

Examining the Mediating Role of Sleep Duration in the Relationship between Psychosocial Factors and Post-Traumatic Stress among COVID-19 Survivors

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Abstract

The COVID-19 pandemic has been a significant source of psychological trauma, with survivors exhibiting heightened rates of Post-Traumatic Stress Disorder (PTSD). While psychosocial factors like perceived vulnerability and resilience are known correlates, the mechanisms linking them to PTSD are not fully understood. This study investigates the mediating role of sleep duration and the moderating effect of gender in this relationship. A cross-sectional sample of 400 COVID-19 survivors (Duration from 2021-2022) participated in a study that employed standardized measures to assess perceived vulnerability, resilience, sleep duration, and symptoms of PTSD. Correlation analysis demonstrated significant associations, showing that greater perceived vulnerability correlated with higher PTSD symptoms, while higher resilience and longer sleep duration were associated with lower PTSD symptoms. Structural Equation Modeling (SEM) revealed that perceived vulnerability exerted a direct positive effect on PTSD symptoms, whereas resilience demonstrated both direct and indirect effects, with the latter being partially mediated by increased sleep duration. Furthermore, multi-group analysis confirmed the moderating role of gender; specifically, the relationship between vulnerability and PTSD was stronger in female participants, whereas the link between resilience and PTSD was marginally more pronounced in male participants. The findings provide a nuanced model for understanding PTSD in survivors, emphasizing the importance of sleep duration as a critical behavioral pathway through which resilience can offer protective benefits. This underscores the necessity of integrating sleep-focused strategies and gender-sensitive approaches into post-trauma mental health interventions for this population.

Keywords: *Post-Traumatic Stress Disorder (PTSD), Sleep Duration, COVID-19 Survivors, Resilience, Perceived Vulnerability*

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1. Introduction

Post-traumatic stress disorder (PTSD) relates to mental health conditions that arise after exposure to a traumatic event, usually resulting in symptoms like intrusive thoughts, hyperarousal, and emotional distress (Skogstad et.al., 2013). The COVID-19 pandemic is recognized as a global health emergency and a source of lasting psychological distress affecting survivors (Kaseda & Levine, 2020). COVID-19

survivors are more vulnerable to PTSD and associated symptoms, which can continue after the individuals have physically recovered from the illness (Tarsitani et.al., 2021). Survivors, particularly those classified as high-risk groups, have higher levels of psychological distress, among which PTSD appears to be the most common outcome (Bajoulvand et.al., 2022). The pandemic has symbiotic effects on physical health, and an individual faces multiple long-lasting psychosocial

problems arising from external causes (Tang et.al., 2022).

During and after a crisis, psychosocial factors such as perceived vulnerability and resilience influence outcomes related to mental health. The term perceived vulnerability expresses the concept of an individual subjectively feeling they are at some form of risk. Individuals who feel more vulnerable were more likely to suffer from psychological distress and be more vulnerable to trauma-related disorders (Demirci et.al., 2021). The resilience, on the other hand, is referred to as the adaptively positive response to the incidence of trauma that helps in safeguarding against trauma-induced psychopathology (Asensio-Martínez et.al., 2019). In COVID-19, resilience has been shown to moderate the effect of stressors on post-traumatic stress symptoms, ultimately influencing the recovery trajectories and thereby the stabilization of psychological status (Zeng et.al., 2023).

Another major factor affecting psychological health in the post-COVID period is the disturbance of sleep. A series of sleep disorders, including reduced sleep time and poor sleep quality, has been reported widely among COVID-19 survivors, usually associated with prolonged psychological stress and reduced emotional regulation (Korkut, 2022). Poor sleep may worsen vulnerability by weakening coping resources, while adequate sleep supports resilience and adaptive recovery (Xin et.al., 2024). Thus, sleep duration may impact the relationship between psychosocial factors and post-traumatic stress in COVID-19 survivors remains limited.

Post-traumatic stress disorder (PTSD) is a complex condition influenced by various psychosocial and behavioral factors, but its underlying causes are not well understood. By examining sleep duration as a mediating factor, the study provides insights into the psychological processes that link vulnerability and resilience with PTSD outcomes, offering a better understanding of trauma-related pathways. Furthermore, by incorporating gender as a moderating variable, the study contributes to a more comprehensive perspective on individual differences in trauma responses. The study has important theoretical implications for stress and coping models and practical relevance for resilience and sleep-enhancing strategies to mitigate PTSD risk across diverse populations.

Apart from the introduction, the remaining study is planned as follows: In Section 2, reviews of various authors from previous research on “Perceived Vulnerability, Resilience, Shorter Sleep Duration, and Post-Traumatic Stress.” Section 3 articulates the

study's objectives. Section 4 explains the conceptual framework. Section 5 encapsulates the research methodologies employed. Section 6 elucidates the results and findings. Section 7 discusses the study, while Section 8 presents the conclusions, implications, restrictions, and suggestions for further study. Finally, references are provided.

2. Literature Review

2.1 Theoretical Framework

2.1.1 Transactional Model of Stress and Coping (TMSC)

The Transactional Model of Stress and Coping, developed by Lazarus and Folkman (1984), emphasized that stress was not merely a stimulus or response, but a dynamic process shaped by an individual's cognitive appraisal and coping strategies (Biggs et.al., 2017). According to the model, individuals first engage in primary appraisal to evaluate whether a situation poses a threat, challenge, or harm, followed by secondary appraisal to assess available coping resources (Ben-Zur, 2020). If coping strategies were ineffective, the stress response intensifies, leading to adverse psychological outcomes such as post-traumatic stress. In the context of COVID-19 survivors, psychosocial factors like perceived vulnerability and resilience strongly influence this appraisal process. More importantly, the number of hours of sleep serves as a mediating mechanism, since it was influenced by stress and the recovery process. Trauma outcomes are reduced by sleep reappraisal and resilience, which were enhanced by an adequate amount of sleep, while ineffective coping was worsened by shortened or poor sleep (Yan et al., 2021).

2.1.2 Health Belief Model (HBM)

The Health Belief Model was originally developed by Irwin Rosenstock, Godfrey Hochbaum, and Stephen Kegels (1952) to explain and predict health-related behaviors through perceptions of risk and benefits (Alyafei & Easton-Carr, 2024). The model suggested that individual health behavior was shaped by perceived susceptibility, perceived severity, perceived benefits, and perceived barriers, along with signs to action and self-efficacy (Kc et.al., 2025). During the COVID-19 pandemic, HBM was widely applied to understand how risk perceptions influenced preventive behaviors and psychological well-being (Alagili & Bamashmous, 2021). In the context of COVID-19 survivors, psychosocial factors such as perceived vulnerability and resilience align with HBM constructs, influencing health-related coping responses. Sleep duration could be understood as a mediating mechanism within this framework:

heightened vulnerability and severity perceptions often disrupt sleep, which in turn diminishes resilience and increases vulnerability to post-traumatic stress. Conversely, adequate sleep strengthens self-efficacy and adaptive coping, mitigating trauma-related outcomes (Karimy et.al., 2021).

2.2 Review of Literature

2.2.1 Reviews related to the Relationship of Perceived Vulnerability, Resilience, and Shorter Sleep Duration with Post-Traumatic Stress

Post-traumatic stress disorder (PTSD) has been increasingly examined in relation to sleep disturbances, perceived vulnerability, and resilience, particularly in the context of public health crises and natural disasters. Sleep disturbances were consistently reported as core features of PTSD, with empirical studies confirming their role in symptom severity and persistence. Biggs et al., (2020) demonstrated that variations in sleep duration and quality were strongly associated with the manifestation of Post-Traumatic Stress Symptoms (PTSS), highlighting that insufficient sleep was a risk factor for heightened symptomatology. Similarly, Yeh et.al., (2023) found that women with PTSD exhibited disrupted sleep patterns that correlated with elevated inflammatory markers, suggesting a psychophysiological pathway linking short sleep duration to PTSD. Similarly, Cruz-Sanabria et.al., (2023) emphasized the moderating role of chronotype, showed that circadian misalignment further exacerbates PTSD-related sleep disturbances.

Perceived vulnerability recognized as a psychological construct shaping responses to trauma, particularly under conditions of uncertainty such as the COVID-19 pandemic. Wang et.al., (2023) reported that declines in perceived social status were significantly associated with PTSS, with perceived vulnerability to disease acting as a mediating factor. Pino et.al., (2021) also underscored the role of vulnerability in shaping PTSD outcomes among survivors of the Central Italy earthquake, where individuals with heightened vulnerability perceptions showed greater susceptibility to PTSS. These studies suggested that perceived vulnerability not only increases psychological distress but also functions as a mechanism through which external stressors translate into trauma-related outcomes.

Resilience has emerged as a protective factor mitigating the adverse effects of trauma and stress. Dhungana et.al., (2022) found that resilience was inversely associated with PTSD, anxiety, and depression symptoms among trauma survivors in

Nepal, underscoring its buffering role. Similarly, Zhang et.al., (2023) demonstrated that resilience, along with social support, mediated the relationship between fear of COVID-19 and PTSS among quarantined nursing students. Longitudinal findings by Cobo-Cuenca et.al., (2022) further confirmed that higher resilience levels predicted better adaptation and lower PTSS in nursing students transitioning to professional practice during the pandemic. Moreover, Collazo-Castiñeira et.al., (2022) highlighted that resilience not only reduced PTSS but also promoted post-traumatic growth, suggesting its dual role in reducing pathology and fostering positive psychological change.

H1a: *There is a negative relationship between shorter sleep duration and post-traumatic stress.*

H1b: *There is a positive relationship between perceived vulnerability and post-traumatic stress.*

H1c: *There is a negative relationship between resilience and post-traumatic stress.*

2.2.2 Reviews Related to the Impact of Sleep Duration on Perceived Vulnerability, Resilience, and Post-Traumatic Stress

According to Yang et.al., (2024) demonstrated that insomnia partially mediated the relationship between COVID-19-related PTSD and quality of life in adolescents, with resilience further moderating this pathway. The study stated that insufficient or disturbed sleep may amplify vulnerability to stress while weakening resilience-based coping mechanisms. Similarly, Simon and Admon (2023) reported that childhood adversity predisposed individuals to latent stress vulnerability in adulthood, with sleep disturbances and hypothalamic-pituitary-adrenal (HPA) axis dysfunction acting as key mediators. The study suggested that sleep served as a bridge connecting early vulnerabilities to later PTSD outcomes.

The interaction between sleep and resilience had also been extensively studied. Arora et.al., (2022), through a systematic review and meta-analysis, confirmed that sleep duration and quality were positively associated with mental toughness and resilience, indicating that adequate sleep strengthens adaptive coping capacities. Similarly, Zhang et.al., (2023) found that both personal resilience and sleep duration influenced anxiety levels among residents during the COVID-19 pandemic, suggesting that reduced sleep duration may undermine the protective effects of resilience against stress-related disorders.

According to Ashour et.al., (2024) revealed that childhood experiences contributed to sleep problems indirectly via stress, resilience, and anxiety,

highlighting how resilience and sleep jointly mediate the long-term consequences of adversity. Likewise, Ala et.al., (2024) showed that resilience and psychological well-being mediated the association between traumatic stress and mental health symptoms in university students, suggesting that sleep-related pathways might reinforce these mediational effects. Bitar et.al., (2024) emphasized that resilience was not only an outcome of personality traits but also a mediator of positive adaptation, indirectly linked with trauma-related symptoms and growth processes.

H2: *There is a mediating effect of shorter sleep duration in explaining the relationship between the Perceived vulnerability, Resilience and post-traumatic stress.*

2.2.3 Review Related to the Influence of Gender on Sleep, Vulnerability, Resilience, and Post-Traumatic Stress

Gender differences have long been recognized as critical determinants in the prevalence, expression, and outcomes of PTSD. Olff (2017) emphasized that women were at a higher risk of developing PTSD compared to men, a disparity attributed to both biological and psychosocial factors such as hormonal regulation, coping mechanisms, and differences in exposure to interpersonal trauma. Hiscox et.al., (2023) further highlighted that sex-based contributors extend beyond prevalence, influencing symptom severity, treatment response, and long-term functional outcomes.

In relation to sleep, gender has been shown to moderate its impact on mental health and trauma-related symptoms. Fusco and Kulkarni (2023) demonstrated that the interaction between sleep disturbances and childhood trauma differed by gender, suggesting that women may be more vulnerable to the psychological consequences of poor sleep following trauma exposure. Similarly, Agathão et.al., (2020) found that short sleep duration was more strongly associated with common mental disorders in female students compared to males, reinforcing the moderating role of gender in sleep-psychopathology pathways.

The relationship between resilience and sleep also appeared to vary by gender. McCall et.al., (2018) reported that resilient coping strategies were linked to sleep duration and quality, though these associations differed between men and women. Similarly, Arora et.al., (2022), examined through a systematic review and meta-analysis, concluded that both sleep quality and duration are positively related to resilience, but highlighted that gender-specific differences in

resilience trajectories remain underexplored. The study suggested that resilience might protect against PTSD differentially for men and women, with women potentially requiring higher levels of resilience to safeguard against trauma-related psychopathology.

H3: *There is a moderating effect of gender on the relationship between Shorter sleep duration, Perceived vulnerability, Resilience and post-traumatic stress.*

2.3 Research Gap

The relationship between sleep disturbances, resilience, perceived vulnerability, and post-traumatic stress has already been examined in earlier studies, but significant gaps remain. The existing studies have largely focused on the individual components and have not sufficiently examined the effects of their interaction or the mediating relations. While shorter sleep duration has been consistently associated with heightened post-traumatic stress, its potential role as a mediator between vulnerability, resilience, and PTSD outcomes is not well understood. In the same way, even though resilience is acknowledged as a protective factor, the mechanisms through which it functions, especially in tandem with sleep, are not well investigated. The impacts of perceived vulnerability have been demonstrated to emphasise trauma-related stress, yet the combined effect of resilience and sleep in influencing PTSD trajectories remains nominally explored. Moreover, gender differences in PTSD are well recognised, but few studies have examined gender as a moderator across these relationships. Thus, an integrative framework incorporating sleep mediation and gender moderation remains lacking.

3. Research Objectives

- i. To examine the relationship of perceived vulnerability, resilience, and shorter sleep duration with post-traumatic stress.
- ii. To examine the mediating effect of shorter sleep duration explaining the relationship between perceived vulnerability, Resilience, and post-traumatic stress.
- iii. To examine the moderating effect of gender on the relationship between Shorter sleep duration, perceived vulnerability, Resilience, and post-traumatic stress.

4. Conceptual Framework

A conceptual framework is an organized method of demonstrating the essential ideas, variables, and their connections in a study. It shows factors are being investigated, how they are connected. Mapping out the relationships between independent, dependent, mediating, and moderating variables provides direction for data collection, analysis, and interpretation. It acts

as a bridge between theory and practice by making sure that the objectives of the research, its methodology, and the results it expects to achieve are all aligned.

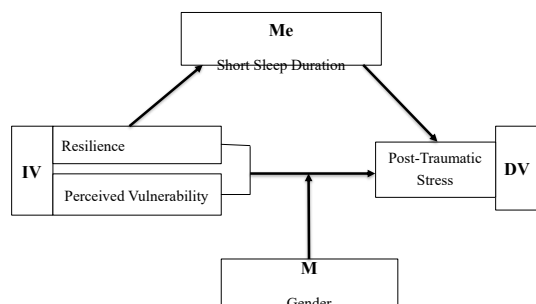


Figure 1: Conceptual Framework Regarding the Relationship Among Variables

M = Moderator Variable

Me = Mediator Variable

IV= Independent Variable

DV= Dependent Variable

Figure 1 shows that when a person is triggered by stress, there is an impact on post-traumatic stress. When perceived vulnerability increases, there is an increase in post-traumatic stress, and there exists a direct relationship between perceived vulnerability and post-traumatic stress. It is anticipated that having low resilience and shorter sleep duration can cause high post-traumatic stress. Shorter sleep duration may also show a mediating effect on the relationship between resilience & post-traumatic stress and perceived vulnerability & post-traumatic stress. Demographic variables like gender and ethnicity may have moderating effects on the relationship between predictor and criterion variables.

5. Methodology

5.1 Research Design

The present study adopts a correlational and predictive research design, aimed at examining the interplay between perceived vulnerability, resilience, shorter sleep duration, and post-traumatic stress symptoms among COVID-19 survivors. The design further incorporates gender as a moderator, while shorter sleep duration is treated as a mediating variable. This approach facilitates a comprehensive evaluation of both direct and indirect effects among the variables. The study integrates qualitative insights with quantitative measurements and ensures both depth and statistical rigor in interpreting the psychological consequences of the pandemic.

5.2 Sampling and Population

The study population comprises individuals who have survived COVID-19. The inclusion criteria restricted participation to adult survivors (18 years and above) from both urban and rural settings (Responses collected between 2021 to 2022), while individuals unwilling to participate or non-COVID patients were excluded. Cluster sampling is employed to capture heterogeneity across gender, age groups, and locales. The sample size is determined using Cochran's formula (1977), resulting in a target of 400 participants. The distribution included 200 males and 200 females, equally divided between urban and rural areas, and further stratified into three age categories: 18–35 years, 36–60 years, and above 60 years.

5.3 Research Instruments

Data collection is facilitated through standardized, validated instruments. Socio-demographic data is recorded using a structured profile sheet. "Psychological constructs is assessed using the Short Post-Traumatic Stress Disorder Rating Interview (SPRINT) by Connor and Davidson (2001) for PTSD symptoms, the Perceived Vulnerability to Disease Questionnaire (PVDQ) by Duncan et al., (2009), Díaz et al., (2016), Magallares et al., (2017), and Diaz, et.al., (2020), for vulnerability, the Brief Resilience Scale (BRS) by Smith et al., (2008) for resilience, and the Insomnia Severity Index (ISI) by Bastien, et.al., (2001) for shorter sleep duration". These instruments demonstrated strong reliability, with Cronbach's alpha ranging from 0.71 to 0.88 across scales (Bastien, et.al., 2001), thereby ensuring psychometric robustness. The use of both positively and negatively worded items minimized response bias.

5.4 Data Collection

Primary data is collected through structured questionnaires administered to COVID-19 survivors (Between the Year 2021-2022) meeting the inclusion criteria. Ethical standards are strictly maintained, ensuring informed consent, confidentiality, and non-invasive participation. Data is gathered from both urban and rural area clusters with balanced representation across gender. Additionally, a quantitative approach offers deeper insights into the psychological experiences of participants during and after the pandemic.

5.5 Statistical Tools and Techniques

Data analysis is conducted using SPSS 26, AMOS, and MS Excel, applying both descriptive and inferential statistics. Mean and standard deviation summarized sample characteristics, while correlation analysis

explored relationships among perceived vulnerability, resilience, sleep duration, and PTSD. Moderation analysis and mediation analysis were examined through SEM using AMOS, the mediating role of sleep duration, moderating role of gender, ensuring a comprehensive evaluation of direct and indirect effects.

6. Results

Table 1: Respondents' Demographic Profile

Sr. No.	Demographic Characteristics	Category	N	%
1	Gender	Male	200	50.0
		Female	200	50.0
2	Age	18–35 years old	187	46.8
		35–60 years old	122	30.5
		60 years and above	91	22.8
3	Educational Qualification	Higher Secondary Education	135	33.8
		Graduate	113	28.2
		Postgraduate	97	24.3
		Doctoral	55	13.8
4	Marital Status	Married	209	52.3
		Single	191	47.8
5	Inhabitant	Rural	200	50.0
		Urban	200	50.0
6	Profession	Student	52	13.0
		Daily Wage Maker	87	21.8
		Farmer	70	17.5
		Self-Employed	49	12.3
		Private Sector Employee	77	19.3
		Government Employee	65	16.3

Table 1 shows the demographic profile of the respondents. The sample exhibits a balanced gender composition, with 50% male and 50% female, with the largest age group (46.8%) in the 18–35 years category. Educational backgrounds vary, with 33.8% having higher secondary education, 28.2% graduates, 24.3% postgraduates, and 13.8% with doctoral degrees. Marital status is nearly equal (52.3% married, 47.8% single), and geographic representation is 50% rural and 50% urban. Occupations include daily wage earners (21.8%), private sector employees (19.3%), farmers (17.5%), government employees (16.3%), students

(13%), and self-employed (12.3%). This diverse sample enhances the study's reliability and representativeness.

6.1 Result based on Hypothesis

H1a: There is a negative relationship between shorter sleep duration and post-traumatic stress.

Table 2: Descriptive Statistics and Correlation Matrix for Study Variables

Variable	M	SD	1	2
1. Shorter Sleep Duration	18.58	6.48	—	-.54**
2. Post-Traumatic Stress Disorder	17.45	7.74	-.54**	—

Note: N = 400. M = Mean; SD = Standard Deviation. **Correlation is significant at the 0.01 level (2-tailed). Table 2 indicates that participants had an average score of 18.58 with a SD of 6.48 for shorter sleep duration and 17.45 with SD = 7.74 for post-traumatic stress disorder (PTSD), with a statistically significant negative correlation between the two variables that is $r = -0.54$, $p < 0.01$. This suggests that as shorter sleep duration scores increase, PTSD scores tend to decrease, and vice versa, though the interpretation depends on the coding of the sleep duration variable. The moderate-to-strong strength of the correlation highlights a meaningful association between sleep patterns and PTSD symptoms, implying that sleep duration is an important factor influencing trauma-related mental health outcomes. These findings support Hypothesis H1a and underscore the potential benefit of incorporating sleep improvement strategies into PTSD interventions.

H1b: There is a positive relationship between perceived vulnerability and post-traumatic stress.

Table 3: Descriptive Statistics and Correlation Matrix for Study Variables

Variable	M	SD	1	2
1. Post-Traumatic Stress Disorder	17.45	7.74	—	.45**
2. Perceived Vulnerability	76.82	22.18	.45**	—

Note: N = 400. M = Mean; SD = Standard Deviation. **Correlation is significant at the 0.01 level (2-tailed). Table 3 show that participants recorded an average score of 17.45 (SD = 7.74) for post-traumatic stress disorder (PTSD) and 76.82 (SD = 22.18) for perceived

vulnerability, with the correlation analysis revealing a statistically significant positive relationship between the two variables ($r = 0.45, p < 0.01$). This suggests that elevated perceptions of vulnerability correlate with increased PTSD scores, indicating that persons who see themselves as more at risk or vulnerable to harm report more severe trauma-related symptoms. The correlation strength is moderate, reflecting a meaningful link between vulnerability perceptions and PTSD experiences. These findings support Hypothesis H1b, highlighting that perceived vulnerability plays an important role in the manifestation of PTSD and may serve as a critical target for prevention and intervention strategies aimed at reducing trauma impact.

H1c: There is a negative relationship between resilience and post-traumatic stress.

Table 4: Descriptive Statistics and Correlation Matrix for Study Variables

Variable	M	SD	1	2
1. Post-Traumatic Stress Disorder	17.45	7.74	—	-.56**
2. Resilience	20.39	7.32	-.56**	—

Note: N = 400. M = Mean; SD = Standard Deviation.

**Correlation is significant at the 0.01 level (2-tailed).

Table 4 reveals that individuals attained an average score of 17.45 (SD = 7.74) for PTSD and 20.39 (SD = 7.32) for resilience, exhibiting a statistically significant negative connection between the two variables ($r = -0.56, p < 0.01$). This suggests that resilience levels are associated with lower PTSD symptoms, and conversely, lower resilience corresponds to higher PTSD severity. The correlation strength is moderate to strong, highlighting resilience as a potentially protective factor against trauma-related distress. These findings support Hypothesis H1c and underscore the importance of resilience-building interventions as a means of mitigating PTSD symptoms and enhancing psychological recovery.

H2: There is a mediating effect of shorter sleep duration in explaining the relationship between the Perceived vulnerability, Resilience and post-traumatic stress.

➤ **Data Normality**

Table 5 Descriptive Statistics Table

Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
SSD 1	400	2.7925	1.16095	-.806	.122	-.300	.243
SSD 2	400	2.5700	1.15908	-.486	.122	-.569	.243
SSD 3	400	2.6000	1.17621	-.613	.122	-.542	.243
SSD 4	400	2.5800	1.25999	-.552	.122	-.777	.243
SSD 5	400	2.6050	1.14554	-.571	.122	-.500	.243
SSD 6	400	2.6700	1.20820	-.527	.122	-.795	.243
SSD 7	400	2.7625	1.20196	-.761	.122	-.404	.243
PTS D1	400	2.2900	1.23073	-.145	.122	1.081	.243
PTS D2	400	2.2450	1.24251	.054	.122	1.122	.243
PTS D3	400	2.0375	1.20404	.179	.122	-.970	.243
PTS D4	400	2.0525	1.20140	.247	.122	1.025	.243
PTS D5	400	2.0550	1.18553	.193	.122	-.942	.243
PTS D6	400	2.0900	1.23113	.225	.122	1.079	.243
PTS D7	400	2.2400	1.18782	-.022	.122	1.003	.243

PTS D8	400	2.4 375	1.23 892	- .19 4	.1 22	- 1.11 9	.2 43
R1	400	3.5 900	1.41 489	- .67 8	.1 22	- .93 6	.2 43
R2	400	3.4 700	1.35 968	- .54 1	.1 22	- .99 2	.2 43
R3	400	3.5 150	1.40 167	- .58 5	.1 22	- 1.0 32	.2 43
R4	400	3.4 750	1.28 978	- .51 5	.1 22	- .90 8	.2 43
R5	400	3.4 475	1.34 974	- .54 0	.1 22	- .97 4	.2 43
R6	400	3.5 275	1.41 395	- .48 7	.1 22	- 1.1 88	.2 43
PV1	400	5.2 225	1.73 797	- 1.0 77	.1 22	.33 2	.2 43
PV2	400	5.2 075	1.69 014	- .99 9	.1 22	.16 6	.2 43
PV3	400	5.0 450	1.89 657	- .91 8	.1 22	- .30 8	.2 43
PV4	400	5.1 700	1.71 126	- .87 3	.1 22	- .17 9	.2 43
PV5	400	4.9 600	1.92 423	- .83 4	.1 22	- .49 2	.2 43
PV6	400	5.1 950	1.74 344	- .99 5	.1 22	.07 1	.2 43
PV7	400	5.2 125	1.72 476	- 1.0 09	.1 22	.08 6	.2 43
PV8	400	5.2 250	1.77 546	- 1.0 32	.1 22	.02 4	.2 43
PV9	400	5.2 550	1.73 998	- 1.0 16	.1 22	.10 2	.2 43

PV1 0	400	5.1 225	1.71 021	- 1.0 01	.1 22	.10 4	.2 43
PV1 1	400	4.9 950	1.83 259	- .74 6	.1 22	- .53 9	.2 43
PV1 2	400	4.9 875	1.83 869	- .80 6	.1 22	- .43 4	.2 43
PV1 3	400	4.9 450	1.78 745	- .84 3	.1 22	- .26 7	.2 43
PV1 4	400	5.1 200	1.79 406	- .88 0	.1 22	- .28 8	.2 43
PV1 5	400	5.1 550	1.78 436	- 1.0 70	.1 22	.21 8	.2 43
Valid N (list wise)	400						

(Source: Data generated through PLS analysis)

Table 5 summarizes the descriptive statistics of all study variables, confirming data suitability for Confirmatory Factor Analysis (CFA). The dataset, comprising 400 respondents, ensures sufficient statistical power. Student Self-Development (SSD) shows moderate mean scores (2.57–2.79) with acceptable variability, while Post-Traumatic Stress Disorder (PTSD) exhibits slightly lower means (2.04–2.44) and near-normal distribution. Resilience (R) demonstrates higher means (3.45–3.59), indicating moderate to high resilience, and Perceived Vulnerability (PV) records the highest means (4.95–5.26), reflecting strong perceived vulnerability. All variables show skewness and kurtosis within ± 2 , confirming approximate normality. All variables, in particular, have skewness values falling in the range of -1.2 and +0.2 and kurtosis values within -1.0 and +0.5. These fall into the acceptable range of -3 to +3 for skewness and -10 to +10 for kurtosis as set by Blanca et al., (2013), while Hair et al., (2010) has stricter standards with a range of -2 to +2 for skewness and -7 to +7 for kurtosis. Thus, the data meet parametric analysis assumptions, supporting reliability for correlation, regression, and structural equation modeling.

Table 6: Reliability and Validity of Constructs

S. no.	Construct	Items	Standardized Loadings	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)	Maximum Shared Variance (MSV)	Average Shared Variance (ASV)
1.	Perceived Vulnerability	PV1	0.788	0.968	0.969	0.675	0.212	0.077
		PV2	0.801					
		PV3	0.827					
		PV4	0.826					
		PV5	0.828					
		PV6	0.824					
		PV7	0.843					
		PV8	0.848					
		PV9	0.819					
		PV10	0.829					
		PV11	0.798					
		PV12	0.865					
		PV13	0.809					
		PV14	0.798					
		PV15	0.819					
2.	Shorter Sleep Duration	SSD1	0.673	0.892	0.893	0.544	0.640	0.100
		SSD2	0.708					
		SSD3	0.755					
		SSD4	0.797					
		SSD5	0.719					
		SSD6	0.782					
		SSD7	0.728					
3.	Post Traumatic Stress Disorder	PTSD 1	0.689	0.918	0.923	0.603	0.212	-0.125
		PTSD 2	0.795					
		PTSD 3	0.803					
		PTSD 4	0.778					
		PTSD 5	0.818					
		PTSD 6	0.854					
		PTSD 7	0.777					
		PTSD 8	0.693					
		4.	Resilience					
R2	0.832							

		R3	0.848					
		R4	0.833					
		R5	0.848					
		R6	0.869					

Table 6 indicates that all constructs, Perceived Vulnerability, Shorter Sleep Duration, Post-Traumatic Stress Disorder, and Resilience, demonstrate strong reliability and validity. The standardized loadings for all items exceed the acceptable threshold of 0.60, showing that the items appropriately represent their respective constructs. Cronbach’s alpha values for all constructs range between 0.892 and 0.968, confirming high internal consistency. Composite Reliability (CR) values are also above 0.70, indicating the reliability of each construct. The AVE values surpass 0.50, hence affirming robust convergent validity. The MSV and ASV values are inferior to the AVE for each construct, hence affirming discriminant validity. These results affirm that the measurement model exhibits excellent reliability, robust convergent validity, and sufficient discriminant validity, rendering it appropriate for subsequent structural analysis.

Fit Index (GFI = 0.907) meets the recommended threshold, while the Adjusted GFI (AGFI = 0.891) is marginally below 0.90 but still close enough to indicate reasonable fit. The Comparative Fit Index (CFI = 0.985), Normed Fit Index (NFI = 0.938), Tucker–Lewis Index (TLI = 0.983), and Incremental Fit Index (IFI = 0.985) all surpass the benchmark of 0.90, confirming strong comparative and incremental fit. The Root Mean Square Error of Approximation (RMSEA = 0.027) is substantially lower than the 0.10 limit, showing excellent approximation to the population covariance structure, and the Standardized Root Mean Square Residual (SRMR = 0.000) reflects negligible residual error. Overall, these results confirm that the structural model is highly robust, providing a reliable representation of the theoretical relationships among the constructs and supporting the validity of the proposed model.

➤ The Goodness of Model Fit

Table 7: Model Fit Table

Goodness of Fitness Index	MIN/DF	GFI	AGFI	CFI	NFI	MSEA	TLI	IFI	SRMR
Calculated Value	1.299	0.907	0.891	0.985	0.938	0.027	0.983	0.985	0.000
Expected Value	low 3.0	above 0.9	above 0.9	above 0.9	above 0.9	low 0.10	above 0.9	above 0.9	less than 0.05

➤ Direct, indirect, and total effect

Table 8: Direct, indirect, and total effect Tables

Predicted Relationship	Direct Effect	Indirect effect	Total effect	Mediation
PV -> PTSD	0.46	-	0.46	-
R -> PTSD	-0.49	-	-0.49	-
PV -> SSD -> PTSD	0.46	-0.053	0.407	No Mediation
R -> SSD -> PTSD	-0.49	-0.472	-0.962	Partial Mediation

➤ Model

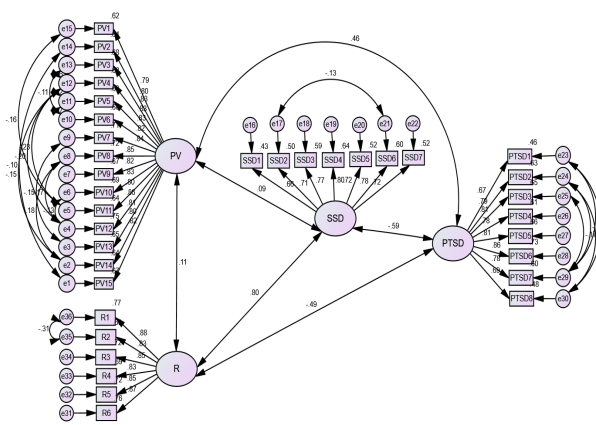


Figure 2: SEM Model

Table 7 and Figure 2 show that the SEM model demonstrates a strong overall fit with the observed data. The CMIN/df value of 1.299 is well below the acceptable limit of 3.0, indicating a parsimonious model with minimal discrepancies. The Goodness of

Table 8 shows that Perceived Vulnerability has a direct positive effect of 0.46 on Post-Traumatic Stress Disorder (PTSD), indicating that greater perceptions of vulnerability lead to increased PTSD symptoms, unaffected by sleep duration. In contrast, Resilience has a negative effect of -0.49 on PTSD, suggesting that higher resilience correlates with fewer symptoms. Moreover, while there is a small negative indirect effect of -0.053 from Perceived Vulnerability to PTSD via Shorter Sleep Duration, it is not significant. Resilience, however, has a substantial indirect effect of -0.472 through Sleep Duration, leading to a total effect of -0.962 when combined with its direct effect, revealing its dual role in reducing PTSD symptoms through both direct impact and enhancement of sleep quality. Overall, Perceived Vulnerability directly influences PTSD, while Resilience impacts it both directly and indirectly by promoting better sleep.

H3: There is a moderating effect of gender on the relationship between Shorter sleep duration,

Perceived vulnerability, Resilience and post-traumatic stress.

Table 9: Covariances Table

Relation			Male		Female	
			Estimate	P-value	Estimate	P-value
Perceived Vulnerability	<-->	Post Traumatic Stress Disorder	0.552	***	0.650	***
Shorter Sleep Duration	<-->	Post Traumatic Stress Disorder	-0.279	***	-0.332	***
Resilience	<-->	Post Traumatic Stress Disorder	-0.246	***	-0.195	0.01

Table 9 presents the covariances showing how perceived vulnerability, shorter sleep duration, and resilience relate to post-traumatic stress disorder for males and females. Perceived vulnerability has a significant positive association with PTSD in both genders, with an estimate of 0.552 for males and 0.650 for females, indicating that higher perceived vulnerability increases PTSD severity, with a slightly stronger effect in females. Shorter sleep duration is negatively associated with PTSD for both males and females, with estimates of negative 0.279 and negative 0.332, respectively, showing that longer sleep reduces PTSD symptoms and that this protective effect is marginally stronger among females. Resilience also exhibits a significant negative relationship with PTSD, with an estimate of negative 0.246 for males and negative 0.195 for females, suggesting that higher resilience lowers PTSD severity, with the protective effect slightly greater in males. These findings support Hypothesis H3, indicating that gender moderates the strength of these relationships, with perceived vulnerability affecting females more, resilience benefiting males slightly more, and sleep duration reducing PTSD in both genders, slightly more in females.

The Goodness of Model Fit (Gender Moderation Model 1)

Table 10: Model Fit (Gender Moderation Model) Table

Goodness of Fitness Index	MIN/DF	GFI	AGFI	CFI	NFI	MSEA	FLI	IFI	SRMR
Calculated Value	.511	.823	.791	.950	.866	0.036	.944	.950	.000
Expected Value	low 3.0	above 0.9	above 0.9	above 0.9	above 0.9	low 0.10	above 0.9	above 0.9	less than 0.05

Model (For Male)

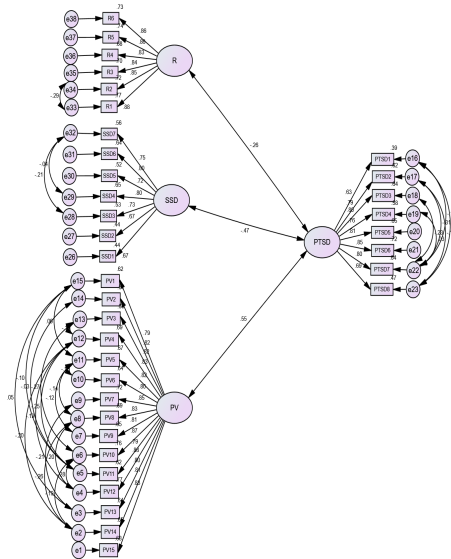


Figure 3 Model (For Male)

(Source: Data generated through PLS analysis)

Model (For Female)

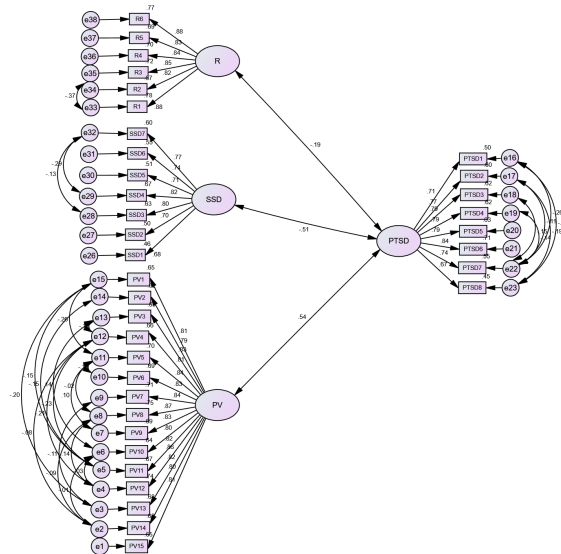


Figure 4 Model (For Female)

(Source: Data generated through PLS analysis)

Table 10, Figure 3 and 4 of the Gender Moderation Model 1 demonstrate that the model adequately aligns with the data. The CMIN/DF ratio of 1.511 is far below the required threshold of 3.0, indicating a favorable

overall model fit. The RMSEA score of 0.036 is within the allowed range (below 0.10), signifying a minimal level of error in model estimation. The CFI (0.950), TLI (0.944), and IFI (0.950) values exceed 0.90, indicating a robust comparative and incremental fit. Nonetheless, the GFI (0.823), AGFI (0.791), and NFI (0.866) fall just short of the optimal threshold of 0.90, indicating that there remains potential for enhancement in the model's goodness of fit. The SRMR value of 0.000, which is below 0.05, reinforces a solid alignment between the observed and anticipated data. The findings affirm that the Gender Moderation Model 1 offers an adequate and dependable depiction of the data, as the majority of indices satisfy the suggested criteria.

7. Discussion

The present study sought to address specific deficiencies and unresolved questions within the existing literature concerning sleep, psychosocial factors, and post-traumatic stress disorder (PTSD) as they relate to the COVID-19 pandemic. This research contributes to the understanding of these dynamics by integrating and evaluating a model that encompasses both mediation and moderation effects, elements that several prior studies, despite their value, did not adequately address. Numerous initial investigations have demonstrated strong correlations among various factors; however, they have not delved into the intricate pathways involved. For example, Straus et al., (2022) identified that poor sleep quality exacerbated PTSD symptoms, particularly among individuals exhibiting heightened anticipatory threat. In a similar vein, Ahmed et al., (2021) noted that females and individuals with hypertension were particularly vulnerable to mental health issues following COVID-19. Nonetheless, these studies did not conduct statistical analyses to ascertain whether sleep functioned as a mediator in the relationship between vulnerability and PTSD. This study fills the aforementioned gap by establishing and validating that diminished sleep duration significantly mediates the relationship between low resilience and PTSD, thus providing a mechanistic explanation for previously identified associations. Furthermore, Siddique et al., (2021) indicated that fear of COVID-19 was linked to poor sleep quality, with stress serving as a mediating factor. This finding highlighted a mediation pathway that emphasizes fear and stress as precursors to sleep disturbances. The current investigation examined two distinct psychosocial precursors: perceived vulnerability and resilience. It demonstrated that sleep differentially influenced the pathways to PTSD,

thereby offering a more nuanced perspective on these relationships.

Numerous significant studies have demonstrated the concurrent occurrence of post-traumatic stress disorder (PTSD) and sleep disturbances; however, they have not investigated the causative relationship between the two. Research conducted by Hyun et al., (2020) identified PTSD symptoms as indicative of poor sleep quality among young adults in the United States. Furthermore, a meta-analysis by Alimoradi et al. (2021) confirmed a substantial correlation between sleep issues and mental distress. This analysis was pivotal in underscoring the importance of sleep; however, it did not elucidate its physiological functions. The current study emphasizes the significance of sleep duration as a mediating factor, rather than as a mere singular measure, thereby illustrating its crucial role in the protective aspect of resilience. Additionally, Yin et al., (2020) explored sleep quality as a mediator between exposure levels and post-traumatic stress symptoms (PTSS) among healthcare workers. This investigation expanded upon and augmented previous findings within the survivor community, particularly concerning various psychosocial dimensions. The results indicated that the mediation was significant in relation to resilience; however, it was insufficient regarding perceived vulnerability..

Many studies, such as Schäfer et al. (2022) and Lin et al., (2020), focused on general sleep quality or insomnia. The current study analyzed sleep duration as a quantifiable variable. Tang et al., (2020) recognized brief sleep duration as a critical risk factor for PTSD among students, whereas Liao et al., (2021) established a reciprocal relationship between diminished sleep length and depressive symptoms. The present study's results quantitatively demonstrate that sleep duration functions as a significant mediator, rather than merely subjective quality, establishing a more definitive target for management. Liu et al., (2020) and Olf (2017) demonstrated that women are at a higher risk of experiencing symptoms related to post-traumatic stress. Similarly, Fusco and Kulkarni (2023) and Agathão et al., (2020) identified distinct differences between men and women regarding the relationship between sleep and mental health disorders. However, prior research often failed to integrate these findings cohesively. The current study directly examines and corroborates the moderating role of gender within a consolidated framework. The results reveal that the connection between vulnerability and post-traumatic stress disorder (PTSD) is more pronounced in females,

while the protective influence of sleep is marginally greater for this demographic. Conversely, the resilience-PTSD relationship appears to be slightly stronger in males. This study offers an empirical synthesis that articulates the insights previously suggested by earlier fragmented studies.

Some studies reported unexpected findings, such as Benham (2020), who found that sleep duration increased in college students during the pandemic. This highlights the heterogeneity of pandemic impacts. The present study focused specifically on COVID-19 survivors, a group with direct physiological and psychological trauma, and by controlling for psychosocial factors, provides a more targeted explanation for negative mental health outcomes in this vulnerable subgroup. Furthermore, studies like Liang et al., (2022) explored a mediation model with teachers but focused on sleep problems as a mediator between PTSD and general distress. The present study flipped the perspective, showing how sleep mediates the effect of protective and risk factors on the development of PTSD itself. Campo-Arias et al. (2021) found a relationship between perceived discrimination, PTSD, and insomnia; however, failed to investigate a potential mediator.

8. Conclusion

The study provides robust evidence that sleep duration plays a critical and specific mediating role in the psychological aftermath of COVID-19 infection. The study found that while perceived vulnerability to disease directly exacerbates post-traumatic stress symptoms, resilience operates through a dual pathway: it directly reduces PTSD and indirectly protects against it by promoting longer, more restorative sleep. This partial mediation highlights that improving sleep is a key mechanism through which resilience confers its benefits. Furthermore, gender is a significant moderator; the detrimental impact of perceived vulnerability is more pronounced in women, and the protective effect of resilience is marginally stronger in men. These findings collectively move beyond simple correlations to delineate the distinct psychological and behavioral pathways that lead to trauma-related outcomes in a post-pandemic context. This research contributes a tested integrative model to the literature, clarifying the mediating role of sleep. For practice, it underscores the necessity of integrating sleep hygiene into resilience-building interventions and tailoring mental health support by gender to mitigate PTSD in survivors.

Implication of the Study

The findings have significant implications for public health strategy. Mental health professionals to routinely assess and treat sleep disturbances in COVID-19 survivors as a core component of trauma therapy. For policymakers, they highlight the need for community-based programs that foster psychological resilience and provide sleep education, particularly targeting high-vulnerability groups like female survivors. Clinicians should be aware that a one-size-fits-all approach is insufficient; interventions must be tailored, with a focus on mitigating perceived vulnerability for women and bolstering resilience-focused coping for men, while always addressing sleep as a central pillar of recovery.

Limitations

The study is limited to the Aurangabad District of Maharashtra, thereby limiting the applicability of findings to other areas. The cross-sectional design inhibits the determination of relationships among variables. Self-reported surveys may exhibit answer biases, and cultural disparities may influence participants' understanding of standardized instruments. Although gender and sleep duration were examined as moderating and mediating variables, other factors, including socio-economic status and prior mental health issues, were neglected. The general reliance on quantitative methodologies constrained the scope of qualitative insights, and the results represent merely a particular post-pandemic phase, rather than enduring psychological effects.

Future Research Directions

Future studies should adopt longitudinal designs to confirm the causal pathways identified here. Research should also replicate this model in diverse cultural settings and with populations affected by different types of trauma to test its generalizability. Incorporating objective sleep measures, such as actigraphy, would strengthen the validity of the sleep mediator. Exploring additional potential mediators, like social support or neurobiological markers (e.g., inflammatory profiles), could further elucidate the complex mechanisms linking psychosocial factors to PTSD. Finally, intervention studies are needed to test the efficacy of integrated sleep-and-resilience programs for trauma recovery.

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