

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/iann20

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To cite this article: Wanxin Zhang, Min Yu, Ying Xu, Xiaoqing Li, Heming Zuo, Zhili Huang & Xuemei Gao (2023) Self-reported sleep status and influencing factors: a webbased national cross-sectional survey in China, Annals of Medicine, 55:2, 2287706, DOI: 10.1080/07853890.2023.2287706

To link to this article: https://doi.org/10.1080/07853890.2023.2287706

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Published online: 04 Dec 2023.



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#### **RESEARCH ARTICLE**

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# Self-reported sleep status and influencing factors: a web-based national cross-sectional survey in China

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#### ABSTRACT

**Objectives:** To investigate self-reported sleep duration, sleep timing, sleep status and influencing factors in the Chinese population.

**Methods:** This web-based cross-sectional survey was conducted in 2022, covering 31 provinces (91%) in China. 11,000 questionnaires were collected, of which 8970 were valid for analysis. Self-reported sleep habits, problems and quality were investigated. Good or fair sleep ratings, enough duration, regular, with no sleep disturbances and <30min sleep latency was defined as a composite variable: 'Good sleep'. Factors influencing sleep patterns and 'Good sleep' were analyzed by multivariate logistic regression.

**Results:** Most participants sleep less than 7h per night (55.13%), usually go to bed at 10–12pm (47.99%), wake up at 6–8 am (49.86%), and take less than 30min to fall asleep (66.30%) with regular sleep schedule (76.01%). Only 12.36% have 'Good sleep'. In the past 3 months, 46.80% of the participants reported symptoms of insomnia, and 21.54% had snoring problems. Among the adults, the young, males, college students, freelancers, and those who resided in urban areas and pandemic-free areas slept later, and the northerners woke up earlier. The adults with low-moderate and moderate income and the minors at elementary and middle school slept earlier and woke up earlier. Mid-aged adults who often napped at noon were more likely to have 'Good sleep' than any other age group, and urban dwellers with the same habit were more likely to have 'Good sleep' than people dwelled in other regions. While people who slept late, woke up too early or too late, slept too little or too much, resided at GMT 7–8 area or pandemic area, had high income, or took up some occupations (entrepreneurs/individuals, professionals, manual and non-manual workers, housewives) were less likely to get a 'Good sleep'.

**Conclusions:** The national survey provided a sleep profile of the Chinese population. Both socio-economic status and personal sleep hygiene habits had an impact on 'Good sleep'.

#### ARTICLE HISTORY

Received 15 June 2023 Revised 17 October 2023 Accepted 15 November 2023

#### KEYWORDS

Sleep; sleep duration; sleep quality; sleep health

# Introduction

Sleep health is defined as a multidimensional pattern of sleep-wakefulness that is adapted to individual, social, and environmental needs and promotes physical and mental well-being [1]. Sleep deficiencies, which include insufficient or long sleep duration, poor sleep quality, and irregular sleep schedules, contribute to a range of suboptimal health outcomes, poorer overall functioning, and well-being [2,3]. The American Academy of Sleep Medicine (AASM) recommends that healthy adults should sleep >7 h per night on a regular basis to promote optimal health, while <7 h sleep is associated with an increased risk of obesity, diabetes, high blood pressure, heart disease and stroke, depression and death [4]. The National Sleep Foundation in the United States recommends 7–9 h of sleep per day for young adults and adults, and 7–8 h for older adults [5,6]. Epidemiological results of sleep duration have been reported in many

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countries [7–11]. In 2014, the Centers for Disease Control and Prevention (CDC) of the United States surveyed 444,306 adult respondents in all 50 states and the District of Columbia, 65.2% of whom reported the recommended amount of healthy sleep [7]. In 2017, a study reported the sleep patterns of 10,976 Canadian adults across the country. The mean sleep duration was 7.12 h per night, and an estimated 54–65% of adults slept the recommended duration (7–9 h) [8]. Another national report of 8649 Mexicans in 2020 showed that the average sleep duration of adults was 7:19 h [9]. Sleep duration in Asians tends to be short. The average sleep duration of Koreans and Japanese was 6.8 h [10] and 5.96 h [11], respectively.

The prevalence of poor sleep quality and self-reported suboptimal sleep has also been noted. A national study from South Korea in 2019 reported that the overall prevalence of poor sleepers (poor sleep quality was defined as the total score >5 of the Pittsburgh Sleep Quality Index) was 41.0% among 165,193 adult participants aged 19 years and older [12]. In Australia, a national survey of 1265 adults showed that 42% were considered to have suboptimal sleep (sleep of inadequate/excessive duration or poor quality), with fairly low rates of professional assessment (16%) and treatment (10%) [13].

In China, the results of a survey from Jilin province showed that the average sleep duration of adults was 7.31 h [14]. Another survey of 0.5 million people from five urban and five rural areas in China showed an average sleep duration of 7.38 h, with 17% reporting symptoms of insomnia [15].

Sleep status varied by geographic areas, socioeconomic differences, and lifestyle factors in China [15-20]. Studies showed that the proportion of insomnia was higher in the rural population than in the urban population in China (19% vs 15%) [15], and that advanced age, unemployment, and low income are associated with poor sleep quality in the rural population [21]. In China, different occupations affect sleep status, e.g. farmers sleep the longest and civil servants sleep the shortest; farmers have the best sleep quality, while professional workers have the worst [18]. In addition, since the outbreak of the COVID-19 pandemic in China, researchers have found that the pandemic increases anxiety and depressive symptoms in the population and increases the risk of developing sleep disorders [22,23].

However, China is a vast country with various geographic and climatic conditions. Southern and northern China have quite different climatic characteristics and lifestyles [24,25]. Previous studies of sleep duration and sleep quality in the Chinese population mainly focused on specific regions and populations, and there is a lack of national-level reports. In this study, we chose questions that we were concerned most to survey about people's sleep status and sleep hygiene habits, shedding light on sleep timing, sleep duration and sleep quality nationwide with the hypothesis that demographic factors, geographic regions and socio-economic factors might exert an effect on sleep in the Chinese population.

# **Methods**

In this study, a web-based questionnaire survey was conducted from January 5th to January 25th, 2022, covering 31 of the 34 provinces, autonomous regions, and municipalities of China. The sleep timing, sleep duration, sleep problems and sleep quality of the Chinese population and their influencing factors were investigated.

# Study design and participants

This survey was distributed online, mainly through a professional online questionnaire platform, People's Daily WeChat, and was approved by the Chinese Sleep Research Society. This study was performed in line with the principles of the Declaration of Helsinki. Respondents across the nation voluntarily clicked on a link on the platform and answered the questions. This was an anonymous survey, so the respondents did not provide information that could identify their ID, and no informed consent form was signed. A total of 11,000 questionnaires were collected. Each questionnaire corresponded to one participant. All the incomplete (as long as one question was not answered) and invalid questionnaires (for example, network problems resulting in abnormal submissions or missing information) were excluded. The final sample size was 8970, with an effective rate of 81.5%.

# Questionnaires

The questionnaire was divided into four parts (Table 1). The first part focused on the demographic information of the participants, including age, sex, residential area (urban/rural area and exact district or counties), annual personal income and occupation. In the second part, we investigated the sleep hygiene habits of the participants over the past three months. Participants were asked to choose their bedtime, waketime, and sleep duration, with a 1-h cut-off. We also investigated sleep latency and the frequency of naps during lunch breaks.

The third part was the self-evaluated sleep status, including sleep disturbances, sleep quality, and sleep schedule. Since the study coincided with the COVID-19 outbreak, in the fourth part, we also investigated the pandemic in the region where the participants were located. The details of the questionnaire are shown in Table 1. All guestions were single or multiple-choice so that participants could complete this survey in five minutes.

# Terminology interpretation and analysis

# Geographic regions

The geographic regions of the participants were categorized in two ways based on their reported locations - northern China and southern China, separated by the Qinling-Huaihe line, and five time zones based on Greenwich Mean Time (GMT). Since the national standard time is GMT 8, we converted the actual sleep and wake-up time according to the time zone in which the participants lived to exclude time zone interference with sleep patterns.

### Possible sleep disturbances

Possible sleep disturbances were inferred from the sleep problems reported by the participants. If participants reported symptoms of insomnia or difficulty falling asleep, they were considered to have possible insomnia. If participants reported snoring, participants were considered to have possible sleep-related breathing disorders. And if participants reported both kinds of troubles, participants were considered to have both insomnia and sleep-related breathing disorders. If participants did not report the above problems but reported sleepiness, easy to wake up, dreamy at night, or other situations, participants were considered to have suboptimal sleep status and may have other sleep problems.

In this study, we also screened participants for possible sleep rhythm problems (advanced and delayed sleep-wake phases) based on self-reported bedtime and waketime without time zone interference. Rhvthm abnormality was set at 2h beyond the average bedtime and waketime according to ICSD-3 [4].

If the self-reported sleep problems cannot be classified as one of the above, the participant was categorized into other sleep problems. The detailed screening flowchart of each questionnaire is shown in Figure 1.

# Good sleep

Based on the results of self-evaluated sleep status, we defined good or fair sleep quality ratings, enough

<b>Fable</b>	e 1.	Question	naires.
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Part 1. Demographic information	
How old are you?	A. 0–18 y B. 19–25 y C. 26–35 y D. 36–45 y E. 46–60 y F. >60 y
Are you male or female? Where do you currently live? Please select your detailed address. What is your annual personal income (¥)?	<ul> <li>A. Male B. Female</li> <li>A. Urban area B. Rural area C. Others (Please select the exact province, city, district or counties)</li> <li>A. 0 B. ≤30,000 C. 30,000–80,000 D. 80,000–150,000 E. 15,000–300,000 F.</li> </ul>
What is your occupation?	<ul> <li>300,000–500,000 G. 500,000–</li> <li>100,000 H. Over 1 million</li> <li>A. Elementary/middle school students D. Professionals E. Freelancers F. Individuals, entrepreneurs G. Corporate white-collar workers H. Civil servant I. Workers J. Service workers K. Housewife L. Retired M. Others</li> </ul>
Part 2. Sleep hygiene status When do you usually go to bed?	A. Before 7 pm B. 7–8pm C.8–9pm D. 9–10pm E. 10–11pm F. 11–12 pm G. 0–1 am H. 1–2 am I. After 3 am
When do you usually get up?	A. Before 5 am B. 5–6 am C. 6–7 am D. 7–8 am E. 8–9 am F. 9–10 am G. 10–11 am H. 11–12 am J. After 1 mm
How long do you sleep each night on average?	A. Less than 3 h B. 3–4 h C. 4–5 h D. 5–6 h E. 6–7 h F. 7–8 h G. 8–9 h H. 9–10 h I. More than 10 h
How long does it take to fall asleep at night?	A. <30 min B. 30–60 min C. >60 min
How often do you take a nap during lunch break?	A. Never B. Occasionally C. Often
Part 3. Self-evaluated sleep status Are you getting enough sleep?	A. Yes B. No, Sleep too little C. No, Sleep too much
Do you have a regular sleep schedule?	A. Yes B. No
Do you have the following sleep disturbances in the past 3 months?	<ul><li>A. Symptoms of insomnia B. Difficulty falling asleep</li><li>C. Snoring D. Sleepiness E. Easy to</li></ul>
(You can choose more than one answer)	wake up F. Dreamy at night G. Others H. No disturbances
How would you rate your sleep quality? Part 4. The impact of COVID-19 on sleep	A. Good B. Fair C. Poor
Is there an outbreak of COVID-19 in your area?	A. Yes B. No

duration, regular, with no sleep disturbances and <30 min sleep latency as composite variable: 'Good sleep'. If participants did not meet any of the criteria above, they were considered of no-'Good sleep'.

#### Statistical analysis

Age was categorized into minors (0-18 y), young adults (19-35 y), middle-aged adults (36-60 y) and old adults(>60 y). According to the wage data released by the National Bureau of Statistics of China (NBSC), income was classified into six levels: no



**Figure 1.** The screening process for the prevalence of sleep disturbances (classified according to the presence of sleep disturbances in the last 3 months). <sup>a</sup>If the participants could not be classified but reported sleepiness, easy to wake up, dreamy at night, or other situations, participants were considered to have suboptimal sleep status and may have other sleep problems.

income, low-income (<¥30,000), low-moderate income (¥30,000–80,000), moderate-income (¥80,000–300,000), high-income (¥300,000–1,000,000), and ultra-high-income (Over 1 million RMB) (as of March 15, 2023, 1¥=\$0.145US). According to the EGP Classification of Hierarchies [26], workers and service workers were combined into manual workers, and corporate white-collar workers and civil servants were

combined into non-manual workers. According to the recommended sleep time [4–6], sleep duration was classified into three categories (<7h, 7–9h, >9h). Bedtime (before 10 pm, 10–12 pm, after 12 am) and wakeup time (before 6 am, 6–8 pm, after 8 am) were also grouped into three categories.

The sleep status of adults and minors was analyzed separately. Descriptive statistics were used to present

demographic data, socioeconomic characteristics, sleep habits and self-evaluation of sleep status. Chi-square tests were used to compare differences in sample sizes for variables in adults and minors. Multivariate logistic regression was used to analyze the socio-demographic factors (age, sex, residence, geographical region, geographical time zone, annual personal income, occupation, pandemic) for differences in sleep patterns. Binary logistic regression analyses were performed to analyze the above socio-demographic factors and sleep hygiene habits on 'Good sleep'. Odds ratios (ORs) with 95% confidence intervals (CIs) were presented in the results. A two-sided Wald test was performed to determine if the ORs in the regression model were statistically significant. Statistical significance was determined using a threshold *p*-value of .05. Statistical analysis was performed in SPSS 26.0.

#### Results

# Demographic and socioeconomic characteristics

Of the total participants, 12.22% were minors and 87.78% were adults, with a high proportion of the young (48.09%) and the mid-aged (36.37%) adults. 58.07% were female and 41.93% were male, with no difference in the gender composition of adults and minors ( $X^2 = 0.13$ , p = .72). Regarding the area of residence, 22.08% resided in rural areas and 74.67% in urban areas, while more minors (34.22%) lived in rural areas than adults (20.40%). According to the geographical regions, 47.18% were southerners and 52.82% were northerners, with no difference in the north-south composition of adults and minors ( $X^2$  = 1.06, p = .32). In the total sample, 62.35% of the population lived in GMT 8 and 29.54% in GMT 7, and the proportion of minors living in GMT 6 was high (17.43%). 67.84% had a COVID-19 pandemic in their place of residence. 24.23% were low-moderate income and 31.05% were moderate income. Non-manual workers accounted for the largest proportion of the total occupational type with 25.24%, followed by college students (18.76%) and professionals (10.68%), while farmers accounted for the least with only 1.22%. 22.45% of minors were already college students. Details of the participants' demographic and socioeconomic information are shown in Table 2.

# Sleep patterns

38.26% of the total sample met the criteria of 7–9h of sleep per night, and most adults (56.68%) slept less

than 7h. However, only 56.03% of minors slept more than 7h. Most people slept at 10–12 pm (47.99%) and woke up at 6–8 am (49.86%). Compared to adults (30.33%), minors (43.07%) were more likely to fall asleep before 10 pm. Most people (64.41% adults and 79.84% minors) fell asleep within 30 min, 21.71% of the total participants fell asleep within 30–60 min, and it took more than 60 min for 12.00% of participants to fall asleep. In terms of habits of napping, 46.18% of the participants (46.58% adults and 43.25% minors) often napped during lunch breaks, while 22.81% never napped (Table 2).

In adults, the young slept later and woke up later. The middle-aged tended to go to bed at 10-12pm and slept <9h. Men were more likely to fall asleep after 12 am compared to women. Compared to rural areas, the urban population slept later and less, and was more likely to wake up between 6-8 am. Northerners woke up early and slept <9h compared to southerners. For time zone, the further west (e.g. GMT 6), the closer people go to bed to sunset, and the further east (e.g. GMT 9), the later people wake up to sunrise. When there was no pandemic, people were more likely to sleep late, wake up after 6 am, and sleep <9h. Compared to the ultra-high incomes, the low-moderate and moderate incomes slept earlier and woke up earlier. Compared to farmers, college students went to bed later and woke up later, sleeping >7h. Freelancers tended to go to bed after 12 am and get up after 8 am Elementary and middle school students went to bed later (more after 12 am) but got up earlier (more before 6 am) (Figure 2A).

In minors, compared to college students, elementary and middle school students slept earlier, woke up earlier, and were more likely to sleep <7 h. Northerners (vs. southerners) and those in the GMT 7-8 (vs. GMT 9) area were more likely to fall asleep by 12 am (Figure 2B).

#### Prevalence of possible sleep disturbances

Based on the presence of sleep disturbances in the last 3 months, 35.52% of participants were suspected of having symptoms of insomnia, 10.26% of them having sleep-related breathing problems, and 11.28% of them having both disturbances. Among the other sleep disturbances, 0.99% of the participants were suspected to have an advanced sleep-wake phase, 1.61% were suspected to have a delayed sleep-wake phase, and the remaining 14.34% were unclassifiable. 26.01% of the participants were basically normal (Table 2).

# Table 2. Demographic and socioeconomic characteristics, sleep hygiene habits and self-evaluation of sleep status.

	Тс	tal	Adults		Minors		Adults vs Minors <sup>d</sup>		Total		tal	Adults		Minors		Adults vs Minors <sup>d</sup>	
	N	%	N	%	N	%	X <sup>2</sup>	p value		N	%	N	%	N	%	X2	p value
Demographic and socioeconomic characteristics Sleep hygiene habits																	
Minors	1096	12.22	_	_	1096	100.00	_	_	Before 10 pm	2860	31.88	2388	30.33	472	43.07	74.16	<.001**
Young adults	4314	48.09	2518	31.98	-	-			10-12pm	4305	47.99	3883	49.31	422	38.50	74.10	1.001
Middle-aged	3262	36.37	1796	22.81	_	_			After 12am	1805	20.12	1603	20.36	202	18.43		
adults																	
Old adults Sex	298	3.32	298	3.78	-	-			Wakeup time <sup>b</sup> Before 6am	2329	25.96	2002	25.43	327	29.84	13.16	.001**
Male	3761	41.93	3296	41.86	465	42.43	0.13	.72	6-8am	4472	49.86	3931	49.92	541	49.36		
Female	5209	58.07	4578	58.14	631	57.57			After 8am	2169	24.18	1941	24.65	228	20.80		
Area of residence	e								Sleep duration								
Rural area	1981	22.08	1606	20.40	375	34.22	115.31	<.001**	Less than 7h	4945	55.13	4463	56.68	482	43.98	111.73	<.001**
Urban area	6698	74.67	6023	76.49	675	61.59			7–9h	3432	38.26	2960	37.59	472	43.07		
Others	291	3.24	245	3.11	46	4.20			More than 9h	593	6.61	451	5.73	142	12.96		
Geographical reg	gion <sup>a</sup>	17.10	2.000	46.00	533	10.62	1.04	22	Sleep latency	50.47				075	70.04	102.12	001**
Northern China	4232	47.18	3699	46.98	533	48.63	1.06	.32	<30 min	5947	66.30	50/2	64.41	125	/9.84	103.13	<.001**
Goographical tim	4/30	52.62	41/5	55.02	202	51.57			50-00 min	1947	21./1	000	25.01	06	7 05		
GMT 6		5 5 1	303	3 85	101	17 43	434 21	< 001**	Nan during lunc	h brea	12.00	990	12.57	00	7.05		
GMT 7	2650	29.54	2318	29.44	332	30.29	131.21	1.001	Basically no	2044	22.79	1796	22.81	248	22.63	6.17	.046*
	2000	2210	2010	22000	002	50.25			lunch break				22.01	2.0	22.05	••••	10.10
GMT 8	5593	62.35	5087	64.61	506	46.17			Occasional	2784	31.04	2410	30.61	374	34.12		
									lunch break								
GMT 9	233	2.60	166	2.11	67	6.11			Often take a	4142	46.18	3668	46.58	474	43.25		
									lunch break								
COVID-19 pande	mic								Self-evaluation of	of sleep	status						
No	2885	32.16	2408	30.58	477	43.52	73.84	<.001**	Sleep adequacy								
Yes	6085	67.84	5466	69.42	619	56.48			Adequate sleep	3052	34.02	25/0	32.64	482	43.98	57.14	<.001**
Annual personal	Incom	e	1177	14 21	042	76.02			Sleep too little	4428	49.36	3953	50.20	4/5	43.34		
NO Income	1970	21.90	112/	14.51	045	70.92	-	-	much	1490	10.01	1221	17.10	139	12.00		
With income	_	_	_	_	253	23.08			Sleen schedule								
Low income	1466	16.34	1290	16.38					Irregular	2152	23.99	1908	24.23	244	22.26	2.05	.162
Low-moderate	2173	24.23	2133	27.09	_	_			Regular	6818	76.01	5966	75.77	852	77.74		
income									5								
Moderate	2785	31.05	2759	35.04	-	-			Possible sleep di	isturbaı	nces						
income																	
High income	496	5.53	493	6.27	-	-			Insomnia	3186	35.52	2885	36.64	301	27.46	246.73	<0.001**
			70	0.01					symptoms	000	10.24	070	11.05	50			
Ultra-high	80	0.89	72	0.91	_	-			Sleep breathing	920	10.26	870	11.05	50	4.56		
Occupation									problems	1012	11 20	028	11 70	<b>Q</b> /I	766		
occupation									Sleen	1012	11.20	920	11.79	04	7.00		
									breathing								
									problems								
Farmers	109	1.22	105	1.33	-	-	-	-	Others								
Entrepreneurs,	531	5.92	527	6.69	-	-			Advanced	89	0.99	59	0.75	30	2.74		
individuals									sleep-wake								
									phase								
Professionals	958	10.68	949	12.05	-	-			Delayed	144	1.61	129	1.64	15	1.37		
									sieep-wake								
Manual workers	887	0 80	882	11 20	_	_			Uncategorized	1286	14 34	1136	14 43	150	13 60		
Non-manual	2264	25 24	2258	28.68	_	_			None	2333	26.01	1867	23 71	466	42 52		
workers	2201	23.21	2250	20.00					Hone	2000	20.01	1007	23.71	100	12.52		
Freelancers	480	5.35	471	5.98	-	_			Sleep quality rat	ing							
Housewife	278	3.1	272	3.45	-	-			Good	3803	42.40	3233	41.06	570	52.01	61.24	<.001**
College	1683	18.76	1437	18.25	246	22.45			Fair	3685	41.08	3270	41.53	415	37.86		
students																	
Elementary/	839	9.35	42	0.53	797	72.72			Poor	1482	16.52	1371	17.41	111	10.13		
middle																	
scnool																	
Scudents	261	100	360	157					Good cloop								
Others	580	4.02 6.47	571	4.37 7 75	- 52	4 94			No	7861	87 64	6900	88 80	862	78 65	93 07	< 001**
e there	500	0.17	571	,.25	55	1.04			Yes	1109	12.36	875	11.11	234	21.35	25.07	2.001

<sup>a</sup>According to the location of the participants, northern China and southern China are divided by the Qinling-Huaihe line.

<sup>b</sup>We converted the bedtime and wakeup time according to the actual time zone where the participants were living.

<sup>4</sup>A chi-square test was used to compare differences in sample sizes for each variable between adults and minors.



**Figure 2.** Socio-demographic factors associated with sleep time<sup>c</sup>, wake time<sup>c</sup> and sleep duration. (A) Adults. (B) Minors. (i) Sleep time. (ii) Wake time. (iii) Sleep duration. <sup>a</sup>Multivariate logistic regression analysis of socio-demographic factors associated with sleep time, wake time and sleep duration (only results with significant differences were shown). <sup>b</sup>According to the location of the participants, northern China and southern China are divided by the Qinling–Huaihe line. <sup>c</sup>We converted the bedtime and wakeup time according to the actual time zone where the participants were living and reclassified. \*Indicates statistical significance (p < .05), \*\*Indicates statistical significance (p < .01).



A (ii)

Figure 2. Continued.

# Self-evaluation of sleep status and factors associated with 'Good sleep'

Overall, participants were satisfied with their sleep status (42.40% considered their sleep quality to be good and 41.08% considered it to be fair), while 16.52% considered their sleep quality to be poor. Most people (76.01%) had regular sleep habits, and 23.99% thought they slept irregularly. For sleep adequacy (which means subjective enough sleep time), the majority of people thought they slept too little (49.36%), 34.02% thought they slept enough, and another 16.61% thought they



A (iii)



Figure 2. Continued.

![](_page_10_Figure_1.jpeg)

![](_page_10_Figure_2.jpeg)

![](_page_10_Figure_3.jpeg)

Figure 2. Continued.

slept too much. Only 12.36% (11.11% adults and 21.35% minors) of the total population met the criteria for 'Good sleep' (Table 2).

Among adults, the middle-aged, urban dwellers, and people who often took lunch breaks were more likely to get 'Good sleep', while people who lived in the GMT 7-8 area, had high income (¥300,000–1,000,000), took up some occupations (entrepreneurs/ individuals, professionals, manual workers, non-manual

workers, housewives), slept late (after 12 am), woke up too early (before 6 am) or too late (after 8 am), slept too little (less than 7 h) or too much (>9 h), and resided in areas with COVID-19 pandemic were less likely to fulfill the criteria. In minors, an early bedtime (before 10 am) can help to get a 'Good sleep', whereas females, in GMT 7 areas, with late bedtimes (after 12 am), late risers (after 8 am), and less sleep (less than 7 h) were less likely to get a 'Good sleep' (Figure 3).

Variables	OR (95% CI) <sup>a</sup>		P value
Age			
Young		Ref	
Middle-aged		1.801 (1.491, 2.174)	<0.001**
Old		1.373 (0.837, 2.253)	0.209
Sex			
Male		Ref	
Female		0.871 (0.744, 1.020)	0.086
Area of residence			
Rural		Ref	-0.004**
Urban		1.644 (1.327, 2.036)	<0.001**
Others		1.559 (1.007, 2.413)	0.046*
Geographical region *	<u>.</u>	D-1	
North		Ref	0.011
South		1.009 (0.865, 1.177)	0.911
Geographical time zone		0.010 (0.045 4.400)	0 107
GMT 6		0.619 (0.345, 1.109)	0.107
GMT 7		0.412 (0.252, 0.675)	<0.001**
GMT 8		0.606 (0.380, 0.965)	0.035*
GMT 9		Ref	
Annual personal income			
None		0.629 (0.299, 1.324)	0.222
Low		0.591 (0.289, 1.210)	0.150
Low-moderate		0.591 (0.293, 1.190)	0.141
Moderate		0.550 (0.275, 1.102)	0.092
High		0.458 (0.217, 0.969)	0.041*
Ultra-high	•	Ref	
Occupation			
Farmers		Ref	
Entrepreneurs, individuals		0.505 (0.278, 0.918)	0.025*
Professionals		0.552 (0.315, 0.966)	0.037*
Manual workers		0.402 (0.227, 0.712)	0.002*
Non-manual workers		0.362 (0.209, 0.628)	<0.001**
Freelancers		0.655 (0.359, 1.194)	0.167
Housewife		0.496 (0.256, 0.961)	0.038*
College students		1.070 (0.585, 1.959)	0.826
Elementary/middle school students		0.883 (0.310, 2.518)	0.816
Retired		0.679 (0.354, 1.306)	0.246
Others		0.701 (0.394, 1.247)	0.227
Bedtime <sup>2</sup>		1 1 70 (0 0 70 1 11 1)	0.004
Before 10pm		1.173 (0.973, 1.414)	0.094
10-12pm		Ref	-0.001**
Anter 12am		0.389 (0.293, 0.515)	<0.001***
		0 707 (0 500 0 800)	0.002**
		0.727 (0.592, 0.892)	0.002**
o-oan		Ket 0.420.(0.220.0.540)	~0.001**
Sleep duration		0.429 (0.339, 0.542)	<b>NU.UU1</b>
		0.206 (0.250, 0.240)	~0.001**
2 0h		0.290 (0.202, 0.348)	<b>\U.UU</b>
Mara than Ob		Rei 0.440 (0.207, 0.654)	~0.001**
Non-during lunch break		0.440 (0.297, 0.004)	<b>NU.UU1</b>
Nover	1	Def	
Occasionally		1 052 /0 850 1 202	0 620
Offen		1 255 /1 020 / 1.303)	0.039
COVID-19 pandomic		1.200 (1.000, 1.027)	0.024
		Pof	
Ves	- <b>-</b>	1920 (0 608 0 065)	0 017*
100		0.020 (0.090, 0.905)	0.017
	0 1 2 3		
	٨		
	A		

**Figure 3.** Socio-demographic factors and sleep habits associated with good sleep. (A) Adults. (B) Minors. <sup>a</sup>Binary logistic regression analysis of socio-demographic factors and sleep habits associated with good sleep. <sup>b</sup>According to the location of the participants, northern China and southern China are divided by the Qinling-Huaihe line. <sup>c</sup>We converted the bedtime and wakeup time according to the actual time zone where the participants were living and reclassified. \*Indicates statistical significance (p < .05), \*\*Indicates statistical significance (p < .05).

Variables		OR (95% CI) <sup>a</sup>	P value
Sex			
Male	•	Ref	
Female	<b>⊢</b> ∎−−1	0.599 (0.430, 0.835)	0.002**
Area of residence			
Rural	•	Ref	
Urban	▶ <b></b>	1.245 (0.849, 1.824)	0.262
Others	·	0.956 (0.408, 2.240)	0.917
Geographical region <sup>b</sup>			
Northern	+	Ref	
Southern	<b>⊢</b> ∎+	0.732 (0.507, 1.057)	0.096
Geographical time zone			
GMT 6	· <b></b>	0.443 (0.191, 1.028)	0.058
GMT 7	+ <b></b>	0.269 (0.115, 0.628)	0.002**
GMT 8	·	0.652 (0.311, 1.366)	0.257
GMT 9	•	Ref	
Annual personal income			
No	•	Ref	
Yes		0.800 (0.531, 1.204)	0.285
Occupation			
College students	•	Ref	
Elementary/middle school students		0.876 (0.522, 1.469)	0.616
Others		0.751 (0.308, 1.829)	0.528
Bedtime <sup>°</sup>			
Before 10pm		<b>2.927 (1.911, 4.484)</b>	<0.001**
10-12pm	•	Ref	
After 12am		0.359 (0.167, 0.773)	0.009**
Wakeup time <sup>°</sup>			
Before 6am	F-	0.720 (0.475, 1.092)	0.122
6-8am	•	Ref	
After 8am	H=	0.429 (0.252, 0.731)	0.002**
Sleep duration			
Less than 7h	P <b>■</b> -1	0.243 (0.157, 0.375)	<0.001**
7-9h	-	Ref	0.011
More than 9h		0.891 (0.570, 1.392)	0.611
Nap during lunch break		Def	
		Ref	0.400
Ottasionally		1.334 (0.864, 2.058)	0.793
COVID 19 pandamic		1.157 (0.746, 1.793)	0.514
No		Dof	
Ves			0 183
100		1.219 (0.091, 1.037)	0.105
	0 1 2	3 4 5	

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#### Figure 3. Continued.

# Discussion

In this study, a web-based questionnaire survey was conducted, covering most regions of China. The sleep timing, sleep duration, sleep problems and influencing factors of 'Good sleep' in the Chinese population were investigated.

More than half of the Chinese population slept for less than 7h in the present study (56.68% in adults and 43.98% in minors). In developed western countries, the prevalence of the population sleeping less than 7h is about 1/3, such as the United States (34.8%) [7], Canada (31.9%) [8], and New Zealand (37%) [27]. In Asia, the length of sleep appears to be generally shorter. In this study, the Chinese slept longer than the Japanese but shorter than the Korean [10,11].

China covers a vast territory. In this study, three dimensions, urban-rural, north-south (latitude), and time zone (longitude), were used to categorize the geographical characteristics of different populations. Studies have reported shorter sleep duration in urban than rural populations in China [15]. In our study, the urban-rural factor influenced sleep patterns and 'Good sleep' in adults, but not in minors. In urban areas, adults slept late and less which could lead to poor sleep. In fact, living in urban areas was an advantageous factor for 'Good sleep' in adults, while lifestyle, mental health, physiological factors, occupation, and age can also affect sleep quality [18–20]. In addition to sleep patterns, other socioeconomic conditions in cities may weaken the unfavorable effects of bad sleep habits on 'Good sleep'.

In this study, both adults and minors in the north slept earlier than in the south. During the study period, it was winter in the northern hemisphere. The southern China was relatively wet and warm, while northern China was mostly dry and cold. It might be the cold nights and large temperature difference between day and night that the northerners tend to go to bed early and wake up early, and reduce the number of recreational activities before bedtime.

China uses the GMT 8 as the national standard time, which can explain the differences of sleep habits among time zones. Besides, geographic and socioeconomic factors may also influence the sleep status of populations in different time zones. In China, the GMT 9 area comprises the northeastern region, which used to be an important area for the development of heavy industry. But in recent years the aging population has increased significantly, and economic development has been slow in GMT 9 area. The GMT 8 region is the lifeblood of China's economic development. The major developed cities (e.g. Shanghai, Beijing, Shenzhen and Guangzhou) are all located in this region. The GMT 7 region encompasses most areas of China's 'Western Development' strategy. The large population but backward of educational resources may explain the poor sleep of elementary/ middle school students of GMT 7. In the results of adults, those in the GMT 7-8 region did not sleep well compared to the GMT 9 region, probably due to high work pressure, and a relatively young population with a small proportion of retired people. The GMT 6 region encompasses the majority of highland areas of China (Xinjiang, Tibet, and Qinghai), which are sparsely populated and economically disadvantaged. Further studies were needed to deeply explain the sleep status between time zones in China.

In China, annual incomes of 300,000–1000,000RMB means a relatively high income in first- and second-tier cities. This group is usually considered to live more comfortably and have more existential and financial stability and longevity than the poorer and richer groups [28,29], yet this income group did not rate their sleep quality as good in our study. This result may be due to the fact that this group didn't sleep as well as expected, or this group had a relatively high

level of culture, education and social status, which requires a higher quality of sleep [30].

During this study, the COVID-19 pandemic was on a plateau in China, but adverse effects of the pandemic on sleep can still be found. Although it was more likely to go to bed early and wake up after 6 am during the pandemic, sleeping more did not equate to 'Good sleep'. At the beginning of the COVID-19 pandemic, studies had reported delayed bedtime and wake-up time in Chinese populations compared to the pre-epidemic period [22,31]. According to our results, the pandemic disrupted the population's sleep habits and rhythm of life, even during the plateau period.

In this study, no differences in sleep patterns and proportion of 'Good sleep' were found by gender among adults, but in minors, girls did not sleep well, and they were more likely to sleep less than 7 h. Reports of gender differences in sleep duration were inconsistent. Some studies have concluded that women sleep longer [32], while some suggest that women are more likely to be short sleepers [33,34]. Further exploration of sleep patterns and self-ratings in sex of different age groups may be necessary.

High proportion (46.80%) of participants had symptoms of insomnia in this study. However, without objective tools, we cannot make a diagnosis of whether the patients had chronic insomnia or other types of insomnia disorder. The American Academy of Sleep Medicine reported a high prevalence of insomnia symptoms in adults, with an estimated range of 35%-50%, which is similar to the findings of this study [35]. While the incidence of diagnosed chronic insomnia is relatively low, ranging from 5% to 15% [35]. Some studies have reported a higher prevalence of insomnia among young people than older people in China [36]. In this study, there was a high proportion of young people. Accelerated urbanization and industrialization, occupational stress and widespread use of streaming media may be responsible for the high prevalence of insomnia among young people [36]. The COVID-19 pandemic may contribute to insomnia, too [37,38].

The percentage of participants with snoring disturbances was 21.54%, of which 11.28% had both symptoms of insomnia and snoring disturbances. The snoring symptoms reported in this study may represent a category of diseases, from habitual snoring to obstructive sleep apnea (OSA). Studies have suggested that Asians have a higher risk of habitual snoring, and the prevalence is higher in older than in younger people [39–41]. As the sample group was young, the results may be lower than the populations.

In this study, symptoms of insomnia and snoring tend to co-occur: 52.3% of those with snoring

disturbances reported insomnia symptoms, and 24.1% of those with insomnia symptoms reported snoring disturbances. Previous studies reported that 42%–80% of patients with OSA reported at least 1 symptom of insomnia, and 39% of OSA patients met the diagnostic criteria for insomnia [42,43]. The prevalence of OSA also ranged from 29.3% to 67% in the elderly population with insomnia [44–46]. However, this study was only a questionnaire survey, so medical diagnosis and further analysis based on demographic factors such as age and occupation are required.

In this study, the symptom of an advanced sleep-wake phase was considered to be 0.99% and a delayed sleep-wake phase was 1.61%. This rate may be high compared to the disease diagnosis. The prevalence of the advanced sleep-wake phase using the International Classification of Sleep Disorders (ICSD) criteria was estimated to be 0%–0.21% and the delayed sleep-wake phase was estimated to be 0.2%–16% [47]. Self-reported sleep disturbances may include sleep subhealth conditions outside of the diagnosis of disease and may affect systemic health as well [48,49].

Overall, multiple sociodemographic and economic factors influence sleep patterns, sleep status and problems. Our findings may contribute to public health decision-making and improve the health of citizens.

#### Limitations

First, the survey was conducted as an online questionnaire, so the investigators could not explain and check information with the respondents, which in turn affected the results. Second, the surveyed population was all Internet users, while those who had no access to the Internet could not participate in this survey, such as people who cannot afford electronic products in remote areas, and the illiterate or the elderly who couldn't answer the questions online. Third, the age of participants was collected as a categorical parameter, and the high percentage of the young (48.09%) and the mid-aged (36.37%) with only 3.78% being over 60 years old may affect the accuracy of the results. Fourth, sleep duration was not calculated by objective measurements, such as polysomnography or actigraphy. Fifth, this survey could only speculate on the tendencies of suspected insomnia, suspected sleep-disordered breathing and other suspected sleep conditions, diagnosis of a specific disease and investigation of the prevalence requires verification of standard and proper medical methods in the future. In addition, some population groups were small and may lack the power to be compared with other groups. It is important to be cautious in generalizing the results to the broader Chinese population.

# Acknowledgment

The authors were grateful to sleep research institute of DeRucci for their help in questionnaire distribution, collection and data entry.

# **Ethical approval**

Our study did not require an ethical board approval because this was a completely voluntary study with no interventions, clinical examinations, or sampling.

Our study did not require informed consent form because this was an anonymous survey, and the respondents did not provide information that could identify their ID.

This was a survey conducted by the China Sleep Research Society which did not have an ethics institute. Peking University and Fudan University had ethics institutes, but they cannot apply for ethics for a project that was not entirely led by them. This study was systematically designed to achieve privacy protection without ethical implications: a survey that was anonymous, voluntary, did not involve the collection of information that clearly identifies individuals, and did not violate the Helsinki Principles and their bylaws. This project was non-interventionist, required only privacy protection, and was not disseminated to people other than the researchers, who in fact did not even know who they are. Besides, the Helsinki Principles and their bylaws were essentially medical ethics, while this project was not strictly medical research. Therefore, we did not have ethical approval.

### **Authors contributions**

Xuemei Gao, Zhili Huang and Heming Zuo were involved in the conception of the study. Wanxin Zhang, Min Yu, Ying Xu and Xiaoqing Li were involved in the data analysis and drafting the manuscript. All authors were involved in the interpretation of the findings. All authors reviewed and approved the final manuscript and agree to be held accountable for all aspects of the work.

### **Disclosure statement**

No potential conflict of interest was reported by the author(s).

#### Funding

This work was not supported by any funding.

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#### Data availability statement

Anonymized data are available upon reasonable request.

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