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ORIGINAL ARTICLE

Associations between coping strategies and insomnia: a longitudinal study of Japanese workers

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Abstract

Study Objectives: Coping with stress is important because stress disturbs sleep. However, only a few longitudinal studies have investigated the association between coping and insomnia. We examined whether individuals with insomnia symptoms used more maladaptive coping strategies than individuals without insomnia symptoms, and evaluated the association between insomnia symptoms and coping strategies.

Methods: In this prospective cohort study, Japanese workers were enrolled and observed over a 2-year period. During both years, self-administered questionnaires on coping and insomnia symptoms were administered. Coping was assessed using the Brief-Coping Orientation to Problems Experienced, and insomnia symptoms were examined using the Athens Insomnia Scale. Generalized estimating equation modeling identified the effects of coping strategies on insomnia severity.

Results: In total, 1358 of 1855 workers at baseline were followed up. Individuals with insomnia symptoms showed a higher use of maladaptive coping strategies and less use of humor and instrumental support than individuals without insomnia symptoms. Active coping, humor, emotional support, and instrumental support were negatively associated with insomnia severity. In contrast, venting, substance use, behavioral disengagement, and self-blame were positively associated with insomnia severity.

Conclusions: This study showed that individuals with insomnia symptoms use both adaptive and maladaptive coping strategies and are more likely to use maladaptive strategies than individuals without insomnia symptoms. In the future, interventions focused on educating people about adaptive coping strategies should be conducted to determine whether coping strategies may prevent insomnia symptoms.

Statement of Significance

We conducted this study to investigate the association between coping strategies and insomnia among Japanese workers. Although insomnia has been found to be associated with coping strategies, it is unclear whether these associations persist in the long term. We found that, across a 2-year observation period, active coping, emotional support, and humor alleviated insomnia-related insomnia severity scores, whereas maladaptive coping strategies, such as self-distraction, substance use, behavioral disengagement, venting, and self-blame, increased these scores. Further, individuals with insomnia symptoms tended to frequently use maladaptive coping strategies. Future studies must examine these associations in greater detail by using sleep diaries and adjusting for other disease conditions that may affect insomnia among Japanese workers.

Key words: AIS; coping; insomnia; longitudinal study; psychosocial factor; Workers

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Introduction

Coping, defined as cognitive and behavioral strategies consciously employed in response to the appraisal of stress, is regarded as a mediator of the association between stress and illness [1, 2]. In stressful situations, implementing an appropriate coping strategy can prevent stress-related diseases [2]. Adaptive coping strategies that involve humor, actively solving problems, and positively interpreting situations lead to faster resolution of privations and help maintain personal psychological health during stress, resulting in a greater sense of safety and security [3]. Contrastingly, maladaptive coping strategies lead to poorer psychological health and allow individuals to indulge in problematic situations and endure their feelings [4].

Coping strategies have been identified as one of the factors in sleep disturbances, including insomnia [5–8]. For example, a nationwide Japanese cross-sectional study reported that maladaptive coping strategies, such as "giving up on problem-solving" and "enduring problems patiently," were positively associated with insomnia symptoms [5]. A large prospective study has shown that maladaptive coping strategies, such as substance use, behavioral disengagement, and self-distraction, mediate the association between stress and insomnia [6]. These coping strategies accelerate insomnia and increase feelings of discomfort by causing insufficient sleep and prolonging insomnia symptoms [8]. In contrast, some studies have found that adaptive coping strategies are negatively associated with insomnia symptoms. For example, two nationwide Japanese cross-sectional studies have shown that adaptive coping strategies, such as "exercising" and "problem-solving," are inversely associated with insomnia symptoms [5, 8]. Taken together, these studies suggest that maladaptive coping strategies may be ineffective and adaptive coping strategies may be effective for insomnia symptoms.

Several studies have suggested that individuals with insomnia may rely more on maladaptive coping strategies [9, 10]. For example, a cross-sectional study among 330 Italian patients with hypertension reported that patients with insomnia symptoms use more coping strategies, such as positive reframing and less emotional support, while using behavioral disagreement than those without insomnia symptoms [9]. Similarly, a small prospective Canadian study reported that individuals with insomnia rely on maladaptive coping strategies and have higher levels of arousal at bedtime than individuals without insomnia [10]. However, a 1-year prospective study of 464 good sleepers in Canada revealed that not all coping strategies are associated with the incidence of insomnia [11].

Some researchers have investigated the mechanism of the association between coping and insomnia; Morin *et al.* suggested that maladaptive coping indirectly affects sleep efficiency by increasing the effects of stress [10]. However, in this study, coping strategies were measured only at baseline, and the within-person associations were not examined. Harvey *et al.* introduced the psycho-bio-behavioral model of vulnerability to insomnia [12]. This model states that stress reactivity is bidirectionally associated with neuroticism that leads to emotion-focused coping, which feeds sleep disruption and finally induces insomnia [12]. However, the extent to which more specific coping strategies relate to insomnia remains unknown.

Most studies on the association between coping strategies and insomnia are cross-sectional in nature. Few studies with longitudinal designs and large sample sizes have investigated the role of coping strategies in insomnia. Although many researchers have attempted to structure different coping strategies into broader concepts, such as adaptive and maladaptive or cognitive and behavioral coping strategies [13–15], the results are not consistent, and external validity has often been overlooked.

Based on the previous literature [5, 8, 16], we hypothesized that coping strategies are directly associated with insomnia symptoms adjusted for stress status. In other words, we hypothesized that coping strategies are one of the mediators between stressors and insomnia. In Japan, many workers do not sleep long enough, and workers' stress has been found to be associated with insomnia [17]. Thus, adaptive coping strategies, such as non-pharmacological measures for insomnia symptoms, are required to maintain the health of Japanese workers. Thus, we conducted this 2-year longitudinal study and included a large number of Japanese workers. Our first objective was to determine whether individuals with insomnia symptoms use more maladaptive coping strategies than individuals without insomnia symptoms. Our secondary objective was to evaluate whether adaptive and maladaptive coping strategies are associated with insomnia symptoms. Finally, our third objective was to examine whether insomnia symptoms at baseline are associated with coping strategies regarding insomnia severity.

Methods

Study design

This 2-year prospective cohort study included workers enrolled from six companies in Tokyo, Osaka, Shizuoka, and Kagoshima in Japan, encompassing the following industries: production, information technology, medicine-related, and precision equipment-related industries. We explained the research objectives to the participants before initiating the study and obtained consent from the companies' health and safety committees. Furthermore, participation in this study was voluntary. Self-administered questionnaires on coping and insomnia symptoms were administered between 2018 and 2020. The questionnaires were distributed to the workers through the representatives of each company, in succession. The workers were instructed to fill out the questionnaires, and completed questionnaires were collected through the representatives of the companies at a later date.

Measures

The self-administered questionnaire contained questions about age; sex; work format (day work or shift work); job type (clerical job, technical, and others); overtime hours (mean number of hours per month, excluding holidays); coping strategy (assessed by the Brief-Coping Orientation to Problems Experienced [Brief-COPE]); sleep-related questions, such as the Athens Insomnia Scale (AIS) and sleep duration; lifestyle habits, such as exercise habits, smoking status (response choices: yes, previously, or no), and alcohol consumption (response choices: daily, sometimes, or never); and the Perceived Stress Scale-10 (PSS-10) score. The same questions were asked in both surveys (2018 and 2020).

Coping: The Brief-Coping Orientation to Problems Experienced

The scale used in our study was the short version of the COPE. This scale comprises 28 items that measure 14 different coping

strategies by summing two items: (1) active coping, (2) planning, (3) positive reframing, (4) acceptance, (5) humor, (6) religion, (7) using emotional support, (8) using instrumental support, (9) self-distraction, (10) denial, (11) venting, (12) substance use, (13) behavioral disengagement, and (14) self-blame [18]. Subscales 1–8 were regarded as adaptive, whereas scales 9–14 were considered maladaptive [19]. The Japanese version of the Brief-COPE has been validated, with a Cronbach's α coefficient of 0.46–0.91 [20]. The Cronbach's α coefficient of each two-item subscale of the Brief-COPE in this study ranged from 0.52 to 0.87. The items were scored on a 4-point Likert scale and summed to calculate the total score for all four classifications. Scores for each subscale ranged from 2 to 8, with higher scores indicating more frequent use of the specified coping strategy.

Insomnia symptoms

The AIS is an eight-item, self-administered questionnaire designed for quantifying sleep difficulty and is based on the tenth revision of the International Statistical Classification of Diseases and Related Health Problems criteria [21]. The Japanese version of the AIS has been validated (with a Cronbach's α coefficient of 0.88) [22], and the Cronbach's α coefficient was 0.85 in this study. The first five items assess sleep symptoms, including difficulty with sleep induction, awakening during the night, early morning awakening, total sleep time, and overall sleep quality. The last three items assess the daytime consequences of insomnia (problems with the sense of well-being, functioning, and sleepiness during the day). Each item is rated from 0 (no problem at all) to 3 (very serious problem), and the total AIS score ranges from 0 to 24. Higher scores indicate worse insomnia severity. The respondents were requested to provide a "positive" rating if they had experienced sleep difficulties at least three times a week during the last month. In the AIS, the cutoff score was set at six for those who were suspected to have insomnia symptoms; this score was based on the sensitivity and specificity derived by comparison with the diagnosis of "nonorganic insomnia" based on the tenth revision of the International Statistical Classification of Diseases and Related Health Problems determined through medical interviews [22, 23].

Other covariates

For stress assessment, we used the PSS-10 [24]. The PSS-10 comprises 10 statements regarding subjective feelings related to everyday problems, personal events and behaviors induced by them, and ways of coping with these issues in the previous month [24]. The Japanese version of the PSS-10 has been validated, with a Cronbach's α coefficient of 0.87 [25]. The Cronbach's α coefficient of the PSS-10 in this study was 0.84. Each item on the PSS-10 ranges from 0 (never) to 4 (very often) and is scored on a 5-point Likert scale. The total scores range from 0 to 40, with a higher score indicating higher levels of perceived stress [24].

Data analysis

First, participants' characteristics and descriptive information at baseline were reported and analyzed using the chi-squared test (nominal scale), *t*-test (continuous variables), or one-way analysis of variance (ordinal scale). Post hoc tests were conducted using Bonferroni analysis. Second, we compared coping strategies by insomnia symptoms at baseline using analysis of covariance. Third, we used generalized estimating equation-based models (odds ratios with 95% confidence intervals [CIs]), allowing us to account for within-person correlations [26]. This method is useful for analyzing repeated longitudinal data [26]. All measures for the dependent variable and all covariates were repeated measures, except for several time-invariant variables (e.g. sex, company). In this analysis, the dependent variable was the AIS score, and the covariates measured were age, sex, job type, shift work status, overtime hours/month, actual rest days/month, alcohol consumption, smoking status, exercise habits, sleep duration, and the individual stress score [27–29]. Sensitivity analyses were performed by repeating the analyses stratified by insomnia symptoms at baseline. In these analyses, we further added the insomnia symptoms at follow-up as the dependent variable. To account for missing values for 1352 participants, multiple imputation was performed using the mice package to produce 20 imputed datasets. Binary variables were imputed using logistic regression, and ordinal variables were imputed using proportional odds logistic regression. Each variable was used as a response with the other variables as explanatory variables. Based on the findings of a previous study, we calculated the effect size as the effect of coping on insomnia symptoms [6]. With an effect size of 0.32, power set at 80%, and an alpha of 0.05, the minimum required sample size for this study was 1064. We used Stata version 15.1 (StataCorp, College Station, TX) for all analyses.

Ethical considerations

This study was conducted in accordance with the tenets of the Personal Information Protection Act enforced in Japan and Ethical Guidelines for Epidemiological Studies jointly announced by the Ministry of Health, Labour and Welfare and Ministry of Education, Culture, Sports, Science, and Technology of Japan. All workers provided written informed consent to participate in this study. This study was approved by the Ethics Committee of the Nihon University School of Medicine (No 29-12-0).

Results

Participants

Figure 1 presents a flowchart of the selection criteria for the study participants. At baseline (May to August 2018), 1946 of the 2137 workers who were employed at these companies responded to the survey. We excluded participants with missing data on sex, age, and AIS (N = 89). Thus, 1855 workers were included in this study at baseline, of whom 1363 responded to the follow-up survey (September to November 2020). Twenty-four workers at baseline retired during this period, and 464 workers quit their jobs at these companies. We also excluded five workers at follow-up because their AIS data were missing. Thus, the retention rate from 2018 to 2020 was 73.2%.

Descriptive statistics

This study used a two-wave panel dataset and analyzed the data of 1358 participants, of whom 1034 were males (76.1%) and 324

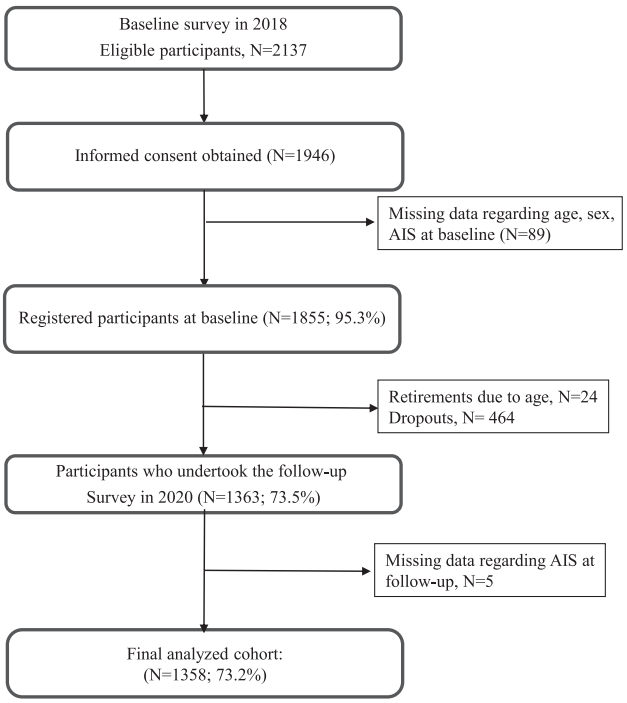

Figure 1. Participant selection flowchart. AIS, Athens Insomnia Scale.

were females (23.9%). The participants' descriptive statistics are detailed in Table 1. The overall average age was 41.2 ± 11.2 years. Most of the participants had a regular (87.9%) employment status, were not involved in management (84.6%), and were non-shift workers (55.1%). AIS score (T = –51.6, p < .001), job category (chi-squared = 5.2, p = .006), overtime hours/month (F = 3.8, p = .010), number of days off/month (F = 5.7, p < .001), shift work (F = 8.4, p < .001), sleep duration (F = 21.3, p < .001), PSS-10 score (T = –17.0, p < .001), and physical activity (chi-squared = 26.2, p < .001) were significantly different between those with and without insomnia symptoms. Post hoc Bonferroni analysis was performed to determine the significant differences between ordinal variables. Regarding overtime work hours/months, the significant categories were <45 h versus unknown (p = .014) and 45–79 h versus unknown (p = .005). Regarding the number of days off/month, the significant groups were 5–8 days versus unknown (p < .001) and 9–12 days versus unknown (p = .030). Regarding midnight shifts, the significant group was no versus yes. Among the sleep duration categories, <5 h/day had significant differences compared with all other groups, and ≥5 h/day or <6 h/day had significant differences compared with ≥7 h/day or <8 h/day and unknown.

Coping strategies

After controlling for covariates, participants with insomnia symptoms reported a lower use of adaptive coping strategies, such as humor (F = 4.15, p = .042) and use of instrumental support (F = 8.36, p = .004), than participants without insomnia. Individuals with insomnia symptoms showed a higher use of maladaptive coping strategies, such as self-distraction (F = 14.42, p < .001), denial (F = 14.18, p < .001), venting (F = 5.53, p = .019), substance use (F = 102.8, p < .001), behavioral disengagement (F = 97.54, p < .001), and self-blame (F = 283.63, p < .001), than participants without insomnia (Table 2). Furthermore, individuals with insomnia symptoms tended to rely more on religion (F = 28.91, p < .001) than individuals without insomnia symptoms (Table 2).

Association between coping strategies and insomnia severity among all participants

Table 3 shows the results of a series of models used to investigate the association between AIS scores and coping strategies among all participants. We examined the AIS scores as a continuous outcome for each coping strategy after adjusting for covariates using the generalized estimating equation models. Active coping (b = –0.14 [95% CI, –0.26 to –0.02], p = .018), humor (b = –0.14 [95% CI, –0.24 to –0.04], p = .007), use of emotional support (b = –0.18 [95% CI, –0.29 to –0.07], p = .002), and use of instrumental support (b = –0.13 [95% CI, –0.24 to –0.03], p = .015) were negatively associated with insomnia severity. Contrastingly, venting (b = 0.15 [95% CI, 0.05 to 0.25], p = .003), substance use (b = 0.33 [95% CI, 0.25 to 0.42], p < .001), behavioral disengagement (b = 0.19 [95% CI, 0.08 to 0.30], p = .001), and self-blame (b = 0.48 [95% CI, 0.39 to 0.57], p < .001) were positively associated with insomnia severity.

Association between coping strategies and insomnia severity among individuals with no insomnia symptoms at baseline

Of the 767 participants without insomnia symptoms at baseline, 70.9% did not have insomnia symptoms over the 2-year period, while 29.1% (n = 223) developed insomnia symptoms. Table 4 shows the results of a series of models used to investigate the association between AIS scores and coping strategies among individuals without symptoms at baseline. Active coping (b = –0.22 [95% CI, –0.35 to –0.08], p = 0.001), humor (b = –0.11 [95% CI, –0.22 to –0.00], p = 0.045), and use of emotional support (b = –0.20 [95% CI, –0.33 to –0.07], p = 0.002) were negatively associated with insomnia severity. In contrast, venting (b = 0.13 [95% CI, 0.02 to 0.25], p = 0.021), substance use (b = 0.36 [95% CI, 0.26 to 0.46], p < 0.001), behavioral disengagement (b = 0.18 [95% CI, 0.05 to 0.30], p = 0.006), and self-blame (b = 0.51 [95% CI, 0.40 to 0.61], p < 0.001) were positively associated with insomnia severity. The dependent variables for insomnia symptoms at follow-up showed the same trend as the above-mentioned results. Humor and use of emotional support were negatively associated with insomnia symptoms. However, substance use, behavioral disengagement, and self-blame were positively associated with insomnia symptoms. Active coping and venting were not associated with insomnia symptoms in this population (Supplementary Table S1).

Association between coping strategies and insomnia among individuals with insomnia symptoms at baseline

Of the 591 individuals with insomnia symptoms at baseline, 29.9% (n = 177) had ameliorated insomnia symptoms. Table 5 shows the results of a series of models used to investigate the association between AIS scores and coping strategies among individuals with insomnia symptoms at baseline. Positive reframing (b = –0.16 [95% CI, –0.30 to –0.01], p = .031), humor (b = –0.17 [95% CI, –0.29 to –0.05], p = .007), use of emotional support (b = –0.17

Table 1. Baseline characteristics of the study population

	Overall	No insomnia	Insomnia		
	(*n* = 1358)	(*n* = 767)	(*n* = 591)	t-Value/chi-square value/F-statistic	*P*
AIS score	5.3 ± 3.9	2.5 ± 1.7	8.9 ± 2.8	−51.6	<.001
Age (years)	41.2 ± 11.2	40.7 ± 11.6	41.7 ± 10.7	−1.8	.065
Male (%)	76.1	76.0	76.3	0.6	.421
Employment status					
Regular	87.9	86.8	89.3	1.37	.254
Non-regular	11.6	12.5	10.3		
Unknown	0.5	0.7	0.3		
Job category					
Management	14.8	17.3	11.5	5.2	.006
Nonmanagement	84.6	81.9	88.2		
Unknown	0.6	0.8	0.3		
Overtime hours/month					
<45 h	86.1	85.8	86.5	3.8	.010
≥45 h/day to <80 h	9.7	8.7	11.0		
≥80 h/	0.7	0.7	0.9		
Unknown	3.5	4.8	1.7		
Number of days off/month					
≤4 days	13.6	14.5	12.5	5.7	<.001
5–8 days	24.8	21.0	29.8		
9–12 days	50.2	51.5	48.6		
≥13 days	8.5	8.9	8.0		
Unknown	2.9	4.2	1.2		
Midnight shift work (22:00–5:00)					
No	55.1	59.2	49.8	8.4	<0.001
Yes	42.1	37.0	48.6		
Unknown	2.9	3.8	1.7		
Sleep duration					
<5 h/day	13.7	6.7	22.8	21.3	<0.001
≥5 h/day or < 6 h/day	27.6	26.5	29.1		
≥6 h/day or < 7 h/day	47.4	51.6	42.0		
≥7 h/day or < 8 h/day	6.4	8.3	3.9		
≥8 h/day	2.7	3.4	1.7		
Unknown	2.2	3.5	0.5		
PSS10 score	18.4 ± 4.9	16.6 ± 4.0	20.8 ± 4.9	−17.0	<.001
Current smoking (%)	30.9	32.0	29.4	1.6	.204
Alcohol use (≥5 days/week)	35.0	35.4	34.5	1.6	.204
Habitual physical activity (>1 h/week)	18.9	22.6	14.3	26.2	<.001

t-Values, chi-squared values, F-statistics, and P-values were calculated using t-tests, χ^2 tests, or an analysis of variance.
AIS, Athens Insomnia Scale; PSS-10 Perceived Stress Scale-10.

[95% CI, −0.30 to −0.03], $p = .020$), and use of instrumental support ($b = -0.25$ [95% CI, −0.38 to −0.12], $p < .001$) were negatively associated with insomnia severity. In contrast, denial ($b = 0.17$ [95% CI, 0.02 to 0.32], $p = .027$), venting ($b = 0.22$ [95% CI, 0.10 to 0.34], $p < .001$), substance use ($b = 0.26$ [95% CI, 0.16 to 0.37], $p < .001$), behavioral disengagement ($b = 0.17$ [95% CI, 0.04 to 0.30], $p = .010$), and self-blame ($b = 0.58$ [95% CI, 0.47 to 0.69], $p < .001$) were positively associated with insomnia severity. The dependent variables for insomnia symptoms at follow-up showed almost similar trends as the abovementioned results. Humor and use of emotional support were negatively associated with insomnia symptoms, whereas denial, venting, substance use, behavioral disengagement, and self-blame were positively associated with insomnia symptoms. Positive reframing was not associated with insomnia symptoms in this population (Supplementary Table S2).

Discussion

Our hypotheses that adaptive coping strategies are protective factors whereas maladaptive coping strategies are risk factors for insomnia symptoms were partially supported by our findings. Previous studies have revealed that maladaptive coping strategies, such as behavioral disengagement, substance use, and self-distraction, characterize those assessed as being vulnerable to insomnia [6, 30]. However, our study revealed that some coping strategies were prospectively associated with insomnia severity. The main findings were as follows: (1) Individuals with insomnia symptoms tended to adopt maladaptive coping strategies. (2) Maladaptive coping strategies, such as venting, substance use, behavioral disengagement, and self-blame, were positively associated with insomnia severity. (3) Active coping, humor, and use of emotional support were negatively associated with insomnia severity. (4) For individuals with insomnia symptoms, positive reframing and use of instrumental support were negatively associated with insomnia severity.

This study showed that active coping, use of emotional support, and humor were negatively associated with insomnia severity and symptoms. These strategies may play an important role in insomnia. Our results suggest that individuals whose insomnia symptoms begin to remit may be better able to employ

Table 2. Differences in coping strategies by insomnia symptoms at baseline

		Insomnia symptoms	No insomnia symptoms				
		N = 591	N = 767	F-statistic not controlling for covariates (ANOVA)	P	F-statistic controlling for covariates (ANCOVA)	P
		Average ± SD	Average ± SD				
Brief-COPE sub-scales							
Adaptive coping	Active coping	5.1 ± 1.4	5.4 ± 1.4	9.12	.003	0.84	.358
	Planning	5.0 ± 1.6	5.3 ± 1.6	20.72	<.001	2.29	.131
	Positive reframing	4.4 ± 1.5	4.6 ± 1.5	7.46	.006	1.06	.304
	Acceptance	5.4 ± 1.5	5.5 ± 1.6	2.12	.146	0.75	.387
	Humor	3.7 ± 1.5	3.9 ± 1.6	15.52	<.001	4.15	.042
	Religion	2.8 ± 1.2	2.6 ± 1.1	42.52	<.001	28.91	<.001
	Use of emotional support	4.1 ± 1.6	4.1 ± 1.6	2.22	.136	0.98	.323
	Use of instrumental support	4.5 ± 1.7	4.8 ± 1.7	14.42	<.001	8.36	.004
Maladaptive coping	Self-distraction	4.8 ± 1.5	4.6 ± 1.6	8.33	.004	14.42	<.001
	Denial	2.8 ± 1.2	2.6 ± 1.1	19.23	<.001	14.18	<.001
	Venting	4.2 ± 1.5	4.1 ± 1.5	0.66	.417	5.53	.019
	Substance use	3.7 ± 2.0	3.1 ± 1.7	38.58	<.001	102.8	<.001
	Behavioral disengagement	3.9 ± 1.5	3.4 ± 1.4	114.42	<.001	97.54	<.001
	Self-blame	4.7 ± 1.8	3.9 ± 1.5	259.6	<.001	283.63	<.001

The covariates included age, company, job type, employment status, shift work status, overtime (hours/month), actual rest (days/month), alcohol consumption, smoking status, exercise habits, sleep duration, and individual stress score.

Table 3. Estimated association between the Athens Insomnia Scale (AIS) scores and coping strategies among all participants

		Crude				Adjusted			
Brief-COPE		B	95% CI	t-Value	P	B	95% CI	t-Value	P
Adaptive coping	Active coping	−0.19	(−0.31 to −0.07)	−3.14	.002	−0.14	(−0.26 to −0.02)	−2.37	.018
	Planning	−0.05	(−0.18 to 0.07)	−0.86	.391	−0.03	(−0.15 to 0.09)	−0.54	.586
	Positive reframing	−0.10	(−0.22 to −0.02)	−1.69	.092	−0.11	(−0.23 to 0.00)	−1.93	.054
	Acceptance	−0.04	(−0.15 to 0.07)	−0.78	.434	−0.03	(−0.14 to 0.07)	−0.61	.542
	Humor	−0.17	(−0.28 to −0.07)	−3.35	.001	−0.14	(−0.24 to −0.04)	−2.71	.007
	Religion	0.08	(−0.05 to 0.21)	1.21	.227	0.06	(−0.07 to 0.19)	0.92	.357
	Use of emotional support	−0.16	(−0.27 to −0.05)	−2.75	.006	−0.18	(−0.29 to −0.07)	−3.09	.002
	Use of instrumental support	−0.12	(−0.14 to 0.06)	−2.2	.028	−0.13	(−0.24 to −0.03)	−2.43	.015
Maladaptive coping	Self-distraction	−0.04	(−0.07 to 0.12)	−0.86	.392	−0.06	(−0.16 to 0.03)	−1.31	.189
	Denial	0.12	(−0.02 to 0.25)	1.7	.089	0.09	(−0.04 to 0.21)	1.30	.195
	Venting	0.15	(0.05 to 0.26)	2.81	.005	0.15	(0.05 to 0.25)	2.96	.003
	Substance use	0.23	(0.14 to 0.31)	5.46	<.001	0.33	(0.25 to 0.42)	7.34	<.001
	Behavioral disengagement	0.23	(0.12 to 0.31)	4.14	<.001	0.19	(0.08 to 0.30)	3.45	.001
	Self-blame	0.49	(0.40 to 0.59)	10.25	<.001	0.48	(0.39 to 0.57)	10.23	<.001

The generalized estimating equation models examining the AIS scores for each coping strategy after adjusting for covariates.
The covariates included age, company, job type, employment status, shift work status, overtime (hours/month), actual rest (days/month), alcohol consumption, smoking status, exercise habits, sleep duration, and individual stress score.

adaptive coping strategies. For example, individuals without insomnia can use active coping to generate positive emotions and behaviors, which may help maintain their health [31]. Thus, active coping may be useful in individuals without insomnia symptoms. Our previous cross-sectional study showed that "sharing worries and concerns with family and friends" has a positive association on nightmares and daytime malfunction due to sleep deprivation, as this coping strategy allows people to reveal their emotions externally [5]. Brosschot *et al.* conceptualized the perseverative cognition model [32], which includes thoughts about feared future events (worry) and those about distressing negative feelings (rumination). This model explains that stressful thoughts activate the body's stress response in the same way as stressors in the physical environment, and prolong hypothalamic–adrenal axis stress [32]. Applying this model, thought processes, such as worry and rumination, have been found to be associated with sleep disturbance. A meta-analysis has revealed significant associations between higher perseverative cognition and poorer sleep quality, shorter sleep duration, and insomnia symptoms [33].

Chu *et al.* also reported that those who have more severe insomnia symptoms desire less emotional support in response to social exclusion [34]. Insomnia can reduce their ability to use effective interpersonal skills and form meaningful connections

Table 4. Estimated association between the Athens Insomnia Scale (AIS) scores and coping strategies among individuals without insomnia symptoms at baseline

		Crude				Adjusted			
Brief-COPE		B	95% CI	*t*-Value	P	B	95% CI	*t*-Value	P
Adaptive coping	Active coping	−0.26	(−0.40 to −0.13)	−3.79	<.001	−0.22	(−0.35 to −0.08)	−3.19	.001
	Planning	0.00	(−0.14 to 0.14)	0.00	.996	0.03	(−0.11 to 0.16)	0.40	.692
	Positive reframing	−0.11	(−0.24 to 0.03)	−1.56	.119	−0.11	(−0.24 to 0.02)	−1.67	.095
	Acceptance	0.00	(−0.13 to 0.12)	−0.07	.947	0.00	(−0.12 to 0.12)	−0.02	.986
	Humor	−0.16	(−0.27 to −0.05)	−2.83	.005	−0.11	(−0.22 to 0.00)	−2.01	.045
	Religion	0.04	(−0.11 to 0.18)	0.49	.627	0.00	(−0.15 to 0.14)	−0.04	.968
	Use of emotional support	−0.20	(−0.33 to −0.07)	−3.03	.002	−0.20	(−0.33 to −0.07)	−3.05	.002
	Use of instrumental support	−0.05	(−0.17 to 0.07)	−0.82	.411	−0.06	(−0.19 to 0.06)	−1.05	.296
Maladaptive coping	Self-distraction	0.02	(−0.09 to 0.13)	0.40	.693	0.00	(−0.11 to 0.11)	0.06	.954
	Denial	0.16	(0.00 to 0.31)	2.01	.044	0.12	(−0.03 to 0.27)	1.54	.124
	Venting	0.14	(0.02 to 0.25)	2.32	.021	0.13	(0.02 to 0.25)	2.31	.021
	Substance use	0.23	(0.14 to 0.31)	5.05	<.001	0.36	(0.26 to 0.46)	6.90	<.001
	Behavioral disengagement	0.21	(0.09 to 0.34)	3.30	.001	0.18	(0.05 to 0.30)	2.73	.006
	Self-blame	0.52	(0.41 to 0.62)	9.59	<.001	0.51	(0.40 to 0.61)	9.65	<.001

The generalized estimating equation models examining the AIS scores for each coping strategy after adjusting for covariates.
The covariates included age, company, job type, employment status, shift work status, overtime (hours/month), actual rest (days/month), alcohol consumption, smoking status, exercise habits, sleep duration, and individual stress score.

Table 5. Estimated association between the Athens Insomnia Scale (AIS) scores and coping strategies among individuals with insomnia symptoms at baseline

		Crude				Adjusted			
Brief-COPE		B	95% CI	*t*-Value	P	B	95% CI	*t*-Value	P
Adaptive coping	Active coping	−0.11	(−0.26 to 0.03)	−1.53	.126	−0.06	(−0.21 to 0.08)	−0.83	.405
	Planning	−0.04	(−0.19 to 0.12)	−0.45	.650	−0.01	(−0.15 to 0.14)	−0.07	.944
	Positive reframing	−0.13	(−0.27 to 0.02)	−1.73	.083	−0.16	(−0.30 to −0.01)	−2.15	.031
	Acceptance	−0.09	(−0.22 to 0.04)	−1.35	.178	−0.07	(−0.20 to 0.06)	−1.07	.284
	Humor	−0.20	(−0.32 to −0.07)	−3.15	.002	−0.17	(−0.29 to −0.05)	−2.71	.007
	Religion	0.16	(0.01 to 0.32)	2.04	.042	0.14	(−0.01 to 0.30)	1.84	.065
	Use of emotional support	−0.14	(−0.27 to 0.00)	−1.93	.054	−0.17	(−0.30 to −0.03)	−2.33	.020
	Use of instrumental support	−0.22	(−0.35 to −0.09)	−3.30	.001	−0.25	(−0.38 to −0.12)	−3.81	<.001
Maladaptive coping	Self–distraction	−0.08	(−0.20 to 0.04)	−1.32	.186	−0.11	(−0.23 to 0.00)	−1.89	.059
	Denial	0.19	(0.04 to 0.35)	2.48	.013	0.17	(0.02 to 0.32)	2.21	.027
	Venting	0.22	(0.10 to 0.34)	3.58	<.001	0.22	(0.10 to 0.34)	3.54	<.001
	Substance use	0.16	(0.07 to 0.25)	3.41	.001	0.26	(0.16 to 0.37)	4.96	<.001
	Behavioral disengagement	0.22	(0.09 to 0.35)	3.32	.001	0.17	(0.04 to 0.30)	2.59	.010
	Self-blame	0.64	(0.53 to 0.74)	11.70	<.001	0.58	(0.47 to 0.69)	10.75	<.001

The generalized estimating equation models were used to examine the risk of insomnia for each coping strategy after adjusting for covariates. The covariates included age, company, job type, employment status, shift work status, overworking (hours/month), actual rest (days/month), alcohol consumption, smoking status, exercise habits, sleep duration, and individual stress score.

[34]. Therefore, individuals with insomnia symptoms may find no value in social support and may have a reduced desire to seek social connections. Previous studies have shown the usefulness of interventions that encourage emotional support in coping with patients' distress [35, 36]. Thus, it is likely that enhancing the likelihood of receiving emotional support reduces stress and helps individuals with insomnia symptoms who are already experiencing inevitable stress deal with the stress more helpfully. Interestingly, our study revealed that humor might be an adaptive coping strategy for insomnia symptoms. Similarly, a small cross-sectional study has shown that coping with humor is negatively associated with sleep disturbance [37]. Thus, these coping strategies may have the potential to improve insomnia symptoms among workers.

The sole use of positive reframing and instrumental support for insomnia symptoms were negatively associated with insomnia scores. This suggests that different coping strategies may be appropriate for different conditions. Previous cross-sectional studies have shown that individuals with insomnia symptoms reported less use of positive reframing [9, 38]. However, we found that positive reframing did not show a significant difference, after adjusting for covariates, between those with and without insomnia symptoms. This contradiction may be due to differences in the study design. For individuals with insomnia symptoms, it may be more supportive to adopt positive reframing and to receive instrumental support to improve insomnia rather than to solve the problem on their own. Further studies are required to investigate more effective coping strategies according to sleep status.

In line with previous studies [6, 39–42], maladaptive coping strategies, such as substance use, behavioral disengagement, venting, and self-blame, were positively associated with

insomnia severity and symptoms in this study. Most studies support the association between maladaptive coping strategies and poor physical and mental health outcomes [4]. Substance use is consistently cited as a major maladaptive coping strategy in most studies; substance use, including drugs and alcohol, leads to insomnia symptoms [39, 40]. Some cross-sectional studies have reported that self-blame is associated with insomnia severity and poor sleep quality [4, 41]. A longitudinal study similar to ours suggested that maladaptive coping strategies, such as substance use and behavioral disengagement, are the mechanisms by which stress exposure leads to insomnia [6]. These findings suggest that workers engaging maladaptive coping strategies are more likely to have higher levels of stress, which may then lead to insomnia over time. Contrastingly, studies on the effects of self-distraction and denial have been less unequivocal.

Previous studies have revealed that individuals with insomnia symptoms are more likely to choose maladaptive coping strategies [9], whereas good sleepers tend to use adaptive coping strategies [10], consistent with our findings. The mechanism of the causal relation between coping and insomnia has not been explained clearly; however, researchers have suggested the following potential mechanisms. First, individuals with insomnia symptoms exhibit more signs of neuroticism, internalization, and perfectionism [43]. A meta-analysis has shown that personality is associated with coping strategies, and neuroticism is associated with more maladaptive coping strategies [44], that is, neuroticism tends to increase stress reactivity, which leads to maladaptive coping that disrupts sleep [12]. Second, sleep deprivation was associated with enhanced responsiveness to negative stimuli, as well as imposing interactivity of emotional imbalances and stimulating joy [45]. It was also shown to be associated with amplified reward-related responses. Thus, insomnia may increase the reactivity of the entire midbrain limbic reward brain network, facilitating biased coping strategies. Third, according to the polyvagal theory, vagal suppression is associated with stress, coping, and sleep [46]. Vagal suppression can be protective because it promotes communication, social interaction, and coping while experiencing stress, rather than the fighting and escape behaviors promoted by the sympathetic nervous system [47]. Vagal tone may underlie the preparation to respond to stress, and vagal suppression reflects the ability for rapid cardiovascular response and recovery rather than hyperarousal [47]. Thus, individuals with high vagal suppression may be preventing insomnia symptoms by applying more contextual coping strategies.

There are several limitations that need to be discussed. First, we could not obtain all the information about physical and mental disorders that may have influenced insomnia. Noncommunicable diseases, such as diabetes and coronary heart disease, are associated with insomnia [48]. Mental disorders, such as depression or anxiety, also influence insomnia. Future studies are required to assess the history of participants who were treated for physical or mental disorders. Second, the survey data were obtained using self-administered questionnaires, which may lead to reporting bias; thus, insomnia was not diagnosed clinically. The prevalence of insomnia according to self-assessments was higher than that reported after clinical diagnosis based on the Diagnostic and Statistical Manual of Mental Disorders criteria [49]. Moreover, we only asked about insomnia symptoms that had been experienced in the last month before the survey; thus, we could not be fully aware of changes over the 2-year period. Future studies should use sleep diary data to investigate more accurate changes in sleep status [50]. Third, participant sampling might have introduced selection biases. Compared with the general population, there was an over-representation of males in this cohort (76.1%). Notably, however, there are more males than females among Japanese workers. Moreover, we believe that there were fewer females in our survey because most of the jobs involved full-time employment. Thus, we could not perform sex-specific analyses. Nonetheless, we adjusted for sex in our models. Furthermore, the participants were employees of only six companies in Japan. Therefore, it may not be possible to generalize the findings to workers from other companies. Fourth, the follow-up rate was not high. Workers who dropped out could have developed insomnia symptoms more frequently during follow-up than the participants, resulting in underestimation with respect to prospective effects of coping strategies on insomnia. This is because the dropout workers are likely to be affected by advancing age or mental illness associated with insomnia [49]. Fifth, the PSS-10 has been widely used in well-being studies, but not with the working population. Future studies should adopt instruments focused on job stress or work-family conflict.

Despite the above limitations, the strengths of our study include the large sample size, a variety of occupations, a 2-year follow-up, and the use of well-validated measures for subjective insomnia symptoms, coping strategies, and perceived stress. Moreover, we used appropriate statistical models to investigate the repeated measures of coping strategies and insomnia severity. This was performed because the frequency and types of coping strategies that individuals generally adopt can differ significantly over time [51].

From a public health perspective, this study supports the important role of coping strategies in the management of insomnia symptoms. The coping strategies mentioned in this study are relatively easy to implement in daily life. Our findings suggest that workers may benefit from learning about adaptive coping strategies, such as humor and use of emotional support, for insomnia symptoms. Although the causal association between coping and insomnia has not been confirmed, future studies should investigate this association in other populations for a longer period and explore the underlying mechanisms involved in the observed associations.

Conclusion

This study suggests that some coping strategies may play an important role in the insomnia severity. Our findings can be used to inform policymakers and health workers regarding the incorporation of adaptive coping strategies for insomnia symptoms among workers. However, more generalized studies assessing the causal association between coping strategies and insomnia are required if this study's results are to be applied to design interventions that alleviate insomnia among workers with long-term conditions.

Supplementary Material

Supplementary material is available at *SLEEP* online.

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Data Availability

The data underlying this article cannot be shared publicly due to the privacy of individuals that participated in the study. The data will be shared on reasonable request to the corresponding author.

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