

JOB CATEGORY DIFFERENCES IN THE PREVALENCE AND ASSOCIATED FACTORS OF INSOMNIA IN STEEL WORKERS IN CHINA

XIAOMING LI, SHIYUE CUI, JIANHUI WU, LIHUA WANG, and JUXIANG YUAN

North China University of Science and Technology, Tangshan, China
School of Public Health

Abstract

Objectives: This study aimed to investigate the prevalence of insomnia and risk factors among different job categories of steel workers in China, in order to improve their quality of occupational life. **Material and Methods:** A cross-sectional face-to-face survey was conducted which involved 5834 steel workers from a large enterprise located in northern China, including front-line, maintenance and inspection, and other auxiliary workers. The *Athens Insomnia Scale* and the *Job Content Questionnaire* were used to assess the status of insomnia and job stress/social support, respectively. Multivariable logistic regression was used to identify factors influencing insomnia. **Results:** The overall prevalence of insomnia was determined at 42.0% (95% confidence interval: 40.7%–43.2%). For front-line, maintenance and inspection, and other auxiliary workers, the prevalence was 42.3%, 39.8%, and 47.9% ($p = 0.001$), respectively. The participants with high stress and low support, and those who had experienced ≥ 2 major life events in the past 12 months, compared to those with low stress and high support, and those without major events, displayed an increased risk of insomnia among all 3 job categories (the adjusted odds ratio ranged 1.56–2.38 and 1.30–1.75, respectively). The educational level, shift work, alcohol consumption, and present illness were identified as influencing factors of insomnia for 1 or 2 job categories. **Conclusions:** The prevalence of insomnia was the highest in the group of other auxiliary steel workers among the 3 job categories of steel workers under consideration. While the influencing factors of insomnia differed among the groups, job stress and major life events were common risk factors of insomnia among the 3 categories of steel workers. *Int J Occup Med Environ Health.* 2020;33(2):215–33

Key words:

insomnia, shift work, job stress, life events, steel workers, job category

INTRODUCTION

At present, insomnia is one of the most common and widely recognized public health problems all over the world. In previous studies [1–4], the prevalence of insomnia ranged 7.1–79.8% in general populations in the world, e.g., 7.1% in Norway [2], 22.1% in the USA [1], 11.9% in Hong Kong of China [3], and 79.8% in Brazil [4]. In China, studies have shown that the prevalence of insomnia ranges 12.7–55.7% in different populations [5–8]. Although the prevalence of insomnia varies considerably in terms of criteria and symp-

toms, the prevalence above 30% for the global general population is commonly accepted. Meanwhile, several studies have reported that the prevalence of insomnia varies by job type [9–11]. For example, the prevalence of insomnia was determined at 23.2% among workers in the USA [9], 31% among manufacturing workers in South Korea [10], 23.2% among male public service workers in Japan [11], and 16.8% among financial workers in France [12].

Insomnia is said to increase the risk of numerous physical and mental diseases, including heart disease, depression,

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Corresponding author: Juxiang Yuan, North China University of Science and Technology, School of Public Health, 21 Bohai Road, Caofeidian Xincheng, Tangshan, Hebei, China (e-mail: yuanjx@ncst.edu.cn).

hypertension, anxiety, stroke, dyslipidemia, atrial fibrillation, obesity, migraine [13], and metabolic syndrome [14]. Furthermore, insomnia is associated with poor work performance, absenteeism, accidents at work [9,10], reduced work productivity, increased workplace costs, and a declined quality of working life [15]. According to an American study, the direct economic costs attributed to insomnia amounted to USD 13.9 billion in 1995 and were projected to increase year-by-year [16].

Such a high prevalence and a multitude of adverse effects suggest that epidemiological studies of workplace insomnia are extremely necessary. There are a lot of occupational hazards that can increase the risk of insomnia, such as hazardous gas, noise, hot environment, strenuous physical work, job stress, night work, etc. [17–19]. However, the prevalence of insomnia and its associated factors are rarely known in steel workers, especially in China.

Several socio-demographic, psychological, lifestyle- and behavior-related, as well as occupational factors are associated with insomnia, including anxiety, physical health, religious beliefs [5], sex [6], alcohol consumption [20], a lack of steady income, less frequent social contacts, reduced social capital, living alone [7], shift work [21], occupational stress [8], etc. However, little is known about whether the prevalence of insomnia and its associated factors are different across job categories of steel workers. This hinders the ability of decision-makers to introduce relevant policies that may protect workers' health and reduce workplace costs. Therefore, the present study aimed to investigate the prevalence of insomnia and its associated factors among different job categories of steel workers in China.

MATERIAL AND METHODS

Participants

The participants were recruited from the Tangsteel company, a large steel enterprise in the Hebei Province in northern China. All 8646 steel workers who participated

in the annual occupational health examination in 2017 had been selected as potential research subjects, from whom 5896 workers eventually participated and completed the survey voluntarily. There were 48 subjects whose demographic information was missing, and 14 subjects who lacked more than a third of the items in the insomnia scale; these 62 subjects were, therefore, rejected. Thus, 5834 participants were included in the final analysis. Data collection was performed in March–July 2017. All the subjects had given their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the North China University of Science and Technology (No. 16040).

The mean age of the subjects was 42.9 (± 8.6) years, and 91.3% were male. As regards the educational level, junior high school education was reported by 23.2%, high school education by 51.9%, and college or university education by 24.9% of the participants. As regards the marital status, 92.4% of the participants were married, 4.7% unmarried, and 2.9% separated or divorced.

Measures

Questionnaire measurements

All the participants were interviewed face-to-face by members of the research team following a structured questionnaire. The questionnaire consisted of 5 parts:

- socio-demographic characteristics (sex, age, educational level, marital status, household income, household living area, etc.),
- living and behavioral habits (smoking, alcohol consumption, tea consumption, physical activity, etc.),
- job characteristics (shift work, employment relationship, job category, job stress, etc.),
- personal characteristics (height and weight, life events, present illness),
- an assessment of insomnia.

Definition of smoking

Current smokers were those who had regularly consumed ≥ 1 cigarette/day for at least the past 12 months. Some participants who had quit cigarettes within the past 12 months were also assigned as current smokers. Ever smokers were those who had quit cigarettes earlier than 12 months before. Never smokers were those who had never smoked in their lifetime.

Alcohol consumption status

Never drinkers were those who had not consumed alcohol in their lifetime. Ever drinkers were those who had once consumed alcohol, but had not done so for the past 6 months. Alcohol consumption was calculated according to the following formula:

$$\begin{aligned} \text{Alcohol consumption (g/day)} = & \\ & [\text{liquor (kg/month)} \times 1000 \times 0.45 + \\ & \text{beer (bottle/month)} \times 640 \times 0.036 + \\ & \text{wine/fruit wine (kg/month)} \times 1000 \times 0.0096] / 30 \end{aligned} \quad (1)$$

Tea drinking

Tea drinkers were those who drank ≥ 1 cup of Chinese black tea, green tea, or jasmine tea per week, continuously for at least 6 months.

Physical activity

The authors assessed physical activity using the Chinese version of the *International Physical Activity Questionnaire* (IPAQ) [22,23]. The Chinese version of IPAQ had been previously identified as having an acceptable reliability and validity. The participants were asked to supply information on their physical activity during the previous 7 days at work, at home, and any recreational or sport, and leisure-time activities. Activities that the individual performed for at least 10 min at a time were collected along with the total duration per day, the number of days, and the intensity (vigorous, moderate, or low) of each activity.

For each individual, the authors assessed their physical activity according to the guidelines for data processing and analysis of IPAQ. The recorded activities of the participants were converted into metabolic equivalent task (MET) [min/week]. The individuals with MET values < 600 were classified as having a low level of physical activity, those with MET values 600–3000 as having a moderate level of physical activity, and those with MET values > 3000 as having a high level of physical activity.

Employment relationship

The individuals who had signed long-term service (until retirement) contracts with the steel company were classified as contract workers; those who had not signed long-term service contracts, but only short-term service contracts or temporary service contracts, were classified as other forms; some people who were assigned to work by the labor dispatch agency, but had not signed any service contracts with the steel company, were also classified as other forms.

Shift work

A majority of the participants worked according to a 4-team/3-shift schedule, so this shift type was analyzed as a separate group. In this group, according to the International Labour Organization (ILO) [24], the day-shift worker is defined as a person working day shift at 8:00–16:00, evening shift at 16:00–24:00, or night shift at 24:00–8:00 of the following day. Some of the participants worked according to a 3-team/2-shift, 5-team/3-shift, or 4-team/2-shift schedule, and they were divided into other shift type groups. The rest of the participants who constantly worked according to a day-shift schedule, without night shifts, were assigned to the day-shift group.

Job stress

The *Job Content Questionnaire* (JCQ) developed by Karasek [25] was employed for evaluating job stress in this study. The reliability and validity of the Chinese version of

JCQ had been previously proven [26]. There are 22 items included in JCQ which can be divided into 3 scales: job demands (5 questions), job control or job decision latitude (9 questions), and social support (8 questions). Every item was scored on a Likert scale from 1 (rarely or never) to 4 (constantly or always). Job demands, job control, and social support were separately calculated by adding up the scores for each item.

The authors evaluated stress using the demand-control ratio (D/C ratio), calculated in the following way:

$$\frac{(\text{the scores of demand})/(\text{the scores of control}) \times (\text{correction factor } (9/5))}{(2)} \quad (2)$$

A D/C ratio of >1 was considered as high stress; otherwise, it was considered as low stress. The social support dimension was divided into low and high groups according to the specific distribution median. Job stress was divided into 4 groups by combining the D/C ratio and social support groups: low stress and high support, low stress and low support, high stress and high support, and high stress and low support. According to the Demand, Control and Support (DCS) model, also developed by Karasek [25], the high stress and low support group is expected to experience the highest levels of stress while the low stress and high support group the lowest levels of stress. The other 2 groups are expected to experience moderate levels of stress.

Life events

The authors recorded major life events during the past 12 months that were self-reported by the participants. The list of these life events included divorces or separations, conflicts, deaths, serious illnesses, marriages and childbirths, which occurred in any member of their family. The participants were given a score of 0 for no such events, 1 for 1 such event, 2 for 2 such events, and so on.

Present health status

The authors requested the participants to self-report all information regarding their current illnesses which had been diagnosed by physicians. The list of current illnesses included respiratory diseases such as chronic bronchitis, asthma, emphysema, phthisis, chronic rhinitis, and non-respiratory (other) diseases such as hypertension, cardiovascular disease, chronic gastritis, rheumatoid arthritis, diabetes, gout, thyroid disorders, liver disease, and alcoholism.

Assessment of insomnia

The *Athens Insomnia Scale* (AIS), which is widely used for assessing insomnia in many countries [27,28], was employed as the insomnia assessment tool in this study. The scale consisted of 8 items, each of which was scored on a 4-point Likert scale from 0 (no problem at all) to 3 (a very serious problem), with the total score ranging 0–24. A score of ≥ 6 , with 6 being the widely accepted cut-off value for insomnia, classified the participant into the insomnia group; other participants were classified to the non-insomnia group.

Job categories

According to work content and workshops, all the participants were divided into the following 3 groups: front-line workers, maintenance and inspection workers, and other auxiliary workers. Front-line workers included the workers who engaged in iron-making, steel-making, hot steel rolling, and cold steel rolling. Maintenance and inspection workers were workers who mainly engaged in the monitoring and maintenance of steel-making instruments and equipment, and the testing of steel products. Other auxiliary workers included workers who engaged in steel deep processing, steel products logistics, and furnace material making.

Statistical analysis

Data were analyzed using SPSS 20.0 for Windows (IBM, Armonk, NY, USA). The socio-demographic characteris-

tics, living and behavioral habits, job characteristics, personal characteristics, and insomnia were described as percentage values of categorical variables. The comparison of the characteristics and percentage of insomnia across different job categories were analyzed using χ^2 tests. A binary logistic regression analysis was used to analyze the association between essential characteristics and insomnia across different job categories, and crude odd ratios (ORs) were calculated. Adjusted odds ratios (aORs) for insomnia and the 95% confidence intervals (95% CIs) of each factor were separately calculated, while other factors were adjusted. In this study, $p < 0.05$ was established as the significance level.

RESULTS

Among the 5834 participants, the groups of front-line workers, maintenance and inspection workers, and other auxiliary workers comprised 2848, 2299 and 687 participants, respectively. The comparison of essential characteristics across the groups representing different job categories are shown in Table 1. The distribution of sex, age, educational level, marital status, household per capita income, household per capita living area, body mass index (BMI), smoking status, alcohol consumption, tea drinking, physical activity, employment relationship, shift work, job stress, life events, and present illness were significantly different among the 3 job categories (alcohol drinking factors, $p = 0.001$; life events factors, $p = 0.015$; other factors, $p < 0.001$).

The prevalence of insomnia across the groups representing the 3 job categories with different essential characteristics is compared in Table 2. The prevalence of insomnia was 42.0% in the total steel workers, and was the highest among other auxiliary workers (47.9% vs. 42.3% for front-line workers, vs. 39.8% for maintenance and inspection workers, $p < 0.001$). The prevalence of insomnia among other auxiliary workers was higher than in other groups of steel workers representing different essential charac-

teristics. These essential characteristics included sex, age of 30–49 years and 40–49 years, a high level of education (high school, college/university and above), being married, household per capita income, household per capita living area of ≥ 20 m², a BMI group of 18.5–24.9, never smoking or smoking 1–20 cigarettes/day, never drinking alcohol, tea drinking, light or heavy physical activity, contract workers, a 3-shift/4-team work schedule, high job stress, and experiencing life events in the past 12 months ($p < 0.05$).

The associations were observed between each essential characteristic and insomnia using logistic regression analyses, as shown in Table 3. Compared to low stress and high support workers, low stress and low support workers (front-line workers: aOR = 1.50, 95% CI: 1.15–1.95; maintenance and inspection workers: aOR = 1.37, 95% CI: 1.02–1.84; other auxiliary workers: aOR = 2.46, 95% CI: 1.33–4.54), and high stress and low support workers (front-line workers: aOR = 2.28, 95% CI: 1.85–2.81; maintenance and inspection workers: aOR = 1.56, 95% CI: 1.23–1.98; other auxiliary workers: aOR = 2.38, 95% CI: 1.52–3.73) have a higher risk of insomnia among the 3 job categories.

Compared to the workers who had not experienced any major life events in the past 12 months, the workers who had experienced ≥ 2 such life events in the past 12 months had a higher risk of insomnia among the 3 job categories (front-line workers: aOR = 1.72, 95% CI: 1.40–2.11; maintenance and inspection workers: aOR = 1.30, 95% CI: 1.02–1.65; other auxiliary workers: aOR = 1.75, 95% CI: 1.08–2.83). In the front-line workers group, workers with an educational level of college/university and above (aOR = 1.39, 95% CI: 1.07–1.81), a 3-shift/4-team work schedule (aOR = 1.26, 95% CI: 1.05–1.52), and respiratory diseases (aOR = 1.48, 95% CI: 1.23–1.78) had a higher risk of insomnia. In the maintenance and inspection workers group, workers who had household per capita income < 1500 ¥/month (aOR = 1.29, 95% CI: 1.07–1.55) or drank alcohol daily had a higher risk of insomnia.

Table 1. Baseline characteristics of the participants by job category in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China

Variable	Participants (N = 5834) [n]				χ^2	p
	front-line workers (N = 2848)	maintenance and inspection workers (N = 2299)	other auxiliary workers (N = 687)	total		
Sex					40.931	<0.001
male	2668	2046	610	5324		
female	180	253	77	510		
Age					310.804	<0.001
<30 years	293	180	19	492		
30–39 years	1030	501	100	1631		
40–49 years	998	916	327	2241		
≥50 years	527	702	241	1470		
Educational level					211.652	<0.001
junior high school or primary	599	482	270	1351		
high school	1369	1322	338	3029		
college/university and above	880	495	79	1454		
Marital status					35.419	<0.001
unmarried	172	90	11	273		
married	2602	2126	661	5389		
other	74	83	15	172		
Household per capita income					23.214	<0.001
<1500 ¥/month	891	765	162	1818		
≥1500 ¥/month	1957	1534	525	4016		
Household per capita living area					17.560	<0.001
<20 m ²	738	702	218	1658		
≥20 m ²	2110	1597	469	4176		
BMI					40.311	<0.001
<18.5	24	20	11	55		
18.5–24.9	1150	887	339	2376		
25.0–29.9	1360	1188	279	2827		
≥30	314	204	58	576		
Smoking status					54.213	<0.001
never	1251	1067	274	2592		
ever	90	113	37	240		

Table 1. Baseline characteristics of the participants by job category in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834) [n]				χ^2	p
	front-line workers (N = 2848)	maintenance and inspection workers (N = 2299)	other auxiliary workers (N = 687)	total		
Smoking status – cont.						
1–20 cigarettes/day	1279	870	284	2433		
>20 cigarettes/day	228	249	92	569		
Alcohol drinking					23.358	0.001
never	1772	1413	395	3580		
ever	51	52	15	118		
<20 g/day	516	343	118	977		
≥20 g/day	509	491	159	1159		
Tea drinking					17.335	<0.001
yes	1665	1211	387	3263		
no	1183	1088	300	2571		
Physical activity					25.688	<0.001
light	152	144	29	325		
moderate	590	593	154	1337		
heavy	2106	1562	504	4172		
Employment relationship					45.835	<0.001
contract worker	2528	2016	664	5208		
other form	320	283	23	626		
Shift work					1268.333	<0.001
3 shifts/4 teams	2097	1066	265	3428		
other shift	43	51	186	280		
day shift	708	1182	236	2126		
Job stress					53.962	<0.001
low stress and high support	685	446	144	1275		
low stress and low support	377	345	71	793		
high stress and high support	821	581	236	1638		
high stress and low support	965	927	236	2128		
Life events					12.384	0.015
0	1806	1478	454	3738		
1	538	478	140	1156		
≥2	504	343	93	940		

Table 1. Baseline characteristics of the participants by job category in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834) [n]			total	χ^2	p
	front-line workers (N = 2848)	maintenance and inspection workers (N = 2299)	other auxiliary workers (N = 687)			
Present illness					54.836	<0.001
health	2027	1544	393	3964		
respiratory diseases	75	49	20	144		
other diseases	746	706	274	1726		

Table 2. Distribution of insomnia in the workers representing 3 job categories with different baseline characteristics in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China

Variable	Participants (N = 5834) [n]						total	χ^2	p
	front-line workers		maintenance and inspection workers		other auxiliary workers				
	total [n]	with insomnia [n (%)]	total [n]	with insomnia [n (%)]	total [n]	with insomnia [n (%)]			
Total	2848	1206 (42.3)	2299	914 (39.8)	687	329 (47.9)	5834	14.673	0.001
Sex									
male	2668	1137 (42.6)	2046	807 (39.4)	610	285 (46.7)	5324	11.461	0.003
female	180	69 (38.3)	253	107 (42.3)	77	44 (57.1)	510	7.925	0.019
Age									
<30 years	293	118 (40.3)	180	66 (36.7)	19	8 (42.1)	492	0.688	0.709
30–39 years	1030	430 (41.7)	501	182 (36.3)	100	47 (47.0)	1631	6.037	0.049
40–49 years	998	446 (44.7)	916	378 (41.3)	327	173 (52.9)	2241	13.247	0.001
≥50 years	527	212 (40.2)	702	288 (41.0)	241	101 (41.9)	1470	0.204	0.903
Educational level									
junior high school or primary	599	241 (40.2)	482	203 (42.1)	270	125 (46.3)	1351	2.806	0.246
high school	1369	583 (42.6)	1322	535 (40.5)	338	167 (49.4)	3029	8.833	0.012
college/university and above	880	382 (43.4)	495	176 (35.6)	79	37 (46.8)	1454	9.291	0.010
Marital status									
unmarried	172	74 (43.0)	90	36 (40.0)	11	4 (36.4)	273	0.359	0.836
married	2602	1098 (42.2)	2126	839 (39.5)	661	316 (47.8)	5389	14.741	0.001
other	74	34 (45.9)	83	39 (47.0)	15	9 (60.0)	172	1.018	0.601

Table 2. Distribution of insomnia in the workers representing 3 job categories with different baseline characteristics in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834) [n]						total	χ^2	p
	front-line workers		maintenance and inspection workers		other auxiliary workers				
	total [n]	with insomnia [n (%)]	total [n]	with insomnia [n (%)]	total [n]	with insomnia [n (%)]			
Household per capita income									
<1500 ¥/month	891	377 (42.3)	765	342 (44.7)	162	86 (53.1)	1818	6.547	0.038
≥1500 ¥/month	1957	829 (42.4)	1534	572 (37.3)	525	243 (46.3)	4016	16.300	<0.001
Household per capita living area									
<20 m ²	738	335 (45.4)	702	302 (43.0)	218	111 (50.9)	1658	4.232	0.121
≥20 m ²	2110	871 (41.3)	1597	612 (38.3)	469	218 (46.5)	4176	10.528	0.005
BMI									
<18.5	24	8 (33.3)	20	8 (40.0)	11	6 (54.5)	55	1.414	0.493
18.5–24.9	1150	504 (43.8)	887	361 (40.7)	339	169 (49.9)	2374	8.446	0.015
25.0–29.9	1360	558 (41.0)	1188	470 (39.6)	279	127 (45.5)	2259	3.351	0.187
≥30	314	136 (43.3)	204	75 (36.8)	58	27 (46.6)	576	2.915	0.233
Smoking status									
never	1251	527 (42.1)	1067	420 (39.4)	274	132 (48.2)	2592	7.215	0.027
ever	90	41 (45.6)	113	54 (47.8)	37	15 (40.5)	240	0.594	0.743
1–20 cigarettes/day	1279	525 (41.0)	870	329 (37.8)	284	134 (47.2)	2433	8.005	0.018
>20 cigarettes/day	228	113 (49.6)	249	111 (44.6)	92	48 (52.2)	569	2.025	0.363
Alcohol drinking									
never	1772	735 (41.5)	1413	520 (36.8)	395	192 (48.6)	3580	19.504	0.000
ever	51	26 (51.0)	52	21 (40.4)	15	6 (40.0)	118	1.336	0.513
<20 g/day	516	206 (39.9)	343	147 (42.9)	118	53 (44.9)	977	1.354	0.508
≥20 g/day	509	239 (47.0)	491	2226 (46.0)	159	78 (49.1)	1159	0.446	0.800
Tea drinking									
yes	1665	710 (42.6)	1211	476 (39.3)	387	180 (46.5)	3263	7.104	0.029
no	1183	496 (41.9)	1088	438 (40.3)	300	149 (49.7)	2571	8.574	0.014
Physical activity									
light	152	57 (37.5)	144	58 (40.3)	29	18 (62.1)	325	6.125	0.047
moderate	590	228 (38.6)	593	230 (38.8)	154	67 (43.5)	1337	1.314	0.518
heavy	2106	921 (43.7)	1562	626 (40.1)	504	244 (48.4)	4172	11.927	0.003
Employment relationship									
contract worker	2528	1081 (42.8)	2016	815 (40.4)	664	319 (48.0)	5208	11.959	0.003
other form	320	125 (39.1)	283	99 (35.0)	23	10 (43.5)	626	1.447	0.485

Table 2. Distribution of insomnia in the workers representing 3 job categories with different baseline characteristics in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834) [n]						total	χ^2	p
	front-line workers		maintenance and inspection workers		other auxiliary workers				
	total [n]	with insomnia [n (%)]	total [n]	with insomnia [n (%)]	total [n]	with insomnia [n (%)]			
Shift work									
3 shifts/4 teams	2097	917 (43.7)	1066	430 (40.3)	265	137 (51.7)	3428	11.581	0.003
other shift	43	17 (39.5)	51	27 (52.9)	186	87 (46.8)	280	1.684	0.431
day shift	708	272 (38.4)	1182	457 (38.7)	236	105 (44.5)	2126	3.096	0.213
Job stress									
low stress and high support	685	225 (32.8)	446	146 (32.7)	144	49 (34.0)	1275	0.088	0.957
low stress and low support	377	162 (43.0)	345	145 (42.0)	71	38 (53.5)	793	3.248	0.197
high stress and high support	821	301 (36.7)	581	209 (36.0)	236	116 (49.2)	1638	14.032	0.001
high stress and low support	965	518 (53.7)	927	414 (44.7)	236	126 (53.4)	2128	16.814	<0.001
Life events									
0	1806	701 (38.8)	1478	568 (38.4)	454	205 (45.2)	3738	7.133	0.028
1	538	241 (44.8)	478	192 (40.2)	140	70 (50.0)	1156	4.934	0.085
≥2	504	264 (52.4)	343	154 (44.9)	93	54 (58.1)	940	7.117	0.028
Present illness									
health	2027	800 (39.5)	1544	568 (36.8)	393	186 (43.7)	3964	14.725	0.001
respiratory diseases	75	40 (53.3)	49	27 (55.1)	20	13 (65.0)	144	0.877	0.645
other diseases	746	366 (49.1)	706	319 (45.2)	274	130 (47.4)	1726	2.195	0.334

DISCUSSION

As shown in this study, the prevalence of insomnia was 42.0% in the total steel workers in China. Compared with the prevalence reported in most previous works, the insomnia prevalence revealed in this study is much higher. The prevalence was reported range 11.9–37.75% among the general population, community residents, adults, and the elderly in China [6,7]. Meanwhile, it was also higher than 24% reported for U.S. workers [9], 32.9% for Korean workers [10], and 4.7% for male workers in Japan [29], but similar to 39.7% for gas transmission industry workers in Iran [30].

The steel workers in the other auxiliary workers group had the highest rate of insomnia (47.9%), while this rate was the lowest in the maintenance and inspection workers group (39.8%). The following potential reasons for this striking discrepancy could be considered and proven in future studies:

1. The work environment (occupational hazards, hazardous circumstances, etc.) and work organization form (working time, job stability, workload, etc.) are very different, because they take on different tasks.
2. Some personal characteristics, such as personality, psychosocial stress, way of live, behavioral habits, etc., should be taken into account.

Table 3. Logistic regression analysis of the factors associated with insomnia in 3 job categories in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China

Variable	Participants (N = 5834)											
	front-line workers (N = 2848)				maintenance and inspection workers (N = 2299)				other auxiliary workers (N = 687)			
	crude OR (95%CI)	P	adjusted OR (95%CI)	P	crude OR (95%CI)	P	adjusted OR (95%CI)	P	crude OR (95%CI)	P	adjusted OR (95%CI)	P
Sex												
male	0.62 (0.87-1.62)	0.002	1.12 (0.80-1.57)	0.522	0.73 (0.68-1.16)	0.015	0.76 (0.57-1.03)	0.078	1.33 (0.41-1.06)	0.210	0.77 (0.43-1.38)	0.375
female	1.00		1.00		1.00		1.00		1.00		1.00	
Age												
<30 years	1.00		1.00		1.00		1.00		1.00		1.00	
30-39 years	1.06 (0.82-1.38)	0.651	0.99 (0.72-1.36)	0.955	0.99 (0.69-1.40)	0.935	0.95 (0.64-1.40)	0.800	1.22 (0.45-3.29)	0.695	1.15 (0.37-3.56)	0.815
40-49 years	1.20 (0.92-1.56)	0.181	1.19 (0.85-1.68)	0.314	1.21 (0.87-1.69)	0.251	0.98 (0.65-1.47)	0.926	1.55 (0.61-3.94)	0.363	1.45 (0.48-4.40)	0.510
≥50 years	1.00 (0.75-1.34)	0.990	0.93 (0.64-1.35)	0.709	1.20 (0.86-1.69)	0.288	0.93 (0.61-1.40)	0.722	0.99 (0.39-2.56)	0.987	0.94 (0.31-2.90)	0.920
Educational level												
junior high school or primary	1.00		1.00		1.00		1.00		1.00		1.00	
high school	1.10 (0.91-1.34)	0.331	1.19 (0.96-1.48)	0.113	0.93 (0.76-1.15)	0.529	0.98 (0.78-1.21)	0.831	1.13 (0.82-1.56)	0.445	1.17 (0.82-1.67)	0.377
college/university and above	1.14 (0.92-1.41)	0.225	1.39 (1.07-1.81)	0.013	0.76 (0.59-0.98)	0.036	0.90 (0.67-1.21)	0.494	1.02 (0.62-1.69)	0.933	1.22 (0.67-2.23)	0.521
Marital status												
unmarried	1.00		1.00		1.00		1.00		1.00		1.00	
married	0.97 (0.71-1.32)	0.832	0.82 (0.56-1.20)	0.304	0.98 (0.64-1.50)	0.919	0.76 (0.46-1.24)	0.272	1.60 (0.47-5.53)	0.455	2.08 (0.51-8.56)	0.307
other	1.13 (0.65-1.95)	0.672	0.81 (0.44-1.48)	0.485	1.33 (0.73-2.43)	0.355	0.99 (0.52-1.92)	0.991	2.63 (0.53-13.07)	0.239	3.54 (0.59-21.38)	0.168

Table 3. Logistic regression analysis of the factors associated with insomnia in 3 job categories in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834)								
	front-line workers (N = 2848)		maintenance and inspection workers (N = 2299)		other auxiliary workers (N = 687)				
	crude OR (95%CI)	adjusted OR (95%CI)	P	crude OR (95%CI)	adjusted OR (95%CI)	P	crude OR (95%CI)	adjusted OR (95%CI)	P
Household per capita income									
<1500 ¥/month	1.00 (0.85–1.17)	0.94 (0.79–1.12)	0.494	1.36 (1.14–1.62)	1.29 (1.07–1.55)	0.001	1.31 (0.92–1.87)	1.34 (0.91–1.98)	0.139
≥1500 ¥/month	1.00	1.00		1.00	1.00		1.00	1.00	
Household per capita living area									
<20 m ²	1.18 (0.99–1.40)	1.19 (0.99–1.43)	0.056	1.22 (1.02–1.46)	1.12 (0.93–1.36)	0.034	1.19 (0.87–1.65)	1.19 (0.85–1.70)	0.309
≥20 m ²	1.00	1.00		1.00	1.00		1.00	1.00	
BMI									
<18.5	1.00	1.00		1.00	1.00		1.00	1.00	
18.5–24.9	1.56 (0.66–3.67)	1.84 (0.76–4.47)	0.179	1.03 (0.42–2.54)	0.84 (0.34–2.12)	0.950	0.83 (0.25–2.77)	0.84 (0.24–2.93)	0.780
25.0–29.9	1.39 (0.59–3.27)	1.63 (0.67–3.97)	0.282	0.98 (0.40–2.42)	0.81 (0.32–2.04)	0.968	0.70 (0.21–2.33)	0.67 (0.19–2.37)	0.536
≥30	1.53 (0.64–3.68)	1.60 (0.64–3.99)	0.312	0.87 (0.34–2.23)	0.64 (0.24–1.66)	0.872	0.73 (0.20–2.65)	0.65 (0.17–2.50)	0.647
Smoking status									
never	1.00	1.00		1.00	1.00		1.00	1.00	
ever	1.15 (0.75–1.77)	1.05 (0.67–1.66)	0.829	1.41 (0.96–2.10)	1.32 (0.87–1.99)	0.083	0.73 (0.37–1.48)	0.84 (0.39–1.79)	0.652
1–20 cigarettes/day	0.96 (0.82–1.12)	0.94 (0.79–1.12)	0.486	0.94 (0.78–1.13)	0.87 (0.71–1.07)	0.487	0.96 (0.69–1.34)	1.04 (0.70–1.53)	0.856
> 20 cigarettes/day	1.35 (1.02–1.79)	1.34 (0.99–1.82)	0.062	1.24 (0.94–1.64)	1.10 (0.81–1.48)	0.131	1.17 (0.73–1.88)	1.32 (0.78–2.24)	0.306

Alcohol drinking																		
never	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ever	1.47 (0.84-2.56)	0.117 (0.77-2.47)	1.38 (0.66-2.05)	0.285 (0.77-2.47)	0.599 (0.59-1.92)	1.06 (0.59-1.92)	0.838 (0.25-2.02)	0.71 (0.25-2.02)	0.515 (0.30-2.88)	0.93 (0.30-2.88)	0.905							
<20 g/day	0.94 (0.77-1.45)	0.527 (0.75-1.15)	1.29 (1.01-1.64)	0.523 (0.75-1.15)	0.038 (1.06-1.75)	1.36 (1.06-1.75)	0.016 (0.57-1.30)	0.86 (0.57-1.30)	0.481 (0.59-1.45)	0.93 (0.59-1.45)	0.735							
≥20 g/day	1.25 (1.02-1.52)	0.028 (0.99-1.52)	1.47 (1.19-1.80)	0.078 (0.99-1.52)	0.000 (1.16-1.82)	1.45 (1.16-1.82)	0.001 (0.70-1.47)	1.02 (0.70-1.47)	0.924 (0.72-1.65)	1.09 (0.72-1.65)	0.699							
Tea drinking																		
yes	0.72 (0.89-1.20)	0.000 (0.81-1.12)	0.67 (0.81-1.14)	0.568 (0.81-1.12)	0.000 (0.77-1.09)	0.92 (0.77-1.09)	0.318 (0.65-1.19)	0.99 (0.65-1.19)	0.908 (0.64-1.23)	0.89 (0.64-1.23)	0.488							
no	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
Physical activity																		
light	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
moderate	1.05 (0.73-1.52)	0.796 (0.70-1.49)	0.94 (0.65-1.36)	0.924 (0.70-1.49)	0.742 (0.65-1.39)	0.96 (0.65-1.39)	0.812 (0.21-1.06)	0.47 (0.21-1.06)	0.070 (0.20-1.13)	0.48 (0.20-1.13)	0.096							
heavy	1.30 (0.92-1.82)	0.134 (0.88-1.77)	0.98 (0.69-1.38)	0.224 (0.88-1.77)	0.890 (0.70-1.41)	0.99 (0.70-1.41)	0.967 (0.25-1.27)	0.56 (0.25-1.27)	0.142 (0.25-1.27)	0.56 (0.25-1.27)	0.166							
Employment form																		
contract worker	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
other form	0.75 (0.68-1.09)	0.000 (0.75-1.30)	0.68 (0.61-1.03)	0.921 (0.75-1.30)	0.000 (0.65-1.22)	0.89 (0.65-1.22)	0.483 (0.43-2.74)	0.93 (0.36-1.92)	0.313 (0.43-2.74)	1.09 (0.43-2.74)	0.855							
Shift work																		
3 shifts/4 teams	1.25 (1.05-1.48)	0.013 (1.05-1.52)	1.26 (0.91-1.27)	0.012 (1.05-1.52)	0.417 (0.96-1.36)	1.14 (0.96-1.36)	0.148 (0.93-1.95)	1.34 (0.94-1.90)	0.107 (0.93-1.95)	1.34 (0.93-1.95)	0.118							
other shift	1.05 (0.56-1.97)	0.884 (0.57-2.11)	1.10 (1.02-3.13)	0.780 (0.57-2.11)	0.043 (0.88-2.79)	1.57 (0.88-2.79)	0.127 (0.76-1.71)	1.10 (0.75-1.61)	0.640 (0.76-1.71)	1.14 (0.76-1.71)	0.535							
day shift	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
Job stress																		
low stress and high support	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
low stress and low support	1.54 (1.19-1.99)	0.001 (1.15-1.95)	1.49 (1.11-1.99)	0.003 (1.15-1.95)	0.007 (1.02-1.84)	1.37 (1.02-1.84)	0.038 (1.33-4.54)	2.23 (1.25-3.99)	0.007 (1.33-4.54)	2.46 (1.33-4.54)	0.004							

Table 3. Logistic regression analysis of the factors associated with insomnia in 3 job categories in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834)											
	front-line workers (N = 2848)				maintenance and inspection workers (N = 2299)				other auxiliary workers (N = 687)			
	crude OR (95%CI)	p	adjusted OR (95%CI)	p	crude OR (95%CI)	p	adjusted OR (95%CI)	p	crude OR (95%CI)	p	adjusted OR (95%CI)	p
Job stress – cont.												
high stress and high support	1.18 (0.96–1.47)	0.122	1.14 (0.92–1.42)	0.242	1.15 (0.89–1.50)	0.280	1.11 (0.85–1.45)	0.430	1.87 (1.22–2.88)	0.004	2.05 (1.30–3.23)	0.002
high stress and low support	2.37 (1.93–2.91)	0.000	2.28 (1.85–2.81)	0.000	1.66 (1.31–2.10)	0.000	1.56 (1.23–1.98)	0.000	2.22 (1.45–3.41)	0.000	2.38 (1.52–3.73)	0.000
Life events												
0	1.00		1.00		1.00		1.00		1.00		1.00	
1	1.28 (1.05–1.55)	0.013	1.26 (1.03–1.54)	0.024	1.08 (0.87–1.33)	0.498	1.07 (0.87–1.33)	0.514	1.22 (0.83–1.78)	0.315	1.16 (0.78–1.73)	0.464
≥2	1.73 (1.42–2.12)	0.000	1.72 (1.40–2.11)	0.000	1.31 (1.03–1.66)	0.028	1.30 (1.02–1.65)	0.035	1.68 (1.07–2.64)	0.024	1.75 (1.08–2.83)	0.023
Present illness												
health	1.00		1.00		1.00		1.00		1.00		1.00	
respiratory diseases	1.48 (1.25–1.75)	0.000	1.48 (1.23–1.78)	0.000	1.42 (1.18–1.70)	0.000	1.38 (1.14–1.68)	0.001	1.01 (0.74–1.37)	0.976	1.02 (0.72–1.44)	0.930
other diseases	1.75 (1.10–2.78)	0.017	1.56 (0.97–2.52)	0.066	2.11 (1.19–3.74)	0.011	2.03 (1.13–3.64)	0.017	2.07 (0.81–5.29)	0.130	2.15 (0.80–5.76)	0.127

Table 4. Logistic regression analysis of the factors associated with insomnia in steel workers in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China

Variable	Participants (N = 5834)			
	crude OR (95%CI)	p	adjusted OR (95%CI)	p
Sex				
male	0.95 (0.79–1.14)	0.579	0.87 (0.71–1.07)	0.196
female	1.00		1.00	
Age				
<30 years	1.00		1.00	
30–39 years	1.51 (0.86–1.30)	0.584	0.99 (0.78–1.26)	0.942
40–49 years	1.25 (1.03–1.53)	0.027	1.13 (0.88–1.45)	0.358
≥50 years	1.08 (0.88–1.33)	0.467	0.93 (0.71–1.21)	0.571
Educational level				
junior high school or primary	1.00		1.00	
high school	1.01 (0.89–1.15)	0.850	1.10 (0.96–1.26)	0.185
college/university and above	0.95 (0.82–1.11)	0.521	1.16 (0.97–1.39)	0.106
Marital status				
unmarried	1.00		1.00	
married	1.00 (0.78–1.28)	0.987	0.82 (0.61–1.09)	0.170
other	1.27 (0.87–1.87)	0.221	0.94 (0.62–1.43)	0.766
Household per capita income				
<1500 ¥/month	1.15 (1.03–1.28)	0.017	1.11 (0.98–1.25)	0.090
≥1500 ¥/month	1.00		1.00	
Household per capita living area				
<20 m ²	1.20 (1.07–1.34)	0.002	1.16 (1.03–1.31)	0.002
≥20 m ²	1.00		1.00	
BMI				
<18.5	1.00		1.00	
18.5–24.9	1.16 (0.67–1.99)	0.603	1.15 (0.66–2.01)	0.632
25.0–29.9	1.04 (0.60–1.79)	0.898	1.05 (0.60–1.84)	0.864
≥30	1.06 (0.60–1.86)	0.849	0.95 (0.54–1.71)	0.885
Smoking status				
never	1.00		1.00	
ever	1.19 (0.91–1.55)	0.207	1.12 (0.85–1.49)	0.414
1–20 cigarettes/day	0.96 (0.86–1.07)	0.463	0.93 (0.82–1.05)	0.245
>20 cigarettes/day	1.28 (1.07–1.54)	0.007	1.22 (0.99–1.48)	0.053

Table 4. Logistic regression analysis of the factors associated with insomnia in steel workers in the study on the prevalence of insomnia and risk factors among 5834 steel workers in Tangshan, China – cont.

Variable	Participants (N = 5834)			
	crude OR (95%CI)	p	adjusted OR (95%CI)	p
Alcohol drinking				
never	1.00		1.00	
ever	1.20 (0.83–1.74)	0.328	1.16 (0.79–1.70)	0.461
<20 g/day	1.05 (0.91–1.21)	0.521	1.07 (0.92–1.25)	0.355
≥20 g/day	1.30 (1.14–1.49)	0.000	1.29 (1.11–1.49)	0.001
Tea drinking				
yes	0.73 (0.89–1.10)	0.000	0.71 (0.59–0.86)	0.001
no	1.00		1.00	
Physical activity				
light	1.00		1.00	
moderate	0.93 (0.73–1.20)	0.584	0.92 (0.72–1.19)	0.539
heavy	1.09 (0.86–1.37)	0.482	1.06 (0.83–1.34)	0.657
Employment form				
contract worker	1.00		1.00	
other form	0.74 (0.68–0.96)	0.000	0.92 (0.76–1.12)	0.923
Shift work				
3 shifts/4 teams	1.18 (1.06–1.32)	0.003	1.21 (1.08–1.37)	0.001
other shift	1.36 (1.06–1.75)	0.016	1.17 (0.89–1.54)	0.265
day shift	1.00		1.00	
Job stress				
low stress and high support	1.00		1.00	
low stress and low support	1.57 (1.31–1.88)	0.000	1.53 (1.27–1.84)	0.001
high stress and high support	1.26 (1.08–1.47)	0.003	1.22 (1.04–1.43)	0.012
high stress and low support	2.01 (1.74–2.33)	0.000	1.96 (1.69–2.28)	0.000
Life events				
0	1.00		1.00	
1	1.18 (1.04–1.35)	0.014	1.18 (1.03–1.36)	0.016
≥2	1.55 (1.34–1.79)	0.000	1.55 (1.69–2.28)	0.000
Present illness				
health	1.00		1.00	
respiratory diseases	1.39 (1.24–1.56)	0.000	1.36 (1.20–1.54)	0.000
other diseases	1.94 (1.39–2.71)	0.000	1.79 (1.27–2.52)	0.001

The 3 groups of workers under analysis exhibit significant differences in terms of socio-demographic characteristics, living and behavioral habits, job characteristics, and personal characteristics considered in this study. Therefore, the authors analyzed the relationship between each variable and insomnia while adjusting for the other remaining variables using a multivariate logistic regression analysis. The results of the multivariate logistic regression analysis show that job stress and life events are common risk factors of insomnia for workers in all 3 job categories. The authors also obtained the same results in all the participants, when analyzing the influencing factors of insomnia (Table 4). Meanwhile, they also observed that alcohol consumption in the quantity of >20 g/day, shift work and current illness were associated with insomnia in all the participants.

Job stress is another risk factor of insomnia, which has been reported in many previous studies [18]. The results presented in this study found that steel workers with high stress and low social support were most likely to suffer from insomnia, and that steel workers struggling with stress had a higher risk of insomnia than steel workers without stress. This finding proves that high job stress is closely associated with an increased risk of insomnia in steel workers in China, just like in workers in other industries or companies. The authors recommend that, in order to ensure a better health condition of steel workers, they should undergo stress management training and team building activities to improve their stress-coping strategies and sleep quality.

The authors also found that the 3 groups of steel workers who had experienced more life events in the past 12 months were associated with a greater risk of insomnia. A study of stressful life events, insomnia, and suicide risks in Chinese adolescents has reached the same hypothesis that stressful life events are related to insomnia [31]. The same results have also been reported in studies that focused on U.S. Army soldiers prior to deployment [32], and on a community of older people in 4 cities in the Hebei Province,

China [33]. These results suggest that, when conducting occupational health management, more attention should be paid to the workers who experience major life events, and that necessary help and mental health promotion should be provided to them. However, the effects of positive and negative events associated with insomnia have not been analyzed, which could be the subject of future studies.

There were several limitations associated with this study. First, this was a cross-sectional study, so it was impossible to explore the causal effect between insomnia and numerous factors. Second, the participants came from a steel company located in a heavily industrialized city in northern China, so the results of this study are limited in terms of generalization to all Chinese steel workers. Third, work conditions and the workplace environment were not evaluated, which could exclude some confounding factors and influence others. Finally, the mental health of the participants should be thoroughly evaluated in order to analyze the insomnia status of steel workers in China.

CONCLUSIONS

This study suggests that the prevalence of insomnia was different in the steel workers groups representing 3 job categories, and that its rate was the highest among other auxiliary workers. Job stress and life events are the common risk factors of insomnia in the 3 job categories of steel workers under analysis. When preparing the appropriate strategies for the prevention and treatment of insomnia among steel workers, policy-makers are recommended to pay more attention to job stress. Furthermore, psychological counseling should be provided to workers who have experienced recent life events.

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