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Stress, Anxiety, Depression, Burnout and Insomnia Among Greek Nurses One Year After the End of the Pandemic: A Moderated Chain Mediation Model

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Abstract: Background: Several studies have reported alarming rates of mental health issues and sleep problems among nurses even in the post-pandemic era. **Objectives**: To investigate the prevalence of stress, anxiety, depression, burnout and insomnia among nurses in Greece one year after the end of the pandemic and to construct a mediation model evaluating the impact of stress on insomnia, the chain mediating roles of depression and burnout, as well as the moderating role of anxiety in the model. **Methods**: This cross-sectional study was conducted online in July 2024 and included 380 hospital nurses who completed the Depression Anxiety Stress Scale (DASS-21), the Copenhagen Burnout Inventory (CBI) and the Athens Insomnia Scale (AIS). **Results**: The prevalence rates of stress, anxiety, depression, burnout and insomnia were 33.9%, 33.3%, 35%, 46.8% and 56.1%, respectively. Multiple regression analysis indicated that the Depression subscale of the DASS-21 explained 40.6% of the variance in AIS, while an additional 7.6% was explained by CBI and another 1.3% rate by the Stress subscale of the DASS-21. Mediation analysis revealed that stress affected insomnia both directly and indirectly through the chain mediating roles of depression and burnout. Anxiety moderated the chain mediation path by enhancing the negative impact of stress on depression. **Conclusions**: The proposed moderated chain mediation model introduces certain factors influencing insomnia and explains how changes in any one of these factors effectuate changes in the other factors, offering insights for individualized interventions.

Keywords: stress; anxiety; depression; burnout; insomnia; nurses

1. Introduction

The COVID-19 pandemic lasted almost three years, from 30 January 2020 when the World Health Organization (WHO) designated the outbreak as a Public Health Emergency of International Concern (PHEIC) [1] and labeled it a pandemic on 11 March 2020 [2], until 5 May 2023 when the WHO announced its official conclusion [3]. The onset of the pandemic completely overwhelmed the health systems in most countries. Major deficiencies of ventilators, intensive care beds, personal protective equipment and significant shortages of health workers exposed the flawed health policies implemented in previous years. Notably, the pandemic had a profound social, economic and psychological impact on populations worldwide, fundamentally changing daily life and affecting public health, far beyond the direct impact of the virus itself [4,5]. Psychological distress prevailed during the pandemic [6], with reports showing increased rates of insomnia, anxiety, depression, stress and burnout among health care workers, particularly nurses [7]. Prolonged and close interaction with patients combined with increased exposure to their emotional distress possibly explains the particular vulnerability of nurses [8].

 doi:10.20944/preprints202412.2393.v1

Sleep disturbances among nurses during the pandemic have understandably drawn plenty of attention from researchers, as they can contribute to physical and mental health problems and are associated with an increased risk of workplace errors; burnout and job change [9–12]. Insomnia, shift work causing circadian rhythms disruption and insufficient sleep are common among nurses, especially hospital nurses who almost exclusively engage in shift work [13,14]. During the pandemic nurses were constantly faced with stressful situations while navigating through complicated procedures of care and treatment. Chronic exposure to increased amounts of stress often causes insomnia [15], whereas good quality sleep protects against the negative impact of stress. Studies during the pandemic reported that insomnia in nurses was associated with stress, anxiety, depression and burnout [16–20]. Results from these studies suggested that insomnia may have a negative effect on depression and anxiety and lead to burnout in nurses [21].

According to the 11th revision of the International Classification of Diseases (ICD-11), the code QD85 is attributed to burnout syndrome which is considered to result from ongoing work-related stress that has not been effectively addressed and resolved [22]. The main component of this syndrome is the feeling of exhaustion experienced by professionals in the occupational context, which is significantly related to job dissatisfaction [23,24]. Healthcare professionals were among the first individuals in the workforce in whom burnout syndrome was investigated [25]. All studies over the past few decades consistently reported high levels of burnout in nursing staff **[26–30]** and simultaneously evidenced constantly high associations of burnout with depression and anxiety [31,32].

The significant correlation between burnout and depression was established from the first publications examining the nature of burnout [33]. This association has prompted several scholars to argue that burnout is likely to be a form of depression [34,35]. However, typical symptoms of depression such as low self-esteem, feelings of guilt, hopelessness and suicidal tendencies are not typical symptoms of burnout. On the other hand, in burnout extended removal from work on vacation has beneficial effects, whereas a depressive episode necessitates psychotherapeutic intervention and/or medication. Research suggests that depression is a significant factor influencing burnout levels of nursing staff [36,37] and previous literature converges on the view that burnout likely acts as a predisposing factor increasing the risk of depression [38–40].

Stress is implicated in the etiology of depression and people who report chronic stress are more likely to be diagnosed with a depressive disorder [41,42]. By definition burnout is understood as the outcome of prolonged unresolved occupational stress [43]. Employment conditions and workload predict anxiety and perceived stress among employees and lack of administrative support is the most important factor responsible for the increase in anxiety [44]. According to research, anxiety and depression are important factors affecting burnout of nurses [32]. Moreover, scholars have investigated the correlation between insomnia and workplace stressors [45]. Consequently, nurses who work in stressful and demanding settings are at increased risk for insomnia, anxiety, depression and burnout [46].

Numerous studies have documented the prevalence of these aforementioned mental health issues among nurses [47,48] but few have focused on their interrelations [49,50] and examined their mediating effects in one model [21,46,51–56]. Also, past and current studies after the official conclusion of the pandemic reveal that these psychological effects could persist for a long time [57–64]. Therefore, in this study we aim to assess the levels and explore the interrelations among stress, anxiety, depression, burnout and insomnia in nurses working in Greek hospitals one year after the end of the pandemic. We are not aware of previous research investigating the chain mediating effects of depression and burnout as well as the moderating role of anxiety in the linkage between stress and insomnia. To address this objective we formulated the following hypotheses:

Hypothesis 1: Stress is positively associated with and predicts insomnia.

Hypothesis 2: Depression mediates the effect of stress on insomnia.

Hypothesis 3: Burnout mediates the effect of stress on insomnia.

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Hypothesis 4: Stress impacts insomnia through a chain mediation effect of depression and burnout.

Hypothesis 5: Anxiety moderates the relationship between stress and depression. The higher the anxiety is, the stronger the positive association between stress and depression will be, and the stronger the chain mediation effect of depression and burnout in the relationship between stress and insomnia.

2. Materials and Methods

2.1. Research Design

To address the above objectives we conducted a cross-sectional study using a homogeneous convenience sampling method [65]. Recruited participants were nurses working in Greek hospitals with a minimum of one year of professional experience. The data were collected via Google Forms and the online questionnaire was shared electronically through the email addresses retrieved from scientific and professional registries of Greek nurses. The invitation email delivered to participants included an anonymous link that provided access to the Google Forms online research platform. Consenting participants declared that they agree to participate voluntarily by marking the "I agree" option as stated on the first page of the online questionnaire, which was considered informed consent. The sample for this study included nurses who consented to take part and subsequently filled out the other sections of the online questionnaire.

2.2. Study Participants

The study was conducted in July 2024. To determine the sample size, given that the target population was 27,103 individuals, and with a confidence level of 95%, a confidence interval of 5%, and an assumption of a 50% response rate, a minimum sample size of 379 participants was required [66]. A total of 500 invitations were emailed, with 380 responses received (response rate: 76%).

2.3. Ethical Considerations

This study was conducted following ethical principles outlined in the General Data Protection Regulation (GDPR - 2016/679) of the European Union, the World Medical Association Declaration of Helsinki (1975, revised 2008), and the guidelines of the International Committee of Medical Journal Editors. The study protocol was approved by the Ethics Committee of Clinical Research of the General Hospital for Thoracic Diseases of Athens "SOTIRIA" (Approval Number: 20649/16-05-2023).

2.4. Measurement Tools

After giving their consent and prior to answering the questionnaires, respondents were asked to provide demographic and professional data, including their gender, age, and years of work experience. Then, they were prompt to fill out the following set of questionnaires:

2.4.1. Depression Anxiety Stress Scale (DASS-21)

The Depression Anxiety Stress Scale-21 (DASS-21) [67] is a measurement tool which comprises three self report subscales intended to evaluate stress, anxiety and depression. Seven statements on a four-point Likert scale make up each subscale ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Scores must be multiplied by 2 to determine the final score. Elevated scores reflect the increasing experience of stress, anxiety and depression. The depression subscale evaluates dysphoria, anhedonia, inertia, hopelessness, feelings of sadness loss of interest or pleasure, self-deprecation and worthlessness (e.g., "I couldn't seem to experience any positive feeling at all"). The anxiety subscale evaluates skeletal muscle effects, situational anxiety, autonomic arousal, and the subjective sensation of anxious affect (e.g., "I felt I was close to panic"). The stress subscale estimates chronic non specific arousal levels such as

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restlessness, nervousness, excitability, agitation, irritability, overreaction and impatience (e.g., "I felt that I was using a lot of nervous energy"). Different cut-off values exist for the conventional severity levels for each subscale; i.e., scores above 9 are indicative for depressive symptoms, above 7 for anxiety, and above 14 for stress. The total score is an indicator of general psychological distress. The DASS-21 is a screening tool designed to identify areas of concern and not a diagnostic instrument for assigning patients to specific diagnostic categories proposed in classification systems. The DASS-21 is acknowledged for its robust psychometric properties [68]. In this research the Greek version of the scale was used [69] and for the present sample, Cronbach's alpha values of the depression, anxiety, and stress subscales were 0.912, 0.902, and 0.914, respectively.

2.4.2. Copenhagen Burnout Inventory (CBI)

The Copenhagen Burnout Inventory (CBI) is the most common instrument for burnout assessment [70], consisting of 19 questions and evaluating the concept of burnout in three subdimensions: the first six questions reflect personal burnout; the next seven questions evaluate work-related burnout; and the last six questions appraise patient-related burnout. The personal burnout subscale measures the level of perceived physical and psychological burnout (e.g., "How often do you feel weak and/or vulnerable to illness?"). Responses options are rated on a five-point Likert ranging from "always" to "never/almost never". The perceived physical and psychological burnout related to work is evaluated by the work-related burnout subscale (e.g., "Do you feel every hour at work is exhausting?"). For this subscale response options, rated on a five-point Likert, range from "to a very high degree" through "to a very low degree" for the first three questions and from "always" to "never/almost never" for the last four questions. The patient-related burnout subscale assesses perceived physical and psychological burnout from interaction with patients (e.g., "Do you feel frustrated working with patients?"). For this subscale response options, rated on a five-point Likert, range from "to a very high degree" through "to a very low degree" for the first four questions and from "always" to "never/almost never" for the last two questions. The answers are converted into scores of 100, 75, 50, 25, 0. All burnout subscales have scores between 0 and 100, with greater scores indicating increased degrees of occupational burnout. In this study, the Greek version of the CBI was used, which is a valid scale, possessing robust psychometric properties [71]. The Cronbach's alpha coefficient for the entire scale in this study was $\alpha = 0.933$. A total score of ≥50 [72–78] indicates professional burnout.

2.4.3. Athens Insomnia Scale (AIS)

The Athens Insomnia Scale (AIS) is a self-report measurement tool intended to measure the severity of insomnia (how severely certain sleep difficulties have affected the responders during the past month) using diagnostic criteria set forth by the 10th Revision of the International Classification of Diseases and Related Health Problems (ICD-10). The scale comprises eight items amongst which the first five assess nocturnal sleep (sleep induction, night-time awakenings, final awakening, total sleep duration, and overall sleep quality) and the final three items are related to daytime dysfunction (well-being, functioning, and drowsiness throughout daytime). Response scores for each item range from 0 to 3 and total score spans from 0 to 24, with greater scores signifying increased severity of insomnia. A diagnostic threshold set at 6 indicates insomnia [79]. The AIS is a widely used tool for assessing insomnia. The Greek version of the AIS has demonstrated good psychometric properties [80]. In this study the Cronbach's alpha coefficient was measured at $\alpha = 0.878$.

2.5. Statistical Analysis

Firstly, since self-report questionnaires were adopted to collect the data, the Harman single-factor test was employed to examine the common method bias [81]. The most significant component determined 39.686% of the variance which is lower than the criterion of 50%. Subsequently, descriptive statistical methods were applied to estimate means and standard deviations for

 doi:10.20944/preprints202412.2393.v1

continuous variables and to calculate the proportion of responders that scored above the cutoff values of clinically significant stress, anxiety, depression, burnout and insomnia. Furthermore, using t-tests and χ^2 tests, we compared the sample to the general population of nurses in Greece regarding years of professional experience, age, and gender, in order to examine the representativeness of the sample. Gender differences as to the study variables were assessed using t-tests. Correlations between all variables included in the present study were investigated using Pearson's correlation test. Linear regression analysis was utilized to determine if the correlated variables were significant predictors of insomnia. Before proceeding with the regression analysis, the prerequisite assumptions were checked, and specifically, normality by visual examination of the predicted probability plots, linearity through the visual review of scatter plot pairs, and homoscedasticity through residuals scatterplot. The independence of residuals was assessed with the Durbin-Watson test. The Variance Inflation Factor (VIF) analysis was performed to determine the absence of multicollinearity in the data. To examine the chain mediation effect of depression and burnout between stress and insomnia we conducted the serial mediation analysis using Hayes' SPSS Process Macro Model 6. The moderating role of anxiety in the chain mediation model was tested using Hayes' SPSS Process Macro Model 83. Regression coefficients reported were unstandardized, and 95% confidence intervals were assessed using 5,000 bootstrap samples [82]. Finally, analysis of simple slopes was performed to report the regulating effect at different levels of anxiety. The data analyses were conducted using SPSS software (Version 24.0). For all statistical analyses, statistical significance was set at $p < 0.05$ (two-tailed).

3. Results

Since the data acquired for the study were derived from self-reports, common method bias testing was required and for this purpose the Harman single factor method test was utilized. Results from the exploratory factor analysis indicated that the first common factor had an explanation rate of 39.686 percent, which was less than the critical value of 50 percent, suggesting no significant common method bias in this study.

A total of 380 nurses (74 males and 306 females) participated in the study. As to gender, age, and years of professional experience no significant differences were identified between the study sample and the total population of nurses working in Greece [66]. Overall, 56.1% of the nurses exhibited insomnia symptoms (AIS ≥ 6), 46.8% presented signs of burnout (CBI ≥ 50), while 31.1% experienced symptoms of general psychological distress (DASS-21>32) [83]. Regarding the severity levels of stress, anxiety, and depression 33.9%, 33.3% and 35% of the participants scored above the recommended normal values in DASS-21, whereas percentages of 25%, 26.8% and 23.9% were found to have moderate to extremely severe levels of stress, anxiety, and depression, respectively. Table 1 presents the mean values and standard deviations of the study variables.

Table 1. Descriptive statistics of participants.

Gender		Age	Work experience (in years)	Athens Insomnia Scale	Copenhagen Burnout Inventory	Depression Anxiety Stress Scale			
						Total	Stress	Anxiety	Depression
Male	Mean	47.57*	21.89	6.35	44.91*	22.67*	10.67*	5.05	6.94
	N	74	74	74	74	74	74	74	74
	S.D.	10.85	11.92	4.23	17.93	21.88	8.2	7.52	7.99
Female	Mean	44.58*	19.92	7.31	49.64*	29.53*	13.47*	7.17	8.88
	N	306	306	306	306	306	306	306	306
	S.D.	10.41	11.47	4.92	19.03	27.42	10.26	9.06	9.67
Total	Mean	45.16	20.30	7.12	48.72	28.2	12.93	6.75	8.5
	N	380	380	380	380	380	380	380	380

 doi:10.20944/preprints202412.2393.v1

S. D.	10.55	11.57	4.80	18.89	26.54	9.95	8.81	9.39

* t test p<0.05, ** t test p<0.01

Regarding gender, female nurses evidenced higher mean scores in the DASS-21 total and the stress subscale compared to male nurses (t-test $p < 0.05$, 29.53 ± 27.42 vs. 22.67 ± 21.88 and t-test $p < 0.05$, 13.47 ± 10.26 vs. 10.67 ± 8.2, Table 1). Additionally, female nurses showed higher scores in the Copenhagen Burnout Inventory (t-test $p < 0.05$, 49.64 ± 19.03 vs. 44.91 ± 17.93, Table 1).

AIS correlated positively with DASS-21 total and its three subscales and negatively with work experience. CBI scores were positively associated with both the AIS scores and the DASS-21 total and its subscales. The Anxiety subscale of the DASS-21 correlated negatively with age and work experience and moreover the Depression subscale showed a negative correlation with work experience. As expected, the three DASS-21 subscales positively correlated with each other (Pearson Correlations $p < 0.01$, Table 2).

Table 2. Correlations among age, work experience, AIS, CBI and DASS-21.

Pearson Correlation N: 380		Age	Work experience (in years)	AIS	CBI	DASS-21 Total	Stress	Anxiety
Work experience (in years)	r	0.894**						
	p	0.001						
Athens Insomnia Scale (AIS)	r	-0.064	-0.126*					
	p	0.214	0.014					
Copenhagen Burnout Inventory (CBI)	r	-0.031	-0.058	0.587**				
	p	0.552	0.257	0.001				
Depression Anxiety Stress Scale (DASS-21 Total)	r	-0.072	-0.132*	0.662**	0.586**			
	p	0.161	0.010	0.001	0.001			
Stress	r	-0.051	-0.089	0.633**	0.590**	0.949**		
	p	0.323	0.083	0.001	0.001	0.001		
Anxiety	r	-0.123*	-0.186**	0.600**	0.499**	0.939**	0.840**	
	p	0.016	0.000	0.001	0.001	0.001	0.001	
Depression	r	-0.034	-0.104*	0.637**	0.563**	0.940**	0.835**	0.822**
	p	0.508	0.044	0.001	0.001	0.001	0.001	0.001

* Pearson Correlations $p < 0.05$, ** Pearson Correlations $p < 0.01$.

We ensured that the prerequisites for the regression analysis were satisfied by checking in advance the necessary assumptions. Independence of residuals was tested using the Durbin-Watson test, with a value of 1.843 (Table 3), supporting the absence of autocorrelation. The VIF values of less than 4 indicated a lack of multicollinearity (Table 3). Normality was verified by visually observing the predicted probability plots. Homoscedasticity was explored through visual review of the scatter

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plot of standardized and predicted residual values. Linearity was confirmed by visually inspecting scatter plots of variable pairs.

Table 3. Stepwise multiple regression.

Dependent Variable: Athens Insomnia Scale	*R* Square	*R* Square Change	*Beta*	*t*	*p*	VIF	Durbin-Watson
DASS-21 Depression	0.406	0.406	0.290	4.310	0.001*	3.382	1.843
Copenhagen Burnout Inventory (CBI)	0.483	0.076	0.296	6.438	0.001*	1.573	
DASS-21 Stress	0.496	0.013	0.217	3.143	0.002*	3.545	

Notes: *Beta* = standardized regression coefficient;

*Correlations are statistically significant at the p <0.01 level (only statistically significant variables are included).

We conducted a multiple regression analysis using the Stepwise method to explore which factors best explain the scores of the Athens Insomnia Scale (AIS). In the multiple regression analysis, AIS was set as the dependent variable, while age, gender, years of work experience, the Copenhagen Burnout Inventory (CBI), and the subscales of the Depression Anxiety Stress Scale (DASS-21) were set as independent variables. The analysis showed that the Depression subscale of the DASS-21 explained 40.6% of the variance in AIS, while an additional 7.6% was explained by CBI and another 1.3% rate was explained by the Stress subscale of the DASS-21 (Table 3). The other variables did not contribute significantly to the AIS variance.

Next, we explored the hypothesis that depression and burnout might act as mediators in the relationship between stress and insomnia. In this analysis, the Stress subscale of the DASS-21 was set as the predictor variable, the Depression subscale of the DASS-21 and CBI as the mediator variables and AIS as the outcome variable. Covariates included work experience and age. Hayes' SPSS Process Macro Model 6 was employed to investigate the chain mediating effect of depression and burnout in the relationship between stress and insomnia. The analysis was based on 5000 bootstrap samples. Unstandardized coefficients for the variables with standard errors are illustrated in Figure 1.

 doi:10.20944/preprints202412.2393.v1

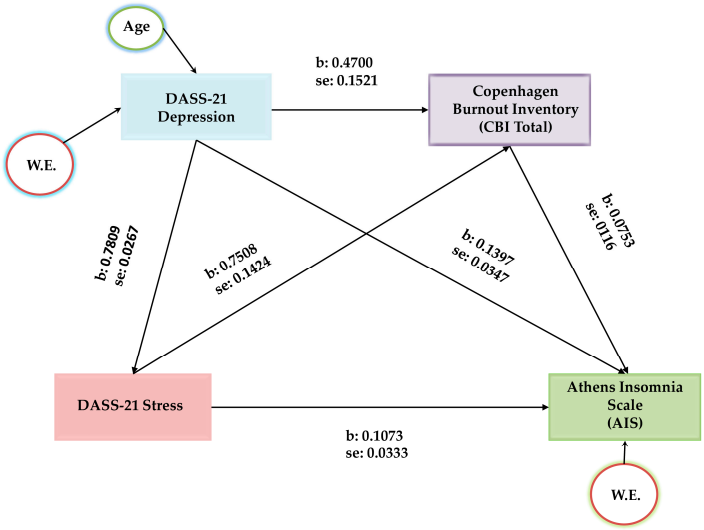

Figure 1. Chain Mediation effect of Depression and Burnout in the relationship between Stress and Insomnia.

The chain mediation analysis revealed that depression and burnout serially mediate the relationship between stress and insomnia. In this context, the covariates, age, and work experience exhibited statistically significant relationships (Figure 1 & Table 4). The total indirect effect of depression and burnout on insomnia was found to be statistically significant [b=0.1932, 95% C.I. (0.1311, 0.1655)]. Furthermore, the direct effect of stress on insomnia in presence of the mediators was proved significant as well (b = 0.1073, p < 0.01). Therefore, there is partial serial mediation of depression and burnout on the relationship between stress and insomnia. This model explains 64.3% of the variance in the AIS outcome variable. In particular, the following three pathways yielded indirect effects that contributed to the total mediating effect: (a) Stress → Depression → AIS, which represents 36.3% of the total effect; (b) Stress → CBI → AIS, rendering 18.8% of the total effect; and (c) Stress → Depression → CBI→ AIS, constituting 9.18% of the total effect.

Table 4. Chain Mediation Analysis of Depression and Burnout on Stress/ Insomnia relationship.

Variable	b	SE	t	p	95% Confidence Interval	
					LLCI	ULCI
Stress -> Depression	0.7809	0.0267	29.2765	0.0000	0.7284	0.8333
Stress -> CBI	0.7508	0.1424	5.2712	0.0000	0.4708	1.0309
Depression-> CBI	0.4700	0.1521	3.0906	0.0021	0.1710	0.7690
Stress-> AIS	0.1073	0.0333	3.2235	0.0014	0.0418	0.1727
Depression-> AIS	0.1397	0.0347	4.0234	0.0001	0.0714	0.2079
CBI->AIS	0.0753	0.0116	6.4684	0.0000	0.0524	0.0982
(1)Stress-> Depression -> AIS	0.1091	0.0290	3.7620		0.0513	0.1655
(2)Stress-> CBI -> AIS	0.0565	0.0146	3.8698		0.0306	0.0885
(3)Stress-> Depression -> CBI-> AIS	0.0276	0.0091	3.0329		0.0109	0.0464
Covariates						
Age -> Depression	0.1540	0.0560	2.7505	0.0062	0.0439	0.2641
W.E. -> Depression	-0.1498	0.0512	-2.9254	0.0036	-0.2505	-0.0491
W.E.-> AIS	-0.0853	0.0369	-2.3117	0.0213	-0.1578	-0.0127
Effects						
Direct	0.1073	0.0333	3.2235	0.0014	0.0418	0.1727
*Total Indirect	0.1932	0.0309			0.1311	0.1655
Total	0.3005	0.0192	15.6336	0.0000	0.2627	0.3383

Notes: W.E., work experience (in years); Ind1: (1)Stress-> Depression -> AIS= Stress -> Depression * Depression-> AIS, Ind2: (2)Stress-> CBI -> AIS= Stress-> CBI * CBI -> AIS, Ind3: (3)Stress-> Depression -> CBI-> AIS= Stress-> Depression * Depression -> CBI * CBI-> AIS * Total Indirect = Ind1+ Ind2+ Ind3, Based on 5000 bootstrap samples.

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Lastly, we investigated the process by which anxiety may moderate the relationship between stress and depression. Specifically, we aimed to investigate if anxiety acting as a moderator is altering the potency of the indirect effect of the above chain mediation, by means of testing the moderating role of anxiety in the pathways of Stress → Depression → AIS and Stress → Depression → CBI → AIS. To perform this moderation analysis, we utilized the PROCESS method, model 83 (Figure 2).

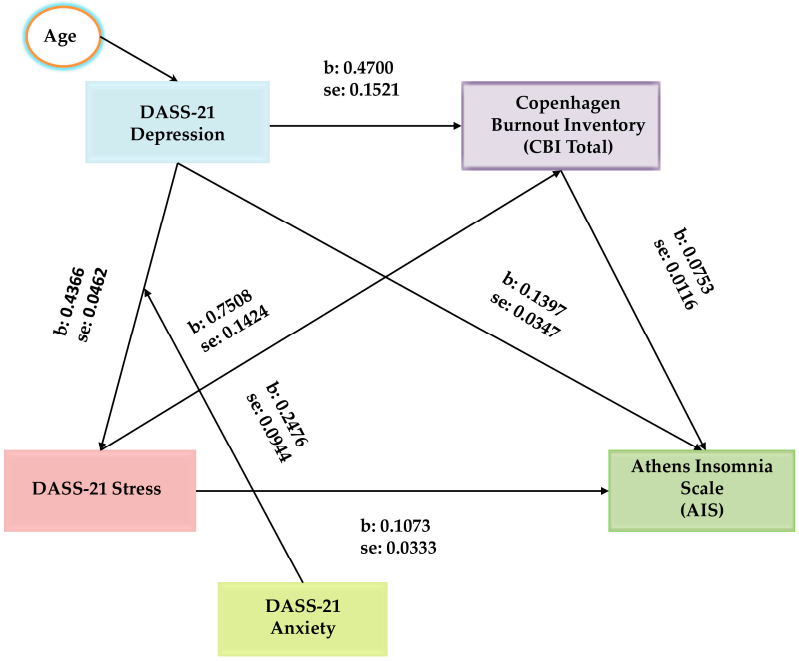

Figure 2. The moderated chain mediation model in this study: Stress impacts insomnia through a chain mediation effect of depression and burnout and anxiety moderates the relationship between stress and depression in the first and third paths of the chain mediation.

In both pathways the index of moderated mediation was significant: b = 0.0009, 95% percentile CI [0.0001, 0.0019] and b = 0.0002, 95% percentile CI [0.0000, 0.0005], providing support for a moderated mediation. 0.37% change in depression can be accounted to the interaction term. The results revealed a significantly positive moderating role of anxiety on the linkage between stress and depression (b = 0.066, t = 2.3841, p = 0.0176), Table 5. This shows that at higher levels of anxiety, the impact of stress on depression is reinforced.

Table 5. Moderated chain mediation analysis of the effect of DASS-21 Anxiety on the association between the DASS-21 Stress and Athens Insomnia Scale (AIS) through DASS-21 Depression. .

Direct Relationships						
Variable	**b**	**SE**	***t***	***p***	**95% Confidence Interval**	
					LLCI	**ULCI**
Stress → Depression	0.4366	0.0462	9.4585	0.0000	0.3459	0.5274
Anxiety → Depression	0.2476	0.0944	2.6214	0.0091	0.0616	0.4333
Stress*Anxiety → Depression	0.0066	0.0028	2.3841	0.0176	0.0012	0.0121

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Stress → CBI	0.7508	0.1424	5.2712	0.0000	0.4708	1.0309
Depression → CBI	0.4700	0.1521	3.0906	0.0021	0.1710	0.7690
Stress → AIS	0.1073	0.0333	3.2235	0.0014	0.0418	0.1727
Depression → AIS	0.1397	0.0347	4.0234	0.0001	0.0714	0.2079
CBI → AIS	0.0753	0.0116	6.4684	0.0000	0.0524	0.0982
Covariates						
Age → Depression	0.1038	0.0516	2.0101	0.0451	0.0023	0.2053
Effects						
Direct	0.1073	0.0333	3.2235	0.0014	0.0418	0.1727
Moderated Indirect Relationships						
Indirect 1: Stress-> Depression -> AIS						
Anxiety (mean-1SD)	0.0610	0.0173	3.5260		0.0288	0.0972
Anxiety (mean)	0.0672	0.0188	3.5744		0.0322	0.1062
Anxiety (mean+1SD)	0.0754	0.0213	3.5399		0.0359	0.1189
Index of Moderated Mediation	0.0009	0.0005			0.0001	0.0019
Indirect 2: Stress-> CBI -> AIS	0.0565	0.0147	3.8435		0.0309	0.0886
Indirect 3: Stress-> Depression -> CBI -> AIS						
Anxiety (mean-1SD)	0.0155	0.0053	2.9245		0.0059	0.0266
Anxiety (mean)	0.0170	0.0058	2.9310		0.0066	0.0293
Anxiety (mean+1SD)	0.0191	0.0066	2.8939		0.0073	0.0333
Index of Moderated Mediation	0.0002	0.0001			0.0000	0.0005

Furthermore, to demonstrate how anxiety moderated the association between stress and depression, a simple slope test was performed. High and low anxiety levels (plus or minus a standard deviation) were grouped to generate the simple effect analysis diagram (Fig. 3). The findings indicated that stress has a significant impact on depression in both high and low anxiety levels. Nevertheless, compared to nurses with a low level of anxiety (simple slope = 0.4366, $t = 9.4585$, $p < 0.001$), stress has a stronger predictive effect on depression in nurses with a high level of anxiety (simple slope = 0.5398, $t = 9.6773$, $p < 0.001$). Hence, the impact of stress on depression is much stronger at high anxiety levels.

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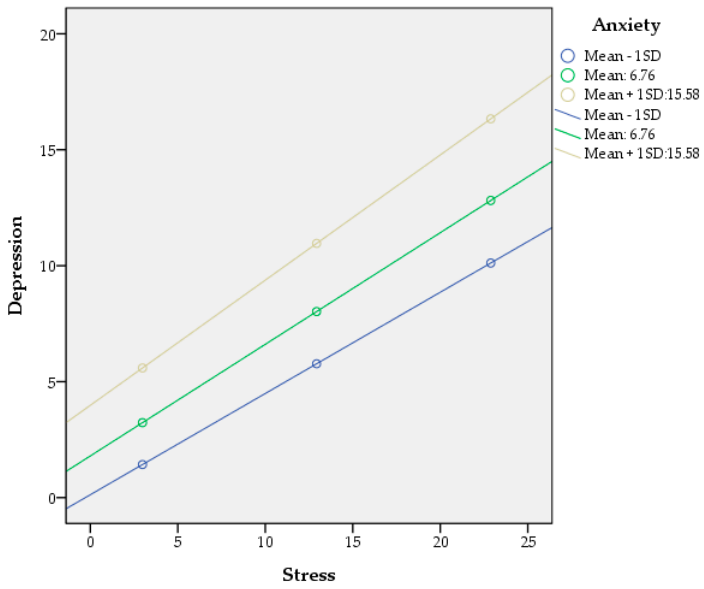

Figure 3. Simple slopes indicating the interaction of the moderation analysis.

4. Discussion

Results from this study evidenced a high prevalence of stress, anxiety, depression, burnout and insomnia among Greek hospital nurses, one year after the end of the pandemic. According to a meta-analysis of studies published up until March 2021, due to the pandemic, 40% of health workers experienced acute stress, 42% anxiety symptoms, 33% depressive symptoms, 37% burnout and 42% insomnia [84]. A review of studies published until 2021, on mental health outcomes among nurses working in emergency hospital settings reported a rate of 29.55% for moderate to severe symptoms of anxiety, 38.79% for depression and 40.66% for insomnia [86]. Meanwhile in Greece, in a study conducted from mid-November to mid-December 2021, 39.7% among hospital nurses exhibited depressive symptoms, 60.1% scored above the cut-off on state anxiety and 46.8% on trait anxiety [55]. Regarding burnout levels, a study performed in February 2021 indicated that 42.9% of nurses had scores suggestive of burnout [28]. Also, a study conducted in May 2020 among Greek hospital nurses reported a 49.7% prevalence of insomnia and 50.3% of stress [16], whereas in a study conducted in approximately two years after the onset of the pandemic [17] and another study conducted two months after the pandemic ended, 61.4% among Greek hospital nurses presented with symptoms of insomnia [86]. Results from studies performed in other countries among healthcare workers after the pandemic are inconclusive, either reporting alarming findings comparable to those during the pandemic [64] or presenting overall improvements in mental health and sleep problems [60]. In Greece, the psychological implications and sleep disturbances seem to persist for a longer period, even after the pandemic [57]. This difference may be attributed to the reduced perceived organizational support and the limited resources of nursing personnel in the Greek National Health System [87,88], who work hard under challenging conditions but are underpaid compared to their colleagues from the other OECD countries [89,90].

Among demographic and work-related factors influencing psychological and sleep symptoms age, gender and work experience were recorded in this study. In agreement with most other studies [91–95] that clearly show that female nurses are the most vulnerable subgroup among healthcare workers especially regarding the mental health impacts, female nurses in this study reported higher levels of stress and burnout and exhibited higher scores in the DASS-21 compared to their male counterparts. The female gender predominates in the nursing sector, unlike in other working environments and literature suggests that women are more likely to be at risk for psychological distress [96–98]. Moreover, hospital nurses are particularly prone to experiencing higher levels of stress and burnout than the other non-hospital nurses [99,100]. Also, in this study age and work

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experience proved to be among influencing factors for presenting psychological issues and sleep problems. Specifically age correlated negatively with anxiety and work experience was negatively associated with anxiety, depression and insomnia. Most existing literature justifies these results [101–105], but certain studies argued that the more experienced nurses were also the more anxious, possibly because they were assigned to more challenging work tasks [106].

This study focused on the effects of stress on insomnia and further investigated the separate and the chain mediating role of depression and burnout and verified the moderating role of anxiety in nurses working in Greek hospitals one year after the end of the pandemic. The results elucidate the underlying mechanism through which stress affects insomnia and identify significant factors influencing insomnia, thus providing guidance for targeted interventions for nurses. This section includes the major findings which are discussed in conjunction with other relevant literature.

4.1. The Influence of Stress on Insomnia

The results from both the regression and the mediation analysis indicated that stress positively predicted insomnia, thus supporting the first hypothesis. From a neurobiological perspective sleep/circadian rhythmicity and the stress response system engage the same neural networks [107]. Stress dysregulation involving the sympathetic-adrenomedullary and the hypothalamic-pituitary-adrenocortical systems may lead to insomnia. Literature suggests that stressful experience is the most common precipitating factor of insomnia [108] and work is one of the most common sources of environmental stress [109]. Occupational stress and insomnia relationship has been investigated by numerous studies and a recent meta-analysis identified the strength of this association [110]. Research indicates that nurses are a vulnerable and high-risk population for occupational stress which is a major risk factor for insomnia in nurses [111]. Notably, hospital nurses compared to community and other non-hospital nurses report higher levels of stress [112]. These stressful experiences are related to the nature of the nursing profession and therefore cannot be easily modified, but the identification of the mediating variables between stress and insomnia could offer valuable insights in order to alleviate the effect of stress on insomnia through the effective manipulation of these mediating variables.

4.2. The Mediating Role of Depression

The results from the regression analysis indicated that depression explained 40.6% of the variance in insomnia and the mediation analysis revealed that stress was positively related to depression that consequently was associated with insomnia, thus supporting the second hypothesis. In this case depression operates as a catalyst between stress and insomnia. Recent research confirms the mediating effect of depression in the association between perceived stress and sleep quality among healthcare workers [113]. The experience of stressful negative life events is implicated in the vulnerability to depression [114]. People are more prone to developing negative cognitive-emotional appraisals when they experience increased levels of stress [115]. Similarly, stressful life events may fuel rumination in some individuals, usually combined with negative emotions [116]. In the long run, failure to regulate these negative cognitions and alleviate these emotions would lead to depression [117,118]. Further, emotional hyperarousal derived from depressive emotions as a result of perceived stress, may disrupt the normal sleep cycle, leading to a spectrum of sleep issues [119–121].

4.3. The Mediating Role of Burnout

The mediation analysis revealed that burnout was not only an outcome of stress but also played a mediating role between stress and insomnia, thus verifying the third hypothesis. Furthermore, the regression analysis evidenced that burnout explained 7.6% of the variance in insomnia. Literature points to a bidirectional association between burnout and insomnia, suggesting that either might be a risk factor for the other [122,123]. Specifically, stress, burnout and insomnia are reciprocally related in a vicious cycle [123,124]. Dysregulation involving the sympathetic nervous system and/or the

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hypothalamic–pituitary–adrenal axis are observed in both burnout and insomnia [124]. A prospective study supported that burnout at baseline not only intensified insomnia symptoms over time for individuals already exhibiting these symptoms at baseline, but it was also related to the emergence of new cases at follow-up [125]. A recent longitudinal population-based cohort study indicated that burnout was the strongest among several risk factors for insomnia [126]. A possible mechanism explaining the way that burnout may cause insomnia implicates emotional exhaustion which contributes to increased sleep reactivity and in turn lead to hyperarousal before sleep and ultimately to sleep problems, like insomnia [127]. Also, a meta-analysis confirmed the relationship between burnout and sleep disorders in nurses and provided information about influencing variables, such as gender, shift work and workplace violence [128].

4.4. The Chain Mediating Role of Depression and Burnout

This study evidenced that depression and burnout play a chain mediating role between stress and insomnia, hence confirming the forth hypothesis. Studies suggest a reciprocal relationship between depression and burnout and some researchers identified burnout as a significant predictor of depressive symptoms [129–132]. Differently, other researchers supported that depression can increase the possibility of burnout [126,133] and an earlier study indicated that current depressive symptoms predicted burnout and furthermore an underlying susceptibility for depression as inferred from a personal and familial history of depression, increased the risk for burnout [134]. Also, there is a debate among researchers over the possibility that burnout and depression overlap [135,136]. In this sense, both depression and burnout can be caused by stressors in the workplace [137] and employees in occupational environments that are particularly demanding and stressful, such as healthcare settings, are prone to suffering from comorbid depression and burnout [138]. This has led some scholars to reconceptualise burnout as a form of 'occupational depression' [139]. However, a recent meta-analysis revealed that depression and burnout are different and robust constructs with no overlap between them [140]. Thus, despite being regarded as distinct nosological entities, depression and burnout syndrome have been found to be intimately linked in a number of studies [141,142]. Further, associations between sleep quality and depressive and burnout symptoms are well established [143,144]. Results from a longitudinal study confirmed that depressive and burnout symptomatology predicted impaired sleep quality, whereas impaired sleep quality did not predict burnout, but only depressive symptoms. The authors argued that work-related stressors also need to be present to elicit an increase in burnout symptoms [145].

4.5. The Moderating Role of Anxiety

Another important result from this study is that anxiety moderates the relationship between stress and depression, thus confirming the filth hypothesis. This finding suggests that the degree to which stress and depression impact insomnia varies depending on anxiety levels. Stress and anxiety are frequently comorbid and research has identified the underlying neurobiological mechanism implicated in the bidirectional association between chronic stress and anxiety disorder [146,147]. Stressful life events often precede anxiety disorders [148] and the positive association between any kind of anxiety and the severity of insomnia is apparent since shared psychopathological mechanisms, such as emotional overactivity, can be identified [149]. A study exploring the symptom level associations between insomnia, depression, and anxiety identified uncontrollable worrying and trouble relaxing as the most central symptoms [150]. The role of emotion dysregulation in insomnia has long been proposed [151] and the cognitive model of insomnia describes one of the patterns of subjective experiences of emotions characterized by increased negatively valenced pre-sleep cognitive activity [152,153]. Rumination and worry are the two components of intrusive thoughts [154] and while rumination is related to dysphoric mood and primarily focuses on the causes of this mood state, worry is associated with anxious mood and involves catastrophizing about future stressful events [155]. Another prospective study demonstrated that anxiety and depression at baseline predicted insomnia at follow-up [156]. Available evidence indicates a reciprocal relationship

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between anxiety and depression as to insomnia [157], but the nature of this relationship may differ across specific insomnia symptoms [158,159]. Also, another study supported that insomnia may have separate, possibly causally different, directional relationships with anxiety disorders as opposed to depression [160].

The moderated chain mediation model constructed in this study clarifies the associations among stress, anxiety, depression, burnout and insomnia, aiming to provide practical implications for prevention and intervention purposes. The hypothesized mechanisms of link between the aforementioned factors influencing insomnia should raise the possibility that some of these nurses suffering from insomnia may simultaneously display symptoms of anxiety, depression and burnout, all caused by the harmful effects of stress [126,161]. Thus, nurses who present with insomnia symptoms should also be assessed and treated for these other symptoms and certain risk factors may differentiate nurses who exhibit distinct combinations of these symptoms which unless recognized and addressed they would contribute to the chronicity of the disturbance [162]. Although the treatment of choice for chronic insomnia is cognitive–behavioral therapy [163], distinguishing among different constellations of co-occurring symptoms would lead to more focused treatment plans targeting at diverse behavioral, psychosomatic, and biological patterns [164,165].

The results from this study highlight the needs for primary prevention measures in the working environment, both at organizational and administrative level, in order to support nurses in dealing with the stressful working conditions. Early identification of risk factors such as demanding working environment, quality of the hospital, night shifts, not having a permanent job, working experience, excessive workload and inadequate rewards would enable the implementation of effective workplace interventions to prevent or reduce mental health problems among nurses. Targeted interventions such as stress management programs, mindfulness-based interventions, training in positive coping strategies to combat stress, frustration, and emotion management through self-compassion techniques and self-care programs can effectively reduce anxiety, depression, burnout and insomnia and may also prove beneficial in managing stress and prevent the occurrence and/or worsening of the above stress-related disorders among nurses [166–169].

Certain limitations should be recognized. First, the cross-sectional method of this study precluded inferences about causal associations among the variables, which could only be established with longitudinal studies. Secondly, the employed convenience sampling methodology could hinder the generalizability of the results. Third, data relied on nurses' self-reports measurements conferring a potential self-report bias. Fourth, important limitation is the lack of information about other work-related variables namely, nurses' work department, work shifts, rotation and staff shortages. Finally, this study focused on specific stress-related risk factors influencing insomnia among nurses, with a limited number of covariates. Future studies may consider including more risk as well as protective factors to improve our understanding about their complex interrelations beyond the pandemic, for prevention and intervention purposes.

5. Conclusions

High prevalence rates of stress, anxiety, depression, burnout and insomnia were observed in hospital nurses one year after the end of the pandemic. More than one in three nurses experienced stress, anxiety and depression, almost half of them displayed signs of burnout and more than half complained about insomnia symptoms. The moderated chain mediation model constructed in this study indicates that stress exerts significant direct and indirect effects on insomnia, mediated by depression and burnout and also that anxiety moderates the relationship between stress and depression. These findings provide insights for designing interventions to reduce the adverse effects of stress and insomnia among nurses, with complementary measures focused on improving potential co-occurring symptoms of anxiety, depression and burnout.

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resources, A.P. and I.I.; data curation, C.S., S.A, M.I and A.T.; writing—original draft preparation, A.P. and A.T.; writing—review and editing, A.P., N.S. and C.S.; supervision, A.P. and A.T.; project administration, I.I. and A.T. All authors have read and agreed to the published version of the manuscript.

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