations impact upon social health. In addition, our results (Tables 3 and 6) indicated that the SHMS V1.0 and HPLP-II scores for the ‘SHS group’ were generally lower than those for the other two groups (‘healthy’ and ‘disease’). Students affected by diseases may worry about their health status and do their best to improve the symptoms and physical signs. They may change their lifestyle, exercise more, and actively treat the disease, which can improve their health status. SHS students, on the other hand, do not pay increased attention to their lifestyle, which as a

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3 result continues to harm their health. More generally, due to heavy study loads and
4 anxiety, most students do not eat regularly, get sufficient sleep, or exercise adequately;
5 and as a result, they may suffer from headaches, insomnia, fatigue, and forgetfulness. It is
6 therefore important to focus attention on SHS and lifestyle factors that threaten the health
7 of young people.
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11 Our study also revealed that men and women show significant differences in both
12 lifestyle and health status. Men and women have different morphological, physiological,
13 metabolic, and genetic characteristics. It is reported that women are more prone to
14 depression, anxiety, and other neuropsychiatric disorders^{39, 40}. This may be because
15 women are more influenced by pressure, and by their surroundings and experiences,
16 which might make them more prone to SHS.
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20 Poor lifestyle is detrimental to personal health. The current health status of today's
21 students may provide an insight into their likely performance as professional workers in
22 the future. Therefore, an understanding of the variables that can affect the health profiles
23 of students warrants serious attention.
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32 **Conclusion**

33 Health status is significantly positively correlated with lifestyle. Poor lifestyle is a
34 risk factor for SHS. Conversely, adopting a healthier lifestyle can improve SHS.
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39 **Limitations**

40 Some limitations should be noted. First, this was a cross-sectional design, which did
41 not allow us to assess causality or the directionality of relationships. Secondly, all
42 information was obtained from self-reported questionnaires, which could result in
43 potential information bias. Multiple assessments and informants may provide a richer and
44 more thorough understanding of SHS.
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51 **Contributors** Study concept and design: Ren Luo, Xiaoshan Zhao; acquisition of data:
52 Jianlu Bi, Ying Huang, Ya Xiao, Jingru Cheng, Fei Li, Tian Wang, Jieyu Chen, Liuguo
53 Wu, and Yanyan Liu; analysis and interpretation of data: Jianlu Bi and Ying Huang;
54 drafting of the manuscript: Jianlu Bi and Ying Huang; critical revision of the manuscript
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3 for important intellectual content: Ren Luo, Xiaoshan Zhao; study supervision: Ren Luo
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29 **Data sharing**

30 No additional data available.
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41 **Figure legend**

42 Fig. 1. Scatter plot of SHMS V1.0 scores and HPLP-II scores
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Sub-Health Measurement Scale Version 1.0

Please read the questions below and fill in your answers referring to the previous 4 weeks.

1. How about your appetite?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
2. How about your sleep?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
3. Are you satisfied with your hair growth? (e.g., early white hair, yellow hair or hair loss, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
4. Do you suffer from palpitations, chest tightness, or shortness of breath?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
5. Do you suffer from gastrointestinal discomfort? (e.g.: acid reflux, belching, nausea, abdominal pain, bloating, diarrhea, constipation, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
6. Do you suffer from abnormal urine? (e.g.: dark urine, dysuria, oliguria, urinary frequency, nocturia, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
7. Do you suffer from head discomfort? (e.g.: dizziness, headache, heavy head, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
8. Are you suffering from eye discomfort? (e.g.: soreness, dryness, more tears, fuzzy, fatigue, and more bloodshot eyes, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
9. Do you suffer hearing system abnormalities? (e.g., tinnitus, hearing loss, earache, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
10. Do you have difficulty with your knees or with bending over?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard	
11. Do you have any difficulty in climbing 3-5 floors?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard	
12. Do you have any difficulty in walking 1500 m?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard	
13. Could the fatigue be alleviated by rest?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
14. Do you have enough energy to cope with everyday life, work, and learn?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
15. You think you are in what physiological (physical) health status? if you are in suboptimal health status, what's the extent:	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	<input type="checkbox"/> mild	<input type="checkbox"/> moderate	<input type="checkbox"/> severe
16. Do you have confidence?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite	
17. Are you satisfied with your living conditions?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
18. Are you optimistic about the future?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite	
19. Are you feeling happy?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
20. Do you feel nervous?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
21. Do you experience bad moods or depression?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
22. Do you feel insecure?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
23. Do you have no reason to feel afraid?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
24. Do you feel lonely?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite	
25. Are you sensitive or suspicious?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
26. How is your memory?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
27. What about your ability to think and solve problems?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
28. How is your psychological health (e.g., emotional, cognitive ability) status? if you are in suboptimal health status, what's the extent:	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	<input type="checkbox"/> mild	<input type="checkbox"/> moderate	<input type="checkbox"/> severe
29. Can you appropriately deal with unhappy events in your life, work, and school?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
30. Are you satisfied with your social relationships?	<input type="checkbox"/> never	<input type="checkbox"/> rarely	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
31. Are you satisfied with your performance in your life, work, and school?	<input type="checkbox"/> never	<input type="checkbox"/> rarely	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good	
32. Can you quickly adapt to new living, working, and learning environments?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	
33. Do you always keep in touch with friends and family	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always	

(e.g., visits, phone calls, other communications)?					
34. Do you have friends to share your happiness and sadness?	<input type="checkbox"/> never	<input type="checkbox"/> few	<input type="checkbox"/> some	<input type="checkbox"/> many	<input type="checkbox"/> very many, more than 5
35. Do you have many colleagues, classmates, neighbors, relatives or friends close to you?	<input type="checkbox"/> never	<input type="checkbox"/> few	<input type="checkbox"/> some	<input type="checkbox"/> many	<input type="checkbox"/> very many, more than 5
36. When you need help, would your family, colleagues, or friends provide physical or emotional support or help?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
37. When you are in trouble, would you seek support and help from others?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
38. What is the status of your social health (e.g., interpersonal relationships, social interactions)?	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	if you are in suboptimal health status, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe	
39. What is the status of your health (including physiological, psychological, and social aspects)?	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	if you are in suboptimal health status, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe	

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Checklist

	Item No	Recommendation	Page
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract <hr/> (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-6
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants <hr/> (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	4-6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	4-6
Study size	10	Explain how the study size was arrived at	4-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding <hr/> (b) Describe any methods used to examine subgroups and interactions <hr/> (c) Explain how missing data were addressed <hr/> (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy <hr/> (e) Describe any sensitivity analyses	7

Continued on next page

Results		Page	
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	7-8
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-10
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

Association of lifestyle factors and **suboptimal health status**: a cross-sectional study of Chinese students

Jianlu Bi^{1,2#}, Ying Huang^{1,2#}, Ya Xiao^{1,2}, Jingru Cheng^{1,2}, Fei Li^{1,2}, Tian Wang^{1,2}, Jieyu Chen^{1,2}, Liuguo Wu^{1,2}, Yanyan Liu³, Ren Luo^{1,2*}, Xiaoshan Zhao^{1,2*}

1. Department of Traditional Chinese Medicine, Nanfang Hospital, Southern Medical University, Guangzhou, Guangdong, 510515, China.

2. School of Traditional Chinese Medicine, Southern Medical University, Guangzhou, Guangdong, 510515, China.

3. Department of Rheumatic diseases, The First Affiliated Hospital of Guangzhou University of Chinese Medicine, Guangzhou, 510405, China

Jianlu Bi and Ying Huang contributed equally to this work.

* Corresponding author 1: Luo Ren, Department of Traditional Chinese Medicine, Nanfang Hospital, Southern Medical University, Guangzhou Avenue North 1838, Guangzhou, 510515, China. E-mail: luoren41671@aliyun.com

* Corresponding author 2: Xiaoshan Zhao, School of Traditional Chinese Medicine, Southern Medical University, Guangzhou Avenue North 1838, Guangzhou, 510515, China. E-mail: zhaoxs0609@163.com.

ABSTRACT

Objectives: Suboptimal health status (SHS) is considered to be an intermediate status between disease and health, and is characterized by a decline in vitality, in physiological function, and in the capacity for adaptation. Although the incidence of SHS is high, the underlying causes remain unclear. Lifestyle is one of the most important factors affecting health status; however, the relationship between SHS and lifestyle has not been elucidated.

Design: Cross-sectional survey

Setting: A questionnaire, based on 'Health Promoting Lifestyle Profile-II (HPLP-II)' and 'Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)', was sent to four colleges in four districts (Guangzhou, Foshan, Zhanjiang, Shaoguan) of China between May and July, 2013.

Participants: A total of 12,429 questionnaires were distributed during the study period, and 11,144 completed responses were received.

Results: The prevalence rates for the 'healthy', 'SHS', and 'disease' groups of respondents (students) were 22.81% (2,542), 55.90% (6,234), and 21.25% (2,368), respectively. Most of the students reported a 'moderate' or 'good' lifestyle. There were significant differences in lifestyle and health status between the two genders. It was notable that health status was significantly positively correlated with lifestyle ($r=0.563$). For every dimension of the HPLP-II model, the mean values were lower for those subjects who reported as 'SHS' or 'disease' than for those who reported that they were 'healthy'. The individual dimensions of the HPLP-II model, including 'spiritual growth', 'health responsibility', 'physical activity', 'interpersonal relations', and 'stress management' were all related to SHS.

Conclusion: Health status is significantly positively correlated with lifestyle. Poor lifestyle is a risk factor for SHS. Conversely, adopting a healthier lifestyle can improve SHS.

Keywords: lifestyle; suboptimal health status (SHS); questionnaire; HPLP-II; student

Strengths and limitations of this study

- The prevalence rate of SHS is 55.90% in Chinese students by a cross-sectional study.
- Health status is significantly positively correlated with lifestyle.
- Poor lifestyle is a risk factor for SHS; conversely, adopting a healthier lifestyle can improve SHS.

For peer review only

Introduction

Suboptimal health status (SHS) is considered to be an intermediate status between disease and health. In the traditional Chinese medicine (TCM) guidelines released by the China Association of Chinese Medicine, it is characterized by a decline in vitality, in physiological function, and in the capacity for adaptation¹⁻³. Over the years, the concept of suboptimal health status has been widely accepted in many other countries, including Japan⁴, Canada, and Australia^{5,6}. According to a survey of civil servants undertaken by ourselves, SHS was applicable to 65.1% of the total survey population⁷; although the incidence of SHS is high, nevertheless the causes remain unclear.

Lifestyle is one of the most important factors affecting health⁸⁻¹¹. To achieve the goal of a healthy population worldwide requires action in both disease prevention and health promotion. Health-promoting lifestyles are a “multidimensional pattern of self-initiated actions and perceptions that serve to maintain or enhance the level of wellness, self-actualization, and fulfillment of the individual.”¹² Working on this basis, Walker and colleagues developed the Health Promoting Lifestyle Profile (HPLP) to describe an individual’s health promotion lifestyle¹². HPLP has since been translated into several languages, and it is used widely to study lifestyle and health status¹³⁻¹⁸.

A number of previous studies have proposed that SHS may be related to poor lifestyle habits, such as going to bed late, work- and study-related stress, physical inactivity, and poor diet pattern^{1,7,19-22}. In the work reported here, we have studied the relationship between SHS and lifestyle factors using the Chinese version of HPLP-II (translated by Yen)¹⁵.

Methods

Survey instruments

A cross-sectional study was conducted among four colleges in four areas of China (Guangzhou, Foshan, Zhanjiang, Shaoguan). Data were collected between May and July, 2013. A questionnaire, which sought information on socio-demographic indicators and which included ‘Health Promoting Lifestyle Profile-II (HPLP-II)’ and ‘Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)’, was used to assess the respondents’ health status and lifestyle. The questionnaire was completed by each volunteer within 30 min. Verbal consents were deemed to be sufficient because the students had volunteered

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for the study and could refuse to take part if they wished. The objective of the survey was to study the students' health status rather than to intervene. All student data were kept strictly confidential. The study was approved by the Ethics Committee of Nanfang Hospital in Guangzhou, China [2012] LunShenZi (No. 035). The ethics committee also approved the consent procedure.

SHS evaluation

The evaluation of SHS was performed according to the clinical guidelines for SHS published by the China Association of Chinese Medicine². Subjects completed the Sub-Health Measurement Scale Version 1.0 (SHMS V1.0), which is a multidimensional, self-report symptom inventory that has been developed by our research group in China²³. SHMS V1.0 consists of 39 items in total, 35 of which are divided amongst 3 symptom dimensions (*physiological*, *psychological*, and *social*) and 10 factors, as indicated in Table 1. Thus, the *physiological* dimension comprises the following factors: physical condition (3 items), organ function (6 items), body movement function (3 items), and vigor (2 items); the *psychological* dimension comprises: positive emotion (4 items), psychological symptoms (6 items), and cognitive function (2 items); and the *society* dimension comprises: social adjustment (4 items), social resources (3 items) and social support (2 items). A final dimension, *healthy evaluation*, comprises 4 further items. For each item, there are five response categories (defined as: 'none', 'occasionally', 'sometimes', 'constantly', and 'always') corresponding, respectively, to the frequency of occurrence of each symptom. In the data analysis, 'none' was assigned a score of 1, 'occasionally', 2, 'sometimes', 3, 'constantly', 4, and 'always', 5. Participants were asked about uncomfortable symptoms that they had experienced during the previous month. The total scores were then calculated. A low total score represents a low estimate of SHS (*i.e.* poor health).

Before the survey, the students had attended an annual school health examination in hospital. The health examination included medical history, a physical examination, blood hematology and biochemistry analyses, rest electrocardiography, and chest radiography. After excluding any participants who were diagnosed with clinical disease in the health examination, the threshold values for SHS in the physiological, psychological, and society dimensions of SHMS V1.0 were 68, 67 and 67, respectively. If subjects were not

in SHS with respect to any of these three dimensions (physiological, psychological, and society), they were considered healthy. The threshold values were determined by the SHS Branch of the CACM in Guangdong. The validity and reliability of SHMS V1.0 has been confirmed, with a Cronbach alpha coefficient and split-half reliability coefficient of 0.917 and 0.831, respectively²³.

Table 1 Theoretical Framework of Sub-Health Measurement Scale Version 1.0 (SHMS V1.0)

dimension	factors	items	item distribution
physiological	physical condition	3	1,2,3
	organ function	6	4,5,6,7,8,9
	body movement function	3	10,11,12
	vigor	2	13,14
psychological	positive emotion	4	16,17,18,19
	psychological symptoms	6	20,21,22,23,24,25
	cognitive function	2	26,27
social	social adjustment	4	29,30,31,32
	social resources	3	33,34,35
	social support	2	36,37
healthy evaluation		4	15,28,38,39
total		39	

Lifestyle evaluation

The Chinese version of HPLP-II is a translation from the English undertaken by Yen¹⁵; it is a revised 52-item instrument that includes 6 dimensions: ‘health responsibility’ (9 items), ‘physical activity’ (8 items), ‘nutrition’ (9 items), ‘spiritual growth’ (9 items), ‘interpersonal relations’ (9 items), and ‘stress management’ (8 items). The names of three of the six original dimensions have been altered (thus, ‘self-actualization’ has been altered to ‘spiritual growth’, ‘interpersonal support’ to ‘interpersonal relations’, and ‘exercise’ to ‘physical activity’)¹⁵. Respondents were asked to report their behaviors on a 4-point Likert scale (1 = never, 2 = sometimes, 3 = often, and 4 = routinely). Following the recommendations of the original authors of the scale, the overall HPLP-II score was obtained by calculating the mean of the responses to all 52 items. HPLP-II scores therefore ranged between 52 and 208. The health-promoting lifestyle score were divided into four levels: 52–90, designated ‘poor’; 91–129, ‘moderate’; 130–168, ‘good’; and 169–208, ‘excellent’. Higher scores indicated a greater frequency of health-promoting behaviors.

2.4. Statistical Analyses

Data are reported as the mean \pm standard deviation (SD) for continuous variables, or as frequencies in the case of categorical variables. Descriptive statistics and univariate analyses were carried out using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). Pearson chi-square (χ^2) tests and independent-sample t tests were used to compare the independent variables versus dependent variables, and the corresponding 95% confidence intervals (CI) were calculated. $P < 0.05$ was considered significant for all tests.

Results

A total of 12,429 questionnaires (including requests for socio-demographic information, and the documents HPLP-II and SHMS V1.0) were distributed during the study period, and 11,144 completed responses were received (a response rate of 89.66%).

Lifestyle condition by gender

A total of 11,144 students aged 18 to 26 years (mean age 20.70 years, SD=1.58) were analyzed. There were 4,780 males and 6,363 females. Table 2 shows the Student's t test results of different levels of HPLP-II by gender. The numbers of students at the 'poor', 'moderate', 'good' and 'excellent' levels were 309, 5,814, 4,587 and 434, respectively. Most students reported 'moderate' or 'good' lifestyles. There were significant differences between males and females at the 'poor', 'moderate' and 'good' levels, but no significant difference at the 'excellent' level. The mean scores for females at the 'poor' and 'moderate' levels were higher than the corresponding scores for males, and the mean scores for females at the 'good' and 'excellent' levels were lower than those calculated for males ($P=0.000$).

Table 2 Lifestyle condition by gender

HPLP-II level	HPLP-II scores		t	P
	Male	Female		
Poor	81.42 \pm 7.82	83.67 \pm 6.79	2.598	0.010
Moderate	113.90 \pm 9.97	115.65 \pm 9.63	6.736	0.000
Good	143.47 \pm 10.06	142.85 \pm 9.83	-2.075	0.038
Excellent	182.6 \pm 11.74	180.80 \pm 11.09	-1.651	0.099

Overall student health status

A total of 11,144 students were evaluated, and the numbers of students in the 'healthy', 'SHS', and 'disease' groups were 2,542, 6,234, and 2,368, respectively. The prevalence rate of SHS was 55.90% (6,234). The major diseases that were reported

affected the respiratory and digestive systems, such as chronic rhinitis (1,074), chronic gastritis (320), chronic pharyngitis (317), piles (109), chronic bronchitis (76) and gastro-duodenal ulcer (75). The mean scores and SD values for the individual dimensions of SHMS V1.0, and for the SHMS V1.0 data overall, are shown in Table 3. There were significant differences between the 'healthy', 'SHS' and 'disease' groups with respect to the physiological, psychological, and society dimensions ($P=0.000$). The mean scores of the subjects in the 'healthy' group were significantly higher than those of the subjects in the 'SHS' and 'disease' groups ($P=0.000$).

The numbers of males in the 'healthy', 'SHS' and 'disease' groups were 1,169, 2,698, and 913, whereas the numbers of females were 1,373, 3,536, and 1,454, respectively. The mean scores for the individual dimensions of SHMS V1.0 were higher in males than in females (Table 3); and there were statistically significant differences between males and females ($P=0.000$). The results suggest that the health status of female students is poorer than that of their male counterparts.

Table 3 SHMS V1.0 scores by health status

	Healthy	SHS	Disease	F	P
Dimensions of SHMS V1.0					
Physiological	82.3±6.91	70.91±9.55	69.84±10.34	1592.251	0.000
Psychological	78.27±7.00	60.73±10.27	62.29±12.61	2784.864	0.000
Society	79.47±7.30	60.73±11.85	64.95±13.73	2434.389	0.000
Gender					
Male	81.16±5.60	65.45±8.03	66.45±10.60	1616.441	0.000
Female	79.36±4.98	64.31±7.45	65.71±9.53	2043.924	0.000
Total	80.19±5.35	64.8±7.73	65.99±9.96	3666.607	0.000

The health status of students by HPLP-II level

As shown in Table 4, the mean scores as determined using SHMS V1.0 increased in line with the transition from the 'poor' level to the 'excellent' level according to HPLP-II; they were significantly positively correlated (Spearman's $r=0.563$, $P=0.000$) (Figure 1). The statistics in Table 5 show that most students at the 'good' HPLP-II level were 'healthy' students, while those at the 'moderate' HPLP-II level were in the 'SHS' and 'disease' categories, and this difference was statistically significant ($\chi^2=1640.444$, $P=0.000$).

Table 4 SHMS V1.0 scores for each HPLP-II level

HPLP-II level	SHMS V1.0 scores (Mean ±SD)
Poor	57.18±11.28
Moderate	64.8±8.93
Good	72.9±8.25
Excellent	81.28±8.75

Table 5 Frequencies of health status categories, for each HPLP-II level

HPLP-II level	Healthy	SHS	Disease	χ^2	P
Poor	11	237	61	1640.444	0.000
Moderate	579	3960	1275		
Good	1663	1957	967		
Excellent	289	80	65		

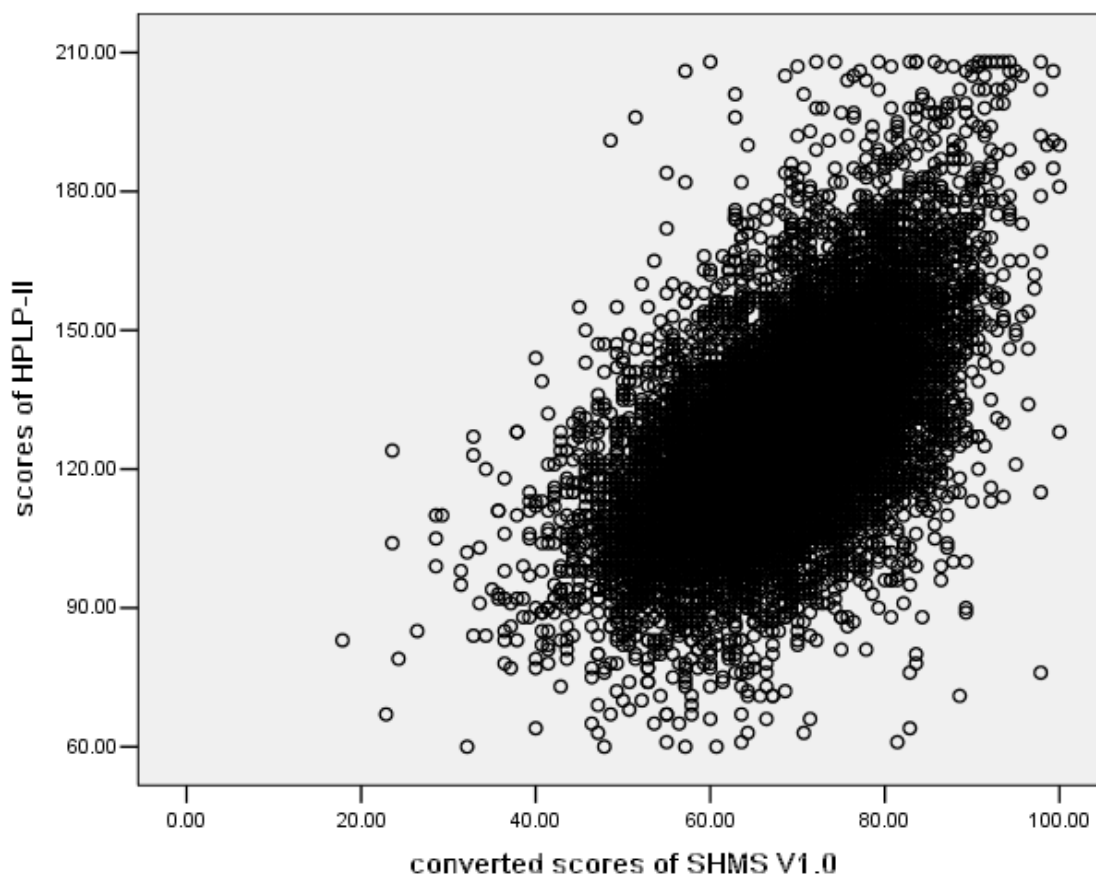


Fig. 1. Scatter plot of SHMS V1.0 scores and HPLP-II scores

Comparative analysis of HPLP-II scores by health status

Table 6 shows the mean score and standard deviation for each HPLP-II dimension. There were statistically significant differences between the 'healthy', 'SHS', and 'disease' groups ($P=0.000$). For each of the HPLP-II dimensions, the mean scores for the 'SHS' and 'disease' groups were lower than those for the 'healthy' group, indicating that students in the two former groups had poorer lifestyles.

Table 6 Scores for each HPLP-II dimension, according to health status

HPLP-II dimensions	No. of items	Healthy Mean \pm SD	SHS Mean \pm SD	Disease Mean \pm SD	F	P
Spiritual growth	9	29.10 \pm 4.33	23.97 \pm 4.74	25.34 \pm 4.92	1081.539	0.000
Health responsibility	9	19.91 \pm 5.09	16.68 \pm 3.95	17.39 \pm 4.11	520.067	0.000
Physical activity	8	19.88 \pm 4.4.99	16.58 \pm 4.35	16.88 \pm 4.47	498.864	0.000
Nutrition	9	23.23 \pm 4.64	20.40 \pm 4.14	21.18 \pm 4.25	392.236	0.000
Interpersonal relations	9	27.87 \pm 4.14	23.75 \pm 4.19	25.11 \pm 4.33	866.506	0.000
Stress management	8	24.33 \pm 3.74	20.59 \pm 3.61	21.41 \pm 3.81	935.300	0.000
Total scale	52	144.31 \pm 20.58	121.96 \pm 18.61	127.29 \pm 19.44	1219.263	0.000

Logistic regression analysis of SHS and lifestyle

Table 7 shows the regression analysis parameter estimates and standard errors for lifestyle and healthy and SHS. For HPLP-II, five of the dimensions ('spiritual growth', 'health responsibility', 'physical activity', 'interpersonal relations', and 'stress management') were entered into the stepwise regression equation.

Table 7 Stepwise regression variables

Variables	B	S.E.	P	OR	95.0% C.I. for OR	
					Lower	Upper
Spiritual growth	-0.142	0.008	0.000	0.867	0.854	0.881
Health responsibility	-0.017	0.008	0.034	0.983	0.968	0.999
Physical activity	-0.032	0.007	0.000	0.969	0.955	0.983
Interpersonal relations	-0.062	0.009	0.000	0.94	0.923	0.958
Stress management	-0.099	0.011	0.000	0.905	0.886	0.925

Discussion

The aim of this study was to examine the relationship between health status and lifestyles so as to obtain a more complete profile of the well-being of students and to identify more effective intervention measures. We found that the prevalence rate of SHS

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3 was 55.90% (6234/11,494). This result is similar to other reports from China^{24,25}. Most
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5 students reported a 'moderate' lifestyle. Notably, health status was significantly positively
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7 correlated with lifestyle ($r=0.563$). The mean values for the 'SHS' and 'disease' groups
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9 were lower than those for the 'healthy' group for every dimension of the HPLP-II model.
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11 Our findings also revealed that 'physical activity', 'health responsibility', 'spiritual
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13 growth', 'interpersonal relations', and 'stress management' are all related to SHS.

14 In 1946, the World Health Organization (WHO) defined health in its broader sense as
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16 "a state of complete physical, mental, and social well-being and not merely the absence
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18 of disease or infirmity"²⁶. With greater understanding of health, the definition has
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20 deepened to take account of suboptimal health status (SHS), which is an intermediate
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22 state between disease and health, as proposed by Wang^{1,3,27}. Prevention and intervention
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24 strategies aimed at SHS are similar to the concept of preventive, predictive and
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26 personalized medicine (PPPM), which is an effective approach to the improvement of
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28 health, the prevention of disease and the treatment of early-stage illness^{1,3}. The results
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30 presented in this study revealed that the prevalence rate of SHS was high (55.90%).
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32 Although the prevalence of suboptimal health is high, there has been a lack of objective
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34 clinical diagnostics for SHS. A number of SHS questionnaires have been established and
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36 evaluated in China, such as SHSQ-25 and MSQA^{20,28}; however, SHSQ-25 is targeted at
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38 physiological and psychological SHS and MSQA is aimed at adolescents. SHMS V1.0,
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40 on the other hand, is a multidimensional questionnaire that includes physiological,
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42 psychological and social dimensions²³. As they enter young adulthood, a number of
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44 students appear with physical, psychological and social problems; hence, SHMS V1.0 is
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46 very suitable for the assessment of the health status of students.

47 Unhealthy behaviors and lifestyles are two important factors that are associated with
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49 10 major causes of death⁸⁻¹¹. Lifestyle is reportedly associated with increased risks of
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51 gastro-duodenal ulcer²⁹, chronic rhinitis³⁰, obesity³¹, neck cancer³², breast cancer³³,
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53 and coronary heart disease³⁴ and "lifestyle diseases" are an increasing threat to health.
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55 Comprehensive lifestyle changes may have therapeutic potential in early cancers³⁵,
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57 diabetes³⁶, and stroke³⁷. The findings of the present study suggested that students
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59 affected by disease had poor lifestyles. The types of diseases in question largely affected
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the respiratory and digestive systems, which are closely related to lifestyle^{30,31}. There are

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3 therefore opportunities for individuals to make changes to poor lifestyle factors and to
4 improve their health status as a result.
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7 Previous studies have proposed that SHS may be related to poor lifestyle factors,
8 such as going to bed late, work- and study-related stress, physical inactivity, and poor diet
9 1, 7, 19-22, 38. This study was designed to assess the relationship between lifestyle and
10 health status. The statistical analysis revealed that health status was significantly
11 positively correlated with lifestyle. SHS and disease students both reported poor lifestyles.
12 Lifestyle factors affect a range of aspects of health status – physiological, psychological
13 and social. Within the framework of HPLP-II, ‘physical activity’ and ‘nutrition’ may
14 affect physiological health, ‘spiritual growth’ and ‘stress management’ influence
15 psychological health, and interpersonal relations impact upon social health. In addition,
16 our results (Tables 3 and 6) indicated that the SHMS V1.0 and HPLP-II scores for the
17 ‘SHS group’ were generally lower than those for the other two groups (‘healthy’ and
18 ‘disease’). Students affected by diseases may worry about their health status and do their
19 best to improve the symptoms and physical signs. They may change their lifestyle,
20 exercise more, and actively treat the disease, which can improve their health status. SHS
21 students, on the other hand, do not pay increased attention to their lifestyle, which as a
22 result continues to harm their health. More generally, due to heavy study loads and
23 anxiety, most students do not eat regularly, get sufficient sleep, or exercise adequately;
24 and as a result, they may suffer from headaches, insomnia, fatigue, and forgetfulness. It is
25 therefore important to focus attention on SHS and lifestyle factors that threaten the health
26 of young people.
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29 Our study also revealed that men and women show significant differences in both
30 lifestyle and health status. Men and women have different morphological, physiological,
31 metabolic, and genetic characteristics. It is reported that women are more prone to
32 depression, anxiety, and other neuropsychiatric disorders^{39, 40}. This may be because
33 women are more influenced by pressure, and by their surroundings and experiences,
34 which might make them more prone to SHS.
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37 Poor lifestyle is detrimental to personal health. The current health status of today’s
38 students may provide an insight into their likely performance as professional workers in
39 the future. Therefore, an understanding of the variables that can affect the health profiles
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of students warrants serious attention.

Conclusion

Health status is significantly positively correlated with lifestyle. Poor lifestyle is a risk factor for SHS. Conversely, adopting a healthier lifestyle can improve SHS.

Limitations

Some limitations should be noted. First, this was a cross-sectional design, which did not allow us to assess causality or the directionality of relationships. Secondly, all information was obtained from self-reported questionnaires, which could result in potential information bias. Multiple assessments and informants may provide a richer and more thorough understanding of SHS.

Contributors Study concept and design: Ren Luo, Xiaoshan Zhao; acquisition of data: Jianlu Bi, Ying Huang, Ya Xiao, Jingru Cheng, Fei Li, Tian Wang, Jieyu Chen, Liuguo Wu, and Yanyan Liu; analysis and interpretation of data: Jianlu Bi and Ying Huang; drafting of the manuscript: Jianlu Bi and Ying Huang; critical revision of the manuscript for important intellectual content: Ren Luo, Xiaoshan Zhao; study supervision: Ren Luo and Xiaoshan Zhao. All authors were involved in the formulation of the research questions.

Competing interests The authors declare that there is no conflict of interests.

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Sub-Health Measurement Scale Version 1.0

Please read the questions below and fill in your answers referring to the previous 4 weeks.

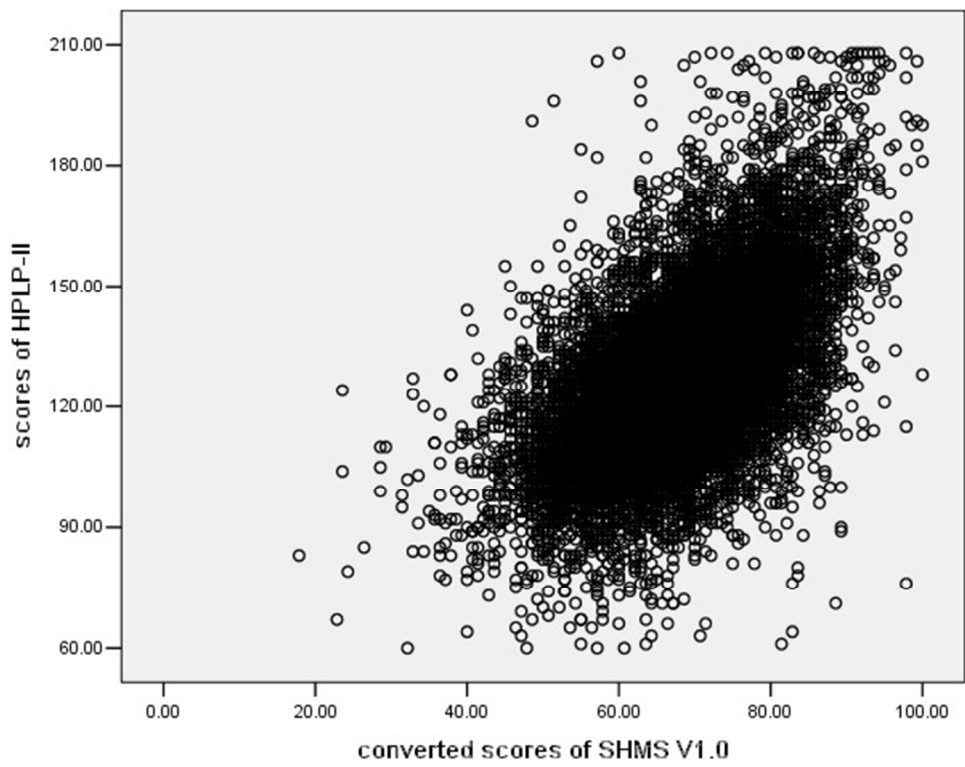
1. How about your appetite?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
2. How about your sleep?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
3. Are you satisfied with your hair growth? (e.g., early white hair, yellow hair or hair loss, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
4. Do you suffer from palpitations, chest tightness, or shortness of breath?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
5. Do you suffer from gastrointestinal discomfort? (e.g.: acid reflux, belching, nausea, abdominal pain, bloating, diarrhea, constipation, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
6. Do you suffer from abnormal urine? (e.g.: dark urine, dysuria, oliguria, urinary frequency, nocturia, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
7. Do you suffer from head discomfort? (e.g.: dizziness, headache, heavy head, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
8. Are you suffering from eye discomfort? (e.g.: soreness, dryness, more tears, fuzzy, fatigue, and more bloodshot eyes, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
9. Do you suffer hearing system abnormalities? (e.g., tinnitus, hearing loss, earache, etc.)	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
10. Do you have difficulty with your knees or with bending over?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard
11. Do you have any difficulty in climbing 3-5 floors?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard
12. Do you have any difficulty in walking 1500 m?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> hard	<input type="checkbox"/> very hard
13. Could the fatigue be alleviated by rest?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
14. Do you have enough energy to cope with everyday life, work, and learn?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
15. You think you are in what physiological (physical) health status? if you are in suboptimal health status, what's the extent:	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	<input type="checkbox"/> mild	<input type="checkbox"/> moderate <input type="checkbox"/> severe
16. Do you have confidence?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite
17. Are you satisfied with your living conditions?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
18. Are you optimistic about the future?	<input type="checkbox"/> never	<input type="checkbox"/> little	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite
19. Are you feeling happy?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
20. Do you feel nervous?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
21. Do you experience bad moods or depression?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
22. Do you feel insecure?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
23. Do you have no reason to feel afraid?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
24. Do you feel lonely?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> some	<input type="checkbox"/> much	<input type="checkbox"/> quite
25. Are you sensitive or suspicious?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
26. How is your memory?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
27. What about your ability to think and solve problems?	<input type="checkbox"/> very poor	<input type="checkbox"/> poor	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
28. How is your psychological health (e.g., emotional, cognitive ability) status? if you are in suboptimal health status, what's the extent:	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	<input type="checkbox"/> mild	<input type="checkbox"/> moderate <input type="checkbox"/> severe
29. Can you appropriately deal with unhappy events in your life, work, and school?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
30. Are you satisfied with your social relationships?	<input type="checkbox"/> never	<input type="checkbox"/> rarely	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
31. Are you satisfied with your performance in your life, work, and school?	<input type="checkbox"/> never	<input type="checkbox"/> rarely	<input type="checkbox"/> general	<input type="checkbox"/> good	<input type="checkbox"/> very good
32. Can you quickly adapt to new living, working, and learning environments?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
33. Do you always keep in touch with friends and family	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always

(e.g., visits, phone calls, other communications)?					
34. Do you have friends to share your happiness and sadness?	<input type="checkbox"/> never	<input type="checkbox"/> few	<input type="checkbox"/> some	<input type="checkbox"/> many	<input type="checkbox"/> very many, more than 5
35. Do you have many colleagues, classmates, neighbors, relatives or friends close to you?	<input type="checkbox"/> never	<input type="checkbox"/> few	<input type="checkbox"/> some	<input type="checkbox"/> many	<input type="checkbox"/> very many, more than 5
36. When you need help, would your family, colleagues, or friends provide physical or emotional support or help?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
37. When you are in trouble, would you seek support and help from others?	<input type="checkbox"/> never	<input type="checkbox"/> occasionally	<input type="checkbox"/> sometimes	<input type="checkbox"/> constantly	<input type="checkbox"/> always
38. What is the status of your social health (e.g., interpersonal relationships, social interactions)?	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	if you are in suboptimal health status, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe	
39. What is the status of your health (including physiological, psychological, and social aspects)?	<input type="checkbox"/> health	<input type="checkbox"/> suboptimal health status	<input type="checkbox"/> disease	if you are in suboptimal health status, what's the extent: <input type="checkbox"/> mild <input type="checkbox"/> moderate <input type="checkbox"/> severe	

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