The association of physical activity and leisure-time sedentary behavior with perceived stress among Chinese adults: A cross-sectional study based on the Chinese health and nutrition survey data

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ABSTRACT

Objective: Physical activity (PA) and sedentary behavior (SB) include several domains, whether the association of PA and SB with perceived stress is domain-specific is not clear. This study aims to identify associations of physical activity (exercise and housework) and leisure-time sedentary behavior (LTSB) with perceived stress among Chinese adults.

Methods: The data were collected from the 2015 China Health and Nutrition Survey (CHNS). Respondents completed multiple questionnaires developed by the CHNS team, from which we extracted and sorted PA and LTSB data. Perceived stress was measured using the 14-item Perceived Stress Scale. PA was measured using a questionnaire covering 7 types of commonly practiced exercises and 4 types of housework activities among Chinese individuals. Consecutive questions were used to inquire about the time spent on each type of PA. The measurement of LTSB was conducted in the same manner. Data analysis involved Chi-square test and logistic regression.

Results: 11,471 adults were included, with an average age of 52.3 years, and 48.3 % were male. 69.9 % (8,019) of respondents reported high perceived stress. Following adjustment for age, gender and other factors, perceived stress was lower for adults reporting medium exercise time (1–2 h) compared with excessively ($\geq$2 h) (OR=1.314 [95 %CI 1.071, 1.612], P<0.001) and least (<1 h) (OR=1.273 [95 %CI 1.115, 1.413], P<0.001) active adults. Perceived stress was higher for adults reporting less housework time (<1 h) compared with adults spending medium (1–2 h) (OR=0.860 [0.744, 0.993], P<0.05) and long ($\geq$2 h) (OR=0.725 [95 %CI 0.628, 0.838], P<0.001) time on housework. Low-level LTSB (<2 h) was associated with higher perceived stress than medium-(2–4 h) (OR=0.817 [0.718, 0.930], P<0.01) and high-level LTSB ($\geq$4 h) (OR=0.668 [0.577, 0.773], P<0.001).

Conclusions: The association of PA and SB with perceived stress is domain-specific. Medium exercise time and extended housework time are associated with reduced perceived stress. Additionally, our findings suggesting that increasing the time spent on LTSB is linked to lower perceived stress levels.

1. Introduction

China is going through a rapid period of social and economic transition, which accelerates the pace of people's lives and intensifies the pressure of competition. The individual psychological problems caused by the rapid social transition are increasingly prominent and become a common social problem. According to the Report on the Development of Chinese National Mental Health (2019–2020), 12–20 % of Chinese residents have poor mental health (Fu et al., 2021. As shown in a recent report by the World Health Organization (WHO), 970 million people worldwide were estimated to be dealing with a mental disorder in 2019

(World Health Organization. World Mental Health Report, 2021). The increased incidence of psychological problems has presented severe challenges to both personal and social development.

Perceived stress is one of the vital signs of mental health. It manifested as the tension and discomfort that people experience in response to stressful situations or unfavourable elements in their daily lives (Yang and Huang, 2003). Prior studies have pointed out that perceived stress is positively associated with depression (Hu and Chen, 2020; Li et al., 2022; Cristobal-Narvaez et al., 2020) and anxiety (Mundy et al., 2015). Statistically, nearly 70 % of primary depression is caused by stress (Hammen, 2005), and stressful experiences are one of the strongest predictors of

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Table 1
Computation Methods for PA and LTSB Among Chinese Adults, China (2015).

Variables		Activities	Calculation
Physical Activity	Total exercise time/day(h)	Wushu (a); gymnastics, dance and acrobatics (b); swimming and running (c); walking (d); soccer, basketball and tennis (e); volleyball and badminton (f); table tennis, tai chi and others (g).	$(a_1 \times 5 + a_2 \times 2 + b_1 \times 5 + b_2 \times 2 + c_1 \times 5 + c_2 \times 2 + d_1 \times 5 + d_2 \times 2 + e_1 \times 5 + e_2 \times 2 + f_1 \times 5 + f_2 \times 2 + g_1 \times 5 + g_2 \times 2)/7$
	Total housework time/day (h)	Shopping (a); cooking (b); washing (c); house cleaning and others (d).	$a + b + c + d$
LTSB	Total LTSB time/day (h)	Watching TV (a); watching video (b); Watching movies or TV shows online or on your smartphone (c); playing video games (d); surfing the internet (e); chatting online (f); playing computer or smartphone games(g); reading, writing, and drawing(h); others (i).	$(a_1 \times 5 + a_2 \times 2 + b_1 \times 5 + b_2 \times 2 + c_1 \times 5 + c_2 \times 2 + d_1 \times 5 + d_2 \times 2 + e_1 \times 5 + e_2 \times 2 + f_1 \times 5 + f_2 \times 2 + g_1 \times 5 + g_2 \times 2 + h_1 \times 5 + h_2 \times 2 + i_1 \times 5 + i_2 \times 2)/7$

*Note: Subscript 1 indicates weekday and subscript 2 indicates weekend.

depression (Ebert et al., 2019). Among the college students in China, 31.5 % participants exhibited mild to significant depressive symptoms (Ma et al., 2022). Too much perceived stress leads to not only mental health problems; but also physical health problems including cardiovascular disease (Strodl et al., 2003), diabetes (Harris et al., 2017), arthritis (Harris et al., 2013) and other chronic diseases. Previous studies have shown a poor prevalence of perceived stress. Being stressed out has become a common issue for all ages (Tan et al., 2020; Kim et al., 2019; Khurshid et al., 2021). Since too much perceived stress has negative consequences in long-term life, the current situation in China and factors related to perceived stress are worth exploring, and improving the ability to cope with stressors plays an important role in health promotion.

The relationship between physical activity, sedentary behavior and perceived stress is mutual. High perceived stress was shown to be linked to serious sleep problems, an increase in the frequency of unhealthy diet and sedentary behavior, and a decrease in physical activity (Shao et al., 2022). A Japanese occupational study has found that after adjusting for variables related to personality traits, people performing high-stress jobs were about 22 % more likely to be physically inactive than those with low-stress jobs (Oshio et al., 2016). Meanwhile, large-scale cross-sectional studies in different countries have shown that stress decreased (Vankim and Nelson, 2013) and psychological well-being increased (Harbour et al., 2008) with increased physical activity, while stress increased (Khurshid et al., 2021; Lee and Kim, 2019; Kilpatrick et al., 2013) with increased sitting time. However, the results were inconsistent in Korean adults (Kim et al., 2019).

China has paid increasing attention to the mental health of citizens in recent years. CHNS incorporated the measurement of adults' perceived stress from 2015. Existing studies focus on perceived stress and physical activity in adolescents and college students (Che et al., 2003; Ge, 2020) rather than adults away from campus. To the best of our knowledge, only one published study with large sample size has explored the association between physical activity and perceived stress in Chinese adults (Cao et al., 2021). However, it did not consider housework, which is an important part of physical activity. To derive and implement effective measures to promote overall health among residents, the data from CHNS were used for further exploration of the associations among physical activity, sedentary behavior and perceived stress. Additionally, more potential confounding factors were taken into account in the analysis, since adults who have graduated face more complex and multiple sources of stress than students.

2. Materials and methods

The participants in the current study were drawn from China Health and Nutrition Survey (CHNS), which is a population-based longitudinal household survey. The survey has been conducted every two to three years since 1989, and was designed to examine the effects of health, nutrition, education, psychological status, et al. The survey spans nine provinces with diverse geography, economic development, public resources, and health indicators. A multistage, random cluster process was used to select samples from each province. Counties were stratified by income (low, middle, and high), and four counties were randomly

chosen from each province using a weighted sampling scheme. The response rate is 88 % at the individual level and 90 % at the household level (Chen et al., 2020).The latest publicly accessible data from the 2015 survey used in this study were made available in 2018.

2.1. Variable selection

Perceived stress served as the dependent variable. The Perceived Stress Scale (PSS), developed by Cohen, Kamarck, and Mermelstein (Cohen et al., 1983), was first presented in CHNS in 2015. This scale has been validated and extensively used in various populations and cultural contexts, making it a reliable tool for assessing perceived stress (Remor, 2006; Lee and Crockett, 1994; Huang et al., 2020). PSS consists of 7 positive and 7 negative questions. It adopts a 5-level Likert scale with a value range of 0–70 points and assigns 1–5 points for each level, with higher scores indicating higher levels of perceived stress for negative questions, and reversely for positive questions. In this study, PSS scores lower than 35 were defined as low perceived stress and assigned a value of 0, while PSS scores higher than 35 were defined as high perceived stress and assigned a value of 1.

Exercise, housework and LTSB were used as independent variables, all of which were collected from the CHNS questionnaire. Exercise and LTSB parts each involved three consecutive questions: "Did you engage in ××× (a type of exercise/LTSB, see Table 2 'Activities' for details) last week?", "How much time did you spend on average per day on ××× during the weekdays?", and "How much time did you spend on average per day on ××× during the weekends?". The respondents were asked to select one of the options for the first question: "yes", "no", or "unknown". If the response to the first question was "no", the subsequent two questions would be skipped, indicating that the respondent spent no time on the type of exercise/LTSB. If the response to the first question was "unknown", the subsequent two questions would also be skipped and assigned a null value. The housework part involved two consecutive questions: "Did you do housework last week?", and "How much time did you spend on ××× (a type of housework, see Table 2 'Activities' for details) per day last week?". The data processing method remains consistent with the description provided above.

Perceived stress is also related to gender, age and socioeconomic status (Cheema et al., 2021). To reduce the impact of confounding variables, this study was adjusted for gender, age, marital status, education, birthplace, employment, income, disease, and life satisfaction.

2.2. Data screening and processing

Each observation had 59 original variables, among which 14 were related to exercise, 18 to sedentary behavior, 4 to housework, 14 to PSS, and 9 were Demographic sociological variables. The components and calculation of total exercise time, housework time, and leisure sedentary time per day were displayed in Table 1. Data were cleared if there were more than 5 % null values for each observation (incomplete observation), or the total duration of sleep, exercise, housework and sedentary behavior was more than 24 h a day (abnormal observation). 48 incomplete observations and 311 abnormal observations were

Table 2

Distribution of Perceived Stress Levels by Demographic Characteristics Among Chinese Adults, China (2015).

	Total	Low perceived stress	High perceived stress	t/χ2	P value
Age		52.49 ± 14.84 (years old)	52.25 ± 15.124 (years old)	0.778	0.437
18–39	2582(22.5)	766(22.2)	1816(22.6)	0.327	0.849
40–59	5246(45.7)	1581(45.8)	3665(45.7)		
60~	3643(31.8)	1105(32.0)	2538(32.7)		
Gender				3.121	0.077
Male	4504(48.3)	1359(49.8)	3145(47.8)		
Female	4813(51.7)	1372(50.2)	3441(52.2)		
Marital status				7.152	0.128
Single	564(4.9)	174(5.1)	390(4.9)		
Married	9943(87.0)	3026(87.8)	6917(86.6)		
Divorced	149(1.3)	43(1.2)	106(1.3)		
Widowed	761(6.7)	198(5.7)	563(7.0)		
Separated	17(0.1)	4(0.1)	13(0.2)		
Education				112.549	<0.001
Elementary education	3576(31.3)	882(25.6)	2694(33.7)		
Secondary education	6277(54.9)	1940(56.3)	4337(54.3)		
Higher education	1588(13.9)	620(18.0)	968(12.1)		
Birthplace				113.116	<0.001
City	2846(24.8)	1044(30.2)	1802(22.5)		
Suburb	885(7.7)	315(9.1)	570(7.1)		
Town	887(7.8)	275(8.0)	612(7.6)		
Rural area	6852(59.7)	1818(52.7)	5034(62.8)		
Employment				33.444	<0.001
Unemployed	6087(53.1)	1690(49.0)	4397(54.8)		
Employed	5384(46.9)	1762(51.0)	3622(45.2)		
Yearly Income				20.310	<0.001
≤50000 Yuan	7393(85.5)	2352(83.1)	5041(86.7)		
>50000 Yuan	1251(14.5)	479(16.9)	772(13.3)		
Disease				15.810	<0.001
No	8890(77.6)	2595(75.3)	6295(78.7)		
Yes	2560(22.4)	852(24.7)	1708(21.3)		
Life Satisfaction				512.471	<0.001
Very good	2169(19.0)	955(27.8)	1214(15.2)		
Good	4619(40.4)	1581(46.0)	3038(38.0)		
OK	4164(36.5)	859(25.0)	3305(41.4)		
Poor	416(3.6)	42(1.2)	374(4.7)		
Very poor	56(0.5)	3(0.1)	53(0.7)		
Sleep time				15.755	<0.001
<6 h	349(3.1)	110(3.2)	239(3.0)		
6–9 h	9083(79.7)	2796(81.7)	6287(78.8)		
≥ 9 h	1965(17.2)	517(15.1)	1448(18.2)		

Note: Percentage in parentheses.

ultimately excluded from the data. Hot deck imputation was utilized to fill in the remaining null values for PA and LTSB. It aims to generate a complete data set for subsequent analysis using traditional methods. This approach involves replacing null values of one or more variables for a non-respondent (called the recipient) with observed values from a respondent (the donor) who shares similar characteristics with the non-respondent (Andridge and Little, 2010). This study uses age, gender, education level, employment status, and income as background variables to find similar observations.

2.3. Statistical method

Preliminary analysis included descriptive statistics, chi-square, and independent t-tests for variables by categories of objects with low and high perceived stress, respectively. Bidirectional ordered correlation analysis was performed to analyze the association between physical activity, sedentary behavior and perceived stress. Binary logistic regression was used to analyze the effects of exercise, housework and sedentary behavior on perceived stress. In the models, we adjusted for factors such as gender, age, marital status, education, birthplace, employment, income, disease, and life satisfaction. The significance level was P<0.05. R was used for data cleaning, and SPSS was used for data analysis.

3. Results

3.1. Basic characteristics

A total of 11,471 participants were included in this study, of which 3,452 (30.1 %) with low perceived stress and 8,019 (69.9 %) with high

Table 3

Comparison of Perceived Stress Levels Across Different Levels of Exercise, Housework, and LTSB Among Chinese Adults, China (2015).

	Group	Total	Low perceived stress	High perceived stress
	Total	11,471	3452(30.1)	8019(69.9)
Exercise ***	<1 h	8016(69.9)	2208(64.0)	5808(72.4)
	1–2 h	2343(20.4)	877(25.4)	1466(18.3)
	≥ 2 h	1112(9.7)	367(10.6)	745(9.3)
Housework ***	<1 h	5364(46.8)	1488(43.1)	3876(48.3)
	1–2 h	2570(22.4)	775(22.5)	1795(22.4)
	≥ 2 h	3537(30.8)	1189(34.4)	2348(29.3)
LTSB ***	<2 h	3607(31.4)	878(25.4)	2729(34.0)
	2–4 h	4709(41.1)	1447(41.9)	3262(40.7)
	≥ 4 h	3155(27.5)	1127(32.7)	2028(25.3)

Note: Percentage in parentheses; P-values were calculated using chi-square tests; ***P<0.001.

perceived stress. Nearly 70 % of Chinese adults feel stressed out. Table 2 displays the basic characteristics of the residents.

The low and high perceived stress groups were significantly different in education, birthplace, employment, income, disease, satisfaction with life, and sleep duration.

3.2. Physical activity, sedentary behavior and perceived stress

Among the respondents, 69.9 % exercised for less than 1 h a day, 20.4 % exercised for between 1 and 2 h a day, and only less than 10 % exercised for more than 2 h a day. In terms of housework duration, 46.8 %, 22.4 % and 30.8 % of the respondents spent less than 1 h, 1–2 h and more than 2 h each day, respectively. In terms of LTSB, 31.4 %, 41.1 % and 27.5 % of the respondents sat for less than 2 h, 2–4 h and more than 4 h per day, respectively. Bidirectional ordered correlation analysis indicated significant differences in the time spent on exercise, housework, and LTSB between low and high perceived stress populations, as shown in Table 3.

3.3. Logistic regression analysis

Logistic regression analysis adopting perceived stress as dependent variables demonstrated (Table 4), that compared to those who exercised between 1 and 2 h per day, those who exercised less than an hour (OR=1.273, P<0.001) or more than two hours (OR=1.314, P<0.001) were associated with higher levels of perceived stress. Daily housework that took between 1 and 2 h (OR=0.860, P<0.05) or more than 2 h (OR=0.725, P<0.001) were associated with lower perceived stress than that took less than 1 h. Low-level LTSB was associated with higher levels of perceived stress than medium- and high-level LTSB (OR=0.817, P<0.01, and OR=0.668, P<0.001, respectively).

4. Discussion

This study examined the association of perceived stress with physical activity (PA) and leisure-time sedentary behavior (LTSB) among Chinese adults based on data from CHNS. The research found that those who exercised for 1–2 h per day had a lower risk of excessive stress than those who exercised for less than 1 h or more than 2 h per day. In addition, increasing low to moderate intensity housework can reduce the likelihood of experiencing high stress. The results of this study were consistent with most national cross-sectional studies. For example, a study of 94 four-year colleges across the United States discovered that students who met the vigorous physical activity recommendation were less likely to report perceived stress (Vankim and Nelson, 2013). Korea National Health and Nutrition Examination Survey in 2017 examined adult health-related factors and demonstrated that people engaged in moderate intensity leisure-time physical activity (LTPA) tended to show decreased perceived stress compared to group with physical inactivity,

however, vigorous intensity LTPA tended to increase perceived stress (Kim et al., 2019). Similarly, in low- and middle-income countries, adolescents and college students who exercised more were associated with lower perceived stress (Khurshid et al., 2021; Pengpid and Peltzer, 2018). Besides, some research has been undertaken among various occupational categories. According to research on PA and perceived stress of exercise therapists, moderate to vigorous PA was not connected with stress, however, walking minutes were negatively related to perceived stress (Pacewicz et al., 2022). Another study discovered the strongest link between high perceived stress at work and low PA levels among university staff (Lopez-Bueno et al., 2020), which indicated that boosting PA is a significant stress management approach. It is well-established that regular physical activity benefits mental health, as confirmed by most studies. However, our study found that high physical activity was correlated with higher perceived stress levels. Several possible reasons may explain this. Firstly, moderate to high-intensity exercise exceeding two hours carries the risk of overtraining. Peluso and Andrade (Peluso and Guerra de Andrade, 2005) found that while moderate exercise benefits mental health, overtraining negatively impacts it, particularly by causing mood disturbances. Overtraining may affect neurotransmitter levels in the brain, such as serotonin, dopamine, and GABA (Meeusen and De Meirleir, 1995; Meeusen et al., 2006), which are crucial for mood regulation and stress response (Young and Leyton, 2002; Möhler, 2012). Armstrong and VanHeest (Armstrong and VanHeest, 2002) suggested that overtraining might share similar causes with depression. Additionally, dedicating excessive time and energy to exercise inevitably reduce time for other important activities like work, study, and family, leading to higher perceived stress due to these time constraints. Therefore, moderate to high-intensity exercise should be sufficient and moderate. However, the more low-intensity physical activity (e.g., housework), the lighter the sensation of stress.

According to a study that monitored adult sitting time in 20 countries, 12 of them averaged more than five hours a day (Bauman et al., 2011), whereas adults in the United States and Canada sat for 8 to 10 h per day (Matthews et al., 2008; Colley et al., 2011). In this study, only LTSB was examined, which lasted about 3 h per day on average. Unlike prior research, the findings of this study revealed that the likelihood of experiencing severe stress decreased as inactive time increased. Compared with those who sat for less than two hours per day, those who sat for 2 to 4 h and those who sat for more than 4 h were less likely to experience high stress, respectively. The results of the current study were inconsistent with most previous conclusions that there were consistently positive associations between SB and perceived stress (Khurshid et al., 2021; Lee and Kim, 2019; Kilpatrick et al., 2013; Zhou et al., 2021). In fact, there always exists debate over the associations between SB and mental health (Bell et al., 2015). Not all types of SB pose health hazards, however, the questionnaires always roughly incorporated different types of SB in the same question. The previous study pointed out that the association of SB with anxiety and stress was domain-specific and showed a difference between

Table 4

The Association of Perceived Stress with Basic Characteristics, PA, and LTSB Among Chinese Adults, China (2015).

Independent variable	OR$_{(a)}$	95 %Cl
Age (ref. ≥ 60 years old)		
40–59 years old	1.246**	1.081, 1.436
18–39 years old	1.392***	1.139, 1.700
Gender (ref. Female)		
Male	0.932	0.822, 1.056
Marital status (ref. Single)		
Married	1.046	0.780, 1.403
Divorced	1.313	0.731, 2.359
Widowed	1.019	0.699, 1.485
Separated	1.023	0.279, 3.748
Education (ref. Elementary education)		
Secondary education	0.821**	0.717, 0.940
Higher education	0.847	0.691, 1.037
Birthplace (ref. Rural area)		
Town	0.882	0.718, 1.082
Suburb	0.724***	0.600, 0.873
City	0.831**	0.723, 0.955
Employment (Unemployed = 0)	0.791***	0.693, 0.904
Yearly income (Below 50000 = 0)	1.028	0.879, 1.202
Disease or not (No disease = 0)	0.888	0.780, 1.012
Life satisfaction (ref. Very good)		
Good	1.475***	1.290, 1.686
OK	2.894***	2.496, 3.357
Poor	5.355***	3.539, 8.102
Very poor	9.035**	2.127, 38.372
Sleep (ref. < 6 h)		
6–9 h	1.135	0.838, 1.537
≥ 9 h	1.187	0.858, 1.643
Exercise (ref. 1–2 h)		
<1 h	1.273***	1.115, 1.413
≥ 2 h	1.314***	1.071, 1.612
Housework (ref. < 1 h)		
1–2 h	0.860*	0.744, 0.993
≥ 2 h	0.725***	0.628, 0.838
LTSB (ref. < 2 h)		
2–4 h	0.817**	0.718, 0.930
≥ 4 h	0.668***	0.577, 0.773
Intercept	2.653	

Note: *P<0.05,**P<0.01,***P<0.001; Footnote (a) represents OR values adjusted for all variables included in the model.

weekdays and weekends (Felez-Nobrega et al., 2020). Screen time as one of the sedentary domains showed a small screen time increment on mental health problems and its progression in youth (Wu et al., 2016), while another research claimed that substituting passive with mentally active sedentary behaviors may reduce depression risk in adults (Hallgren et al., 2020). It follows then that different types of sedentary time may play different roles in different populations (Kikuchi et al., 2014). The individual questionnaire in our study asked questions about sedentary behaviors (eg., watching TV, watching movies, reading, etc.) that can be classified as leisure-time sedentary behavior (LTSB), and the results showed that LTSB may play an effect on stress relief. Even so, a severe sedentary lifestyle has undoubtedly posed a threat to health. Due to the data scarcity of learning or occupational sedentary behavior, the role of different types of sedentary behavior in relation to perceived stress has not been elucidated in this paper, which needs to be further explored in the future.

Many demographic and sociological factors were incorporated into the analysis in this study, and it was discovered that age, education, birthplace and employment had an impact on perceived stress. The findings revealed that the incidence of high stress was 1.39 and 1.25 times higher in people aged 18 to 39 and 40 to 59, respectively, than in people over 60. The results corroborate our subjective perception, that people of youth and middle age, when transitioning from student identity to social identity or reconciling career ambitions with the needs of the family, are likely to be very stressful, and that those 60 and older, on the other hand, usually have retired from their employment and don't need to raise family, which greatly relieved them from work and financial pressure. Furthermore, those who were employed reported lower stress than those who were unemployed, and higher levels of education were associated with lower levels of perceived stress. Individual education level was found to be positively related to subjective well-being (Yue et al., 2021), whereas stress and happiness were found to be negatively related (Liu, 2019). Higher levels of education increase professional competitiveness, which raises expectations of future earnings and job advancement. This may be one of the key factors contributing to greater happiness and lower stress. According to this study, the sort of birthplace that reflects a family's economic and social status also affected perceived stress. In terms of income, it didn't demonstrate significant relationship with perceived stress in this study. The Report on National Mental Health Development in China (2019–2020) provided strong evidence for the stated conclusions about income. Additionally, life satisfaction was closely related to perceived stress, which is in line with prior research (Xie and Fan, 2014), while sleep duration did not show links with perceived stress in this study.

5. Conclusions

Our results indicate that dedicating more time to low to moderate-intensity household activities correlates with reduced perceived stress. However, inadequate or excessive exercise is associated with heightened levels of perceived stress. Additionally, our findings deviate slightly from previous studies, suggesting that increased time spent on LTSB is linked to lower perceived stress. Further investigation is warranted to explore the relationship between domain-specific sedentary behaviors and perceived stress.

6. Limitations

There are some deficiencies in this paper. Firstly, the cross-sectional data limits the ability to infer causal relationships between PA, SB, and perceived stress. We can keep tabs on how this dataset is updated in the future and analyze the longitudinal data. Secondly, by focusing solely on exercise, household chores, and LTSB, other forms of PA and SB were not considered, overlooking their unique relationships with stress. Finally, in addition to external factors, individual characteristics will also have an impact on perceived stress, which was not included in the model in this study. Further discussion is needed in the future.

Ethical approval

This study used only publicly available de-identified data. The researchers from the Carolina Population Center who were responsible for the collection of CHNS data received ethical approval from the University of North Carolina at Chapel Hill.

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CRediT authorship contribution statement

Jiale Peng: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Hong Ren:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data used in this article can be downloaded from the web at https://www.cpc.unc.edu/projects/china.

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