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**Research Article**

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# Comparison of workplace impairment and daily activity impairment in acute and chronic insomnia disorder: A study of Chinese adults

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**Abstract: Background:** Insomnia is a common condition that adversely affects work productivity, and a significant proportion of individuals with acute insomnia disorder (AID) eventually develop chronic insomnia disorder (CID). However, it remains unclear whether workplace impairment and daily-activity impairment occur early in the course of insomnia. **Methods:** This cross-sectional study included 295 AID and 305 CID participants. Multiple linear regression were used to assess associations between insomnia, workplace and daily activity impairment, and related factors (daytime sleepiness, depressive and anxiety symptoms). Restricted cubic spline (RCS) analysis was also conducted to explore nonlinear relationships. Mediation analysis was performed to assess the potential mediating effects of daytime sleepiness, depressive symptoms, and anxiety symptoms between insomnia and workplace and daily-activity impairment. **Results:** No significant differences were found between the AID and CID groups in presenteeism or productivity-loss costs ($P$>0.05). Insomnia severity, daytime sleepiness, and depressive and anxiety symptoms were the correlated factors of workplace impairment and daily activity impairment ($P$<0.05). A nonlinear relationship between depressive symptoms and presenteeism, as well as between daytime sleepiness and daily-activity impairment, was identified in both groups ($P$ for overall <0.01, $P$ for non-linearity <0.05). Mediation analysis showed that in the AID group, depressive symptoms mediated the effects on absenteeism and daily-activity impairment (mediation proportions: 37.02% and 28.61%). In the CID group, anxiety symptoms had a greater mediating effect on presenteeism and daily-activity impairment (mediation proportions: 53.01% and 31.70%). **Conclusions:** Presenteeism and productivity-loss costs occur in AID and are comparable with those resulting from CID. Depressive and anxiety symptoms are also important mediators of workplace and daily-activity impairment in AID. We recommend investing in portable and effective interventions to improve work productivity.

**Key words:** Insomnia, Workplace impairment, Daily activity impairment, Presenteeism, Absenteeism

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## 1 Introduction

Insomnia is a highly prevalent mental disorder that imposes a substantial economic burden, largely due to work productivity loss (Natsky et al., 2020; Sutton, 2021; Van Someren, 2021). Previous research has found that individuals with insomnia face employment-related challenges, including workplace impairment (presenteeism: reduced work performance, and absenteeism: time lost from work) and daily-activity impairment (functional limitations in daily activities outside work) (Espie et al., 2018; Streatfeild et al., 2021; Espel-Huynh et al., 2022; Chalet et al., 2023). However, most studies focus on insomnia symptoms in general, rather than distinguishing between different stages of an insomnia disorder.

Distinguishing between acute insomnia disorder (AID) and chronic insomnia disorder (CID) is crucial for both clinical practice and public health policy. AID is a significant sub-type of insomnia with a high annual incidence of 36.6% (Ohayon and Reynolds, 2009; Boyle et al., 2024). It is common, and 40% of individuals with AID (i.e., 3 d to 3 months) transition to CID (i.e., 3 months or longer) (Ellis et al., 2012; Ellis et al., 2014). However both stages of insomnia disorder are associated with symptoms such as daytime sleepiness, anxiety, and depression (Passarella and Duong, 2008; Khachatryan, 2021; Yang et al., 2023; Zhang et al., 2023), which may further impact work performance, social interactions, and overall quality of life (Khachatryan, 2021). The progression from AID to CID represents not only a temporal extension of symptoms but often an escalation in severity, comorbidity, and functional impairment (Boyle, et al., 2024). However, the specific contributions of these symptoms to workplace and daily-activity impairment at different stages of insomnia disorder have not been systematically examined.

To address these gaps, our aim in this study was to investigate the associations between different stages of insomnia disorder (AID group vs. CID group) and impairment in both workplace and daily activity. We also explored the roles of daytime sleepiness, and of depressive and anxiety symptoms. On the basis of prior related studies, we propose the following hypotheses:

Hypothesis 1: Individuals with AID already experience workplace and daily activity impairment.

Hypothesis 2: Related insomnia symptoms of daytime sleepiness, depression and anxiety are significantly associated with workplace and daily activity impairment in both groups.

Hypothesis 3: Related insomnia symptoms of daytime sleepiness, depression and anxiety mediate the relationship between insomnia and impairment in workplace and daily activity, with potential differences between AID and CID.

## 2 Methods

The methods of study population, measurements and statistical analysis are presented in **Supplemental Appendix S1.**

## 3 Results

### 3.1 Sample characteristics

Of the eligible patients, 86.61% (634/732) provided informed consent. A total of 34 participants were missing social demographic information and were excluded from the analyses, resulting in a final sample size of 600, as shown in **Fig. 1**. Of these, 295 were classified as AID and 305 as CID. Overall, 56% were employed full- or part-time, 36.17% were students, and 7.83% were unemployed. Compared with participants with CID, those with AID were generally younger, more educated, and fell into the demographic of workers and students with lower income.

The range of ISI scores was 8 to 28 for both groups. There was no significant difference in

insomnia severity between the two groups. Compared to patients with CID, those with AID showed more depressive symptoms but less anxiety. Presenteeism and daily activity impairment were similar across groups, although absenteeism was higher in the CID group. Productivity loss costs were also comparable between groups ($578.08 for CID vs. $494.61 for AID), as shown in **Table 1**.

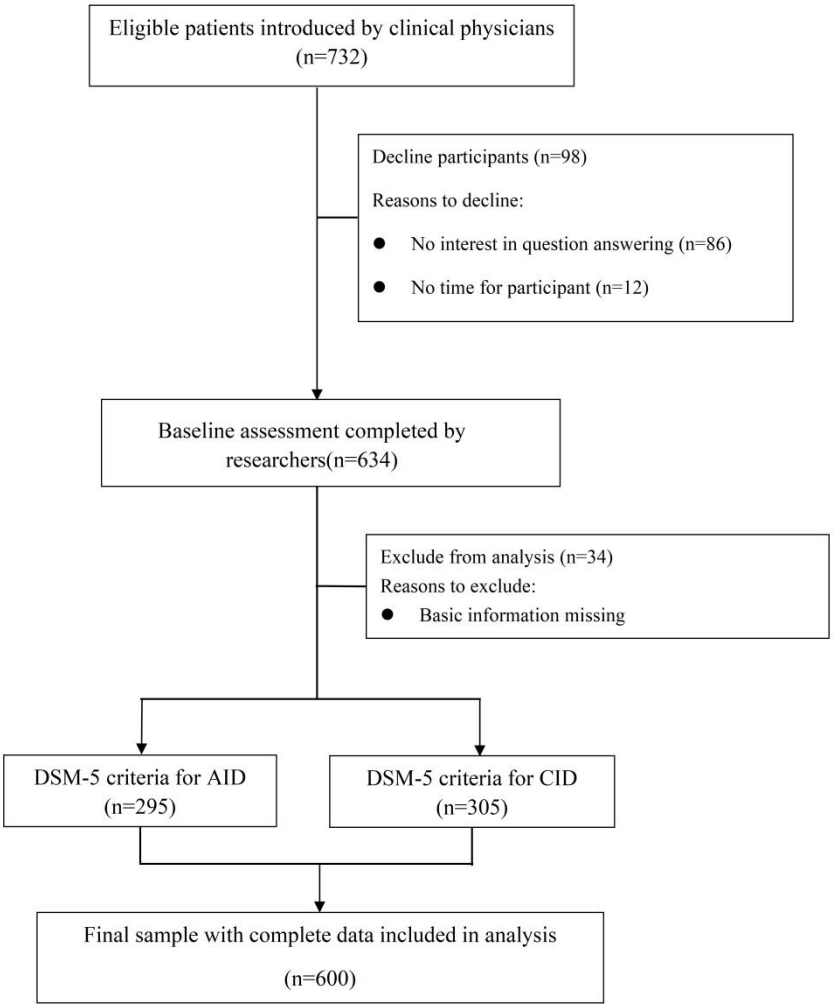


**Fig 1. Flowchart of the study**

Abbreviation: AID: acute insomnia disorder; CID: chronic insomnia disorder;

**Table 1 Demographic characteristics of participants between AID and CID**

| | Level | Total (n=600) | AID (n=295) | CID (n=305) | t/χ2 | *P* |
|---|---|---|---|---|---|---|
| Age (mean±SD) | | 35.01±11.52 | 33.30±11.55 | 36.59±11.23 | 3.61[a] | <0.001*** |
| BMI (mean±SD) | | 21.94±3.39 | 22.12±4.20 | 21.93±3.35 | -0.04[a] | 0.326 |
| Sex (n, %) | Male | 177（29.50） | 89 (30.17) | 88 (28.85) | 0.13[b] | 0.792 |
| | Female | 423（70.50） | 206 (69.83) | 217 (71.15) | | |
| Education (n, %) | College or above | 495（82.50） | 264 (89.49) | 231 (75.74) | 19.65[b] | <0.001*** |
| | Senior high schools or below | 105（17.50） | 31 (10.51) | 74 (24.26) | | |
| Occupation (n, %) | Full or part-time job | 336 （56.00） | 144（48.81） | 192（62.95） | 15.42[b] | <0.001*** |
| | Students | 235（39.17） | 139（47.12） | 96（31.48） | | |
| | No jobs | 29（4.83） | 12（4.07） | 17（5.57） | | |
| Married (n, %) | Married | 321（53.50） | 129（43.73） | 192（62.95） | 22.57[b] | <0.001*** |
| | Divorce or others | 24（4.00） | 13（4.41） | 11（3.61） | | |
| | Unmarried | 255（42.50） | 153（51.86） | 102（33.44） | | |
| Income (n, %) | <5000 Yuan | 317（52.83） | 180 (61.02) | 137 (44.92) | 37.10[b] | <0.001*** |
| | 5000-10000 Yuan | 156（26.00） | 44 (14.92) | 112 (36.72) | | |
| | 10000-15000 Yuan | 72（12.00） | 40 (13.56) | 32 (10.49) | | |
| | >15000 Yuan | 55（9.17） | 31 (10.51) | 24 (7.87) | | |
| ISI (n, %) | Subclinical Insomnia | 265（44.17） | 123 (41.69) | 142 (46.56) | 2.90[b] | 0.235 |
| | Moderate Insomnia | 270（45.00） | 143 (48.47) | 127 (41.64) | | |
| | Hyper-insomnia | 65（10.83） | 29 (9.83) | 36 (11.80) | | |
| ESS (n, %) | No Drowsiness | 442（73.67） | 204 (69.15) | 238 (78.03) | 6.10[b] | 0.018* |
| | Drowsiness | 158（26.33） | 91 (30.85) | 67 (21.97) | | |
| PHQ-9 (n, %) | No depression | 148 (24.67) | 94 (30.82) | 54 (18.31) | 13.65[b] | 0.003** |
| | Mild depression | 266 (44.33) | 119 (39.02) | 147 (49.83) | | |
| | Moderate depression | 165 (27.50) | 82 (26.89) | 83 (28.14) | | |
| | Severe depression | 21 (3.50) | 10 (3.28) | 11 (3.73) | | |
| GAD-7 (n, %) | No Anxeity | 208 (34.67) | 81 (26.56) | 127 (43.05) | 19.17[b] | <0.001*** |
| | Mild Anxeity | 257 (42.83) | 142 (46.56) | 115 (38.98) | | |
| | Moderate anxiety | 87 (14.50) | 52 (17.05) | 35 (11.86) | | |
| | Severe anxiety | 48 (8.00) | 30 (9.84) | 18 (6.10) | | |
| Presenteeism (mean±SD) | | 0.17±0.23 | 0.16±0.22 | 0.19±0.24 | 1.60[a] | 0.110 |
| Absenteeism (mean±SD) | | 0.04±0.11 | 0.03±0.09 | 0.07±0.17 | 1.39[a] | <0.001*** |
| Overall Work impairment (mean±SD) | | 0.20±0.25 | 0.18±0.24 | 0.22±0.26 | 2.04[a] | 0.042* |

| | | | | | |
|---|---|---|---|---|---|
| Daily activity impairment (mean±SD) | 0.39±0.23 | 0.37±0.21 | 0.41±0.25 | 1.75[a] | 0.082 |
| Productivity Loss, US dollar (mean±SD) | 537.03±2772.05 | 494.61±1746.07 | 578.08±3491.30 | 0.37[a] | 0.713 |

[a] : $\chi 2$ value; [b]: $t$ value *P<0.05; ** P<0.01; *** P<0.001

Abbreviation: AID: acute insomnia disorder; CID: chronic inosmnia disorder; ISI： Insomnia Severity Index; ESS: Epworth Sleepiness Scale; MEQ: Morningness-Eveningness Questionnaire; GAD-7: 7-item Generalized Anxiety Disorder Questionnaire; PHQ-9: 9-item Patient Health Questionnaire.

### 3.2 Linear regression of overall work impairment and daily activity impairment in multiple models

Based on the results of Spearman's rank correlation (**Supplemental Appendix S2**), we adjusted covariates and used the multiple linear regression analyses to test the relationship between insomnia and impairment in both workplace and daily activity. We set subclinical insomnia as the reference, and found that greater severity of insomnia was associated with greater impairment in daily activities, and with presenteeism and absenteeism. The presence of daytime sleepiness significantly influenced the relationship between insomnia severity and both presenteeism ( $\beta$=0.05, 95%CI: 0.02 – 0.09, $P$<0.01) and daily-activity impairment ( $\beta$=0.04, 95%CI: 0.01-0.08, $P$ <0.05). Furthermore, hyper-anxiety moderated the association between insomnia severity and both presenteeism ( $\beta$=0.11, 95% CI: 0.03-0.18, $P$ <0.01) and daily-activity impairment ( $\beta$=0.14, 95% CI: 0.07-0.22, $P$ <0.001). Meanwhile mild depression ( $\beta$=0.06, 95% CI: 0.01-0.10, $P$ <0.05), moderate depression ( $\beta$=0.11, 95% CI: 0.05-0.17, $P$ <0.001), and severe depression ( $\beta$=0.11, 95% CI: 0.01-0.22, $P$ <0.05) moderated the relationship between insomnia severity and daily-activity impairment.

There were no significant differences between the AID and CID groups in terms of presenteeism ( $\beta$= 0.00, 95% CI: −0.03-0.04, $P$ = 0.813) or absenteeism ( $\beta$=−0.01, 95% CI: −0.03-0.01, $P$ = 0.455). However, participants with AID showed significantly less daily-activity impairment compared to those with CID ( $\beta$=−0.04, 95% CI: −0.08- -0.01, $P$ <0.05). These results are presented in **Supplemental Appendix S3**.

### 3.3 Non-linear relationships between related insomnia symptoms and workplace impairment

When ESS, PHQ-9, and GAD-7 scores were evaluated as continuous variables, positive correlations between these factors and impairment in both workplace and daily activities persisted. The reference thresholds for the RCS analysis were selected based on widely accepted clinical cutoffs: ESS=10, PHQ-9 and GAD-7=5, and ISI=15.

Interestingly, the RCS curve model effectively captured the nonlinear associations between ESS scores and daily-activity impairment in both groups ($P_{overall}$<0.001, $P_{nonlinearity}$ < 0.001), with the impact of sleepiness accelerating sharply when ESS scores exceeded a threshold of 10. The CID curves were consistently positioned above the AID curves (**Fig. 2c**). Similarly, PHQ-9 scores

demonstrated a strong inverted U-shaped association with presenteeism in both groups ($P_{overall} < 0.001$, $P_{nonlinearity} < 0.001$), with the positive correlation peaking at scores of 5 to 10 and diminishing beyond 10 (**Fig. 2d**). Linear relationships were observed between ESS scores and both presenteeism ($P_{overall} < 0.001$, $P_{nonlinearity} = 0.436$) and absenteeism ($P_{overall} < 0.001$, $P_{nonlinearity} = 0.778$). In addition, there was a significant positive linear-correlation between PHQ-9 scores and absenteeism ($P_{overall} < 0.001$, $P_{nonlinearity} = 0.774$), as well as daily-activity impairment ($P_{overall} < 0.001$, $P_{nonlinearity} = 0.051$). However, we did not find a non-linear relationship between ISI or GAD-7 scores and impairment in either workplace or daily activity (all $P_{nonlinearity} > 0.05$), see **Supplemental Appendices S4 and S5**.

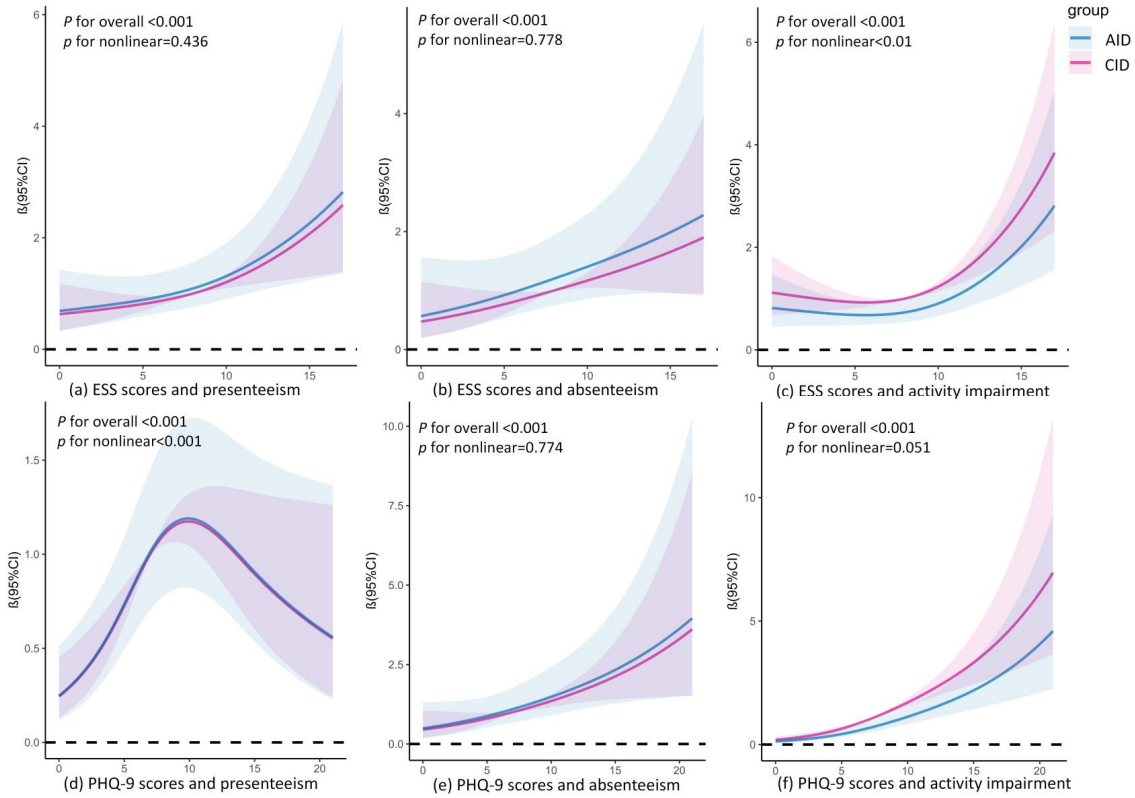


**Fig 2. Three cubic spline of workplace impairment and daily activity impairment**

Abbreviation: AID: acute insomnia disorder; CID: chronic inosmnia disorder; ESS：Epworth Sleepiness Scale；PHQ-9: 9-item Patient Health Questionnaire；

The analyses were adjusted for potential confounders including sex, age, BMI, occupation, income and married status.

a-c. Considering that an ESS score above 10 indicates clinical daytime sleepiness, we used an ESS of 10 as the reference threshold

d-f. Considering that an PHQ score above 5 indicates clinical anxiety, we used an GAD of 5 as the reference threshold.

### 3.4 Mediation analysis for associations of factors with work and daily-activity impairment

Based on the correlation and multiple linear-regression analysis results, we were able to determine that ESS, PHQ-9, and GAD-7 were likely acting as mediators. In the AID group, PHQ-9 scores did not significantly mediate the relationship between ISI scores and presenteeism, but served as the primary mediator between ISI scores and absenteeism, accounting for 37.02% of the total effect ( $\beta$ =0.002, $P$<0.05). PHQ-9 also significantly mediated the association between ISI scores and daily-activity impairment (28.61% of the effect, $\beta$=0.005, $P$<0.001). In the CID group, PHQ-9 did not mediate the relationship between ISI scores and absenteeism ( $\beta$ =0.000, $P$=0.810), but did mediate the relationship between ISI scores and daily-activity impairment (30.25% of the effect, $\beta$ =0.006, $P$<0.001). These results are shown in **Fig. 3**.

GAD-7 scores did not significantly mediate the relationship between ISI scores and either presenteeism ( $\beta$=0.003, $P$=0.140) or absenteeism ( $\beta$=0.001, $P$=0.168) in the AID group, but were a significant mediator for daily-activity impairment (20.70% of the effect, $\beta$=0.005, $P$<0.001). In the CID group, GAD-7 significantly mediated the relationship between ISI scores and presenteeism (53.01% of the effect, $\beta$=0.003, $P$<0.05), and also mediated the relationship between ISI scores and daily-activity impairment (31.70% of the effect, $\beta$=0.006, $P$<0.001; see **Supplemental Appendix S6**).

Finally, ESS scores were not a mediating factor of the relationship between ISI scores and workplace/daily-activity impairment in either group (**Supplemental Appendix S7)**. Further subgroup analyses of the categorically mediating factors revealed consistent mediation results (see **Supplemental Appendix S8)**.

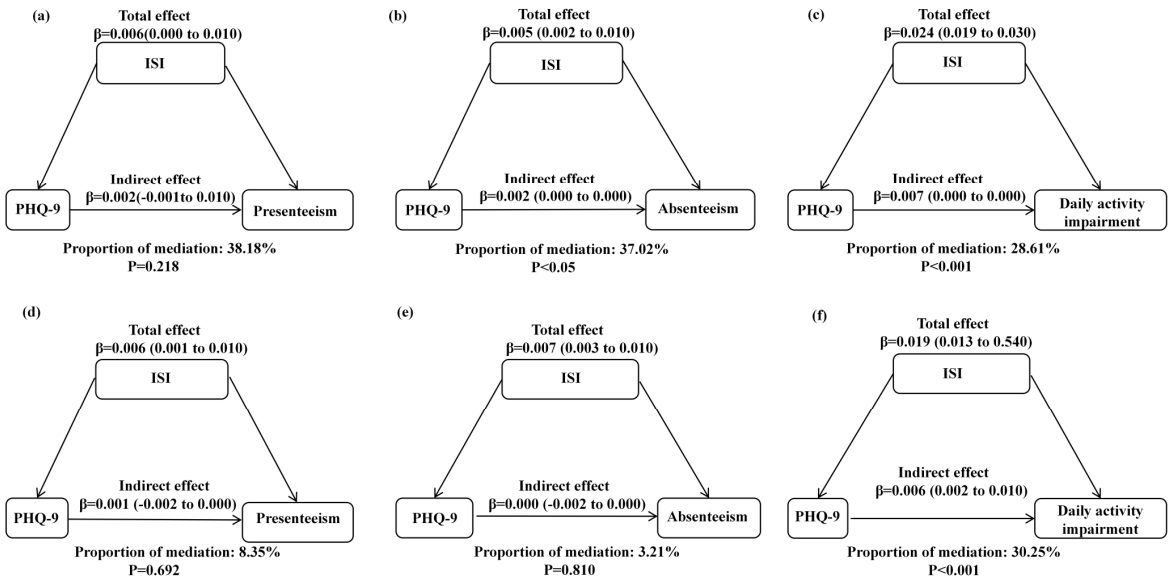


**Fig 3. Mediation analysis model of the relationship between PHQ and workplace impairment and daily activity impairment among AID and CID group.**

a to c mediate analyses in AID group; d to f mediate analyses in CID group. (a) independent variable: ISI score, dependent variable: Presenteeism, mediated variable: PHQ score; (b) independent variable: ISI score, dependent variable: Absenteeism, mediated variable: PHQ score; (c) independent variable: ISI score, dependent variable: Daily

activity impairment, mediated variable: PHQ score; (d) independent variable: ISI score, dependent variable: Presenteeism, mediated variable: PHQ score; (e) independent variable: ISI score, dependent variable: Absenteeism, mediated variable: PHQ score; (f) independent variable: ISI score, dependent variable: Daily activity impairment, mediated variable: PHQ score;

The analyses were adjusted for potential confounders including sex, age, BMI, occupation, income and married status.

Abbreviation: AID: acute insomnia disorder; ISI：Insomnia Severity Index; PHQ-9: 9-item Patient Health Questionnaire.

## 4 Discussion

In this study, there do not appear to be any significant differences between participants with AID and CID in terms of presenteeism and productivity-loss costs. Furthermore, daytime sleepiness, depressive symptoms, and anxiety symptoms are all significantly associated with impairments in both workplace and daily activity. Importantly, depressive and anxiety symptoms play a key mediating role in the relationship between insomnia severity and both workplace and daily-activity impairment, with the pattern of mediation differing between AID and CID. These findings highlight the importance of early identification and targeted intervention for insomnia and emotional symptoms to prevent long-term productivity loss.

Our study indicates that insomnia-related productivity-loss costs are similar for individuals with AID and CID, with an average cost of $537 over three months without treatment. Currently, assessments of productivity-loss costs for insomnia primarily focus on developed countries (Fang et al., 2024). For instance, Thairt et al. (Thiart et al., 2016) reported that insomnia patients experience average productivity-loss costs of approximately $8142 (original currency: € 2,900) over a six-month period without treatment. Although the productivity-loss costs among individuals with insomnia in China are lower than those observed in developed countries, they still accounts for a third of the average three-month wage in China (China, 2024). In light of these findings, adapted economic results should be generated using health technology assessment evidence on the quantification and valuation of insomnia-related productivity loss from countries with similar characteristics to the decision-making country(Chauhan et al., 2023). Given the high prevalence of insomnia, it is essential to conduct further investigations into the economic burden of insomnia in developing countries, with large sample sizes.

This study demonstrates that presenteeism during the acute stage of insomnia disorder is as significant as it is during chronic stages. Specifically, the occurrence of presenteeism is associated with occupational stress factors like heavy job demands and a lack of social support(Janssens et al., 2016; Takano et al., 2023), and these stressors may trigger AID (Kim et al., 2011; Ellis, et al., 2012). Furthermore, individuals with AID frequently report more severe distress, sleep disruption, and stress(Ji et al., 2019; Boyle, et al., 2024), all of which contribute to distraction in the workplace. In individuals with CID, the persistence of insomnia symptoms over time contributes to continuous declines in work efficiency, concentration, and motivation, which in turn result in sustained presenteeism (Kessler et al., 2011; Takano, et al., 2023). However, our results show that patients with CID experience significantly more absenteeism and daily-activity impairment than those with AID. A possible explanation is that CID often combines with medical conditions (e.g., cardiometabolic diseases) or mental-health conditions (e.g., depression)(Perlis et al., 2022), which may require individuals to take time off work to recover. Therefore, early intervention for AID is crucial for maintaining workplace productivity and preventing progression to CID, which may lead to severe

absenteeism. Treatments such as digital cognitive behavioural treatment for AID could be effective(Yang, et al., 2023). Providing digital therapies for use during breaks or after work offers employees convenient treatment without disrupting their work schedules (Espie, et al., 2018; Kjørstad et al., 2022).

We were able to demonstrate a positive linear relationship between depressive symptoms and both absenteeism and daily-activity impairment among individuals with insomnia, which is consistent with previous findings (Beck et al., 2011; Evans-Lacko and Knapp, 2016; Wang et al., 2020; Eßl-Maurer et al., 2022). Notably, we observed a nonlinear association between depressive symptoms and presenteeism in both AID and CID, with a stronger relationship at low levels of depression that diminished as depression severity increased. This result may be explained by underlying neural mechanisms. With mild depression levels, individuals may experience prefrontal-cortex dysfunction, leading to impaired attention and executive function (Salehinejad et al., 2017), yet still attempt to continue working, resulting in presenteeism. As depressive symptoms worsen, dysregulation of neural circuits involved in motivation and energy (e.g., mesolimbic dopamine pathways) may contribute to greater fatigue and anhedonia(Fox and Lobo, 2019), and this severe depression increases the likelihood of absenteeism rather than presenteeism (Beck, et al., 2011; Johnston et al., 2019). Laboratory studies illustrate that both insomnia and depression are associated with altered connectivity in brain regions governing emotional regulation and cognitive control, which may underlie the observed impairments in the workplace(Huang et al., 2012).

Our mediation analysis further reveals that depressive symptoms significantly mediate the relationship between insomnia and both absenteeism and daily-activity impairment in AID. In CID, the mediating effect on absenteeism disappears, while the mediating effect on daily-activity impairment becomes stronger. This may reflect the fact that AID more strongly triggers daily functional impairment by disrupting sleep-dependent emotional regulation and prefrontal-limbic connectivity (Weng et al., 2025). In contrast, individuals with CID may develop compensatory adaptations in the workplace to cope with their negative emotions (Perogamvros et al., 2020); this could weaken the mediating effect of depression on the relationship between insomnia and absenteeism. Meanwhile, the stronger mediating effect of depressive symptoms on daily-activity impairment in the CID group may be attributed to the frequent co-occurrence of other symptoms such as anxiety, which can amplify the negative impact of chronic insomnia on daily functioning. This aligns with our findings on the mediation effects of anxiety symptoms.

Anxiety symptoms appear to be more positively and linearly associated with workplace and daily-activity impairment in AID than in CID. This finding highlights the important role of anxiety symptoms in the onset and development of insomnia in the workplace (Ellis et al., 2021). Anxiety symptoms related to the workplace not only disrupt sleep but also activate the hypothalamic-pituitary-adrenal (HPA) axis (Xue et al., 2025), leading to higher stress responses and further impairments to work productivity and daytime functioning (Xi et al., 2019; Okawara et al., 2024). Compared to AID, mediation analyses in our study revealed that anxiety symptoms play a significantly greater mediating role in the relationship between CID and absenteeism. This indicates that individuals with CID experience more persistent and severe anxiety in its own right(Dressle et al., 2022), and anxiety-related factors of arousal and avoidance behaviour are strong predictors of absenteeism(Hendriks et al., 2015).

We found that significant daytime sleepiness (ESS scores $\geqslant 10$) is strongly associated with greater daily-activity impairment compared to non-significant sleepiness (ESS scores $<10$), in both AID and CID. Notably, this association is stronger for daily-activity impairment in CID, whereas in AID, daytime sleepiness is more closely related to workplace impairment. Pronounced sleepiness is likely to cause neurocognitive deficits, contributing to daytime functional impairments(Hein et al.,

2017). Previous evidence illustrates that insomnia with physiological hyperarousal is more strongly linked to neurocognitive performance deficits (Edinger et al., 2021). According to Spielman's 3P model, AID is widely acknowledged to be initiated by predisposing factors of physical and/or psychological arousal, while CID is thought to be generated by perpetuating factors of long-term negative behaviors and cognitions(Ellis, et al., 2021). Therefore, daytime sleepiness among those with AID may reduce workplace performance by causing neurocognitive deficits, while for those with CID it may cause a deterioration in daily activity through wrong behaviors or beliefs due to excessive daytime rest. However, these results should be interpreted with caution, as our findings indicate that daytime sleepiness directly affects both workplace and daily activity impairment, rather than acting as a mediating factor. The complexity of the relationship between daytime sleepiness and workplace or daily-activity impairment in individuals with insomnia warrants further investigation.

## 5 Limitations and future directions

Our study has both strengths and limitations.We used standard clinical criteria to diagnose insomnia disorder in our sample, and this is the first study to explore the relationships between different stages of insomnia and workplace impairment. One limitation of the study is the lack of objective data on presenteeism and absenteeism. Self-assessments of workplace impairment are prone to biases such as recall bias. In addition, the use of a cross-sectional design prevents us from establishing causality between variables. Longitudinal studies would be necessary to examine changes in workplace performance over time and identify causal factors. Finally, our research here focuses on patients with insomnia disorder. This may limit the applicability to broader populations, such as those who have insomnia symptoms caused by other mental conditions or physical conditions.

## 6 Conclusions

Our study sheds light on workplace impairment in acute insomnia disorder, with similar effects found in chronic insomnia disorder. Early identification of AID provides an opportunity to prevent long-term work productivity loss. Depressive and anxiety symptoms mediate the relationship between insomnia and workplace performance in both AID and CID. Future research should focus on cost-effective and specific strategies for insomnia and negative emotions to inform workplace health policies.

**Data availability statement**

The data set used or analyzed during the current study is available from the corresponding author on reasonable request.

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**Author contributions**

Leqin FANG, Shixu DU, Bin ZHANG and Sufei ZENG designed the study. Leqin FANG, Shixu DU, Hangyi YANG and Xue LUO collected the data and conducted the statistical analysis. Leqin FANG, Shuqiong ZHENG and Shufei ZENG interpreted the results. Leqin FANG and Shixu DU wrote the first draft of the manuscript. Hangyi YANG, Xue LUO, Zhiting HUANG, Shuqiong ZHENG, Hangyi YANG, Shufei ZENG and Bin ZHANG revised the manuscript. All authors contributed to and approved the final version of the manuscript.

**Compliance with ethics guidelines**

Leqin FANG, Shixu DU, Hangyi YANG, Xue LUO, Shuqiong ZHENG, Zhiting HUANG, Yuhan ZHAO, Shufei ZENG, Bin ZHANG declare that they have no conflict of interest.

All procedures followed were in accordance with the ethical standards of the Medical Ethics Committee of Nanfang Hospital of Southern Medical University (ethical approval No.NFEC-202307-K30). Written informed consent was obtained from all participants. All methods were carried out in accordance with relevant guidelines and regulations.

**Declaration on the Use of Generative AI Tools**

During the preparation of this work the author(s) used Claude in order to improve the language of several paragraphs. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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**Supplementary information**

Appendix S1.

Appendix S2.

Appendix S3.

Appendix S4.

Appendix S5.

Appendix S6.

Appendix S7.

Appendix S8.