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Mediating effect of health consciousness in the relationship of lifestyle and suboptimal health status: a cross-sectional study involving Chinese urban residents

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ABSTRACT

Objective Suboptimal health status (SHS), a third state between good health and disease, can easily develop into chronic diseases, and can be influenced by lifestyle and health consciousness. No study has surveyed the intermediation of health consciousness on the relationship between lifestyle and SHS. This study aimed to analyse the association of lifestyle and SHS, and intermediation of health consciousness in Chinese urban residents.

Design A cross-sectional face-to-face survey using a four-stage stratified sampling method.

Participants We investigated 5803 Chinese urban residents aged 18 years and over. We measured SHS using the Sub-Health Measurement Scale V1.0. We adopted a structural equation model to analyse relationships among lifestyle, health consciousness and SHS. We applied a bootstrapping method to estimate the mediation effect of health consciousness.

Results Lifestyle had stronger indirect associations with physical (β −0.185, 95% CI −0.228 to −0.149), mental (β −0.224, 95% CI −0.265 to −0.186) and social SHS (β −0.216, 95% CI −0.257 to −0.179) via health consciousness than direct associations of physical (β −0.144, 95% CI −0.209 to −0.081), mental (β −0.146, 95% CI −0.201 to −0.094) and social SHS (β −0.130, 95% CI −0.181 to −0.077). Health consciousness has a strong direct association with physical (β 0.360, 95% CI 0.295 to 0.427), mental (β 0.452, 95% CI 0.392 to 0.510) and social SHS (β 0.434, 95% CI 0.376 to 0.490). Ratio of mediating effect of health consciousness to direct effect of lifestyle with physical, mental and social SHS was 1.28, 1.53 and 1.66, respectively.

Conclusions Health consciousness was more important in preventing physical, mental and social SHS than lifestyle. Therefore, it might be useful in changing unhealthy lifestyle and reducing the influence of poor lifestyle on physical, mental and social SHS.

Strengths and limitations of this study

- The participants, who were recruited through a cross-sectional survey using a four-stage stratified sampling method, were representative of Chinese urban residents.
- To the best of our knowledge, this is the first representative analysis of the mediating effect of health consciousness on the association of lifestyle with physical, mental and social suboptimal health status.
- Although we used a four-stage stratified sampling method, sampling errors are still inevitable.
- This study only included the seven most common lifestyle factors.

INTRODUCTION

In 1946, the WHO[1] defined health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'. It is reported that non-communicable diseases (NCDs) account for an estimated 80% of the total deaths and 70% of the total number of disability-adjusted life-years in the early twentieth century.[2] Moreover, NCD increase steadily with urbanisation and ageing,[3] being attributed with more than 88% of total deaths in China in 2019.[4] Furthermore, a study pointed out that NCDs accounted for 18 of the 20 leading causes of age-standardised years lived with disability on a global scale.[5] The preclinical status of NCDs and its early detection have become major issues in the promotion of basic health service in the reform of healthcare.[6]

Suboptimal health status (SHS), an intermediate status between chronic disease and health, is believed to be a subclinical and reversible stage of chronic disease.[7] People in SHS, although without a diagnosable condition, are characterised by a decline in vitality and physiological function, ambiguous health complaints, general weakness and lack of vitality. In fact, it has become a new public health challenge in China.[8 9]

It is reported that SHS can be measured objectively using microbiome,[10] telomere length,[11] plasma stress hormones,[12] plasma metabolites[13] and glycan.[14] However, these objective measures are not easily accessible, and sometimes may not be obvious, especially when people have uncomfortable feelings without abnormal symptoms. A self-rated method that uses a questionnaire is widely applicable in assessing SHS. In China, the Sub-Health Measurement Scale (SHMS V1.0), Suboptimal Health Status Questionnaire (SHSQ-25)[15] and Chinese Sub-Health Scale (CSHES)[16] were widely used for assessing SHS. However, compared with the other questionnaires, SHMS V1.0 assesses of the physical, mental and social aspects of SHS, which is in accordance with the health concept proposed by WHO in 1947.

SHS has a prevalence of above 65% in China,[17–20] and has become an increasingly concerning problem in many countries.[21 22] Moreover, its prevalence may be severely underestimated since many individuals are not aware that they suffer from SHS. For instance, in an investigation involving 6000 Chinese self-reported 'healthy people,' 72.8% were in 'suboptimal health status.'[23] Thus, identifying the influencing factors of SHS is important in preventing it, and would provide important information for first-level prevention of NCD.[24] In accordance with the definition released by the WHO, SHS has three dimensions: physical, mental and social adaption.[25] SHS concept is mainly based on Transitional Chinese Medicine and prevention is important.[26 27]

Lifestyle is an important factor associated with SHS. This includes smoking, alcohol use, skipping breakfast, poor nutrition, lack of exercise and sleep problems.[28 29] The first SHS study on urban Chinese population[9] pointed that SHS was associated with risk factors of chronic diseases and contributed to the development of them. In SHS, individuals can prevent a chronic disease by modifying their poor lifestyles, as supported by China's Blue Book on Self-Care.[30] Although, it is a given fact that individuals ought to change their bad lifestyles when experiencing adverse health issues, this is difficult to achieve in practice.[31 32] Studies revealed that better knowledge and strong beliefs improve the adherence to lifestyle changes[33 34] and prevent and control chronic diseases;[35 36] better knowledge and strong beliefs are important expressions of health consciousness.

Health consciousness is a psychological construct that corresponds to the awareness about one's health, and the willingness to change one's behaviours in order to improve it.[37 38] Moreover, it is related to anxiety, stress, depression and non-treatable diseases.[39] However, to our knowledge, there are no studies on the association of health consciousness to SHS. People may present different suboptimal health states in their physical, mental and social adaptation; thus, it is necessary to analyse SHS separately. We aimed to investigate whether improved health consciousness is associated with better lifestyle and less physical, mental and social SHS. Moreover, we aimed to discover the possible mediating effect of health consciousness on the association of lifestyle with physical, mental and social SHS. Thus, we used structural equation models to clarify these questions, on the basis of a representative sample of Chinese urban residents.

METHODS

Study design and population

We conducted a cross-sectional survey using a four-stage stratified sampling method from December 2017 to October 2018. In the first stage, we chose one province each from five administrative divisions in China; we selected Guangdong province, Heilongjiang province, Sichuan province, Gansu province and Tianjin city. Second, we chose three to four cities from each province by considering their level of economic development and regional distribution. Subsequently, we randomly selected two to four streets in the selected urban areas. Lastly, we investigated the urban residents who conveniently qualified from each street.

This study included individuals aged 18 years and older, who lived in an urban area for more than 6 months, and volunteered in our investigation. We excluded individuals who had a confirmed disease in the last 2 months, were unable to complete the questionnaire due to visual or hearing impairment and with missing values in lifestyle, health consciousness and SHS items. We investigated a total of 6578 individuals and excluded 775. Thus, we analysed a total of 5803 urban residents. Among them, 1704, 1328, 954, 925 and 892 participants were from Guangdong, Heilongjiang, Sichuan, Gansu and Tianjin provinces, respectively. All participants that volunteered provided their verbal consent prior to data collection, and were given the option to cease from participating anytime. They were also invited to give advices regarding the questionnaire. All data were kept strictly confidential.

Patient and public involvement

The participants were not involved in the development of the research question or design of this study. However, we disseminated the results of this analysis through public conferences, including summarised statements and open access to the published reports.

Survey instrument

We used a self-designed questionnaire for investigation, which is comprised of four parts: general demographic characteristics, which included age, gender, marital status, highest education level, per capita monthly household income and insurance; lifestyle, which included smoking, bad diet habit, alcohol intake, breakfast consumption, physical exercise, early to bed (before 11 p.m.) and sleep time; health consciousness, which included health knowledge, care for health and effect of leisure promoting health; and SHMS V1.0. Each volunteer completed the questionnaire within 30 min. Verbal consents were deemed to be sufficient because the participants had volunteered for the study and could refuse to take part if

they wished. The objective of the survey was to study the health status of the participants rather than intervene. All data were kept strictly confidential. The ethics committee approved the consent procedure.

SHS assessment

We performed SHS assessment using SHMS V1.0, which was developed by our research group. It comprised of 39 items[25] that were proven to have high reliability and validity in a Chinese population.[40] SHMS V1.0 consists of three subscales: physical suboptimal health status (PS), mental suboptimal health status (MS), and social suboptimal health status (SS). PS consists of 14 items that comprises four factors: physical condition, organ function, body movement function and vigour. MS consists of 12 items that comprises three factors: positive emotion, psychological symptoms and cognitive function. SS consists of 9 items that comprises three factors: social adjustment, social resources and social support. For each item, there are five response categories (1=none, 2=occasionally, 3=sometimes, 4=constantly and 5=always) that correspond to the frequency of occurrence of each symptom. We asked the participants regarding the uncomfortable symptoms that they had during the previous month. We then calculated the total scores. A low total score represents a low estimate of SHS (ie, poor health). The cut-off value for suboptimal health assessment referred to norms of SHMS V1.0 for Chinese urban residents were established by our research group.[41]

Lifestyle evaluation

Smoking was comprised of none smokers, past smokers and current smokers. Bad diet habit was divided into 'yes' (if any one of the following seven situations exist: irregular eating time, dieting, overeating, dietary bias or pickiness, salty tasty, spicy tasty and using snacks instead of meals), and 'no'. Alcohol intake was divided into 'never', 'occasionally', 'little everyday' and 'much everyday'. Breakfast consumption was comprised of 'never', 'occasionally' (ie, 1 or 2 days a week), 'sometimes' (ie, 3 or 4 days a week), 'frequently' (ie, 5 or 6 days a week) and 'everyday'. Physical exercise was divided into 'everyday', 'frequently' (ie, 5 or 6 days a week), 'sometimes' (ie, 3 or 4 days a week) and 'occasionally' (ie, 1 or 2 days a week, and no physical exercise). Sleep time were divided into three groups, '<7 hours/day', '7 to 9 hours/day' and '≥9 hours/day'.

Health consciousness evaluation

Health knowledge and attention to health consisted of 'very few/low', 'few/low', 'general', 'much/high' and 'very much/high'. Effect of leisure on health consisted of 'no effect', 'some effect' and 'very effective'.

Quality control and data management

The investigators for each site were trained through face-to-face, video conferencing and telephone. Before the conduct of the investigation, we made sure that its purpose and importance were explained to the participants in detail, and obtained their verbal informed consent. The respondents answered the questionnaires independently and according to their own understanding, while missing data were re-answered after checking by the investigators. Before data coding and entry, suspicious duplicate questionnaires, which are those with a repetition rate higher than 80% and completion rate lower than 80% were excluded. All questionnaire data were double-entered using EpiData 3.1 software. The two data sets were cross compared for validity and errors.

Statistical analysis

Description was using means (SD) and proportions. We used a one-way analysis of variance (ANOVA) with least significant difference test for multiple comparisons. Cluster effect nested within sampling regions was examined by using interclass correlation coefficient (ICC) calculated in a two-level linear multilevel model. We used structural equation modelling (SEM) to analyse the complexity of associations between lifestyle, health consciousness and SHS (Model 1: SEM model of lifestyle, health consciousness and PS; Model 2: SEM model of lifestyle, health consciousness and MS; Model 3: SEM model of lifestyle, health consciousness and SS). Mediating effect of health consciousness was the same with indirect association of lifestyle and SHS via health consciousness. Ratio of mediating effect of health consciousness to direct effect of lifestyle (indirect effect divided by direct effect) and proportion of mediating effect of health consciousness to total effect (indirect effect divided by total effect multiply by a hundred) of lifestyle with physical, mental and social SHS were also calculated. We used the relative χ^2 minimum discrepancy per degree of freedom (CMIN/DF), root mean-square error of approximation (RMSEA), comparative fit index (CFI), goodness-of-fit index (GFI), and adjusted goodness-of-fit index (AGFI) to assess the model fit. We applied the bootstrapping method of repeat sampling by 2000 times to verify statistical significance and calculate the CIs for the direct, indirect and total effects. Participants with missing data were deleted from analysis. All p values were two-sided, with values <0.05 considered as statistically significant. We used IBM SPSS Statistics 20.0 for descriptive analysis. Lastly, we conducted SEM analysis with AMOS (SPSS Statistics V.20·0, SPSS Inc, Chicago, Illinois, USA).

RESULTS

Participants' demographic characteristics

Baseline characteristics of all study participants are presented in table 1. Of the 5803 participants, 2772 (47.77%) were men and 3031 (52.23%) were women. The mean age was 40.90±15.46 years. Most of the participants (65.98%) were married. Moreover, 3320 (57.21%) of the participants have a per capita monthly household income (RMB) of less than 5000 RMB. Participants with compulsory school (up to grade 9), high school, junior college and university degree and above were 1343 (23.14%),

Table 1 Participant's demographic characteristics (n=3535)

Characteristic	N	%
Gender		
Man	2772	47.77
Woman	3031	52.23
Married status		
Unmarried	1556	26.81
Married	3829	65.98
Divorced or widows	386	6.65
Information missing	32	0.55
Per capita monthly household income (RMB)		
<5000	3320	57.21
>=5000	2419	41.69
Information missing	64	1.10
Highest education level		
Compulsory school (through grade 9)	1343	23.14
High school graduation	1298	22.37
Junior college degree	1374	23.68
University degree and above	1786	30.78
Information missing	2	0.03

1298 (22.37%), 1374 (23.68%) and 1786 (30.78%), respectively.

Association of lifestyle, health consciousness and SHS

The mean (*SD*) of the overall SHS, PS, MS and SS transformed scores were 67.15 (11.99), 70.92 (12.67), 67.01 (14.55) and 61.46 (15.56), respectively. The ANOVA results showed that various groups of lifestyle and health consciousness differed on physical SHS, mental SHS and social SHS (table 2). People who never smoked had the highest physical and social SHS scores; however, participants who quit smoking had lower physical, mental and social SHS scores than participants who were still smoking. People who had bad diet habits and consumed the most alcohol had the lowest physical, mental and social SHS scores. Physical, mental and social SHS scores were higher for participants who regularly consumed breakfast, engaged in regular physical exercise, had early bedtimes (ie, before 11 p.m.) and longer sleep duration.

SEM analysis of lifestyle, health consciousness and SHS

Because we used the multistage sampling method in this study, there might be a cluster effect nested within sampling regions. We examined ICC and its significance using a two-level linear multilevel model. For physical, mental and social SHS, there was no cluster effect in the regions, while the ICC was 0.028, 0.01 and 0.035, with p values of 0.085, 0.103 and 0.084, respectively. Thus, traditional SEM models could be used in the analysis of the association of lifestyle, health consciousness and SHS (figure 1). Three models fit reasonably well to the data. As shown in the models: (1) all indicator variables that we hypothesised as predictors were significantly related to their respective latent factors, p<0.001; (2) lifestyle had a direct negative association with PS (β −0.144, p<0.001), MS (β −0.146, p<0.001) and SS (β −0.130, p 0.001); (3) health consciousness had direct positive association with PS (β 0.360, p<0.001), MS (β 0.452, p<0.001) and SS (β 0.434, p<0.001), and mediating effects on the association of lifestyle with PS, MS and SS.

The association paths of lifestyle and health consciousness on SHS are presented in table 3. Although lifestyle and health consciousness were both associated with SHS, health consciousness had larger associations with PS (β 0.360), MS (β 0.452) and SS (β 0.434) than lifestyle (β −0.329, −0.370 and −0.345 respectively). Association of lifestyle and PS could be direct (β −0.144, 95% CI −0.209 to −0.081) and indirect (β −0.185, 95% CI −0.228 to −0.149), with faintly larger indirect association than direct association. However, the indirect association (β −0.224, 95% CI −0.265 to −0.186) of lifestyle and MS was obviously higher than direct association (β −0.146, 95% CI −0.201 to −0.094). The same higher indirect association (β −0.216, 95% CI −0.257 to −0.179) was found in the association of lifestyle and SS than direct association (β −0.130, 95% CI −0.181 to −0.077). Ratio of mediating effect of health consciousness to direct effect of lifestyle with physical, mental and social SHS was 1.28, 1.53 and 1.66, respectively. Proportion of mediating effect of health consciousness to total effect of lifestyle with physical, mental and social SHS was 56.23%, 60.54% and 62.61%, respectively.

DISCUSSION

In this large cross-sectional study involving a representative sample, we found that lifestyle health consciousness showed significantly mediating effects on the association of lifestyle with PS, MS and SS. The direct associations of PS, MS and SS with health consciousness were all significantly higher than lifestyle. However, the indirect associations of lifestyle with PS, MS and SS were higher than indirect associations via health consciousness.

SHS is a subjective feeling that lacks objective clinical diagnostics; thus, a self-assessed questionnaire is the most appropriate method of determining it. SHMS V1.0 is a multidimensional scale that includes physical, mental and social dimensions that correspond to the WHO's more comprehensive definition of health.[42] Moreover, it is widely used in China for assessing SHS in urban residents, workers and students.[17 18 25 29] We found that Chinese urban residents had low scores in PS, MS and SS, which means that they are at high risk to SHS in physical, mental and social adaption. This result is in accordance with other studies involving young and middle-aged intellectuals in Guangzhou,[43] Chinese migrant workers[44] and those that use other SHS evaluation questionnaires in China, such as the SHSQ-25.[6 9] Similarly, African[14] and Caucasian[45] studies showed the same SHS rate.

To the best of our knowledge, this is the first representative analysis of the mediating effect of health consciousness on the association of lifestyle with physical, mental and

Table 2 Group comparisons of lifestyle, health consciousness and suboptimal health status

Variates	N	PS mean (SE)	MS mean (SE)	SS mean (SE)
Smoking				
Never	3987	71.56 (12.48)†, ‡	67.13 (14.46)†	62.15 (15.16)†, ‡
Quit	614	68.32 (13.49)*, ‡, §	65.41 (15.11)*, ‡, §	58.38 (17.2)*, ‡
<20 cigarettes/day	1027	70.31 (12.67)*, †	67.4 (14.44)†	60.93 (15.53)*, †
≥20 cigarettes/day	164	70.85 (12.90)†	68.26 (15.44)†	61.02 (17.86)
Bad diet habits				
No	3357	73.1 (12.52)†	70.2 (14.14)†	64.19 (14.77)†
Yes	2446	67.92 (12.25)*	62.64 (13.97)*	57.71 (15.84)*
Alcohol intake				
Never	2077	71.93 (13.13)†, ‡, §, ¶	68.18 (14.66)†, ‡, §, ¶	62.61 (15.78)†, ‡, ¶
Occasionally	3099	70.86 (12.06)*, ‡, §, ¶	66.55 (14.21)*, ¶	61.15 (15.11)*, ¶
Little everyday	421	68.85 (13.65)*, †, ¶	66.29 (15.75)*, ¶	59.93 (16.69)*, ¶
Some everyday	106	68.35 (12.88)*, †, ¶	65.17 (13.79)*, ¶	60.27 (14.29)¶
Much everyday	72	63.47 (14.37)*, †, ‡, §	60.1 (16.45)*, †, ‡, §	53.97 (20.69)*, †, ‡, §
Breakfast consumption				
Never	139	67.93 (15.07)§, ¶	62.4 (17.25)§, ¶	53.46 (19.83)‡, §, ¶
Occasionally	600	66.88 (12.63)§, ¶	62.69 (14.12)§, ¶	55.79 (16.70)§, ¶
Sometimes	830	68.03 (11.99)§, ¶	61.81 (13.07)§, ¶	56.37 (15.38)*, §, ¶
Frequently	1539	71.07 (11.94)*, †, ‡, ¶	66.48 (14.01)*, †, ‡, ¶	61.75 (14.52)*, †, ‡, ¶
Everyday	2671	72.91 (12.73)*, †, ‡, §	70.22 (14.46)*, †, ‡, §	64.69 (14.75)*, †, ‡, §
Physical exercise				
Never	848	68.55 (13.27)†, ‡, §, ¶	64.24 (14.4) †, ‡, §, ¶	58.21 (15.68)†, ‡, §, ¶
Occasionally	2338	70.43 (11.78)*, §, ¶	65.54 (13.92)*, ‡, §, ¶	60.36 (14.45)*, ‡, §, ¶
Sometimes	1373	71.26 (13.11)*, ¶	67.54 (14.53)*, †, §	61.51 (16.75)*, †, §, ¶
Frequently	608	71.77 (13.03)*, †, ¶	68.72 (14.85)*, †, ‡	64.57 (15.24)*, †, ‡, ¶
Everyday	627	74.73 (12.73)*, †, ‡, §	73.53 (14.82)*, †, ‡, §	67.12 (15.11)*, †, ‡, §
Early to bed				
Never	947	70.29 (12.36)§, ¶	64.8 (14.74)§, ¶	59.72 (15.61)§, ¶
Occasionally	1512	70.3 (11.94)§, ¶	65.57 (13.71)§, ¶	60.08 (15.33)§, ¶
Sometimes	1224	70.01 (12.84)§, ¶	65.84 (14.46)*, †, §, ¶	60.47 (15.99)§, ¶
Frequently	997	71.49 (12.76)*, †, ‡, ¶	68.36 (14.46)*, †, ‡, ¶	63.07 (14.79)*, †, ‡, ¶
Everyday	1113	72.98 (13.39)*, †, ‡, §	70.99 (14.84)*, †, ‡, §	64.52 (15.49)*, †, ‡, §
Sleep time				
<3 hours/day	35	62.96 (12.11)‡, §, ¶	58.87 (13.81)‡, §, ¶	49.68 (20.42)‡, §, ¶
<5 hours/day	145	62.44 (12.88)‡, §, ¶	56.97 (14.78)‡, §, ¶	48.51 (18.88)‡, §, ¶
<7 hours/day	1377	67.89 (12.34)*, †, §, ¶	64.88 (14.09)*, †, §, ¶	59.86 (15.83)*, †, §, ¶
<9 hours/day	3748	72.47 (12.29)*, †, ‡, ¶	68.14 (14.38)*, †, ‡	62.65 (14.82)*, †, ‡
≥9 hours/day	492	71.09 (13.67)*, †, ‡, §	68.15 (15.30)*, †, ‡	61.95 (16.59)*, †, ‡
Health knowledge				
Very few	1332	70.27 (12.55)§, ¶	65.17 (14.79)‡, §, ¶	58.31 (15.43)†, ‡, §, ¶
Few	1794	70.38 (12.51) §, ¶	65.77 (14.27)‡, §, ¶	60.13 (15.41)*, ‡, §, ¶
General	1913	70.71 (12.52)§, ¶	67.54 (14.37)*, †, §, ¶	62.55 (15.13)*, †, §, ¶
Much	628	74.11 (12.58)*, †, ‡	71.47 (13.79)*, †, ‡, ¶	67.2 (14.62)*, †, ‡, ¶
Very much	120	74.65 (15.97)*, †, ‡	75.26 (15.28)*, †, ‡, §	70.61 (18.46)*, †, ‡, §
Care for health				

Continued

Table 2 Continued

Variates	N	PS mean (SE)	MS mean (SE)	SS mean (SE)
Very low	329	67.73 (14.32)‡, §, ¶	61.09 (16.65)‡, §, ¶	55.25 (17.71)‡, §, ¶
Low	789	67.61 (13.11)‡, §, ¶	62.33 (14.42)‡, §, ¶	56.1 (16.47)‡, §, ¶
General	2485	69.5 (11.9)*, †, §, ¶	65.37 (13.69)*, †, §, ¶	59.76 (14.35)*, †, §, ¶
High	1752	73.66(12)*, †, ‡, ¶	70.3 (13.74)*, †, ‡, ¶	65.28 (14.44)*, †, ‡, ¶
Very high	437	76.86 (13.36)*, †, ‡, §	76.27 (14.12)*, †, ‡, §	70.57 (15.73)*, †, ‡, §
Effect of leisure promoting health				
No effect	733	65.7 (12.87)†, ‡	60.94 (14.56)†, ‡	54.24 (17.22)†, ‡
Some effect	3870	70.37 (12.04)*, ‡	66.1 (13.76)*, ‡	60.68 (14.39)*, ‡
Very effective	1163	76.39 (12.75)*, †	74.11 (14.58)*, †	69 (15.28)*, †

Transformed scores were analysed here. Statistical analysis included a one-way analysis of variance followed by least significant difference multiple comparisons test.
*p< 0.05 as compared to answer code 1.
†p<0.05 as compared to answer code 2.
‡p<0.05 as compared to answer code 3.
§p<0.05 as compared to answer code 4.
¶p<0.05 as compared to answer code 5.
MS, mental suboptimal health status; PS, physical suboptimal health status; SS, social suboptimal health status.

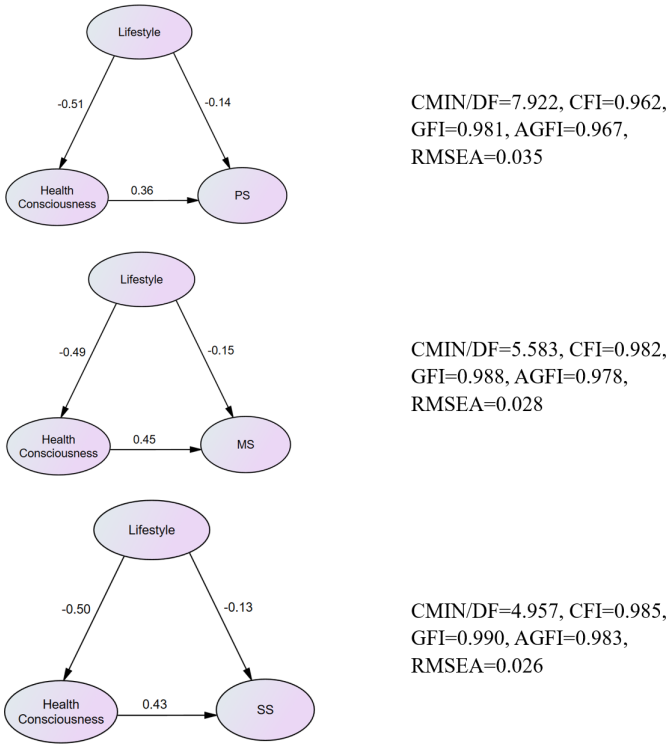

Figure 1 Structural equation model of lifestyle, health consciousness and PS (model 1), MS (model 2) or SS (model 3). All the standardised regression coefficients are presented as single-headed arrows, and statistically significant at 0.05 significance level. AGFI, adjusted goodness-of-fit index; CFI, comparative fit index; CMIN/DF, minimumdiscrepancy per degree of freedom; GFI, goodness-of-fit index; MS, mental suboptimal health status; PS, physical suboptimal health status; RMSEA, root mean-square error of approximation; SS, social suboptimal health status.

social SHS. All variables included in lifestyle and health consciousness were accordingly significantly associated. Urban residents who engage in unhealthy lifestyle practices, such as smoking, alcohol intake, bad diet habits, irregular breakfast consumption, less physical exercises, less frequent early to bed and short sleep time were more likely to get into PS, MS and SS. A study[42] revealed that breakfast eating habits are significantly associated with lifestyle, and appear to be a useful predictor of a healthy lifestyle; people who skip breakfast are prone to unhealthy behaviours, such as limited exercise.[46] Moreover, insufficient sleep is associated with several health-risk behaviours,[47] such as not meeting physical activity recommendations,[48] using cigarettes and alcohol, and feeling sad or hopeless.[49] Furthermore, poor diet was the third greatest influencing factor for physical and social health, which was in line with previous studies.[50 51]

This study investigated the significant associations of health consciousness with PS, MS and SS, which were relatively more significant than those of lifestyle. Moreover, in this study, health consciousness, included health knowledge, attention to health and effect of leisure on health. As the internal power of healthy behaviour, health consciousness is the most important and fundamental factor in promoting health. In fact, individuals who had more health knowledge believed that they had control over their health.[52]

The most important finding was that health consciousness played a mediating effect in the relationship of lifestyle with physical, mental and social SHS, which was higher than direct effect of lifestyle. Studies have shown that health consciousness is correlated with health behaviour, information seeking and health coping.[53] Modifying the attitudes is effective in promoting changes in health behaviour,[54] since health-conscious people are attentive to health warnings regarding the risks of having an unhealthy lifestyle.[55]

Table 3 Influencing path of lifestyle and health consciousness on SHS

SHS	Pathway	Mean standardised effects	95% CI Lower bound	95% CI Upper bound	P value
PS					
	Lifestyle—PS (total)	−0.329	−0.385	−0.278	<0.001
	Lifestyle—PS (direct)	−0.144	−0.209	−0.081	<0.001
	Lifestyle—health consciousness—PS (indirect)	−0.185	−0.228	−0.149	<0.001
	Health consciousness—PS	0.360	0.295	0.427	<0.001
MS					
	Lifestyle—MS (total)	−0.370	−0.408	−0.330	<0.001
	Lifestyle—MS (direct)	−0.146	−0.201	−0.094	0.001
	Lifestyle—health consciousness—MS (indirect)	−0.224	−0.265	−0.186	<0.001
	Health consciousness—MS	0.452	0.392	0.510	<0.001
SS					
	Lifestyle—SS (total)	−0.345	−0.383	−0.308	<0.001
	Lifestyle—SS (direct)	−0.130	−0.181	−0.077	0.001
	Lifestyle—health consciousness—SS (indirect)	−0.216	−0.257	−0.179	<0.001
	Health consciousness—SS	0.434	0.376	0.490	<0.001

MS, mental suboptimal health status; PS, physical suboptimal health status; SHS, suboptimal health status; SS, social suboptimal health status.

Limitations

This study has some limitations. First, although we used face-to-face interviews, all data were collected from a respondent-completed questionnaire; thus, responses may have a level of inherent inaccuracy or bias. Second, although we used a four-stage stratified sampling method, sampling errors are still inevitable. Lastly, this study only included the seven most common lifestyle factors.

CONCLUSION

In this large representative cross-sectional study of Chinese urban residents, we found that direct association of lifestyle with physical, mental and social SHS were smaller than direct association and mediating effect of health consciousness. Moreover, health consciousness was more important in preventing physical, mental and social SHS than lifestyle, and might be useful in changing unhealthy lifestyle and reducing the influence of poor lifestyle on physical, mental and social SHS.

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REFERENCES

1 World Health Organization. What is the WHO definition of health? World Health Organization, 2020. Available: http://www.who.int/suggestions/faq/en/
2 Strong K, Mathers C, Leeder S, *et al*. Preventing chronic diseases: how many lives can we save? *Lancet* 2005;366:1578–82.
3 Wang L, Kong L, Wu F, *et al*. Preventing chronic diseases in China. *Lancet* 2005;366:1821–4.
4 Transcript of press conference of the office of health China action promotion committee on July 31, 2019. Available: http://www.nhc.gov.cn/xcs/s7847/201907/0d95adec49f84810a6d45a0a1e997d67.shtml
5 GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-

specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the global burden of disease study 2015. *Lancet* 2016;388:1459–544.
6 Wang Y, Ge S, Yan Y, *et al*. China suboptimal health cohort study: rationale, design and baseline characteristics. *J Transl Med* 2016;14:291–302.
7 Wang W. Suboptimal health: a potential preventive instrument for non-communicable disease control and management. *J Transl Med* 2012;10:A45.
8 Yan Y-X, Liu Y-Q, Li M, *et al*. Development and evaluation of a questionnaire for measuring suboptimal health status in urban Chinese. *J Epidemiol* 2009;19:333–41.
9 Yan YX, Dong J, Liu YQ, *et al*. Association of suboptimal health status and cardiovascular risk factors in urban Chinese workers. *J Urban Health* 2012;89:329–38.
10 Sun Q, Xu X, Zhang J, *et al*. Association of suboptimal health status with intestinal microbiota in Chinese youths. *J Cell Mol Med* 2020;24:1837–47.
11 Alzain MA, Asweto CO, Zhang J, *et al*. Telomere length and accelerated biological aging in the China suboptimal health cohort: a case-control study. *OMICS* 2017;21:333–9.
12 Yan Y-X, Wu L-J, Xiao H-B, *et al*. Latent class analysis to evaluate performance of plasma cortisol, plasma catecholamines, and SHSQ-25 for early recognition of suboptimal health status. *Epma J* 2018;9:299–305.
13 Wang H, Tian Q, Zhang J, *et al*. Population-Based case-control study revealed metabolomic biomarkers of suboptimal health status in Chinese population-potential utility for innovative approach by predictive, preventive, and personalized medicine. *Epma J* 2020;11:147–60.
14 Adua E, Memarian E, Russell A, *et al*. Utilization of N-glycosylation profiles as risk stratification biomarkers for suboptimal health status and metabolic syndrome in a Ghanaian population. *Biomark Med* 2019;13:1273–87.
15 Yan YX, Dong J, Li M, *et al*. Establishment of cut off point for suboptimal health status using SHSQ-25. *Chi J Health Statistics* 2011;28:256–8.
16 Xu L, HM N, Shen HY, *et al*. Item selection in development of Chinese sub-health state evaluation scale. *Chi J Health Statistics* 2012;29:10–13.
17 Xue YL, Xu J, Liu GH, *et al*. Study of association between personality and sub-health status among urban residents aged more than 14 years old in 4 cities in China. *J Southern Med Univ* 2019;39:443–9.
18 Xue YL, Xu J, Liu GH, *et al*. The mediating effect of adversity quotient on the correlation between stressful life events and sub-health status. *Modern Preventive Medicine* 2019;46:82–5.
19 Sun X, Wei M, Zhu C, *et al*. The epidemiological investigation of sub-health status in Guangdong. *Shandong Med J* 2008;48:59–60.
20 J X, HB L, Zhu H, *et al*. Prevalence and influence factors of sub-health status among urban residents in Tianjin. *Chin J Public Health* 2016;32:76–80.
21 Sou J, Goldenberg SM, Duff P, *et al*. Recent im/migration to Canada linked to unmet health needs among sex workers in Vancouver, Canada: findings of a longitudinal study. *Health Care Women Int* 2017;38:492–506.
22 Dunstan RH, Sparkes DL, Roberts TK, *et al*. Development of a complex amino acid supplement, fatigue Reviva™, for oral ingestion: initial evaluations of product concept and impact on symptoms of sub-health in a group of males. *Nutr J* 2013;12:115.
23 Liu Z, Li M. The third state and psychosomatic medicine research. *Med Philosophy* 2001;22:36–8.
24 Kupaev V, Borisov O, Marutina E, *et al*. Integration of suboptimal health status and endothelial dysfunction as a new aspect for risk evaluation of cardiovascular disease. *Epma J* 2016;7:19.
25 Bi J, Huang Y, Xiao Y, *et al*. Association of lifestyle factors and suboptimal health status: a cross-sectional study of Chinese students. *BMJ Open* 2014;4:e005156.
26 Wang W, Russell A, Yan Y. Global health epidemiology reference group (GHERG). traditional Chinese medicine and new concepts of predictive, preventive and personalized medicine in diagnosis and treatment of suboptimal health. *Epma J* 2014;5:4–12.
27 Wang W, Yan Y. Suboptimal health: a new health dimension for translational medicine. *Clin Transl Med* 2012;1:1–28.
28 Lolokote S, Hidru TH, Li X. Do socio-cultural factors influence college students' self-rated health status and health-promoting lifestyles? A cross-sectional multicenter study in Dalian, China. *BMC Public Health* 2017;17:478.
29 Chen J, Xiang H, Jiang P, *et al*. The role of healthy lifestyle in the implementation of regressing suboptimal health status among college students in China: a nested case-control study. *Int J Environ Res Public Health* 2017;14:240.
30 Yang Y, Yang DK, Wang RJ. *2015 annual report on the development of China's investment*. China: Shanghai University of Finance and Economics Press, 2015.
31 Siripitayakunkit A, Hanucharurnkul S, Melkus GDE, *et al*. Factors contributing to integrating lifestyle in Thai women with type 2 diabetes. *Thai J Nurs Res* 2008;12:166–78.
32 Barclay C, Procter KL, Glendenning R, *et al*. Can type 2 diabetes be prevented in UK general practice? A lifestyle-change feasibility study (ISAIAH). *Br J Gen Pract* 2008;58:541–7.
33 Alm-Roijer C, Stagmo M, Udén G, *et al*. Better knowledge improves adherence to lifestyle changes and medication in patients with coronary heart disease. *Eur J Cardiovasc Nurs* 2004;3:321–30.
34 Jasmine TJX, Wai-Chi SC, Hegney DG. The impact of knowledge and beliefs on adherence to cardiac rehabilitation programs in patients with heart failure: a systematic review. *JBI Libr Syst Rev* 2012;10:399–470.
35 Kitson A, Brook A, Harvey G, *et al*. Using complexity and network concepts to inform healthcare knowledge translation. *Int J Health Policy Manag* 2017;7:231–43.
36 Gazmararian JA, Williams MV, Peel J, *et al*. Health literacy and knowledge of chronic disease. *Patient Educ Couns* 2003;51:267–75.
37 Gould SJ. Consumer attitudes toward health and health care: a differential perspective. *J Consum Aff* 1988;22:96–118.
38 Michaelidou N, Hassan LM. The role of health consciousness, food safety concern and ethical identity on attitudes and intentions towards organic food. *Int J Consum Stud* 2008;32:163–70.
39 Dumitrescu AL, Kawamura M, Dogaru B, *et al*. Investigating the relationship between self-reported oral health status, oral health-related behaviours and self-consciousness in Romania. *Oral Health Prev Dent* 2008;6:95.
40 Lu Y, Xu J, Cai YJ, *et al*. Reliability and validity of shs measurement scale version 1.0 for measuring the shs of urban residents in three districts. *Chin J Health Psychol* 2013;21:707–8.
41 Xu J, Xue YL, Liu GH, *et al*. Establishment of the norms of Sub-Health measurement scale version 1.0 for Chinese urban residents. *J South Med Univ* 2019;39:271–8.
42 Chen J, Cheng J, Liu Y, *et al*. Associations between breakfast eating habits and health-promoting lifestyle, suboptimal health status in southern China: a population based, cross sectional study. *J Transl Med* 2014;12:348.
43 Cui ZG, Xu J, WX W, *et al*. Study of status and its impacting factors of sub-health in young and middle-aged intellectuals in Guangzhou. *Chin Med Herald* 2015;12:12–16.
44 Huang XW, Xu J, WX W, *et al*. Status and influencing factors of Sub-health in new generation of Chinese migrant workers in pearl River delta of China. *Chin Gen Prac* 2017;20:95–103.
45 Adua E, Roberts P, Wang W. Incorporation of suboptimal health status as a potential risk assessment for type II diabetes mellitus: a case-control study in a Ghanaian population. *Epma J* 2017;8:345–55.
46 Keski-Rahkonen A, Kaprio J, Rissanen A, *et al*. Breakfast skipping and health-compromising behaviors in adolescents and adults. *Eur J Clin Nutr* 2003;57:842–53.
47 Ma C, Xu W, Zhou L, *et al*. Association between lifestyle factors and suboptimal health status among Chinese college freshmen: a cross-sectional study. *BMC Public Health* 2018;18:105.
48 Stea TH, Knutsen T, Torstveit MK. Association between short time in bed, health-risk behaviors and poor academic achievement among Norwegian adolescents. *Sleep Med* 2014;15:666–71.
49 Zahra J, Ford T, Jodrell D. Cross-Sectional survey of daily junk food consumption, irregular eating, mental and physical health and parenting style of British secondary school children. *Child Care Health Dev* 2014;40:481–91.
50 Nielsen MB, Gjerstad J, Frone M. Alcohol use among Norwegian workers: associations with health and well-being. *Occup Med* 2018;68:96–8.
51 Steele J, Fisher J, Skivington M, *et al*. A higher effort-based paradigm in physical activity and exercise for public health: making the case for a greater emphasis on resistance training. *BMC Public Health* 2017;17:300.
52 Zhubing S, Zhenyi W. A correlation research of university students' lifestyle behaviors and psychological sub-health in Guizhou. *J Nanjing Univ Nat Sci* 2014;13:155–60.
53 Espinosa A, Kadić-Maglajlić S. The role of health consciousness, patient-physician trust, and perceived physician's emotional appraisal on medical adherence. *Health Educ Behav* 2019;46:991–1000.
54 Sheeran P, Maki A, Montanaro E, *et al*. The impact of changing attitudes, norms, and self-efficacy on health-related intentions and behavior: a meta-analysis. *Health Psychol* 2016;35:1178–88.
55 Kaskutas LA, Greenfield TK. The role of health consciousness in predicting attention to health warning messages. *Am J Health Promot* 1997;11:186–93.