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Association between insomnia and job stress: a meta-analysis

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Abstract

Purpose Insomnia has become one of the foremost health concerns among workers. Despite a significant number of epidemiological studies have reported on the correlation between insomnia and job stress, comprehensive evidence remains insufficient. Therefore, this research seeks to provide evidence with greater reliability, through summarizing relevant contemporary literature via a meta-analysis.

Methods Literature from across Europe and Asia that was of both a prospective and cross-sectional design was included, if well-controlled odds ratios were available. The meta-analysis was undertaken in accordance with the guidelines devised by PRISMA, including tests for publication bias and heterogeneity.

Results High job stress was associated with a greater risk of suffering from insomnia (random OR = 1.73, 95% CI 1.46–2.05), and the correlation between effort-reward imbalance and insomnia was statistically significant (random OR = 2.63, 95% CI 1.22–5.69). Higher demand was correlated to a relatively greater risk of insomnia (random OR = 1.35, 95% CI 1.20–1.51), while the pooled effect of low control was not found to be statistically significant. The summary random odds ratio of heavy workload was 2.76, and a pooled odds ratio of 1.67 (fixed, 95% CI 1.11–2.52) was calculated in low social support. With regard to the overall population, work-family conflict was correlated with insomnia (random OR = 2.32, 95% CI 1.53–3.51). The subgroup analysis provided comparable outcomes, for both males (fixed OR = 1.97, 95% CI 1.50–2.57) and females (random OR = 2.80, 95% CI 1.30–6.05). Egger's regression indicated that publication bias may be apparent in the syntheses of effort-reward imbalance, low social support, and work-family conflict ($p < 0.05$). Heterogeneity was caused by design, measuring the exposure or outcome, in addition to the region where the research was conducted.

Conclusions The correlation between insomnia and higher levels of job stress, effort-reward imbalance, high demand, heavy workload, and low social support was determined. Publication bias and heterogeneity were partially observed. Furthermore, future studies with improved methodologies and a focus on mechanisms are anticipated.

Keywords Insomnia · Job stress · Meta-analysis

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Introduction

Insomnia is the most common sleep disorder, having become one of the foremost health concerns for workers internationally. Over the previous 30 years, a large number of epidemiological studies have investigated and reported on the correlation between insomnia or sleep disturbance and stressors in the workplace. Knudsen [16] investigated 1715 full-time employees, identifying a close relationship between work overload and insomnia, while role conflict, as well as job latitude, was correlated with difficulty in maintaining sleep. A further investigation [25] involving 1786 workers from 8 electrical appliance factories, applying both DCS and ERI on the same population, illustrated the significant association between job stress and insomnia

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symptoms. Comparable conclusions have also been drawn in other research [13, 14, 26, 30, 31].

Nevertheless, the distinctions between these findings were readily apparent, while in certain studies, the estimated confidence intervals of effects were too wide to draw meaningful conclusions. Moreover, an array of instruments was adopted for measuring exposure and results among the literature, with the majority of studies being of a cross-sectional nature, where a sole study is believed to lack strength in terms of validity and dependability. In this research, we undertook a comprehensive search and analysis of the literature concerned with the correlation between insomnia symptoms measured by scales and job stress variables, as a means of producing evidence with greater reliability. Additionally, we used meta-analyses to summarize the varied literature from Europe and Asia that was both prospective and cross-sectional by design, accounting for the deficiencies in the breadth of evidence within previous research.

Methods

The meta-analysis was undertaken in accordance with the procedures formulated by PRISMA [21]. Research that has reported on the correlation between insomnia and job stress (including effort-reward imbalance, high demand, low control, heavy workload, low social support and work-family conflict) was searched for through four online data bases (PubMed, SCI, EM, Ovid), with January 2014 as the latest search date, utilizing a combination of search words. The inclusion criteria were that the study was a cross-sectional or prospective investigation with a control group, that the subjects had been working no less than one year, that a clear measure of insomnia and job stress was apparent, that the number or rate of insomnia symptoms among groups was assessed respectively, that the research was published between 1980 and 2014 in either English or Japanese, and that it utilized sound quality control. We excluded those studies that lacked detailed information for either exposure or outcome. Odds ratios with 95% confidence intervals (95% CI) concerning the correlation between job stress and insomnia, alongside other relevant information, was extracted by the two investigators independently, then scrutinized by experts in occupational health. Pooled OR and 95% CI were estimated using the fixed or random effects model, according to heterogeneity between studies for synthesis. We tested for heterogeneity among the research through I–V method with I^2, exploring the source of heterogeneity via subgroup analyses. Publication bias was tested through a funnel plot, Begg's rank correlation, and Egger's linear regression. The trim and fill method was adopted for sensitivity analysis. All of the statistical analyses

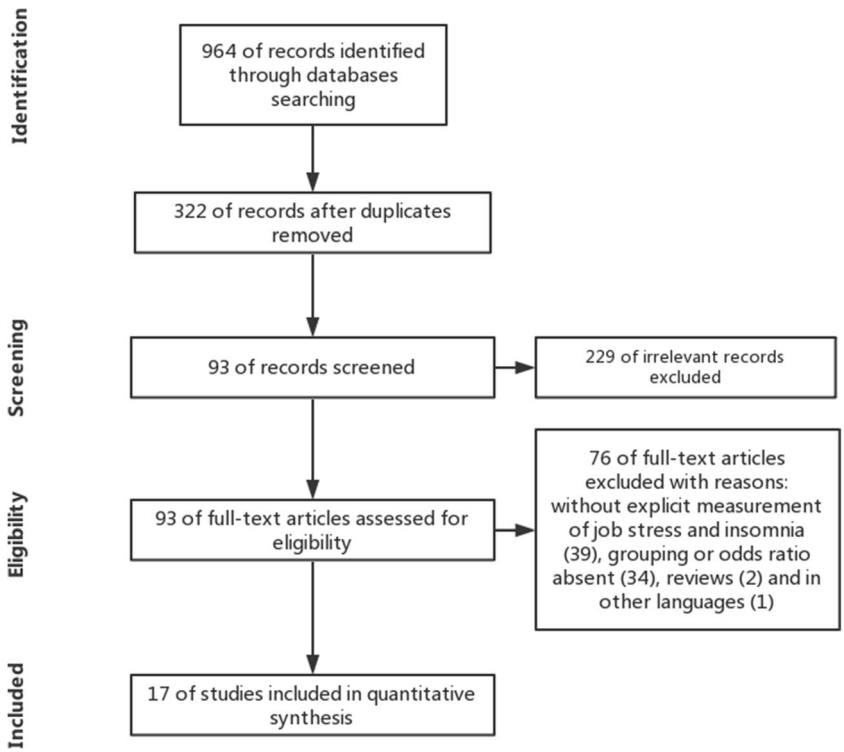

Fig. 1 Flow of information through selection progress of studies

were undertaken using Stata software (version 14.0 MP) with packages METAN, METABIAS and METATRIM [4, 12, 32, 33, 36].

Results

Characteristics of the included studies

Seventeen studies analyzing the outcomes associated with insomnia symptoms were identified following a selection procedure (Fig. 1), with the relevant literature comprising of 12 cross-sectional studies and five prospective studies. Twelve studies investigated the effect of overall job stress on insomnia symptoms. Five reported the effect of effort-reward imbalance. Seven investigations were relevant to heavy workload, while three reports considered low social support. Five studies that concerned high demand or low control were also included. Furthermore, two studies reported outcomes separately according to gender across four populations. Overall, 105,835 participants from six different countries were included in the research. Exposure and outcome were measured through questionnaires designed by the investigators, or through widely used standard scales for job stress (Table 1).

Job stress and insomnia symptoms

Based on the pooled analysis, high job stress was associated with a greater risk of suffering from insomnia symptoms (random OR = 1.73, 95% CI 1.46–2.05) with heterogeneity apparent between across the studies (I^2 = 72.4, $p < 0.001$, Fig. 2). The correlation between effort-reward imbalance and insomnia symptoms was

Table 1 Exposure and outcome measured through questionnaires designed by the investigators, or through widely used standard scales for job stress

No.	Author	Year	Method	Exposure	Region	Sample size
1	Lallukka, T [17]	2014	Prospective	Work-family conflict	Finland/British/Japan	9713
2	Yoshioka, E [35]	2013	Cross-sectional	Total job stress Effort-reward imbalance Heavy workload	Japan	5951
3	Akerstedt, T [3]	2012	Prospective	Heavy workload High demand Low control	Sweden	3637
4	Zhang, X [37]	2011	Cross-sectional	Total job stress	China	336
5	Kim, H. C [15]	2011	Cross-sectional	Total job stress	Korea	8155
6	Edme, J. L [9]	2011	Prospective	Total job stress Effort-reward imbalance	Northern France	2062
7	Lallukka, T [18]	2010	Cross-sectional	Work-family conflict	Finland	5819
8	Ota, A [25]	2009	Prospective	Total job stress Effort-reward imbalance Heavy workload Low social support	Japan	730
9	Nomura, K [23]	2009	Cross-sectional	Total job stress	Japan	1209
10	Ota, A [24]	2005	Cross-sectional	Total job stress	Japan	1081
11	Linton, S. J [19]	2004	Prospective	Total job stress Heavy workload	Sweden	2066
12	Edell-Gustafsson [8]	2002	Cross-sectional	Total job stress	Sweden	169
13	Akerstedt, T [2]	2002	Cross-sectional	Heavy workload High demand	Sweden	5720
14	Akerstedt, T [1]	2002	Cross-sectional	Total job stress	Sweden	58,115
15	Nakata, A [22]	2001	Cross-sectional	Total job stress High demand Low control Low social support	Japan	530
16	Tachibana, H [29]	1998	Cross-sectional	Heavy workload	Japan	319
17	Kageyama, T [11]	1998	Cross-sectional	Total job stress	Japan	223

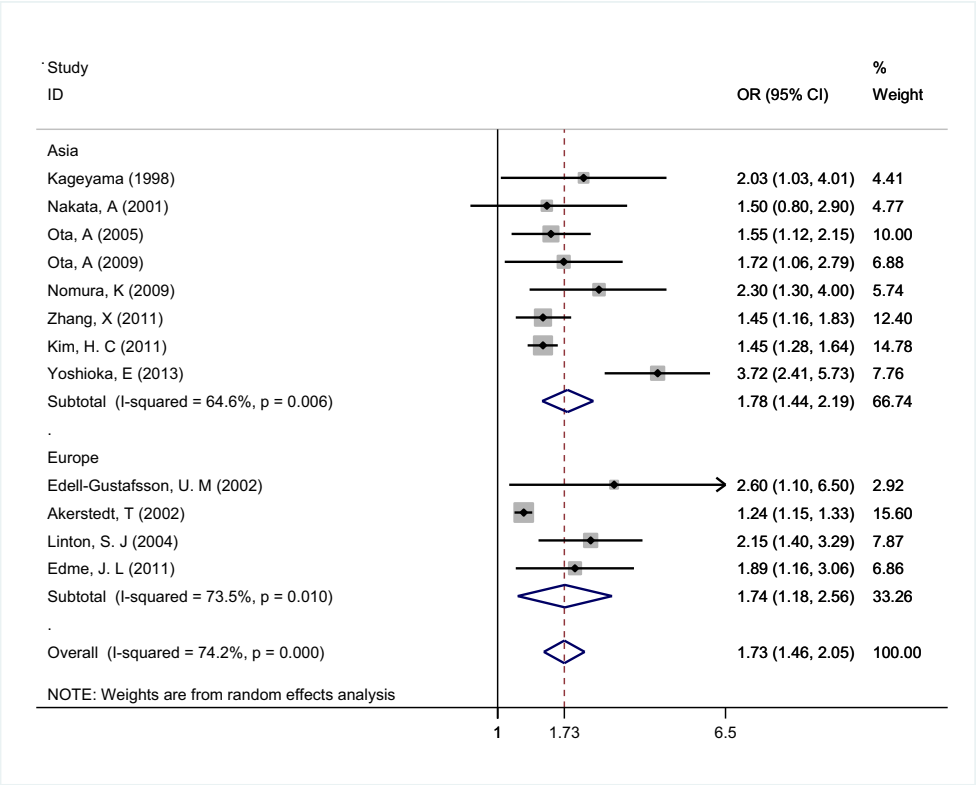

Fig. 2 Association between job stress and insomnia

statistically significant (random OR = 2.63, 95% CI 1.22–5.69). Furthermore, heterogeneity was identified across the five studies (I^2 = 95.1%, $p < 0.001$, Fig. 3). Regarding high demand and low control (Fig. 4), the summary odds ratio was 1.23 (95% CI 1.14–1.26) in the fixed effects model (I^2 = 34.4%, $p = 0.166$). Additionally, distinct syntheses were undertaken in relation to the subgroup for high demand and low control, with subgroup heterogeneity being apparent ($p = 0.026$). Higher demand was correlated to a relatively greater risk of insomnia symptoms (OR = 1.35, 95% CI 1.20–1.51), while the pooled effect of low control was not found to be

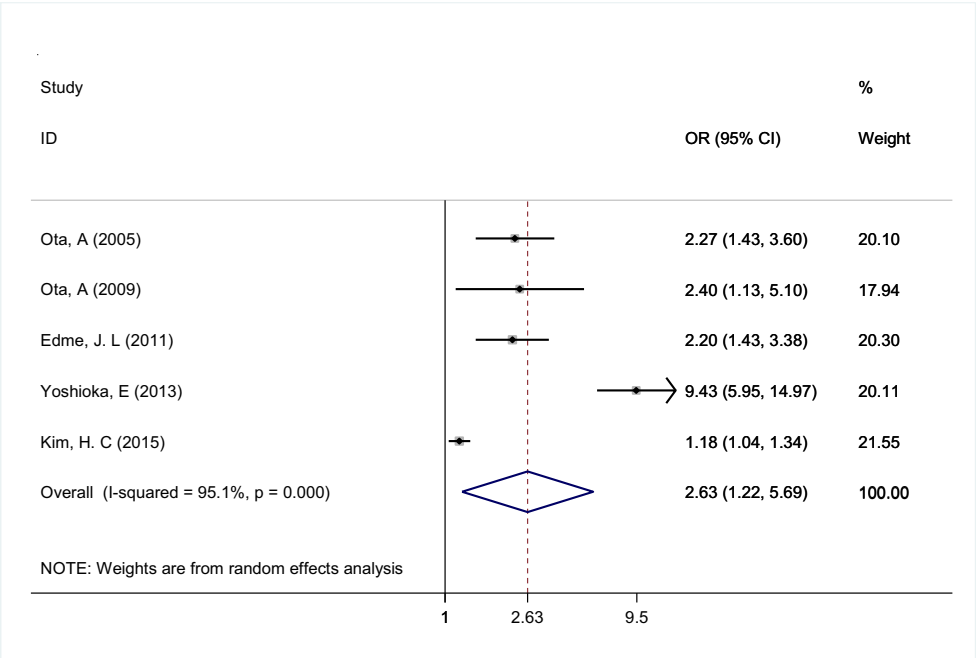

Fig. 3 Association between effort-reward imbalance and insomnia

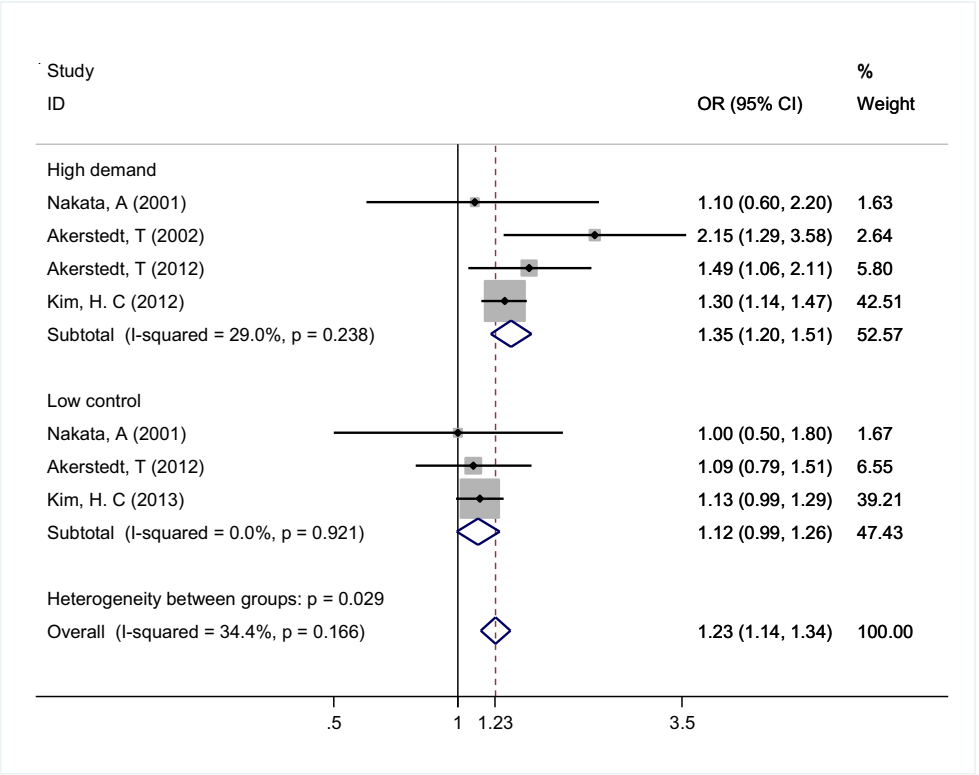

Fig. 4 Association between high-demand-low-control and insomnia

statistically significant. The summary odds ratio of heavy workload was 2.76 (random effects model with $I^2 = 88.5\%$, $p < 0.001$), suggesting that a higher workload may compound the risk of insomnia symptoms in occupational populations (Fig. 5). A pooled odds ratio of 1.67 (95% CI 1.11–2.52) was calculated following an investigation of 3 studies concerned with low social support through a random effects model, with some heterogeneity present ($I^2 = 61.3\%$, $p = 0.075$, Fig. 6). An additional two studies involving four different populations reported a correlation between work-

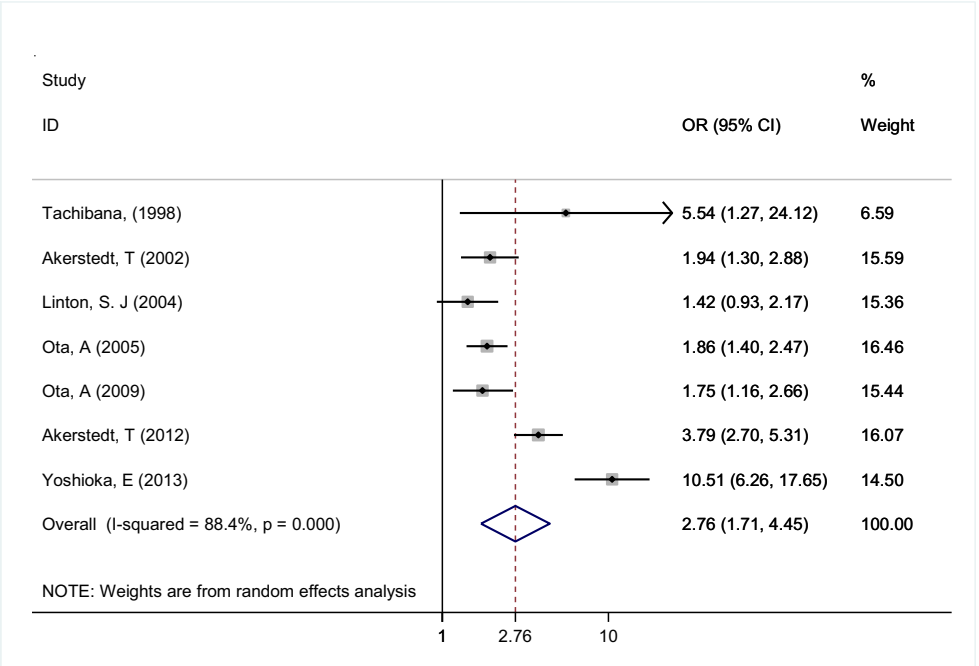

Fig. 5 Association between heavy work load and insomnia

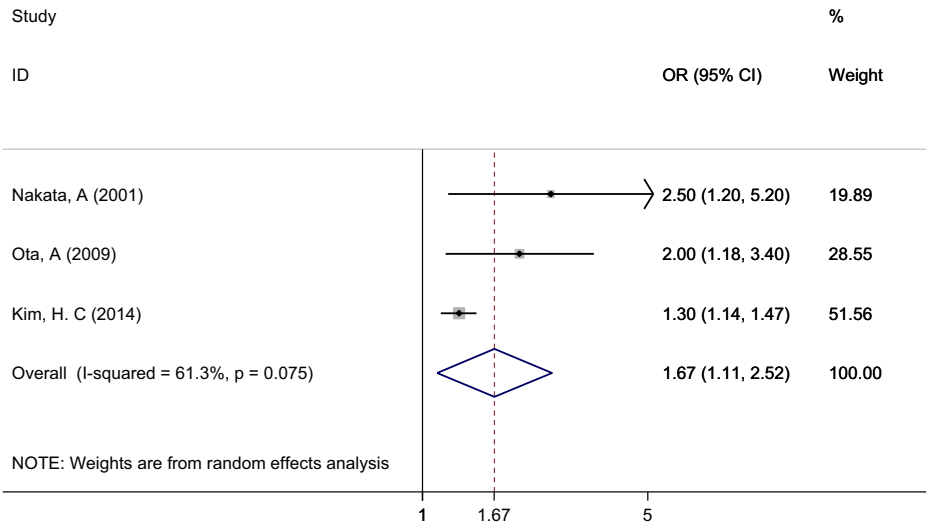

Fig. 6 Association between low social support and insomnia

family conflict and insomnia symptoms in males and females. With regard to the overall population, work-family conflict was correlated with insomnia symptoms (random OR = 2.32, 95% CI 1.53–3.51, $I^2 = 80.5\%$, $p < 0.001$, Fig. 7). The subgroup analysis provided comparable outcomes, for both males (fixed OR = 1.97, 95% CI 1.50–2.57) and females (random OR = 2.80, 95% CI 1.30–6.05).

Publication bias and sensitivity analysis

Based on Begg's rank correlation test, no publication was detected in all six syntheses ($p > 0.1$), although certain asymmetrical plots were still observed (Table 2, Fig. 8). Egger's regression indicated that publication bias may be apparent in the syntheses of effort-reward imbalance, low social support,

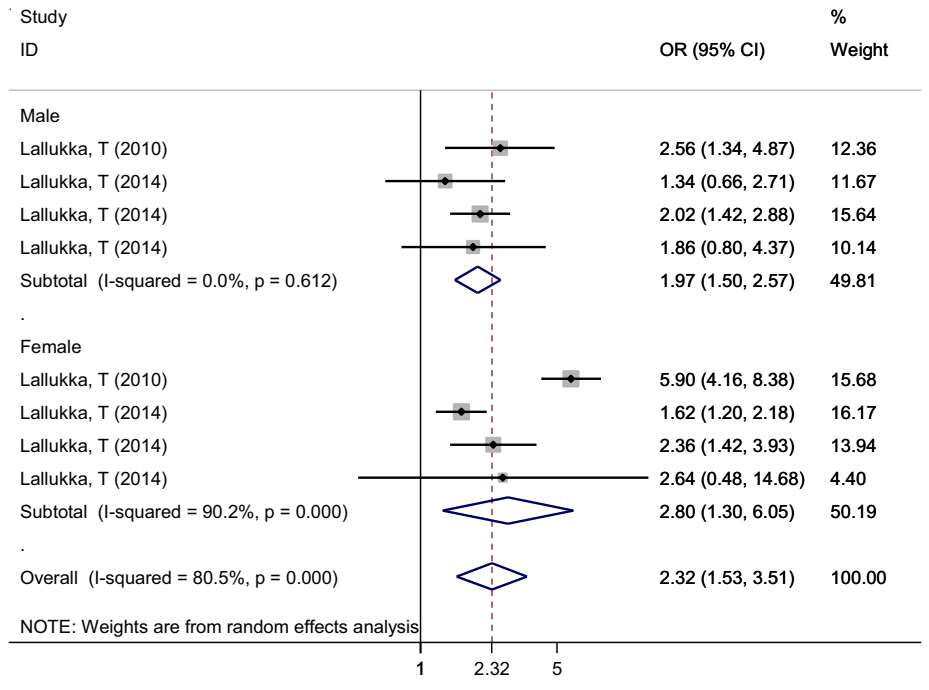

Fig. 7 Association between work-family conflict and insomnia

Table 2 Begg's rank correlation test for publication bias

Exposure	Kendall's score	SE	z	P	Publication bias
Job stress	3	12.85	0.16	0.88	None
Effort-reward imbalance	− 2	4.08	0.24	0.81	None
High demand and low control	1	1.91	0.00	1.00	None
Heavy work load	− 1	5.32	0.00	1.00	None
Low social support	3	1.91	1.04	0.30	None
Work-family conflict	− 2	4.08	0.24	0.81	None

and work-family conflict ($p < 0.05$, Table 3). Concerning the results of the sensitivity analysis via the trim and fill method, the adjusted effect of low social support on insomnia symptoms was significantly lower, suggesting a predisposition towards publication bias, while the impacts altered negligibly following amendment in the other two summaries (Table 4).

Sources of heterogeneity

For those four syntheses showing between-studies heterogeneity, additional subgroup analysis was undertaken (Table 5). Heterogeneity was caused by design in three of the four pooled studies. Regarding the other subgroups, heterogeneity could also be derived from measuring the exposure or outcome, in addition to the region where the research was conducted.

Discussion

Summary of the findings

The correlation between insomnia symptoms and the aforementioned job stress variables was identified based on our comprehensive appraisal of 17 pertinent studies. Syntheses indicated that higher job stress was associated with a greater risk of developing insomnia symptoms among occupational populations, while a similar relationship was also identified in relation to other variables, for example, effort-reward imbalance, high demand, heavy workload, low social support, and work to family conflict. However, the pooled effect of low control on insomnia symptoms was not statistically significant. Therefore, the findings of this study were, to a great extent, consistent with other evidence pertaining to a greater risk of sleep dysfunction stemming from mental factors.

Our findings were largely consistent with the previous literature outlined at the outset of the research [20]. The investigation has revealed that a high level of work demand was related to a 1.48 times greater risk of developing sleep disturbances. The pooled odds ratio of job strain across the four articles was 1.35, indicating a susceptibility to insomnia symptoms among workers who have a high degree of job stress. It has also been proposed that a greater level of social assistance may act as a protective variable in relation to insomnia, whereas the opposite trend, namely reduced levels of social support, does not have a significant effect. With regard to the effort-reward imbalance, the correlation with future development of sleep disturbances has also been indicated.

Despite the mechanism through which job stress results in insomnia still being unclear, researchers continue to report on potential pathways through which stress affects sleep. Sleep reactivity, which has been defined as the proclivity towards exhibiting pronounced sleep disturbance in response to a sleep challenge, is reported as a premorbid vulnerability for future insomnia, which may mitigate the risks conferred by stress-

Table 3 Egger's linear regression for publication bias

Exposure	Intercept and 95%CI	t	P	Publication bias
Job stress	0.58 (− 2.91, 4.06)	0.38	0.72	No
Effort-reward imbalance	− 4.21 (− 8.04, − 0.37)	− 3.49	0.04	Yes
High demand and low control	2.12 (− 39.46, 43.70)	0.65	0.63	No
Heavy work load	− 3.11 (− 8.16, 1.94)	− 1.71	0.16	No
Low social support	4.26 (2.45, 6.08)	29.79	0.02	Yes
Work-family conflict	− 3.53 (− 6.36, − 0.70)	− 3.97	0.03	Yes

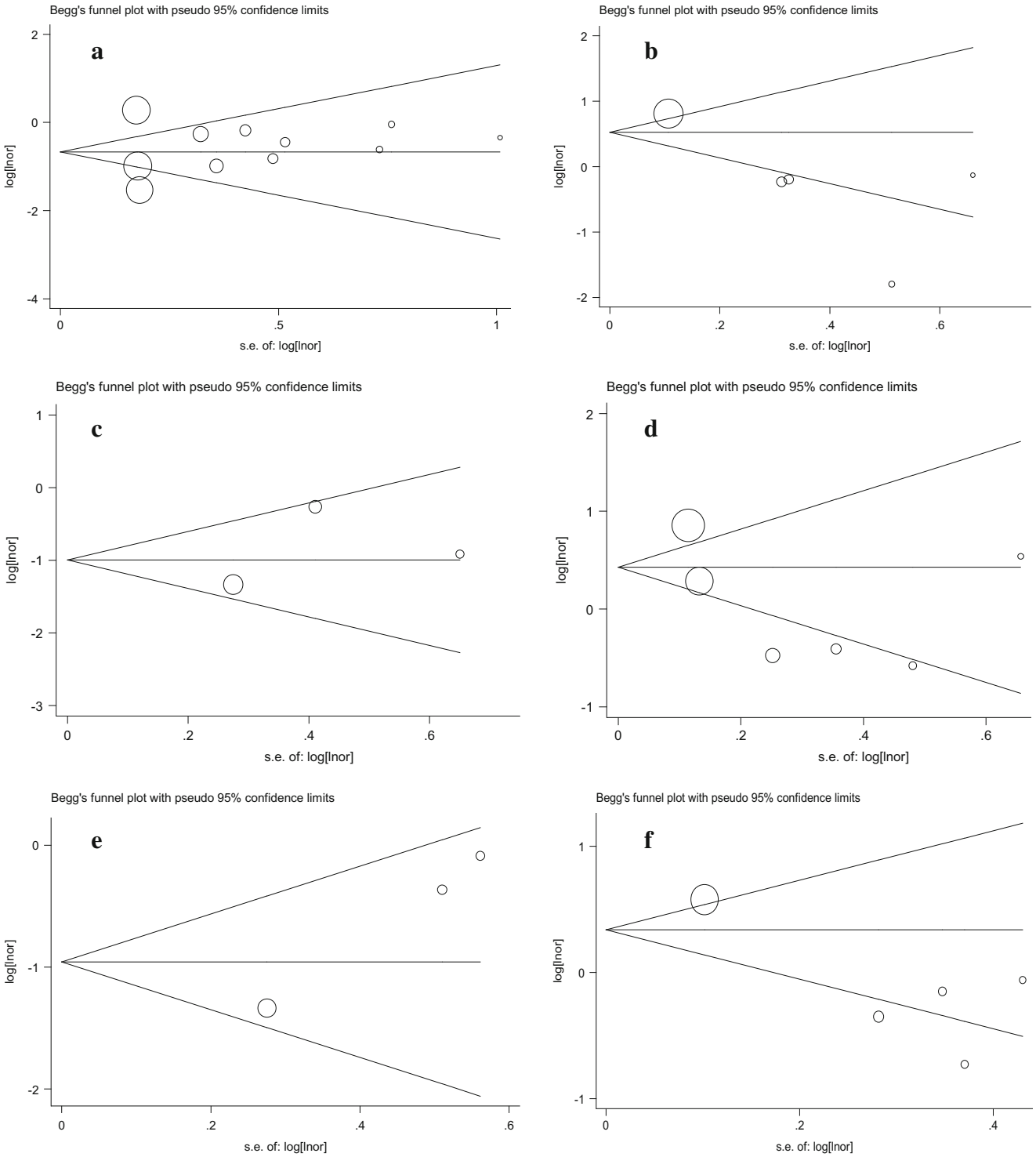

Fig. 8 Funnel plots of publication bias. **a**. Job stress; **b**. Effort-reward imbalance; **c**. High demand and low control; **d**. Heavy work load; **e**. Low social support; **f**. Work-family conflict

induced intrusion in the development of insomnia [7]. Furthermore, it has also been evidenced through a twin-cohort study that sleep reactivity in response to stress comprises of a substantial genetic element, in addition to an environmental influence [6]. Additionally, our previous study [10] has also indicated an interaction between gene and job stress on insomnia's prevalence, given that serotonin transporter gene-linked polymorphic region (5-HTTLPR) could

Table 4 Comparison between unadjusted and adjusted effects by trim and fill

Sub-group	Unadjusted		Adjusted		
	OR	τ^2	*n*	OR	τ^2
Effort-reward imbalance	2.63	0.810	0	1.691	0.810
Low social support	1.12	0.353	2	0.262	0.693
Work-family conflict	1.67	0.330	0	1.402	0.330

amend the effect of job-associated stress on workers' sleep disorders. Nevertheless, additional theoretical and experimental research, particularly focusing on biological mechanisms, is anticipated to advance our understanding.

Limitations

A degree of heterogeneity was detected was across the research, which may diminish the estimation accuracy, given that random effects models were utilized for the majority of the syntheses. Heterogeneity may derive from the research design, measurement of exposure or outcomes, and in part, the geographical location of the research, given that the 17 studies included were from Japan, Sweden, Finland, Britain, Korea, and China, while the majority were also cross-sectional. Concerning the tools adopted for measuring exposure or outcome, both standard scales such as the Job Content Questionnaire (JQS), Job Demand-Control Questionnaire (DCQ), Effort-Reward Imbalance Questionnaire (ERI) for exposure measurement, and Athens Insomnia Scale (AIS) for outcome were utilized, in addition to self-designed questionnaires. We considered that measurements made with those questionnaires did not provide such good quality as the standard scales, which may enhance the risk of bias. Furthermore, adopting various questionnaires in order to measure the same variables was rather irrational. Moreover, assessments of job stress and sleep disorders were reliant upon self-reported data obtained via questionnaires, which may introduce greater bias than objective measures.

Additionally, reflecting a typical problem in relation to meta-analysis research, publication bias was also observed through Egger's regression, even if Begg's test indicated negative results. Publication bias across the research related to effort-reward imbalance, low social support, and work-family conflict, which were statistically significant and not able to be omitted. This potentially has an acute effect on the pooled results' validity, given that a scant few investigations have incorporated a synthesis of those three variables. Sensitivity analysis via the trim and fill method also indicated this manner of uncertainty by providing a somewhat lower adjusted summary effect, particularly in relation to the variable of low social support.

Table 5 Sub-group analyses to explore source of heterogeneity

Sub-group	Total job stress		Effort-reward imbalance		Heavy work load		Low social support	
	n	OR (95% CI)	*n*	OR (95% CI)	*n*	OR (95% CI)	*n*	OR (95% CI)
Design								
Prospective study	3	1.93 (1.48–2.52)	2	1.93 (1.48–2.52)	1	2.00 (1.18–3.4)	6	1.83 (1.51–2.21)
Cross-sectional study	9	1.35 (1.28–1.43)	3	1.35 (1.28–1.43)	2	1.33 (1.17–1.50)	2	4.88 (3.59–6.64)
	$= 0.01$		$p = 0.02$		$p = 0.14$		$p < 0.01$	
Measure of exposure								
Standard scale	9	1.63 (1.48–1.80)	5	1.47 (1.32–1.65)	3	1.35 (1.20–1.53)	8	2.41 (2.05–2.84)
Nonstandard questionnaire	3	1.26 (1.18–1.35)	0	–	0	–	0	–
	$p < 0.01$		–		–		–	
Measurement of outcome								
Standard scale	7	1.63 (1.47–1.80)	4	1.43 (1.27–1.61)	2	1.33 (1.18–1.51)	8	2.41 (2.05–2.84)
Nonstandard questionnaire	5	1.28 (1.19–1.37)	1	2.20 (1.43–3.38)	1	2.50 (1.20–5.20)	0	–
	$p < 0.01$		$p = 0.06$		$p = 0.10$			–
Location								
Asia	8	1.57 (1.43–1.72)	4	1.43 (1.27–1.61)	3	1.35 (1.20–1.53)	3	2.43 (2.06–2.88)
Europe	4	1.28 (1.19–1.37)	1	2.20 (1.43–3.38)	0	–	1	1.99 (0.93–4.26)
	$p < 0.01$		$p = 0.06$			–	$p = 0.62$	

Certain methodological concerns should also be raised in relation to the interpretation of the study results. In order to ensure comprehensive collection of evidence, many cross-sectional studies were included in this meta-analysis. The results suggest that the correlation between job stress and insomnia is not necessarily based on a definite, causal relationship. For example, a poor mental state may be the result of poor sleep quality, rather than the other way around. Furthermore, a single exposure measure may be unable to entirely capture the sustained effects of job stress over time in relation to long-term sleep disturbance [5], even in prospective studies. A third variable, known as confounding, is associated with both exposure and outcome. For example, biological susceptibility or personality may play a causal role, given the actual mechanism through which work variables, including stress and other mental factors, have an impact on sleep. An improved methodology, for example, undertaking well-conducted cohort studies or experimental designs, is expected to provide a causal relationship in future studies. Additionally, for assessing heterogeneity, only a few variables were considered as sources and were analyzed in subgroups. Meta-regression was not conducted in order to estimate the with-study variance, given the insufficient number of studies included in the research [34]. A similar problem arose during the sensitivity analysis of publication bias via a trim and fill method, which has been shown to lack validity in scenarios where a small number of studies are being considered [5, 27, 28]. Lastly, language has also been a limitation within our study. Drawing on a broader collection of literature across other languages would enable more credible and unbiased results to be obtained.

Conclusions

Our findings have presented the correlation between insomnia symptoms and higher job stress, in addition to the effect of effort-reward imbalance, high demand, heavy workload, and low social support. No evidence was found that low control has a similar impact on sleep disturbance. The effect of work-family conflict was suspicious, given the low reliability introduced through publication bias. Nevertheless, while interpreting our results, it will be more rational to perceive our results as an indication, rather than a confirmation, of trends. This is due to the inability to justify "cause and effect" in the majority of the included research alongside the uncertainty resulting from publication bias and heterogeneity that remained insufficiently explored.

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