## **Original Article**

## The Sequential Mediating Roles of Body Pain and Self-Reported Health Status in the Relationship between Sleep Duration and Life Satisfaction



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## Abstract

**Objective** This study examines the sequential mediating roles of body pain and self-reported health in the association between sleep duration and self-reported life satisfaction among elderly Chinese adults.

**Methods** Data from the fifth wave of the China Health and Retirement Longitudinal Survey (CHARLS) were used to analyse the relationships between sleep duration and body pain, self-reported health, and life satisfaction through logistic regression and Restricted Cubic Spline (RCS) analyses. The sequential mediation effects of body pain and self-reported health status were examined *via* chain mediation analysis.

**Results** Logistic regression analysis showed that sleeping fewer than 6 hours or 6–7 hours was linked to higher risks of body pain, poor health, and dissatisfaction with life compared to sleeping 7–8 hours (all P < 0.05). Additionally, those sleeping more than 9 hours also had increased risks of poor health and dissatisfaction with life compared to those sleeping 7–8 hours (all P < 0.05). Chain mediation analysis showed that body pain and self-reported health status sequentially mediated 46.15% of the association between sleep duration and life satisfaction.

**Conclusion** Body pain and self-reported health may shape the relationship between sleep duration and life satisfaction in elderly Chinese adults.

Key words: Sleep; Life satisfaction; Health status; Pain

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### INTRODUCTION

 $S_{\rm health\ and\ well-being\ and\ is\ associated} health\ and\ well-being\ and\ is\ associated with\ various\ aspects\ of\ daily\ functioning and quality\ of\ life^{[1,2]}. Recent\ studies\ have\ further$ 

explored the implications of sleep duration on health in adolescent and elder adults<sup>[3-7]</sup>. Conversely, body pain can severely impact an individual's daily functioning and overall life satisfaction<sup>[8]</sup>, whereas self-reported health status serves as a pivotal determinant of subjective well-being and life

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satisfaction<sup>[9]</sup>. Understanding the intricate interplay among these factors is essential for developing targeted interventions to improve health outcomes and enhance quality of life.

Previous studies have investigated the independent associations between sleep duration, body pain, self-reported health status, and life satisfaction. A systematic review highlighted the need to understand the mechanisms linking sleep and pain intensity to optimize pain management interventions, identifying putative mediators such as mood, depression, anxiety, stress, and physical activity<sup>[10]</sup>. Researchers reported that inadequate sleep duration was associated with an increased risk of mortality in a prospective study of men in the United States, highlighting the importance of sufficient sleep for overall health and longevity<sup>[11]</sup>. Furthermore, scholars have reported a positive correlation between better sleep quality and increased physical activity during the day among patients with chronic pain, underscoring the impact of sleep on pain management and functional outcomes<sup>[12]</sup>. Another study examined the interrelationships among sleep, pain, and mood disturbances in older adult patients at a pain clinic and provided insights into how sleep disturbances may contribute to both pain and mood disturbances, which in turn can impact life satisfaction. Furthermore, inadequate sleep has consistently been associated with lower life satisfaction, emphasizing the critical role of sufficient sleep in maintaining psychological and emotional wellbeing<sup>[13,14]</sup>.

Chronic pain has been shown to adversely affect sleep quality and duration, suggesting a bidirectional relationship where pain disrupts sleep and poor sleep exacerbates pain perception<sup>[15,16]</sup>. The researchers also discussed the potential mediating role of sleep in the relationship between pain and health outcomes, various including life satisfaction<sup>[15]</sup>. Recent findings further support this connection, as two Mendelian randomization studies have identified that short sleep duration is causally associated with an increased risk of pain<sup>[6,7]</sup>. Additionally, one study revealed that sleep disturbances were linked to poorer health-related quality of life, both directly and indirectly, through their association with pain intensity<sup>[17]</sup>. Furthermore, physical, mental and social health status were found being associated with self-rated life satisfaction among older adults in India<sup>[18]</sup>.

Gaps remain in our understanding of the mechanisms by which sleep duration relates to life

satisfaction, particularly regarding the mediating effects of body pain and self-reported health status. Given the complex nature of these relationships, robust methodological approaches are crucial for accurately capturing the dynamic interplay among pain, sleep, and life satisfaction. Therefore, the aims of this study were to investigate 1) the associations of sleep duration with body pain, self-reported health status, and life satisfaction and 2) the sequential mediating roles of body pain and selfreported health status on the association between sleep duration and life satisfaction.

#### METHODS

#### Study Design and Participants

This study utilized fifth wave data from the China Health and Retirement Longitudinal Survey (CHARLS), which was accessed in 2020. The CHARLS, conducted by the China Center for Economic Research at Peking University, is a nationally representative longitudinal study focusing on middle-aged and older adults across 28 provinces in China. Comprehensive details regarding the CHARLS can be found in the cohort profile<sup>[19]</sup>. For this study, a total of 19,367 participants completed the fifth wave survey. We excluded individuals with missing data for any variables used in the analysis: individuals with missing data on sleep duration (n = 429), body pain, self-reported health status (n = 1,583), life satisfaction (n = 13), age, sex (n = 199), education (n = 9), marital status, smoking, alcohol consumption, and residence (n = 3). As a result, 17,131 eligible individuals were included in this cross-sectional analysis.

#### **Primary Variables of Interest**

**Sleep Duration** Sleep duration was evaluated with a single question: "In the past month, how many hours of sleep did you typically get at night?" Furthermore, nighttime sleep duration was categorized into five groups: < 6 hours, 6–7 hours, 7–8 hours, 8–9 hours, and > 9 hours. The continuous variable of sleep duration serves as the exposure (X) in the chain mediation analysis.

**Body Pain** The participants responded to the question "Do you often experience distress due to pain?" with the following options: none (1), a little (2), somewhat (3), quite a bit (4), or very (5). We categorized "Body pain" into two binary variables: "quite a bit" or "very" indicated the presence of body pain, whereas "none" (1), "a little" (2), or

"somewhat" (3) indicated the absence of body pain. The binary body pain variable was one of the outcomes the in Restricted Cubic Spline (RCS) analysis. We used the 5-point Likert scale data on body pain as the first mediator in the chain mediation analysis.

**Self-Reported Health Status** The participants responded to the question "How do you perceive your health condition?" with the following options: very good (1), good (2), fair (3), poor (4), or very poor (5). We categorized "Self-reported health status" into two binary variables: "very good" "good" and "fair" were classified as "good", whereas "poor" and "very poor" were classified as "good". The binary self-reported health status variable was one of the outcomes in the RCS analysis. Additionally, we used the 5-point Likert scale data on self-reported health status as the second mediator in the chain mediation analysis.

Life Satisfaction The dependent variable of our study, life satisfaction, was based on the following question: "How satisfied are you with your life-as-awhole?" The responses to the question were as follows: completely satisfied (1), very satisfied (2), somewhat satisfied (3), not very satisfied (4), or not at all satisfied (5). We categorized "life satisfaction" into two binary variables: "completely satisfied", "very satisfied" and "somewhat satisfied" were classified as "satisfied", whereas "not very satisfied" and "not at all satisfied" were classified as "not satisfied". The binary life satisfaction variable was included as one of the outcomes in the RCS analysis, and we utilized the 5-point Likert scale data on life satisfaction as the outcome in the chain mediation analysis.

## Covariates

In the fifth wave of the CHARLS, sociodemographic data were collected, covering age, sex (male, female), education level [less than lower secondary (1), upper secondary & vocational training (2), tertiary (3)], marital status (married, unmarried), and residential area (rural, urban). Smoking status was categorized as nonsmoker or current or former smoker, whereas alcohol consumption status was classified as nondrinker or current or former drinker.

## Statistical Analysis

Descriptive statistics were employed to analyse the demographic characteristics and primary variables of interest. Associations between 5 sleep duration groups (exposure) and binary outcomes (body pain, self-reported health status and life satisfaction) were assessed *via* logistic regression models adjusted for age, sex, education level, marital status, smoking status, alcohol consumption status and residence. RCS analysis was conducted to evaluate the dose–response relationships between sleep duration and binary outcomes (body pain, self-reported health status and life satisfaction).

The Association between Sleep Duration (5Categories) and Body PainBody pain: sleepduration group + covariates.

The Association between Sleep Duration (5 Categories) and Self-Reported Health Status Selfreported health status: sleep duration groups + covariates.

The Association between Sleep Duration (5 Categories) and Life Satisfaction Life satisfaction: sleep duration groups + covariates

Spearman correlation analysis was used to assess the associations between sleep duration and the five-point scales for body pain, self-reported health status, and life satisfaction, with Bonferroni correction applied to adjust for multiple mediation comparisons. Chain analysis was performed to examine the sequential mediating roles of body pain (M1) and self-reported health status (M2) in the association between sleep duration (X) and life satisfaction (Y), adjusting for age, sex, education level, marital status, smoking status, alcohol consumption status, and residence. The mediating effect was examined through a bootstrap estimation approach with 5000 repetitions, and the indirect effect was deemed significant if the 95% confidence interval did not encompass 0.

M1: a1 × X + Covariates

M2:  $a2 \times X + d21 \times M1 + Covariates$ 

Y:  $b2 \times M2 + b1 \times M1 + c1 \times X + Covariates$ 

Indirect effect from X to Y via M1: a1 × b1

Indirect effect from *X* to *Y via* M2: a2 × b2

Indirect effect from X to Y via M1 and M2: a1 × d21 × b2

Total indirect effects: a1 × b1 + a2 × b2 + a1 × d21 × b2

Total direct effect: c1

Total effect = c1 + a1 × d21 × b2 + a1 × b1 + a2 × b2

Descriptive statistics, logistic regression and Spearman correlation analyses were performed *via* Stata for Windows software, version 17.1. RCS and chain mediation analysis were performed *via* R for Windows software, version 4.4.0. The significance threshold was set at P < 0.05.

### RESULTS

#### **Descriptive Statistics**

Table 1 summarizes the demographic characteristics and primary variables of interest for the 17,131 participants. This study included 8,020 (46.82%) males and 9,111 (53.18%) females, with a mean age of 63.03 ± 9.51 years. Among the total sample, 14,940 (87.21%) individuals had an education level less than lower secondary, 1,828 (10.67%) had completed upper secondary or vocational training, and 363 (2.12%) had attained tertiary education. With respect to marital status, 14,582 (85.12%) individuals were married, whereas 2,549 (14.88%) currently were not in marriage. There were 6,627 (38.68%) individuals who reported previous smoking habits, 6,256 (36.52%) who reported consuming alcohol, and 1,013 (64.29%) who lived in rural areas.

In terms of the cut-off for sleep duration, 6,127 (35.77%) individuals reported sleeping fewer than 6 hours, 4,297 (25.08%) reported sleeping between 6 and 7 hours, 2,938 (17.15%) reported sleeping 7–8 hours, 2,649 (15.46%) reported sleeping 8–9 hours, and 1,120 (6.54%) reported sleeping  $\geq$  9 hours. Furthermore, 3,126 (18.25%) individuals reported body pain, 4,233 (24.71%) reported poor health status, and 1,373 (8.12%) reported dissatisfaction with life (Table 1).

## Logistic Regression Analysis between the 5 Sleep Groups and Outcomes

After adjustment for age, sex, education level, marital status, smoking status, alcohol consumption status and rural living status, compared with individuals who slept 7–8 hours, those who slept fewer than 6 hours [odds ratio (OR) = 2.322, 95% *CI*: 2.047–2.634, P < 0.001] and those who slept 6–7 hours (OR = 1.202, 95% *CI*: 1.043–1.385, P = 0.011) had an elevated risk of body pain. Conversely, there was no significant association between sleeping 8–9 hours (OR = 0.943, 95% *CI*: 0.801–1.111, P = 0.483) or sleeping  $\geq$  9 hours (OR = 1.119, 95% *CI*: 0.919–1.363, P = 0.264) and body pain compared with the reference group (Table 2).

Furthermore, in terms of the associations with self-reported health status, individuals who slept < 6 hours (OR = 2.407, 95% CI: 2.152–2.693, P < 0.001), those who slept between 6 and fewer than 7 hours (OR = 1.244, 95% CI: 1.099–1.409, P = 0.001), and those who slept  $\ge$  9 hours (OR = 1.321, 95% CI: 1.115–1.566, P = 0.001) had a heightened risk of

poor health status compared with individuals who slept 7–8 hours. Conversely, there was no significant association between sleeping 8–9 hours and poor

# **Table 1.** Demographic characteristics of the participants assessed in 2020 (*n* = 17,131)

Characteristics	Mean ± Standard deviation / n (%)			
Age, years	63.03 ± 9.51			
Sex				
Male	8,020 (46.82)			
Female	9,111 (53.18)			
Education level				
Less than lower secondary	14,940 (87.21)			
Upper secondary & vocational training	1,828 (10.67)			
Tertiary	363 (2.12)			
Marital status				
Married	14,582 (85.12)			
Not in marriage	2,549 (14.88)			
Smoking				
Yes	6,627 (38.68)			
No	1,0504 (61.32)			
Alcohol consumption				
Yes	6,256 (36.52)			
No	1,0875 (63.48)			
Residence				
Urban	6,118 (35.71)			
Rural	11,013 (64.29)			
Sleep duration, h	6.07 ± 1.85			
< 6	6,127 (35.77)			
6–	4,297 (25.08)			
7–	2,938 (17.15)			
8–	2,649 (15.46)			
≥ 9	1,120 (6.54)			
Body pain				
Yes	3,126 (18.25)			
No	14,005 (81.75)			
Self-reported health status				
Poor	4,233 (24.71)			
Good	12,898 (75.29)			
Life satisfaction				
Not Satisfied	1,373 (8.12)			
Satisfied	15,260 (89.08)			

*Note.* x = Mean, s = Standard Deviation.

health status compared with the reference group (OR = 1.010, 95% CI: 0.877–1.163, P = 0.889) (Table 2).

In addition, regarding the associations with life satisfaction, individuals who slept fewer than 6 hours (OR = 2.352, 95% CI: 2.009–2.752, P < 0.001), those who slept between 6 and 7 hours (OR = 1.283, 95% CI = 1.077, 1.528, P = 0.005), and those who slept  $\geq$  9 hours (OR = 1.393, 95% CI: 1.093–1.776, P = 0.007) had a heightened risk of dissatisfaction with life compared with individuals who slept 7–8 hours. Conversely, there was no significant association between sleeping between 8 and 9 hours and dissatisfaction with life compared with the reference group (OR = 0.976, 95% CI: 0.796–1.197, P = 0.816) (Table 2).

## The U-Shaped Association between Sleep Duration and Outcomes

This study investigated the relationships between sleep duration and the risk of body pain, poor health status and dissatisfaction with life via RCS analysis. Figure 1 depicts a U-shaped pattern between sleep duration and the risk of body pain (Figure 1A), poor health status (Figure 1B) and dissatisfaction with life (Figure 1C). Specifically, at shorter sleep durations, there is a gradual decrease in the risk of body pain, poor health status, and dissatisfaction as sleep duration increases. However, once the duration of sleep exceeds 7 hours, the risk of body pain, poor health status, and dissatisfaction paradoxically escalates with further increases in sleep duration. This highlights a pivotal turning point in the trend of adverse outcome risk around a specific sleep duration (i.e., 7 hours), culminating in a U-shaped curve. Further statistical analysis robustly confirmed the statistical significance of this U-shaped relationship (nonlinear test P value: < 0.001).

# Spearman Correlation between Sleep Duration and Outcomes

After Bonferroni correction, the Spearman correlation revealed that sleep duration was negatively associated with body pain (r = -0.206, P < 0.001), self-reported health status (r = -0.205, P < 0.001) and life satisfaction (r = -0.117, P < 0.001). In addition, body pain was positively related to self-reported health status (r = 0.444, P < 0.001) and life satisfaction (r = 0.172, P < 0.001). Furthermore, self-reported health status was positively correlated with life satisfaction (r = 0.252, P < 0.001)(Table 3).

## **Chain Mediation Analysis**

A chain mediation analysis was conducted utilizing the "lavaan" package to explore the potential serial mediating roles of body pain and self-reported health status in the relationship between sleep duration and life satisfaction. First, we examined the association between sleep duration and body pain, revealing a negative relationship ( $\beta = -0.127$ ,  $s_x = 0.005$ , P < 0.001). These findings suggest that longer sleep duration is associated with a lower likelihood of body pain. Next, we investigated whether sleep duration and body pain were directly associated with selfreported health status. The results indicated that sleep duration was inversely related to self-reported health status ( $\beta$  = -0.061,  $s_x$  = 0.004, P < 0.001), meaning that a longer sleep duration was associated with better perceived health. Conversely, body pain was positively associated with self-reported health status ( $\beta$  = 0.319,  $s_x$  = 0.006, P < 0.001), indicating that individuals reporting more body pain tended to perceive their health as poorer. Finally, we delved into the interplay among sleep duration, body pain, self-reported health status, and life satisfaction. Sleep duration was negatively associated with life

Sleep duration (h)	Body pain			Self-reported health status		Life satisfaction			
	OR	95% Cl	Р	OR	95% CI	Р	OR	95% Cl	Р
< 6	2.322	2.047-2.634	< 0.001	2.407	2.152-2.693	< 0.001	2.352	2.009-2.752	< 0.001
7–	Ref.	-	-	Ref.	-	-	Ref.	-	-
6-	1.202	1.043-1.385	0.011	1.244	1.099-1.409	0.001	1.283	1.077-1.528	0.005
8-	0.943	0.801-1.111	0.483	1.010	0.877-1.163	0.889	0.976	0.796-1.197	0.816
≥ 9	1.119	0.919-1.363	0.264	1.321	1.115-1.566	0.001	1.393	1.093-1.776	0.007

Table 2. Associations between sleep duration and body pain, self-reported health status, and life satisfaction

*Note. CI*: confidence Interval; *OR*: odds ratio; Ref: reference group. All the models were adjusted for age, sex, education level, marital status, smoking status, alcohol consumption status and residence.

satisfaction ( $\beta = -0.028$ ,  $s_x = 0.003$ , P < 0.001), whereas body pain ( $\beta = 0.046$ ,  $s_x = 0.005$ , P < 0.001) and self-reported health status ( $\beta = 0.175$ ,  $s_x = 0.006$ , P < 0.001) were positively associated with life satisfaction (Figure 2 and Supplementary Table S1, available in www.besjournal.com). We utilized the bootstrap method with 5000 iterations to examine the mediating effects. A significant mediating effect was indicated by a 95% confidence interval that did not encompass 0. The total indirect effect of sleep duration ( $\beta = -0.024$ ,  $s_x = 0.001$ , 95% *CI*: -0.026 to -0.021, P < 0.001) on life satisfaction in the elderly population was decomposed into three pathways:

Sleep duration  $\rightarrow$  body pain  $\rightarrow$  life satisfaction ( $\beta = -0.006$ , s<sub>x</sub> = 0.001, 95% *Cl*: -0.007 to -0.004, *P* < 0.001).

Sleep duration  $\rightarrow$  self-reported health status  $\rightarrow$  life satisfaction ( $\beta$  = -0.011, s<sub>x</sub> = 0.001, 95% *CI*: -0.012 to -0.009, *P* < 0.001).

Sleep duration  $\rightarrow$  body pain  $\rightarrow$  self-reported health status  $\rightarrow$  life satisfaction ( $\beta = -0.007$ , s<sub>x</sub> = 0.000, 95% *Cl*: -0.008 to -0.006, *P* < 0.001) (Supplementary Table S2, available in www. besjournal.com). The effect of sleep duration on life satisfaction in the elderly population was partially serially mediated by body pain and self-reported health status, with a mediated proportion of 46.15% (Supplementary Table S2).

#### DISCUSSION

This study demonstrated U-shaped relationships between sleep duration and body pain, self-reported health status, and subjective life satisfaction in a national sample of Chinese elderly individuals. Furthermore, the chain mediation model revealed that body pain and self-reported health status were significantly associated with life satisfaction, whereas sleep duration had a negative and significant effect on life satisfaction in the elderly population. Hence, to increase life satisfaction among elderly individuals, it is imperative to monitor and address factors such as sleep duration, body pain, and self-reported health status and implement suitable interventions to improve these aspects.

In the present study, both short sleep duration (< 6 hours or 6–7 hours) and long sleep duration ( $\geq$ 



**Figure 1.** U-shaped relationships between sleep duration and body pain, self-reported health status, and life satisfaction. All models were adjusted for age, sex, education level, marital status, smoking status, alcohol consumption status and residence.

9 hours) were linked to lower life satisfaction, indicating a U-shaped curve between sleep duration and life satisfaction. This finding is consistent with previous research. For example, a cross-sectional study conducted among Norwegian adolescents revealed a positive statistical association between sleep duration on school days and psychological well-being<sup>[20]</sup>. Similarly, another study reported a positive association between sleep duration and life satisfaction in a homogeneous sample of healthy governmental employees<sup>[21]</sup>. Specifically, this phenomenon in the elderly population warrants attention. Research indicates that older adults may face greater challenges to life satisfaction when experiencing both short and long sleep durations. This may be due to their heightened sensitivity to health and quality of life issues. Additionally, older adults might struggle more with adjusting and optimizing sleep duration due to physiological changes and social factors<sup>[22]</sup>. Future studies could further explore the specific impact of sleep duration on life satisfaction in older adults, considering individual differences and special needs, to better

Table 3. Spearman correlations between sleepduration, body pain, self-reported status and lifesatisfaction

Variable	1	2	3	4	
Sleep duration	1.000				
Body pain	-0.206***	1.000			
Self-reported status	-0.205****	0.444***	1.000		
Life satisfaction	-0.117****	0.172***	0.252***	1.000	
Note *** D < 0.001					





**Figure 2.** Chain mediation analysis. The models investigate the effect of sleep duration (independent variable) on life satisfaction. The sequential mediators in this analysis included body pain and self-reported health status. The mediation model was adjusted for age, sex, education level, marital status, smoking status, alcohol consumption status, and residence. <sup>\*\*\*</sup>P < 0.001.

develop intervention strategies and improve their quality of life.

On the one hand, short sleep duration was associated with an increased risk of body pain, whereas long sleep duration was not significantly related to body pain. Among individuals with temporomandibular disorders, a significantly greater number of patients in the short sleep group reported pain than did those in the long sleep group<sup>[23]</sup>. Moreover, a noteworthy cohort study revealed that a comprehensive sleep score, incorporating variables such as sleep duration, chronotype, insomnia, snoring, and daytime sleepiness, was linked to the persistence or recurrence of chronic musculoskeletal pain lasting more than three months<sup>[24]</sup>. Additionally, prior investigation revealed no significant а correlation between longer sleep duration and subsequent pain<sup>[25]</sup>. However, individuals reporting short sleep durations were 2.4 times more likely to utilize nonprescription pain medication than those who did not<sup>[26]</sup>. On the other hand, both short and long sleep durations were related to poor subjective status, which indicated a U-shaped health relationship between sleep duration and self-rated health status. Previous research revealed that a short sleep duration of < 6 hours was linked to poorer self-rated health and a greater frequency of days with poor physical health over the previous 30 days than an optimal sleep duration of 7–9 hours<sup>[27]</sup>. Consistent with another study, the findings revealed an anticipated inverted U-shaped (i.e., quadratic) relationship between the previous night's sleep duration and self-rated health<sup>[28]</sup>.

Finally, our study revealed that sleep duration can indirectly predict life satisfaction through the chain mediation of body pain and self-reported health status. Our findings align with those of previous studies, indicating that sleep duration significantly negatively predicts an individual's chronic pain<sup>[15,29,30]</sup>. For a deeper exploration, sleep duration has been shown to involve various neurobiological mechanisms, encompassing the opioid, monoaminergic, orexinergic, immune, melatonergic, and endocannabinoid systems. Additionally, it influences the hypothalamuspituitary-adrenal axis, as well as the adenosine and nitric oxide signalling pathways. These mechanisms collectively modulate endogenous pain responses, inflammation, affective states, mood, and other physiological conditions. Moreover, different endogenous substances, such as dopamine, orexin, melatonin, and vitamin D, play roles in augmenting pain sensitivity<sup>[31-33]</sup>. However, pain is a crucial risk factor for self-rated health, especially among elderly individuals, and can trigger a range of self-reported health issues<sup>[34]</sup>. Pain is an important public health concern and has documented negative associations with various health outcomes and detrimental effects on quality of life, ultimately contributing to poor self-rated health<sup>[35,36]</sup>. A previous study confirmed that individuals with body pain in the general population are more inclined to have poor self-rated health<sup>[37]</sup>. Therefore, chronic pain is significantly associated with poor self-rated health. A shorter duration of sleep exacerbates bodily pain, consequently heightening the likelihood of reporting poorer health status and ultimately diminishing life satisfaction. In summary, the findings of this study not only enhance our comprehension of the inherent mechanisms linking sleep duration to life satisfaction by exploring the chained mediation involving body pain and self-reported health status but also advance and extend research on the factors impacting life satisfaction.

Expanding on the limitations of this study, it is crucial to acknowledge that the reliance on questionnaires for data collection opens the door to potential biases in responses, necessitating careful consideration during interpretation. Next, we only considered sleep quantity without accounting for sleep quality, which has also been linked to adverse outcomes in previous research<sup>[38,39]</sup>. This omission may affect the comprehensiveness of our findings and limit our understanding of the full impact of sleep on health. Additionally, in the present study, we did not control for unobserved family background confounders. This oversight may result in an overestimation of the effects of sleep, as we did not account for family-level heterogeneity<sup>[40]</sup>. Furthermore, in this study, we focused on elderly Chinese adults, which may limit the applicability of the findings to other populations due to cultural and demographic factors. Future research should address these limitations to enhance generalizability. Finally, given the correlational and predictive design of this study, it is challenging to establish definitive causal relationships. Enhancing the validity of the findings could be achieved through longitudinal studies, which are useful for capturing temporal changes and offering deeper insights into the dynamics of the relationships observed. It is crucial that such studies include meticulous control of various factors to minimize the influence of confounding variables and enhance the reliability of the outcomes.

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*Competing Interests* The authors have no conflicts of interest to declare.

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