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Cumulative health burden and psychological functioning in patients with obstructive sleep apnoea – the mediating role of stress

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Abstract

Introduction and Objective. Obstructive sleep apnoea (OSA) often co-occurs with multiple comorbidities. The aim of the study is to examine whether stress mediates the relationship between comorbidity burden and psychological functioning in OSA patients, and whether optimism moderates these relationships.

Materials and Method. Sixty OSA patients aged 27–81 (45 males, 15 females) completed questionnaires assessing stress (PSS-10), optimism (LOT-R), life satisfaction (SWLS), and mental health (GHQ-28). Patients were categorised into groups with and without comorbid conditions; the number of comorbidities was treated as a continuous variable. The relationships between variables, as well as mediation and moderation effects, were assessed using Partial Least Squares Path Modelling.

Results. Patients with comorbidities reported higher stress than those without (mean = 16.38 vs. 12.077; $p = 0.039$). Comorbidity count correlated with stress levels ($\beta = 0.358$; $p < 0.01$). Stress predicted life satisfaction ($\beta = -0.503$; $p < 0.001$) and correlated with mental health disorder symptoms ($\beta = 0.564$; $p < 0.001$). Stress fully mediated the relationship between comorbidity burden and both life satisfaction ($\beta = -0.180$; $p < 0.01$) and mental health problems ($\beta = 0.202$; $p < 0.01$). Optimism moderated the stress-life satisfaction relationship ($\beta = 0.206$; $p < 0.05$).

Conclusions. Stress mediates the relationship between comorbidity burden and psychological functioning in OSA patients. Hence, stress screening and management should be incorporated into OSA care, particularly for patients with multiple comorbidities. The results obtained support the holistic approach to OSA management addressing the psychological burden of multimorbidity.

Key words

patients, optimism, stress, life satisfaction, multimorbidity, obstructive sleep apnoea, mental health

INTRODUCTION AND OBJECTIVE

Obstructive sleep apnoea (OSA) is increasingly recognised as a systemic disorder with far-reaching health implications beyond disrupted sleep. It is characterised by recurrent episodes of upper airway collapse during sleep that lead to intermittent hypoxia and sleep fragmentation [1, 2], and affects approximately 936 million adults aged 30–69 years globally, with prevalence exceeding even 50% in some countries [3]. The condition rarely exists in isolation; rather, it frequently co-occurs with numerous comorbidities, including cardiovascular diseases, metabolic disorders, respiratory and psychiatric conditions, with systematic reviews identifying associations with heart disease, stroke, kidney disease, asthma, COPD, hyperlipidaemia, prediabetes, diabetes, and psychological comorbidities, including stress and depression [4, 5], creating a complex clinical picture for both patients and healthcare providers.

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The multimorbidity associated with OSA presents a significant challenge to the overall well-being of patients. When multiple health conditions coexist, the burden on physiological and psychological resources may increase disproportionately, beyond what might be expected from each condition in isolation. This phenomenon can be understood through the theoretical framework of allostatic load, i.e., the cumulative physiological toll exacted on the body due to repeated cycles of adaptation to stressors [6]. As the number of comorbidities increases in OSA patients, so too may the allostatic load, potentially overwhelming adaptive capacities and creating a cascade of negative health outcomes.

Stress appears to play a pivotal role in this relationship between disease burden and psychological functioning. The presence of multiple chronic conditions may act as persistent stressors, activating physiological stress responses and psychological distress. In turn, elevated stress levels are known to adversely affect various aspects of psychological well-being, including life satisfaction and mental health, through both direct and indirect pathways [7–9]. Research demonstrates that prolonged stress can lead to increased anxiety, depression, and hopelessness, whilst simultaneously diminishing overall life satisfaction and subjective well-being. Moreover, stress may act as a mediating factor

through which various life challenges impact psychological functioning, suggesting that stress management could be a crucial intervention target for improving well-being outcomes. Recent research has demonstrated that patients with OSA experience significantly higher levels of perceived stress compared to healthy controls, with stress strongly correlating with symptoms of depression and anxiety [10]. Despite the intuitive nature of these connections, however, the specific mechanisms through which comorbidity burden affects psychological functioning in OSA patients remain incompletely understood.

Several factors may influence how individuals respond to the stress associated with multiple health conditions. Psychological resources, for example, optimism, have been identified as potential buffers against the negative impact of stress on well-being [11, 12]. Recent evidence from daily diary studies demonstrates that dispositional optimism significantly attenuates negative affect reactivity to daily stressors, suggesting that optimistic individuals are better equipped to maintain emotional equilibrium when facing health challenges [11]. Furthermore, optimism appears to exert its protective effects through multiple pathways, including reducing perceived stress levels and stress anticipation which, in turn, leads to fewer psychological symptoms [12]. Optimistic individuals may maintain higher levels of life satisfaction despite experiencing health-related stressors, suggesting a potential moderating effect on the relationship between stress and psychological outcomes.

Understanding these complex interrelationships is crucial for developing comprehensive approaches to OSA management that address not only the primary sleep disorder but also its broader psychological impacts. Current treatment guidelines for OSA focus predominantly on addressing respiratory parameters through continuous positive airway pressure (CPAP) therapy or alternative interventions [13]. Although CPAP can improve sleepiness, health-related quality of life, and mood symptoms [14], researchers increasingly recognise that multidisciplinary approaches and shared decision-making are necessary for successful treatment [2]. Despite this knowledge, less attention still has been paid to managing the psychological burden of the disease and its comorbidities [1].

Considering the above, the aim of the study is to investigate whether stress mediates the relationship between comorbidity burden and psychological functioning in patients with OSA. Specifically, it is hypothesised that (1) a higher number of comorbidities will be associated with increased stress levels; (2) elevated stress will negatively impact life satisfaction and mental health; and (3) stress will mediate the relationship between comorbidity burden and psychological outcomes. An additional aim is to explore whether optimism moderates the relationship between stress and psychological functioning, potentially buffering against the negative effects of stress on well-being.

Notably, it is hoped that the investigation of these relationships will contribute to a more nuanced understanding of the psychological implications of multimorbidity in OSA, and hence identify potential targets for intervention that extend beyond traditional OSA management approaches.

MATERIALS AND METHODS

Participants and procedure. The study sample consisted of 60 adult patients (45 males, 15 females) aged 27 – 81 years (M = 52.12, SD = 14.25) diagnosed with obstructive sleep apnoea (OSA) who were receiving additional treatment at the Ophthalmology Clinic of the Military Institute of Aviation Medicine (WIML) in Warsaw, Poland. Patients were recruited during their scheduled medical appointments at the Ophthalmology Clinic between February 2023 – January 2025. The recruitment employed a convenience sampling method, with all eligible patients attending the Ophthalmology Clinic during the study period being invited to participate. Patients who met the inclusion criteria and agreed to participate were enrolled in the study. Those who did not participate either did not meet the inclusion criteria (primarily the confirmed OSA diagnosis requirement) or declined participation.

In terms of demographic characteristics, 33 participants (55.0%) were married, 18 (30.0%) were single, 6 (10.0%) were divorced, and 3 (5.0%) were widowed. The majority of patients (47; 78.3%) lived in large cities with populations over 500,000, 5 (8.3%) resided in towns with up to 100,000 inhabitants, 3 (5.0%) in medium-sized cities (101,000–500,000 inhabitants), and 5 (8.3%) in rural areas. Regarding education, 33 participants (55.0%) had completed higher education, 23 (38.3%) secondary education, and 4 (6.7%) vocational education.

Inclusion criteria were (1) a confirmed diagnosis of OSA based on polysomnography, (2) age ≥ 18 years, and (3) sufficient cognitive capacity to provide informed consent and complete self-report questionnaires. Exclusion criteria included acute psychiatric conditions that would interfere with participation.

The study protocol was approved by the Ethics Committee reviewing biomedical research at the Military Institute of Aviation Medicine (Decision No. 10/2020). Participation in the study was completely anonymous and voluntary, and all participants provided written informed consent prior to enrolment. Participants completed a set of self-report questionnaires during their clinical visit.

Measurements. A purpose-designed questionnaire was used to collect socio-demographic data, including participants' age, gender, education level, marital status, employment status, and place of residence. Additionally, participants indicated the presence of comorbid conditions from a list which included diabetes, hypertension, heart disease, cancer, rheumatoid arthritis, multiple sclerosis, kidney disease, overweight, obesity, depression, neurosis, and anxiety disorders. The number of comorbidities was categorised into 3 groups: 0, 1, or 2+ conditions for analytical purposes.

Perceived stress was assessed using the 10-item version of the Perceived Stress Scale (PSS-10) by Cohen, Kamarck, and Mermelstein, in the Polish adaptation by Juczyński and Ogińska-Bulik [15]. This instrument measures the intensity of stress related to one's life situation over the past month. The scale contains 10 questions concerning various subjective feelings related to personal problems and events, behaviours, and coping strategies. Sample items included 'In the last month, how often have you felt nervous and stressed?'and 'In the last month, how often have you felt that you were unable to control the important things in your life?' Responses were

provided on a 5-point scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often), with total scores ranging from 0 – 40. Higher scores indicated greater perceived stress. The Polish adaptation demonstrates good internal consistency (Cronbach's α = 0.86).

Dispositional optimism was measured using the Life Orientation Test-Revised (LOT-R) by Scheier, Carver, and Bridges, in the Polish adaptation by Poprawa and Juczyński [16]. This scale is designed for assessing dispositional optimism in adults, and contains 10 statements, of which 6 have diagnostic value for dispositional optimism. Sample items included 'In difficult times, I usually expect a favourable outcome' and 'I'm always optimistic about my future'. Participants respond on a 5-point scale: 0 = definitely does not apply to me, 1 = rather does not apply to me, 2 = neither applies nor does not apply, 3 = rather applies to me, 4 = definitely applies to me. Total scores range from 0 – 24, with higher scores indicating higher levels of optimism. The Polish version shows satisfactory internal consistency (Cronbach's α = 0.76).

Life satisfaction was assessed using the Satisfaction with Life Scale (SWLS) by Diener, Emmons, Larson, and Griffin, in the Polish adaptation by Juczyński [16]. The scale contains 5 statements, and participants evaluate to what extent each relates to their life so far. Sample items included 'In most ways, my life is close to my ideal' and 'I am satisfied with my life'. Responses are marked on a scale from 1 – 7 (1 = strongly disagree, 7 = strongly agree). The measurement yields an overall index of life satisfaction, with total scores ranging from 5 – 35. Higher scores indicate greater life satisfaction. The Polish adaptation demonstrates satisfactory reliability (Cronbach's α = 0.81).

Mental health was assessed using the 28-item General Health Questionnaire (GHQ-28) by Goldberg, in the Polish adaptation by Makowska and Merecz [17]. This questionnaire evaluates the mental health status of adults and identifies individuals whose psychological state has undergone temporary or long-term breakdown due to experienced difficulties, problems, or mental illness, as well as those at significant risk of mental health disorders. The GHQ-28 consists of 28 questions answered on a 4-point scale. In addition to the overall score, the GHQ-28 provides 4 subscales: somatic symptoms, anxiety and insomnia, social dysfunction, and depression symptoms. The questionnaire includes items such as 'Have you recently been feeling perfectly well and in good health?' (somatic symptoms) and 'Have you recently lost much sleep over worry?' (anxiety and insomnia). Higher scores indicate greater severity of mental health disorder symptoms. The Polish adaptation demonstrates high internal consistency coefficients and satisfactory absolute stability.

Remarkably, all questionnaires used in this study have been validated in Polish populations and demonstrated adequate psychometric properties in previous research.

Statistical analyses. The hypotheses were tested using Partial Least Squares Path Modelling (PLS-PM), a predictive modelling approach aimed at maximising the explained variance of the dependent variables (latent constructs), not to fit the model to the covariance matrix (as is the case with Covariance-Based SEM). This method is recommended when the primary goal of the analysis is prediction, the structural model is complex, and the sample size is relatively small (as was the case in the current study), as PLS-PM maintains statistical power with smaller samples compared to Covariance-Based Modelling. PLS-PM is also a variance-based method that does not require multivariate normality, with statistical inference relying on non-parametric bootstrapping. Due to the predictive nature of the model, traditional model fit indices are not applicable [18].

The model was specified as a reflective single-indicator model, in which latent constructs represent the scores of psychometric questionnaires (PSS-10, SWLS, GHQ-28, LOT-R) as well as the number of comorbidities. Since each construct was operationalised using a single final indicator, no measurement model assessment was conducted (e.g., factor loadings or validity indices). For the structural model assessment, the Variance Inflation Factor (VIF) was used. The highest observed VIF value was 2.59, indicating no multicollinearity issues [18].

To examine the moderating role of optimism (LOT-R), an interaction term was created by multiplying the standardised values of PSS-10 and LOT-R, which was then included as an additional exogenous predictor. When the interaction path was found to be significant, a simple slopes test was conducted to examine the direction and strength of the relationship.

Bootstrap resampling with 5,000 samples was used to estimate confidence intervals. All analyses were performed using the plspm package in R.

RESULTS

Patients with comorbidities (n = 47) reported higher stress than those without (mean = 16.38 vs. 12.077, $U = 190$; $p = 0.039$, effect size (rank-biserial correlation) = 0.378). In the next step of the analysis, the number of comorbidities was treated as a continuous variable. Descriptive statistics of the examined variables and the correlation matrix are presented in Table 1.

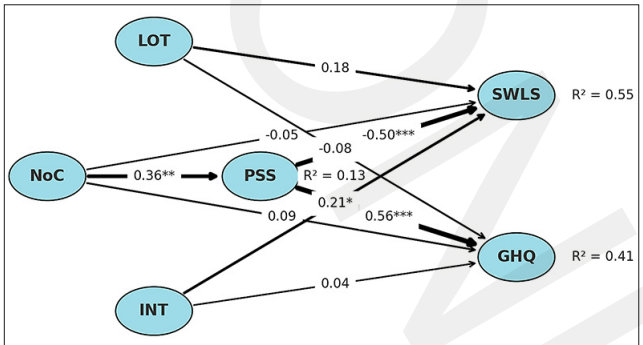
The results presented in Table 1 indicate a statistically significant correlation between the number of comorbid conditions and stress, which supports Hypothesis 1. A strong negative correlation was also found between stress and life satisfaction, as well as a positive correlation with the GHQ score, which supports Hypothesis 2.

Table 1. Descriptive statistics of the studied variables and Pearson's correlation coefficients

Variable	Min	Max	Mean	SD	Skew	Kur	Pearson's r			
							1	2	3	4
1) No. of comorbidities	0	6	1.90	1.46	0.52	-0.02	-			
2) Stress (PSS-10)	3	34	15.4	7.04	0.72	-0.25	0.358**	-		
3) Life Satisfaction (SWLS)	6	34	21.5	6.14	-0.65	0.09	-0.229	-0.705***	-	
4) Mental health (GHQ-28) [1]	9	43	22.1	9.07	0.73	-0.36	0.306*	0.633***	-0.420***	-
5) Optimism (LOT-R)	7	24	15.9	4.08	-0.24	-0.07	-0.142	-0.619***	0.545***	-0.436***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; [1] – Higher GHQ scores indicate greater severity of mental health disorder symptoms; SD – Standard Deviation; Skew – Skewness; Kur – Kurtosis

To test Hypothesis 3 and examine the moderating role of optimism, a PLS-PM analysis was conducted. The results are presented in Figure 1 and Table 2.



NoC – Number of comorbidities; INT – Interaction PSS-10 x LOT-R; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 1. Analysed path model

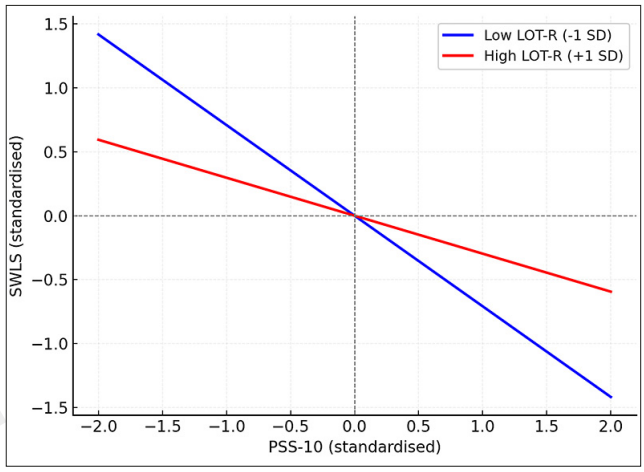


Figure 2. Optimism as a moderator of the relationship between stress and life satisfaction

The results (Tab. 2) showed that the number of comorbidities is a significant predictor of stress (PSS-10). Moreover, higher levels of stress were significantly associated with lower life satisfaction (SWLS) and higher levels of mental health disorder symptoms (GHQ-28). The indirect effects of the number of comorbidities, mediated by stress, on life satisfaction and mental health, were also statistically significant. Thus, Hypothesis 3 was supported.

Moreover, the analysis did not reveal a significant interaction between stress and optimism (LOT-R) in relation to mental health. However, for life satisfaction, the interaction between stress and optimism was found to be statistically significant. The moderation effect is illustrated in Figure 2.

Analysis revealed that at a low level of optimism (LOT-R = –1 SD), the relationship between stress and life satisfaction was strong and negative: β = –0.710, SE = 0.122, 95% CI [–0.916, –0.446]; $p < 0.001$. At an average level of optimism, this relationship was also significant: β = –0.503; SE = 0.143; 95% CI [–0.777, –0.207]; $p = 0.003$. However, at a high level of optimism (LOT-R = +1SD), the relationship was not statistically significant: β = –0.297; SE = 0.228; 95% CI [–0.736, 0.154]; $p = 0.189$.

DISCUSSION

The primary aim of this study was to examine whether stress mediates the relationship between comorbidity burden and psychological functioning in patients with OSA. It was hypothesised that: (1) a higher number of comorbidities would be associated with increased stress levels; (2) elevated stress would negatively impact life satisfaction and mental health; and (3) stress would mediate the relationship between comorbidity burden and psychological outcomes. Additionally, it was investigated whether optimism moderates the relationship between stress and psychological functioning.

The results obtained provide strong support for all 3 primary hypotheses. First, a significant positive correlation was found between the number of comorbidities and stress levels (β = 0.358; p < 0.01), with patients having one or more comorbidities reporting significantly higher stress levels compared to those without comorbidities. Specifically, mean stress levels increased from 12.077 in patients without comorbidities to 16.38 in those with at least one comorbidity (p = 0.039). This pattern supports the concept of allostatic load, whereby the accumulation of health conditions creates

Table 2. Path estimates for the PLS model

Path	β	Mean.Boot	SE	95% CI [LL, UL]	*p*
NoC → Stress (PSS)	0.358	0.361	0.110	[0.138, 0.568]	0.005
NoC → Life satisfaction (SWLS)	-0.048	-0.053	0.116	[-0.282, 0.169]	0.638
NoC → Mental Health (GHQ)	0.087	0.087	0.104	[-0.114, 0.289]	0.457
Stress → Life satisfaction (SWLS)	-0.503	-0.500	0.143	[-0.777, -0.207]	<0.001
Stress → Mental Health (GHQ)	0.564	0.569	0.159	[0.253, 0.871]	<0.001
Indirect effect: NoC → Stress → Life satisfaction (SWLS)	-0.180	-0.181	0.051	[-0.289, -0.091]	0.002
Indirect effect: NoC → Stress → Mental Health (GHQ)	0.202	0.205	0.060	[0.089, 0.335]	0.001
Total effect: NoC → Life satisfaction (SWLS)	-0.228	-0.231	0.113	[-0.448, -0.011]	0.039
Total effect: NoC → Mental Health (GHQ)	0.289	0.288	0.112	[0.065, 0.495]	0.009
Optimism (LOT-R) → Life satisfaction (SWLS)	0.183	0.170	0.114	[-0.065, 0.388]	0.120
Optimism (LOT-R) → Mental Health (GHQ)	-0.083	-0.085	0.138	[-0.362, 0.180]	0.532
Interaction effect Stress x Optimism → Life satisfaction (SWLS)	0.206	0.210	0.112	[0.011, 0.428]	0.045
Interaction effect Stress x Optimism → Mental Health (GHQ)	0.041	0.047	0.128	[-0.203, 0.298]	0.725

NoC – Number of comorbidities; β – Original Sample Estimate; Mean.Boot – średnie bootstrapowe; SE – Standard Error; 95% CI [LL, UL] – Confidence Interval [Lower Limits; Upper Limits]

an increasing burden on patients' adaptive resources. Systematic reviews of allostatic load have demonstrated that this cumulative burden can be identified through both biomarkers and clinical criteria, with measurable impacts on physical and mental health outcomes [6]. The findings of the current study extend this framework specifically to OSA patients with multiple comorbidities, suggesting that the allostatic load framework may be particularly relevant for understanding the psychological burden in this population.

Second, stress emerged as a strong predictor of life satisfaction ($\beta = -0.503$; $p < 0.001$) and was strongly correlated with mental health ($\beta = 0.564$; $p < 0.001$). These findings align with extensive literature demonstrating the detrimental effects of chronic stress on psychological well-being and quality of life in patients with chronic conditions [19], and extend them to the specific context of OSA. The results are also consistent with and extend previous research on stress in OSA populations [10]. Notably, the stress levels observed in the current study in comorbid OSA patients (16.38) are comparable to those reported by Wong et al. (15.3 ± 6.9), despite differences in sample characteristics. This suggests the robustness of elevated stress as a feature of OSA across diverse patient populations. Research consistently shows that individuals with chronic medical conditions experience significantly higher levels of psychological distress compared to the general population, with some studies reporting that the odds of experiencing psychological distress are 3 times higher among chronically ill patients [20]. The prevalence of stress among patients with various chronic diseases has been reported to be as high as 68.7%, with similarly elevated rates of anxiety (51.1%) and depression (58.8%) [21]. These psychological consequences appear to be consistent across different types of chronic conditions, with recent evidence indicating that diverse conditions such as cardiovascular disease, kidney disease and respiratory disorders, all contribute to poorer mental health outcomes [22]. Importantly, psychological distress among chronically ill patients is not only a quality-of-life concern but also has implications for healthcare utilisation and disease management, with depressive symptoms independently associated with greater use of outpatient care services, particularly among patients with cardiovascular disease [23].

Most importantly, the mediation analyses in the current study revealed that stress fully mediates the relationship between comorbidity burden and both life satisfaction and mental health. The indirect effects were significant for both outcomes (life satisfaction: $\beta = -0.180$; $p < 0.01$; mental health: $\beta = 0.202$; $p < 0.01$), while the direct effects became non-significant when stress was included in the models. This suggests that the impact of multiple health conditions on psychological functioning operates primarily through increased stress levels, rather than through direct pathways. These findings align with broader research on stress as a mediating mechanism across various health contexts; for example, intervention studies focused on stress reduction have demonstrated that decreases in stress during treatment are associated with improved well-being outcomes, supporting the causal role of stress as a mediator between life circumstances and psychological functioning [9]. The results obtained extend this understanding to the specific context of comorbidity burden in OSA, highlighting a potentially universal mechanism through which health challenges impact psychological outcomes.

All in all, these findings have some important clinical implications. Primarily, they suggest that stress represents a 'common final pathway' through which multimorbidity affects psychological well-being in OSA patients, highlighting the potential value of stress screening and stress management interventions in this specific population, particularly for those with multiple comorbidities. However, despite growing recognition of OSA as a global health issue, current efforts remain fragmented and insufficiently integrated across health systems, with a large proportion of OSA cases remaining undiagnosed or inadequately managed [1]. Nevertheless, rather than focusing solely on managing individual conditions, a more holistic approach that addresses the cumulative stress burden may be more effective in improving patients' quality of life. This aligns with emerging perspectives in OSA management that emphasise the need for multidisciplinary approaches and shared decision-making for successful treatment outcomes [2]. Such approaches recognise that OSA is not merely a respiratory disorder, but a complex systemic condition with psychological dimensions that require integrated care strategies. Recent narrative reviews further advocate for moving beyond the 'one-size-fits-all' approach toward personalised treatment paradigms that consider both physiological parameters and comorbidity profiles, including psychological aspects [24]. Moreover, routine stress screening using simple tools such as the PSS-10 could be integrated into regular follow-up appointments to identify patients at risk for poor psychological outcomes [25]. Furthermore, stress management interventions should be considered as an integral component of comprehensive OSA care, including cognitive-behavioural stress management programmes, mindfulness-based stress reduction (MBSR) interventions, brief psychological interventions that can be delivered in clinical settings, and group-based stress management programmes that also provide peer support. The identification of stress as a mediator suggests that addressing stress may have downstream benefits for both life satisfaction and mental health, providing a clear therapeutic target that may be more amenable to intervention than the underlying health conditions themselves.

Recent literature emphasises the importance of controlling for confounding variables in OSA research. Luo et al. [26] identified complex symptom networks in OSA patients that can be disrupted by additional clinical variables, while Goman et al. [27] highlighted the bi-directional relationship between OSA and mood disorders, including the influence of psychotropic medications. The COVID-19 pandemic has added another layer of complexity to mental health research. Studies have documented neurophysiological changes in PTSD patients post-COVID [28] and cases of cognitive disintegration following SARS-CoV-2 infection [29]. While the exclusion criteria in the current staudy helped reduce some potential confounds by excluding patients with diagnosed psychiatric disorders, the study did not exclude patients with a COVID-19 history or those on psychotropic medications. It was acknowledged that these factors represent important confounding variables that should be systematically controlled in future OSA research designs to further strengthen causal inferences.

Additionally, the exploratory moderation analyses yielded mixed results; therefore, optimism showed a marginally significant moderating effect on the relationship between stress and life satisfaction ($\beta = 0.206$; $p < 0.05$). Specifically,

whilst stress was strongly associated with reduced life satisfaction in patients with low optimism (β = -0.710; p <.001), this relationship became non-significant in highly optimistic patients (β = -0.297; p =.19).

This suggests that optimism may serve as a protective factor, helping patients maintain life satisfaction despite experiencing stress. However, optimism did not moderate the relationship between stress and mental health (β = 0.041; p =.73), with stress showing equally strong associations with poorer mental health, regardless of optimism levels. These mixed findings offer a nuanced perspective on the literature regarding the buffering role of optimism [11, 12]. The results obtained in the current study reveal an important domain-specificity in this protective effect, i.e., optimism appears to buffer against stress impacts on cognitive evaluations of life satisfaction, but not on broader mental health symptoms. This differentiated pattern suggests that psychological resources may operate selectively, with varying effectiveness, across different domains of psychological functioning. Therefore, these findings suggest that interventions aimed at enhancing psychological resources and resilience may be beneficial, at least for maintaining life satisfaction, and positive psychology interventions that foster optimism and other protective factors could complement stress reduction approaches.

Limitations of the study. Notwithstanding the above, several limitations of this study should be acknowledged. Firstly, the cross-sectional design precludes causal inferences about the relationships observed. Hence, longitudinal studies are needed to confirm the temporal sequence of these relationships and to determine whether changes in stress levels over time mediate changes in psychological functioning. Additionally, the sample size (N = 60) was relatively small, which may have limited statistical power, particularly for the moderation analyses. This limitation is compounded by the gender imbalance in the sample, with only 15 female participants (25%), which precluded meaningful gender-based analyses. Future studies should aim for larger, more balanced samples to explore potential gender differences in the relationships between OSA, stress, and psychological functioning.

Further limitations include the generalisability of the findings. The study was conducted at a single medical institution, which may limit the representativeness of the sample. Moreover, self-report measures for psychological variables were relied on, which may be subject to response bias and social desirability effects. Future research would benefit from incorporating objective assessments alongside self-report measures to validate these findings.

Regarding comorbidity assessment, the use of a simple count of comorbidities, rather than weighted indices that account for disease severity, may not fully capture the complexity of multimorbidity burden. The study also does not differentiate between types of comorbidities or their specific levels of severity, which could have differential impacts on psychological outcomes.

Although demographic information, such as education level, marital status, and place of residence, was collected, these variables were not included in the PLS model. Given the relatively small sample size, the inclusion of additional predictors would have increased model complexity and reduced the statistical power of the analyses. Moreover, several demographic categories were under-represented, which limited the feasibility of meaningful subgroup analyses. Future research with larger and more diverse samples should explore the potential moderating effects of demographic factors.

However, despite these limitations, the study provides valuable insights into the mechanisms linking multimorbidity with psychological functioning in OSA patients. By identifying stress as a key mediator, it highlights a potentially modifiable target for intervention that could improve the overall well-being of this specific patient population.

CONCLUSIONS

This study demonstrates that stress plays a crucial mediating role in the relationship between comorbidity burden and psychological functioning in patients with obstructive sleep apnoea. The accumulation of health conditions appears to impact life satisfaction and mental health primarily through increased stress levels, rather than through direct effects. These findings underscore the importance of comprehensive stress assessment and management in OSA patients, particularly those with multiple comorbidities.

Based on the results obtained, several practical recommendations emerge for clinical practice:

Implementation of routine stress screening. Healthcare providers should incorporate brief stress assessments into regular OSA follow-up appointments, with particular attention to patients presenting with multiple comorbidities.

Development of integrated care pathways. OSA clinics should consider establishing referral pathways to psychological services, or integrating mental health professionals into multidisciplinary OSA care teams.

Prioritising patients with multimorbidity. Given the clear relationship between comorbidity burden and stress, patients with multiple health conditions should be prioritised for psychological support services.

Consideration of group interventions. Group-based stress management programmes could be cost-effective while providing additional benefits through peer support and shared experiences.

Addressing stress early. The results suggest that intervention at the stress level may prevent downstream effects on life satisfaction and mental health, making early intervention crucial.

In conclusion, the results suggest that interventions targeting stress reduction may be particularly beneficial for improving psychological well-being in this specific population. The potential buffering effect of optimism on the stress-life satisfaction relationship, although marginally significant, warrants further investigation as it may inform the development of psychological interventions that enhance resilience.

Future research should employ longitudinal designs to confirm these mediational pathways and explore the effectiveness of specific stress management interventions in improving psychological outcomes for OSA patients with multimorbidity. Additionally, larger studies are needed to more definitively examine the role of psychological resources, such as optimism in

moderating these relationships. Research should also investigate which stress management approaches are most effective for this population, and whether early stress intervention can prevent the development of psychological complications in newly-diagnosed OSA patients with comorbidities.

The findings of this study underscore the importance of a multidisciplinary approach in OSA management. By demonstrating the complex interplay between OSA, psychological stress, and mental health outcomes, the study contributes to a growing body of evidence supporting integrated care models. Future research would benefit from collaboration between sleep medicine specialists, psychologists, psychiatrists, and other healthcare professionals to develop comprehensive assessment protocols and integrated interventions. Such multidisciplinary efforts could lead to more personalised treatment strategies that address both the physiological and psychological aspects of OSA and its comorbidities.

Ultimately, the findings advocate for a shift from a purely biomedical approach to OSA management towards a more holistic model that recognises and addresses the psychological burden of living with multiple chronic conditions. This integrated perspective not only enhances our understanding of the impact of OSA on patients' lives, but also paves the way for more effective, patient-centred interventions that can improve both treatment adherence and quality of life outcomes.

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