

# Sex-Specific Moderation Effect of Age on the Associations Between Insomnia Symptoms and Various Psychological Distresses

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**Background:** Insomnia is closely related to psychological distress. This study aims to examine the role of age and sex in the association between various psychological distresses and insomnia symptoms.

**Participants and Methods:** This population-based study used data provided by cumulative respondents of the annual survey of the Taiwan Suicide Prevention Center between 2006 and 2019. Potential respondents were aged  $\geq 15$  years and were selected by a stratified proportional randomization method according to the distribution of population size, sex, and age in different geographic areas of Taiwan. The Five-Item Brief Symptom Rating Scale was used to measure insomnia symptoms and four psychological distresses: depression, anxiety, hostility, and inferiority. The independent relationship between insomnia symptoms with depression, anxiety, hostility, and inferiority was further examined according to age and sex.

**Results:** A total of 28,649 participants were included (women, 50.2%). The four types of psychological distress correlated differentially with insomnia symptoms. Concerning interaction effects, sex moderated the interaction effects between age with depression, anxiety, and hostility. In men, and not in women, age moderated the relationship between insomnia symptoms and all four psychological distresses. Specifically, the effect sizes of the associations between insomnia symptoms and depression, anxiety, and hostility showed an age-dependent decreasing trend in men.

**Conclusion:** The associations between psychological distresses and insomnia symptoms varied in strength and according to age in a sex-specific manner.

**Keywords:** insomnia symptoms, moderation effect, psychological distress, sex-specific

## Introduction

Emotional regulation is a key function of sleep,<sup>1</sup> and the literature suggests that sleep-wake regulation and emotional control may share common neurobiological underpinnings.<sup>2,3</sup> Because insomnia features differential strengths of association with various physical<sup>4</sup> and psychiatric disorders,<sup>5,6</sup> insomnia is also considered to have different, but close, patterns of associations with various forms of psychological distress as well.<sup>7-9</sup>

The nature of stressors and stress responses from which psychological distress originates differs according to sex and evolve across age;<sup>10</sup> hence, the association between insomnia and psychological distresses might also differ with sex and age. Concerning age, insomnia features the strongest association with depressive symptoms during adolescence.<sup>11</sup> By contrast, depressive symptoms in older adults are

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more closely associated with daytime sleepiness than insomnia.<sup>12,13</sup> The abundant epidemiological research on insomnia has focused more on the effect of age on insomnia rather than on how factors correlated with insomnia change with age. The promise of the latter avenue of research is demonstrated by the finding that age moderates the relationship between insomnia and quality of life, hypnotics use, and marital status.<sup>14</sup> However, whether the associations between insomnia and various forms of psychological distresses present to similar degrees in both younger and older adults remains unclear.

Various aspects of insomnia also reportedly differ according to sex: eg, prevalence rates,<sup>15</sup> age of onset,<sup>16</sup> psychosocial correlates,<sup>17,18</sup> symptoms,<sup>19</sup> pathophysiology,<sup>20</sup> and psychiatric comorbidities.<sup>21</sup> Further, women with major depressive disorders have a higher risk of developing sleep disturbances,<sup>22</sup> including hypersomnia,<sup>23</sup> than do men. Similar findings were observed in adolescence: girls with emotional disturbances were at higher risk of developing sleep problems than were boys in the follow-up study.<sup>24</sup> By contrast, the depressive symptoms of boys were more likely to co-occur with insomnia than were those of girls.<sup>25</sup>

Understanding how the association between forms of psychological distress and insomnia change according to age and sex is important to tailoring specific treatment strategies.<sup>26</sup> Hence, sampling randomly from a nationally representative dataset of the Taiwanese population, the present study sought to (1) investigate the associations between various forms of psychological distress and insomnia symptoms using the Five-Item Brief Symptom Rating Scale (BSRS-5), (2) assess the effects of age on the associations identified in (1), and (3) evaluate the extent to which the effects identified in (2) differed according to sex.

## Participants and Methods

### Participants

The present population-based study used the data provided by cumulative respondents to the annual survey performed by the Taiwan Suicide Prevention Center from 2006 to 2019; a computer-assisted telephone interview system is used to select potential participants from a database of landline telephone numbers, which was sampled with a stratified proportional randomization method based on the distribution of population size, age, and sex in different geographic areas of Taiwan.<sup>27</sup> Approximately 2100 participants were recruited each year for analysis (with

a sampling error of +2.10% in 95% confidence interval). All participants were aged  $\geq 15$  years old and agreed to participate in the survey anonymously. All data were collected by well-trained interviewers over the telephone. The representation of the sample is ensured by the chi-square goodness-of-fit test and the raking weighting method. In addition to collecting the participants' results on the BSRS-5, we obtained basic demographic data, including age, sex, level of education, marital status, and occupation.

### Ethical Approval

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All participants provided oral consent prior to survey commencement by telephone interview. This study was approved by the Institutional Review Board of the National Taiwan University Hospital (N0. 201204034RIC).

### Assessment of Psychological Distress Using the BSRS-5

This study used the BSRS-5 to measure four dimensions of common psychological distresses and insomnia. The BSRS-5 is a five-item self-report questionnaire with a total score cut-off of six or more (sensitivity: 78.0%; specificity: 74.3%) for the identification of psychiatric morbidity and the global severity of clinical symptoms.<sup>28,29</sup> Brief instruction was provided to the participants before the administration of BSRS-5 to ensure its validity. Participants were asked to rate the degree to which they felt distressed from each dimension of BSRS-5 during the week preceding the assessment. The BSRS-5 contains the following five items: (1) feeling tense or keyed up; (2) feeling blue; (3) feeling easily annoyed or irritated; (4) feeling inferior to others; and (5) having trouble falling asleep, for example, initial, maintenance, and late insomnia. A 5-point Likert system was used to rate each item of the BSRS-5 as follows: 0, not at all; 1, a little bit; 2, moderately; 3, quite a bit; 4, extremely. A total score was calculated for each respondent. The five items of the BSRS-5 represent the psychopathology of anxiety, depression, hostility, inferiority, and insomnia, respectively. The insomnia item of the BSRS-5 was used as the dependent variable for the following statistical analyses.

## Statistical Analyses

Statistical Analysis System (version 9.1, SAS Institute) was used for all analyses. In addition to performing descriptive statistics, independent Student's *t*-tests or ANOVA tests were used to compare the severity of insomnia symptoms according to sociodemographic and clinical variables for univariate analyses. A Spearman's rank correlation analysis was used to evaluate the linear relationship between insomnia symptoms and the other four items in the BSRS-5. For the multivariable analyses, multiple ordinal logistic regression analyses were used to assess the independent associations between the four dimensions of psychological distresses with the severity of insomnia symptoms. In addition to the survey year, all sociodemographic factors that differed significantly according to the severity of insomnia symptoms were specified into the ordinal logistic regression models to control for the confounding effects. To prevent collinearity between the four dimensions of the psychological distresses, each form of psychological distress was specified into separate ordinal logistic regression models as the independent variable. To examine the moderation effect of age, the statistical significance for the interaction terms of each psychological distress with age was tested. Three-way interaction terms for sex, age, and each psychological distress were also evaluated to examine if there is a sex difference in the interaction effects between age and each psychological distress. Analyses were then stratified by sex to illustrate sex-based differences in the moderation effect of age. The statistical significance level was set to  $p < 0.05$ .

## Results

A total of 28,649 individuals (women, 50.2%) participated in the surveys. Table 1 summarizes the relationship between sociodemographic characteristics and clinical variables according to the severity of insomnia symptoms. Participants who were older, women, less educated, divorced/widowed, or unemployed were associated with more severe insomnia symptoms. Those whose total BSRS-5 scores exceeded 5 had more severe insomnia symptoms (Table 1).

Table 2 illustrates the between-item associations of the BSRS-5; all the associations were statistically significant, with Spearman's rank correlation coefficients ranging from 0.21 to 0.50. Specifically, the correlation coefficients of insomnia symptoms with the other four items of the BSRS-5 ranged from 0.21 to 0.32. Depression had the

**Table 1** Characteristics of Participants (n=28,649)

	Total	Severity of Insomnia Symptoms	p for t-test/ANOVA
	n (%)	Mean±SD	
<b>Age (years)</b>			
< 25	4570 (16.0)	0.25±0.65	<0.001
25–34	5354 (18.7)	0.38±0.78	
35–44	5445 (19.0)	0.40±0.81	
45–54	5282 (18.5)	0.45±0.85	
55–64	4018 (14.0)	0.49±0.89	
≥ 65	3949 (13.8)	0.49±0.90	
<b>Sex</b>			
Men	14,260 (49.8)	0.36±0.79	<0.001
Women	14,389 (50.2)	0.45±0.84	
<b>Education</b>			
College and above	9606 (33.5)	0.33±0.72	<0.001
Senior high school and below	18,970 (66.2)	0.45±0.86	
<b>Marital status</b>			
Single	9009 (34.0)	0.35±0.76	<0.001
Married	16,444 (62.0)	0.42±0.81	
Divorced/widowed	953 (3.6)	0.75±1.13	
<b>Job status</b>			
With current job	16,213 (56.6)	0.39±0.79	<0.001
Without current job	12,388 (43.2)	0.44±0.85	
<b>Brief Symptom Rating Scale</b>			
≥ 6	2141 (7.5)	1.87±1.33	<0.001
<5	26,508 (92.5)	0.29±0.62	

strongest correlation with insomnia symptoms, and inferiority the weakest.

Table 3 summarizes the independent associations between the various forms of psychological distress with insomnia symptoms. All four common psychological distresses remained correlated with insomnia symptoms after controlling for covariates. Depression was most to accompany insomnia symptoms in aggravating a respondent (odds ratio (OR): 3.01, 95% confidence interval (CI): 2.90–3.13). While inferiority also correlated with insomnia symptoms, its effect size was the smallest of the four forms of psychological distress (OR: 2.21, 95% CI: 2.13–2.30). Specifically, the point estimate and 95% CI of inferiority did not overlap with any of the other three psychological distresses. The details of the full models were summarized in [Supplementary Table S1](#). Once stratified according to age, the severity of four forms of psychological distress remains significantly correlated

**Table 2** Spearman's Rank Correlation Analyses for the Items of BSRS-5

	1	2	3	4	5	6	7
1. Trouble falling asleep	1						
2. Feeling tense or keyed up	0.30*	1					
3. Feeling easily annoyed or irritated	0.29*	0.43*	1				
4. Feeling blue	0.32*	0.46*	0.50*	1			
5. Feeling inferior to others	0.21*	0.37*	0.36*	0.39*	1		
6. Total scores of BSRS-5	0.65*	0.61*	0.69*	0.67*	0.57*	1	
7. Total scores of BSRS-5 except for the sleep item	0.35*	0.66*	0.76*	0.72*	0.64*	0.91*	1

Note: \* $p < 0.01$ .

Abbreviation: BSRS-5, the Five-Item Brief Symptom Rating Scale.

**Table 3** The Ordinal Logistic Regression Analyses Examining the Individual Relationship Between Various Psychological Distresses with Insomnia Symptoms, Stratified by Age\*

Psychological Distresses	Insomnia Symptoms							p-value for Age Interaction
	Total	Age						
		< 25	25–34	35–44	45–54	55–64	≥ 65	
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	
Anxiety	2.89 (2.78–3.00)	3.14 (2.83–3.48)	3.38 (3.09–3.69)	2.84 (2.60–3.10)	2.90 (2.66–3.17)	2.74 (2.47–3.04)	2.21 (1.98–2.47)	<0.001
Hostility	2.70 (2.60–2.79)	3.11 (2.82–3.43)	2.62 (2.42–2.82)	2.56 (2.37–2.76)	2.78 (2.57–3.02)	2.68 (2.42–2.97)	2.55 (2.30–2.84)	0.06
Depression	3.01 (2.90–3.13)	3.14 (2.83–3.48)	3.06 (2.81–3.33)	2.96 (2.73–3.22)	3.33 (3.05–3.64)	2.87 (2.60–3.17)	2.63 (2.35–2.93)	0.08
Inferiority	2.21 (2.13–2.30)	2.32 (2.11–2.55)	2.39 (2.20–2.59)	2.05 (1.89–2.23)	2.35 (2.16–2.56)	1.87 (1.70–2.06)	2.31 (2.06–2.59)	< 0.001

Note: \*All models adjusted for sex, age, education, marital status, job status, and survey year.

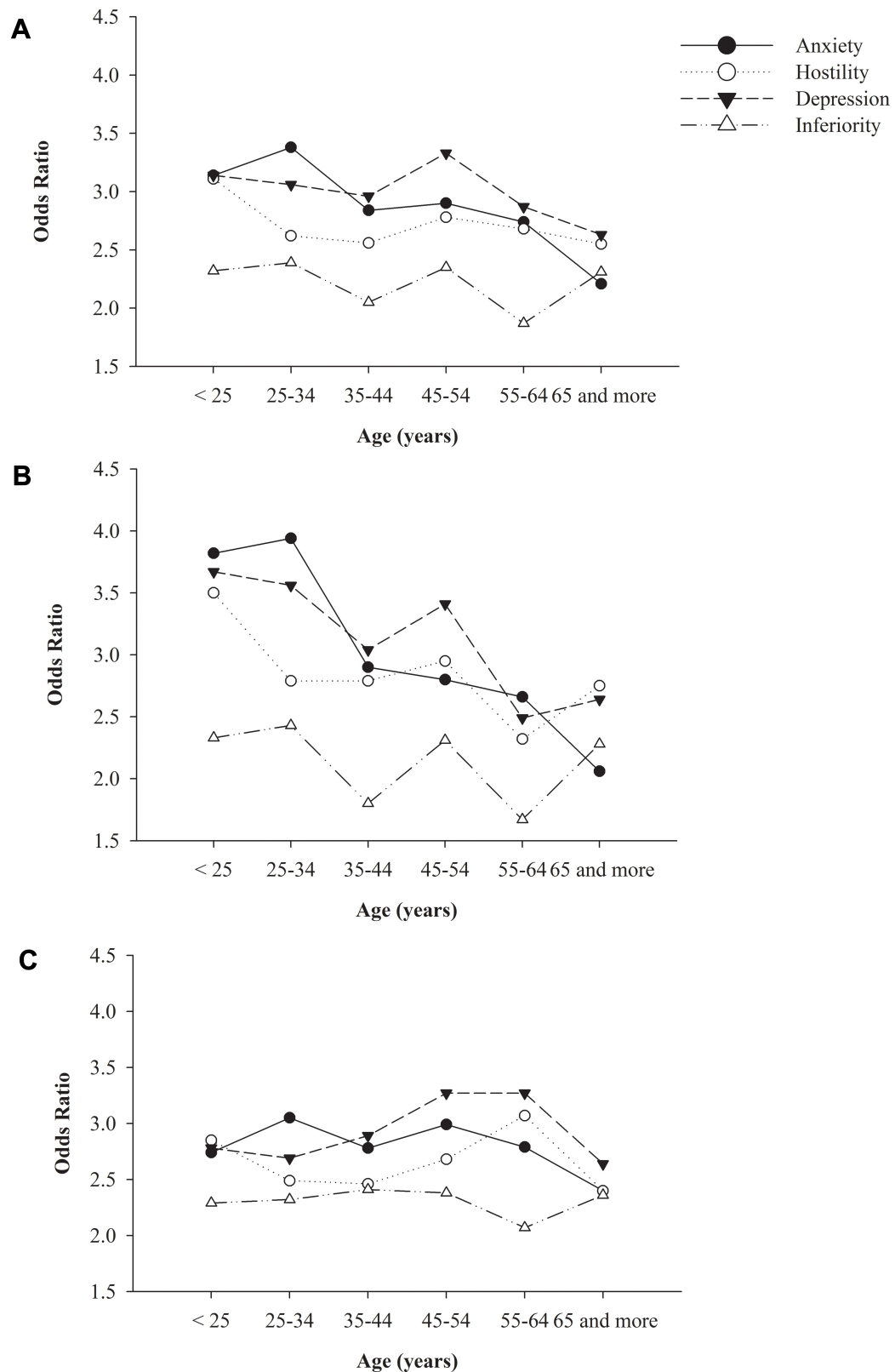
with that of insomnia symptoms across all age spans. However, the strength of these associations varied with age (Figure 1A). Thus, the interaction between each type of psychological distress with age was examined, revealing that age moderates the relationship between anxiety ( $p$  for the interaction term  $< 0.001$ ) and inferiority ( $p$  for the interaction term  $< 0.001$ ) with insomnia symptoms.

To examine whether there are sex differences in terms of the interaction effects between age and each psychological distress, the three-way interaction terms (sex X, age X, each psychological distress) were tested. The results showed that, except for “feeling inferiority to others” ( $p = 0.22$ ), the three-way interaction terms are significant for “feeling tense or keyed up” ( $p < 0.001$ ), “feeling easily annoyed or irritated” ( $p < 0.001$ ), and “feeling blue” ( $p < 0.001$ ). When further stratified by sex, the overall association patterns remained: depression had the greatest effect size, and inferiority the smallest (Tables 4 and 5). The details of the full models for both sexes were summarized in Supplementary Tables S2 and S3. In terms of the moderation effect of age, all of the associations between the four dimensions of psychological distresses with insomnia were significantly moderated by age among men (Table 4). The strength of the associations between the three psychological distresses other than inferiority with insomnia illustrates an

age-dependent decreasing trend (Figure 1B). In terms of inferiority, the strength of associations followed an age-related pattern, in which the age group of 35–44 years (OR: 1.80, 95% CI: 1.61–2.02) and 55–64 years (OR: 1.67, 95% CI: 1.45–1.91) have the smallest effect size. The effect sizes and their 95% CI between inferiority with the other three psychological distresses did overlap after the age of 65. By contrast, no moderation effects of age were detected among women (Table 5). The relative effect sizes across life span were similar for the four psychological distresses among women (Figure 1C).

## Discussion

By sampling from the cumulative respondents to a national survey, the present study examined the patterns of association between common forms of psychological distress with insomnia symptoms and how they differed with age and sex. Our findings indicate that various psychological distresses correlate with insomnia symptoms; the effect sizes of these associations differ in magnitude and are moderated differentially by age among men. To the best of our knowledge, the present study is the first to report the moderation effect of age and its dependence on sex.



**Figure 1** The age trends of the associations between various psychological distresses and insomnia symptoms. Panel (A) total participants, (B) men, (C) women.

**Table 4** The Ordinal Logistic Regression Analyses Examining the Individual Relationship Between Various Psychological Distresses with Insomnia Symptoms in Men, Stratified by Age\*

Psychological Distresses	Insomnia Symptoms							p-value for Age Interaction
	Total	Age						
		< 25	25–34	35–44	45–54	55–64	≥ 65	
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	
Anxiety	2.98 (2.82–3.16)	3.82 (3.25–4.50)	3.94 (3.44–4.50)	2.90 (2.55–3.31)	2.80 (2.47–3.18)	2.66 (2.29–3.10)	2.06 (1.75–2.42)	<0.001
Hostility	2.81 (2.67–2.96)	3.50 (3.01–4.07)	2.79 (2.48–3.13)	2.79 (2.48–3.13)	2.95 (2.61–3.33)	2.32 (2.02–2.67)	2.75 (2.36–3.20)	0.03
Depression	3.13 (2.96–3.30)	3.67 (3.14–4.30)	3.56 (3.14–4.04)	3.04 (2.69–3.42)	3.41 (2.99–3.89)	2.49 (2.16–2.86)	2.64 (2.26–3.08)	< 0.001
Inferiority	2.12 (2.01–2.23)	2.33 (2.02–2.69)	2.43 (2.16–2.73)	1.80 (1.61–2.02)	2.31 (2.06–2.60)	1.67 (1.45–1.91)	2.28 (1.95–2.67)	<0.001

**Note:** \*All models adjusted for sex, age, education, marital status, job status and, survey year.

**Table 5** The Ordinal Logistic Regression Analyses Examining the Individual Relationship Between Various Psychological Distresses with Insomnia Symptoms in Women, Stratified by Age\*

Psychological Distresses	Insomnia Symptoms							p-value for Age Interaction
	Total	Age						
		< 25	25–34	35–44	45–54	55–64	≥ 65	
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	
Anxiety	2.81 (2.67–2.97)	2.74 (2.39–3.13)	3.05 (2.71–3.44)	2.78 (2.47–3.14)	2.99 (2.64–3.38)	2.79 (2.42–3.22)	2.40 (2.06–2.80)	0.47
Hostility	2.62 (2.49–2.75)	2.85 (2.50–3.25)	2.49 (2.25–2.75)	2.46 (2.22–2.72)	2.68 (2.39–2.99)	3.07 (2.65–3.56)	2.40 (2.07–2.79)	0.07
Depression	2.92 (2.77–3.07)	2.78 (2.41–3.19)	2.69 (2.39–3.03)	2.89 (2.57–3.24)	3.27 (2.90–3.70)	3.27 (2.84–3.77)	2.64 (2.25–3.09)	0.42
Inferiority	2.31 (2.19–2.44)	2.29 (2.02–2.60)	2.32 (2.07–2.60)	2.41 (2.14–2.72)	2.38 (2.10–2.70)	2.07 (1.81–2.38)	2.36 (1.99–2.79)	0.67

**Note:** \*All models adjusted for sex, age, education, marital status, job status and, survey year.

## Different Strengths of Associations Between Various Psychological Distresses and Insomnia Symptoms

The forms of psychological distress measured by the BSRS-5 have also been included in several psychometric scales for measuring depression symptomology.<sup>30–32</sup> Depression, anxiety, and hostility are categorized as affective symptoms; inferiority as a cognitive symptom; and insomnia as a somatic symptom. A recent network analysis revealed different associations between the items of the inventory of depressive symptomatology. Specifically, depression was partially associated with insomnia, but irritability (a symptom of hostility), anxiety, and interpersonal hypersensitivity (a symptom of inferiority) were not directly associated with insomnia.<sup>33</sup> Our findings also agreed with the previous observation of different co-worsening patterns between insomnia symptoms and the four psychological distresses. Specifically, when compared with the cognitive symptom of inferiority, affective symptoms (depression, anxiety, and hostility) measured by the BSRS-5 were more likely to worsen in tandem with

insomnia symptoms. The greater effect size between affective symptoms and insomnia may be attributable to the subcortical areas that underlie both emotion control and sleep-wake regulation.<sup>1</sup> Furthermore, affective symptoms are often the final common pathway for various psychopathologies that might trigger insomnia. An indirect association between insomnia symptoms and the cognitive symptom of inferiority mediated by affective symptoms would account for the smaller effect size of their association.

## Sex-Specific Moderation Effect of Age

Previous research has indicated that the strengths of the associations between common mental disorders and insomnia do not vary with age.<sup>14</sup> When analyzing the participants as one group, we found that age only moderated the relationships between insomnia symptoms and anxiety or inferiority. When we stratified the analysis according to sex, age was found to moderate all four forms of psychological distresses among men. By contrast, the association between any form of psychological distress



and insomnia symptoms retained a similar degree of strength across life among women.

Age-dependent decline of effect sizes among men was found in the relationships between depression, anxiety, and hostility with insomnia symptoms. These findings may be ascribed to the well-documented age-dependent increase in the prevalence of insomnia;<sup>34,35</sup> eg, relative to young adults, older adults with depression report more somatic symptoms and less affective-cognitive symptoms.<sup>36–38</sup> By contrast, the weakest association between the severity of inferiority and insomnia symptoms was found among middle-aged men. As mid-life crises experienced by men may encompass inferiority, middle-aged men may adapt with greater ease to changes in inferiority as a normal developmental task and not necessarily suffer from sleep-wake disturbances as a result. However, no moderation effect of age was identified in women. This finding may be ascribed to sex-based differences in sleep physiology, life experiences, and social expectations.<sup>39</sup>

## Sex-Based Differences in the Moderation Effect of Age

In sleep physiology, sleep structure changes with normal aging: total sleep duration, rapid eye movement, slow-wave sleep, and sleep efficiency decrease, while arousal rates increase.<sup>40</sup> The normal aging process increases the risk of insomnia that may not accompany an increased risk of psychological distress. Compared with older men, older women experience greater decreases in total sleep duration and sleep efficiency across age.<sup>41</sup> This difference may expose older women to a heightened risk of developing psychological distress, which shares a pathological mechanism with the deterioration of sleep function.<sup>42</sup> Eventually, the sex difference in the aging process of sleep physiology leads to comparable strength of association between psychological distresses and insomnia symptoms in the late life of women.

The previous study also found that women are more likely to be predisposed to psychological distresses and insomnia across all age groups,<sup>43–45</sup> report mental distress and somatic symptoms,<sup>23</sup> and rank psychological distresses as the main cause of insomnia.<sup>18</sup> By contrast, men are more likely to express emotional distress by non-affective manners with age due to social expectations and an increased self-inhibition in emotional expression.<sup>46,47</sup> Meanwhile, men are also more likely to rank job stress, as the main cause of insomnia.<sup>18</sup> These sex-based differences

may also contribute to the comparable associations between the severity of psychological distress with insomnia symptoms in younger and older women.

## Implications

Our findings have several implications. First, the differential effect sizes between various psychological distresses and insomnia symptoms suggest that affective symptoms, compared with cognitive symptoms, may induce different levels of hyperarousal. Furthermore, the moderation effect of age suggests that the impact of psychological distresses on the arousal system (arousability) may vary with age, particularly in males. Because emotional and cognitive hyperarousal has been defined as one of the core components in the modern pathomechanism models of insomnia,<sup>52,53</sup> our findings of age- and sex-specific effects help to refine the current theoretical schema. Second, a shared biological vulnerability has been suggested in individuals who had co-occurring mood disorders and insomnia and those who had insomnia only;<sup>54</sup> our findings echo the elevated risk of mood disturbances in individuals with insomnia symptoms. Besides, the age- and sex-specific effect further implicates that young males who have insomnia symptoms might be exposed to a higher risk of concurrence or of developing psychological distresses. This finding suggests the significance of public health to investigate and intervene in insomnia symptoms in young males.

## Limitations

This study is subject to several limitations. First, its cross-sectional design precluded causal inferences and the distinction between age and cohort effects. Second, participants in this study joined the annual survey anonymously. Hence, we risked having sampled duplicated data. However, the number of eligible participants ranged between 18 and 20 million between 2006 and 2019.<sup>48</sup> Hence, the risk of duplicated participants should be very low. Third, physical morbidities were not controlled for in this study. The association between psychological distresses with insomnia symptoms could be biased away from the null under the confounding effect of physical comorbidities. Because physical illness is more prevalent in older adults, while we expect the moderation effect of age to remain even if the confounding effects of physical morbidities are partialled out, it is unclear whether the sex-based differences would persist. Besides, even if the prevalence of physical morbidities increases with age, the association between physical morbidities and major depressive disorder is reportedly low among older adults.<sup>49</sup>

Hence, the possible confounding effects of physical morbidities in this study might be modest. Fourth, we did not control for the influence of hypnotics use, which is expected to compromise the strength of the association between psychological distresses and insomnia symptoms. Because hypnotics are used more frequently with age,<sup>50</sup> the confounding effects of hypnotics use may inflate the moderation effect of age in both sexes. However, the robustness of the male-specific moderation effect of age in this study is assured by the lack of this finding among the women respondents – despite the more frequent use of hypnotics among older women than men in Taiwan.<sup>51</sup> Finally, in order to prevent statistical collinearity, this study only specified one type of psychological distress in each regression model. Hence, co-occurrences of psychological distresses may also confound our main findings, including the sex-specific moderation effect. However, the higher rates of co-occurring psychopathologies could not explain the higher rate of insomnia among women.<sup>17,18</sup> This evidence mitigates the impact of confounding co-occurring psychopathologies on our main findings.

## Conclusions

The strong association between insomnia symptoms and non-psychotic psychopathology renders insomnia symptoms an effective probe to detect various psychological distresses, especially in a culture that tends to somatize psychopathology.<sup>55</sup> The data presented herein expands our knowledge of how age influences the associations between common psychological distresses and insomnia symptoms, help to gain insight into the underlying psychopathology that co-occurs with insomnia symptoms across life, and will help to inform the development of tailored interventions to address insomnia symptoms. Mechanisms that underlie age-mediated moderation of insomnia symptoms and its sex-based differences warrant further investigation.

## Abbreviations

BSRS-5, the Five-Item Brief Symptom Rating Scale; CI, confidence interval; OR, odds ratio.

## Data Sharing Statement

All data and materials related to the study can be obtained by contacting the corresponding author.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors report no financial or non-financial conflicts of interest for this work.

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