

# *The Role of Sleep Quality and Duration in the Development of Pain: A Prospective Cohort Study of Chinese Older Adults*

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**Abstract:** Using data from five waves (2011–2020) of the China Health and Retirement Longitudinal Study, this study examined longitudinal associations between sleep characteristics and incident pain in 10,253 Chinese adults aged  $\geq 45$  years who were pain-free at baseline. Sleep measures included subjective quality, nighttime duration (short, healthy, long). Generalized linear mixed-effects models adjusting for demographic, lifestyle, and health-related covariates showed that poor sleep quality significantly increased the risk of future pain (adjusted OR=2.33, 95% CI: 2.20–2.47). Compared with healthy sleep (6–8 h), short sleep duration (<6 h) was associated with higher pain risk (OR=1.77, 95% CI: 1.67–1.88), while long sleep (>8 h) unexpectedly showed a lower risk (OR=0.84, 95% CI: 0.77–0.93). These associations remained consistent across head/neck, trunk, and limb pain. The findings suggest that poor sleep quality and insufficient nighttime sleep are robust predictors of future pain among middle-aged and older adults.

## 1. Introduction

Pain poses a major health challenge among Chinese older adults<sup>[1]</sup>, with a prevalence of ~31.5% that increases with age<sup>[2]</sup>. It impairs daily activities, sleep, and well-being, often leading to social isolation and depression<sup>[3]</sup>. The bidirectional sleep–pain relationship is well established<sup>[4-5]</sup>. Notably, over 65% of chronic pain patients report concomitant sleep difficulties<sup>[6]</sup>, yet evidence on daytime napping remains contradictory<sup>[7-8]</sup>. Using CHARLS data, this study examines longitudinal associations between sleep and pain to inform pain management in aging populations.

## 2. Methods

### 2.1. Study Design and Participants

In this study, Wave 1 (2011) of the CHARLS served as the baseline, with all subsequent follow-up surveys (2013, 2015, 2018, and 2020) included until the final follow-up (Wave 5, 2020). Figure 1 illustrates the participant selection process. Among 17,314 CHARLS participants aged >45 years, we first excluded 2,023 individuals with fewer than two non-missing follow-up records. Next, we

excluded 5,038 participants who reported baseline pain. Ultimately, 10,253 participants were included in the final analysis.

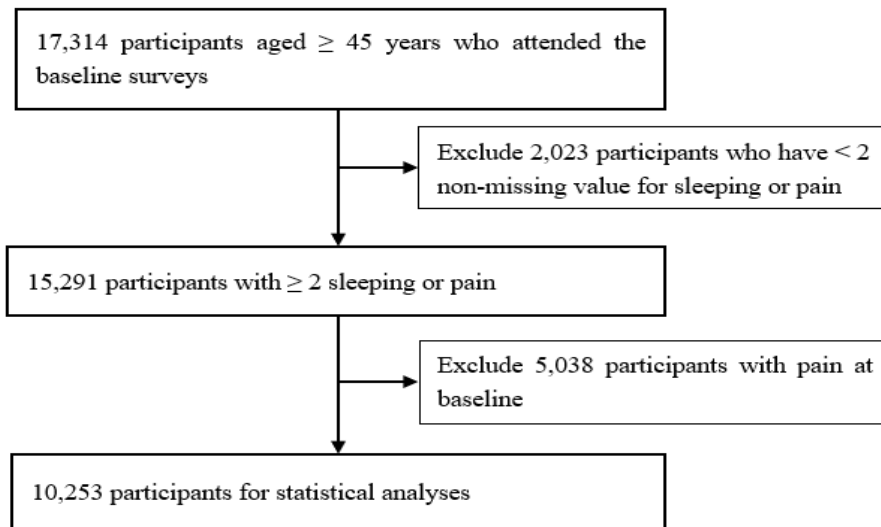


Figure 1: Selection process of the study population.

## 2.2. Indicators

Pain was assessed by self-reported frequent bodily pain (yes/no), with pain sites categorized into head/neck, trunk, and limbs based on 16 specific locations. Sleep assessment included subjective sleep quality (good/poor, from past-week restless sleep) and nighttime sleep duration classified as short (<6 h), healthy (6–8 h), or long (>8 h). Covariates comprised sex, age, household registration (Hukou), marital status (married/partnered vs. unmarried), education, smoking, drinking, and presence of any of nine chronic diseases (hypertension, diabetes, cancer, chronic lung disease, heart disease, stroke, emotional/neuropsychiatric disorders, memory-related diseases, arthritis).

## 2.3. Statistical Analysis

Used generalized linear mixed-effects models (GLMMs) to analyze longitudinal associations between sleep (quality, duration, napping) and pain, adjusting for demographics and health behaviors (R 4.3.3; two-sided  $P < 0.05$ ).

## 3. Results

### 3.1. Baseline Characteristics of the Study Population

Compared to the good sleep quality group, they were more often female, older, non-married, less educated, non-smokers, non-drinkers, and had more chronic diseases (all  $P < 0.001$ ) (Table 1). No rural/urban difference was observed ( $P = 0.835$ ).

Table 1: Baseline characteristics of included participants.

	Overall	Good sleep quality	Poor sleep quality	P value
<b>Number (%)</b>	10253 (100)	5505 (57.2)	4122 (42.8)	
<b>Sex, n (%)</b>				
Male	5422 (52.9)	3117 (56.7)	1881 (45.6)	<0.001
Female	4823 (47.1)	2380 (43.3)	2241 (54.4)	
<b>Age, mean (SD)</b>	58.40 (9.24)	58.24 (9.22)	59.05 (9.39)	<0.001
<b>Hukou, n (%)</b>				
Rural	7769 (75.8)	4142 (75.3)	3112 (75.5)	0.835
Non-rural	2478 (24.2)	1358 (24.7)	1009 (24.5)	
<b>Marital status, n (%)</b>				
Married or partnered	9184 (89.6)	5007 (91.0)	3570 (86.6)	<0.001
Other marital status	1069 (10.4)	498 (9.0)	552 (13.4)	
<b>Education, n (%)</b>				
Below primary school	4040 (39.4)	2044 (37.1)	1789 (43.4)	<0.001
Primary school	2264 (22.1)	1233 (22.4)	885 (21.5)	
Middle school or above	3937 (38.4)	2226 (40.5)	1445 (35.1)	
<b>Smoking status, n (%)</b>				
Never smokers	5964 (58.2)	3069 (55.8)	2600 (63.1)	<0.001
Ever smokers	4287 (41.8)	2435 (44.2)	1521 (36.9)	
<b>Drinking status, n (%)</b>				
Never drinkers	6557 (64.0)	3433 (62.4)	2790 (67.7)	<0.001
Ever drinkers	3692 (36.0)	2071 (37.6)	1332 (32.3)	
<b>Chronic disease, n (%)</b>				
No	5247 (51.2)	3026 (55.0)	1845 (44.8)	<0.001
Yes	5005 (48.8)	2479 (45.0)	2277 (55.2)	

### 3.2. Longitudinal Association between Sleep and Pain

Longitudinal associations between sleep and pain (Table 2) were analyzed using GLMMs. Poor sleep quality (OR=2.33, 95%CI:2.20-2.47) and insufficient sleep (OR=1.77,95%CI:1.67-1.88) significantly increased pain risk after full adjustment (Model 3). Excessive sleep showed a weak protective effect (OR=0.84,95%CI:0.77-0.93). Daytime napping slightly reduced pain risk (OR=0.92,95%CI:0.87-0.98). These findings highlight sleep's role in pain management.

Table 2: Longitudinal association between sleep and pain.

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
<b>Subjective sleep quality</b>			
Good	1.00	1.00	1.00
Poor	2.47 (2.34, 2.61)	2.36 (2.24, 2.50)	2.33 (2.20, 2.47)
<b>Duration of sleep</b>			
Healthy	1.00	1.00	1.00
Lacking	1.84 (1.73, 1.95)	1.79 (1.69, 1.90)	1.77 (1.67, 1.88)
Excessive	0.88 (0.80, 0.97)	0.85 (0.77, 0.93)	0.84 (0.77, 0.93)

### 3.3. Longitudinal Association between Sleep and Pain Areas

Longitudinal associations between sleep and pain areas (head/neck, trunk, limbs) are shown in Table 3. Poor sleep quality increased pain risk across all areas (ORs ~2.30–2.44). Insufficient sleep also raised risk (ORs ~1.79–1.95), while excessive sleep showed modest protective effects (ORs 0.83–0.91).

Table 3: Longitudinal association between sleep and pain areas.

	Body Pain Areas		
	Head & neck	Trunk	Limbs
<b>Subjective sleep quality</b>			
good	1.00	1.00	1.00
poor	2.44 (2.27, 2.62)	2.39 (2.24, 2.56)	2.30 (2.15, 2.45)
<b>Duration of sleep</b>			
healthy	1.00	1.00	1.00
lacking	1.95 (1.82, 2.10)	1.79 (1.67, 1.91)	1.79 (1.67, 1.91)
excessive	0.91 (0.81, 1.03)	0.88 (0.78, 0.98)	0.83 (0.74, 0.93)
<b>All results are after adjusting for covariates: gender, age, Hukou, marital status, education level, smoking status, drinking status, and chronic disease.</b>			

## 4. Discussion

Pain affects billions of people worldwide, with the functional limitations and negative impacts on quality of life being particularly distressing for older adults<sup>[9-10]</sup>. This study found that good subjective sleep quality, longer sleep duration, daytime napping, especially having a napping duration for over 30 minutes were associated with reduced risk of pain incidence among Chinese older adults.

### 4.1. Association Between Subjective Sleep Quality, Sleep Duration, and Pain

These findings are consistent with previous research. According to statistics, 43.4% of patients with moderate-to-severe pain experience sleep disturbances<sup>[11]</sup>. A systematic review encompassing 16 longitudinal studies found that sleep deterioration increases the risk of developing pain by two- to threefold<sup>[12]</sup>. Furthermore, insomnia and non-restorative sleep have been associated with more than a twofold increase in the risk of chronic pain<sup>[13]</sup>. Poor sleep quality not only elevates pain risk but may also exacerbate pain intensity in affected individuals<sup>[14]</sup>. However, some studies contradict our findings, suggesting that longer sleep duration is not always better. Both short sleep duration (<6 hours) and prolonged sleep (>9 hours) may worsen next-day pain severity<sup>[15]</sup>. These discrepancies may stem from differences in study populations, including racial/ethnic background<sup>[16]</sup> and age distribution<sup>[17]</sup>.

Our findings align with prior studies examining the effects of sleep quality and duration on head/neck, limb, and trunk pain. Large-scale longitudinal studies from Denmark and the United Kingdom have consistently demonstrated a strong association between insomnia and increased prevalence of chronic tension-type headaches<sup>[18-19]</sup>. Behavioral sleep interventions in chronic migraine patients have shown significant reductions in pain intensity<sup>[20-21]</sup>. Comparative studies reveal that patients with sleep disorders exhibit poorer improvement in neck pain compared to those without sleep disturbances<sup>[22]</sup>. Sleep deprivation has been shown to exacerbate pain responses in rheumatoid arthritis patients and activate arthritis-related joint pain<sup>[23]</sup>. Notably, among older adults undergoing knee or hip replacement surgery, increased preoperative sleep duration correlates with reduced postoperative pain and decreased opioid use<sup>[24]</sup>. Multiple studies have established that poor

sleep quality and insufficient sleep duration elevate the risk of developing low back pain, dorsalgia, and thoracic pain<sup>[25–27]</sup>. These collective findings underscore the systemic relationship between sleep parameters and musculoskeletal pain across anatomical regions.

## 4.2. Advantages and Deficiencies

This is among the few longitudinal studies on sleep and pain, using generalized linear mixed-effects models to fully utilize each year's follow-up data. Pain risk was further analyzed by site (head/neck, trunk, limbs). Limitations include self-reported pain (possible recall bias vs. physician assessment, but robust for binary pain); and the cohort design, which provides temporal and strength evidence but cannot establish causality. Natural experiments or instrumental variable methods are needed for causal inference.

## 5. Conclusion

In conclusion, this longitudinal study demonstrates that poor subjective sleep quality and short nighttime sleep increase pain risk in middle-aged and older Chinese adults. Comprehensive sleep assessment and sleep improvement may thus offer a feasible non-pharmacological approach to reduce pain burden in aging populations. Future research should clarify causal mechanisms and evaluate sleep-based interventions for pain prevention across diverse populations.

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