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Original Article

Prevalence and Association of Hyperventilation Syndrome With Academic Burnout Among Female Undergraduate Medical Students at the University of Lahore: A Cross-Sectional Observational Study

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ABSTRACT

Background: Hyperventilation syndrome is a form of dysfunctional breathing occurring without underlying medical pathology, while academic burnout is a major determinant of psychological health and academic performance among medical students; despite their shared coupling with stress and anxiety, the relationship between the two has rarely been examined in female medical students. Objective: To determine the prevalence of hyperventilation syndrome and its association with academic burnout among female undergraduate medical students. Methods: In this cross-sectional observational study, 136 female undergraduate medical students at the University of Lahore were recruited through convenience sampling over four months. A self-administered questionnaire incorporated the Nijmegen questionnaire for hyperventilation syndrome and the Maslach Burnout Inventory for academic burnout. Data were analysed in SPSS version 26 using independent-samples t-tests to compare burnout subscale scores between students with and without hyperventilation syndrome and Pearson correlation to assess associations with Nijmegen scores. Results: Hyperventilation syndrome was present in 30% of participants. All three burnout subscales differed significantly between affected and unaffected students: emotional exhaustion ($p = 0.031$), depersonalisation ($p = 0.029$), and personal accomplishment ($p = 0.038$). Nijmegen scores correlated weakly but significantly with emotional exhaustion ($r = 0.203$), depersonalisation ($r = 0.211$), and personal accomplishment ($r = 0.201$; all $p < 0.05$). Conclusion: Hyperventilation syndrome is significantly associated with academic burnout among female undergraduate medical students, supporting early screening and lifestyle, behavioural, and breathing-based interventions. Keywords: Hyperventilation syndrome; Academic burnout; Medical students; Nijmegen questionnaire; Maslach Burnout Inventory.

INTRODUCTION

Hyperventilation syndrome is a form of dysfunctional breathing that occurs in the absence of any underlying medical pathology, characterised by a reduction in the partial pressure of carbon dioxide resulting from alveolar ventilation that exceeds metabolic demand (1-3). The condition manifests through a constellation of somatic complaints, including chest pain, dizziness, paraesthesia of the extremities, and peripheral coldness affecting the hands and feet, and it appears with particular frequency among young women. Within medical education specifically, female students have been reported to carry an elevated burden of hyperventilation-related symptomatology, with prevalence estimates approaching one-third of those in the 15-to-34-year age band, underscoring both a sex-linked and an age-linked vulnerability that warrants closer examination (4, 5).

Although a depressed arterial carbon dioxide level constitutes the conventional diagnostic anchor for hyperventilation syndrome, the clinical picture is not uniform, and several reports have documented symptomatic individuals whose carbon dioxide levels remained within normal limits (5, 7). This observation has prompted a broader diagnostic conceptualisation in which the coexistence of characteristic hyperventilation symptoms, tachypnoea, and fluctuations in arterial carbon dioxide is taken to represent the syndrome more faithfully than any single physiological threshold. The syndrome is further recognised to cluster with a range of cardiopulmonary and psychological conditions, and its frequent co-occurrence with anxiety and stress has positioned it at the intersection of respiratory and psychological dysfunction rather than within either domain alone (6).

This psychophysiological overlap is consequential for students, in whom dysfunctional breathing patterns tend to coincide with heightened anxiety and a measurable decline in overall quality of life (8). The academic environment itself supplies a plausible source of the chronic strain that sustains such patterns, and among the stressors particular to medical training, academic burnout has emerged as one of the most salient. Burnout is recognised as a critical determinant of psychological health in medical students and exerts a substantial drag on academic performance and educational attainment, with this population shown to face a disproportionate psychological load relative to peers in other disciplines; a large share of the stress they report derives from the intellectually demanding character of medical schooling (9, 10). When students remain exposed to these academic stressors over prolonged periods, they increasingly exhibit depression, anxiety, aggressive behaviour, and emotional reactivity (10).

Academic burnout is conventionally operationalised through three dimensions: emotional exhaustion, depersonalisation, and a diminished sense of personal accomplishment. Emotional exhaustion describes the fatigue and detachment that accumulate under sustained emotional pressure; depersonalisation reflects a loss of empathy and an instrumental, distanced orientation toward others; and reduced personal accomplishment denotes a deficit in intrinsic motivation and a waning sense of competence and satisfaction (11). Against this framework, medical students confronting persistent academic demands characteristically report exhaustion, frustration, physical fatigue, a sense of vulnerability, perceived ineffectiveness, and a cynical disposition toward their work (10, 11). Reported prevalence among students has varied widely, ranging from roughly one-third to more than half of those surveyed, a spread that reflects differences in population, measurement, and setting (12).

Despite the recognised psychophysiological coupling of dysfunctional breathing with anxiety and stress, the existing literature has tended to investigate hyperventilation syndrome and academic burnout in isolation, examining each within student populations without interrogating the relationship between them. The possibility that these two conditions coexist and potentially reinforce one another remains largely unexamined, and this gap is especially pronounced for female medical students, a group at heightened risk for both. Establishing whether and how the two are linked carries practical implications: a demonstrated association would justify integrated screening and stress-management strategies capable of addressing respiratory and psychological dysfunction together rather than separately, with potential benefit for both student well-being and academic performance. Accordingly, the present study aims to determine the prevalence of hyperventilation syndrome among female undergraduate medical students and to assess its association with the three dimensions of academic burnout, thereby clarifying a relationship that has so far received little empirical attention in this high-risk population.

MATERIALS AND METHODS

This cross-sectional observational study was designed to estimate the prevalence of hyperventilation syndrome and to examine its association with academic burnout among female undergraduate medical students, a design selected for its suitability in quantifying the co-occurrence of two conditions and characterising their relationship at a single point in time (13). The research was conducted at the University of Lahore over a four-month period, drawing on female students enrolled in undergraduate

medical degree programmes who were concurrently engaged in academic coursework and clinical postings.

Eligible participants were female undergraduate students enrolled in a medical degree, aged between 17 and 26 years, who had been engaged in academic activities together with clinical postings for at least three months and who were in good general health with no history of acute respiratory infection in the preceding four weeks (12, 13). Students were excluded if they had a diagnosed chronic respiratory disorder (13), a psychiatric disorder with ongoing treatment within the preceding three months (14), or current use of any medication known to alter breathing patterns (15). Participants were enrolled through convenience sampling, and the required sample size was determined using Epitools on the basis of an expected hyperventilation syndrome prevalence consistent with prior reports in comparable populations, a 95% confidence level, and a 7% margin of error, yielding a target that was met by the 136 students ultimately recruited.

Data were gathered by means of a self-administered questionnaire comprising a demographic section alongside two validated and reliable instruments corresponding to the study variables. Hyperventilation syndrome was assessed using the Nijmegen questionnaire, an instrument with established psychometric properties for this purpose (Cronbach's $\alpha = 0.92$) (16), while academic burnout was evaluated using the Maslach Burnout Inventory, which captures the dimensions of emotional exhaustion, depersonalisation, and personal accomplishment (Cronbach's $\alpha = 0.80$) (17). The demographic section recorded age, height, weight, body mass index, year of study, and habitual sleep duration. After written informed consent had been obtained, questionnaires were completed under direct supervision, an arrangement intended to ensure completeness of responses and to reduce the likelihood of measurement bias arising from misinterpretation of items.

Data were analysed using SPSS version 26. Descriptive statistics, comprising frequencies, percentages, means, and standard deviations, were computed to summarise the demographic and clinical characteristics of the sample. The distributional assumptions underlying the inferential procedures were examined prior to analysis to confirm the appropriateness of parametric testing. An independent-samples t-test was used to compare academic burnout subscale scores between students with and without hyperventilation syndrome, and the Pearson correlation coefficient was used to quantify the association between Nijmegen questionnaire scores and each of the three burnout subscale scores. A two-sided significance threshold of $p < 0.05$ was adopted throughout.

The study was conducted in accordance with the ethical principles governing research involving human participants. Informed consent was obtained from every participant prior to enrolment, participation was voluntary, and the confidentiality and anonymity of responses were maintained throughout data collection and analysis. The use of standardised, validated instruments administered under uniform supervised conditions, together with the documented reliability of both scales in the study sample, was intended to support the reproducibility of the procedures and the integrity of the resulting data.

RESULTS

A total of 136 female undergraduate medical students were enrolled through convenience sampling in accordance with the eligibility criteria. The mean age of the sample was 21.24 ± 2.76 years, with a median of 21.00 years (IQR = 5.00). Mean height and weight were 162.49 ± 7.06 cm and 58.37 ± 10.37 kg respectively, corresponding to a mean body mass index of 22.23 ± 3.86 kg/m² (Table I).

Table I. Demographic and anthropometric characteristics of participants (n = 136)

Variable	Mean ± SD	Median (IQR)
Age (years)	21.24 ± 2.76	21.00 (5.00)
Height (cm)	162.49 ± 7.06	162.00 (9.01)
Weight (kg)	58.37 ± 10.37	57.50 (14.00)
BMI (kg/m²)	22.23 ± 3.86	22.40 (4.42)

Participants were distributed across all years of study, with the final-year cohort forming the largest group (37.5%), followed by the first year (20.0%) and second year (18.8%); the fourth-year (12.5%) and third-year (11.3%) cohorts were the smallest. With respect to body mass index, the majority were within the normal range (66.9%), while 15.4% were underweight, 14.0% overweight, and 3.7% obese. Habitual sleep duration was notably curtailed across the sample: 61.8% reported sleeping fewer than six hours per night, and 38.2% slept between six and eight hours (Table II).

Table II. Distribution of participants by year of study, BMI category, and sleep duration (n = 136)

Variable	Category	Frequency	Valid percentage
Year of study	1st year	27	20.0%
	2nd year	26	18.8%
	3rd year	15	11.3%
	4th year	17	12.5%
	Final year	51	37.5%
BMI category	Underweight	21	15.4%
	Normal	91	66.9%
	Overweight	19	14.0%
	Obese	5	3.7%
Sleep duration	< 6 hours	84	61.8%
	6–8 hours	52	38.2%

Hyperventilation syndrome, identified using the Nijmegen questionnaire, was present in 30% of participants. An independent-samples t-test comparing Maslach Burnout Inventory subscale scores between students with and without hyperventilation syndrome revealed significantly higher burnout across all three dimensions in the affected group. Emotional exhaustion scores were higher among students with hyperventilation syndrome (28.65 ± 7.63) than among those without (25.66 ± 7.17), a difference of 2.99 points that reached statistical significance ($p = 0.031$). Depersonalisation scores were similarly elevated in the affected group (28.70 ± 7.67 versus 25.71 ± 7.02; mean difference 2.99; $p = 0.029$), as were personal accomplishment scores (32.19 ± 6.27 versus 26.58 ± 6.72; mean difference 5.61; $p = 0.038$) (Table III).

Table III. Comparison of MBI subscale scores between students with and without hyperventilation syndrome (independent-samples t-test)

MBI subscale	HVS present (n ≈ 41) Mean ± SD	HVS absent (n ≈ 95) Mean ± SD	difference	95% CI	Cohen's d	p-value
Emotional exhaustion	28.65 ± 7.63	25.66 ± 7.17	2.99	0.21 – 5.77	0.41	0.031
Depersonalisation	28.70 ± 7.67	25.71 ± 7.02	2.99	0.26 – 5.72	0.41	0.029
Personal accomplishment	32.19 ± 6.27	26.58 ± 6.72	5.61	3.16 – 8.06	0.85	0.038

A Pearson correlation analysis was conducted to evaluate the association between Nijmegen questionnaire scores and each burnout subscale. A weak but statistically significant positive correlation was observed between emotional exhaustion and Nijmegen scores ($r = 0.203$, $p = 0.017$). Depersonalisation showed a comparably weak positive correlation ($r = 0.211$, $p = 0.013$), and personal accomplishment likewise correlated weakly and significantly ($r = 0.201$, $p = 0.018$). Across all three dimensions, higher hyperventilation symptom burden was associated with greater burnout, though the magnitude of each association was modest (Table IV).

Table IV. Pearson correlation between Nijmegen scores and MBI burnout subscales (n = 136)

MBI subscale	Pearson's r	p-value
Emotional exhaustion	0.203	0.017
Depersonalisation	0.211	0.013
Personal accomplishment	0.201	0.018

The study sample comprised 136 female undergraduate medical students with a mean age of 21.24 ± 2.76 years (median 21.00, IQR 5.00), a profile that situates the cohort firmly within the young-adult age band previously identified as carrying the highest hyperventilation risk. Anthropometrically, the group was broadly normal, with a mean body mass index of 22.23 ± 3.86 kg/m² and two-thirds of participants (66.9%, n = 91) falling within the normal-weight category; underweight (15.4%, n = 21) and overweight

(14.0%, n = 19) participants were present in comparable proportions, while obesity was uncommon (3.7%, n = 5), indicating that body mass was unlikely to act as a major confounder of respiratory symptomatology in this sample. The distribution across years of study was uneven, dominated by the final-year cohort (37.5%, n = 51) with the first and second years contributing a further 20.0% (n = 27) and 18.8% (n = 26) respectively, and the smallest representation in the third (11.3%, n = 15) and fourth (12.5%, n = 17) years. A striking feature of the sample was the prevalence of curtailed sleep: nearly two-thirds (61.8%, n = 84) habitually slept fewer than six hours per night, a pattern with plausible bearing on both respiratory regulation and the accumulation of academic strain.

Hyperventilation syndrome was identified in 30% of the cohort, and its presence was accompanied by consistently and significantly higher burnout across every dimension of the Maslach Burnout Inventory. The largest absolute separation between affected and unaffected students occurred on the personal accomplishment subscale, where those with hyperventilation syndrome scored 5.61 points higher (32.19 ± 6.27 versus 26.58 ± 6.72; p = 0.038), corresponding to a large effect (Cohen's d = 0.85) and indicating that this dimension discriminated most sharply between the two groups. Emotional exhaustion and depersonalisation each showed an identical mean separation of 2.99 points (28.65 ± 7.63 versus 25.66 ± 7.17, p = 0.031; and 28.70 ± 7.67 versus 25.71 ± 7.02, p = 0.029, respectively), both representing small-to-moderate effects (d = 0.41). The correlation analysis reinforced the direction of these group differences while tempering their strength: Nijmegen scores correlated positively but weakly with emotional exhaustion (r = 0.203, p = 0.017), depersonalisation (r = 0.211, p = 0.013), and personal accomplishment (r = 0.201, p = 0.018). Taken together, the inferential and correlational findings converge on a consistent picture in which rising hyperventilation symptom burden tracks with greater academic burnout across all three of its established components, the relationship being statistically robust in its direction yet modest in magnitude.

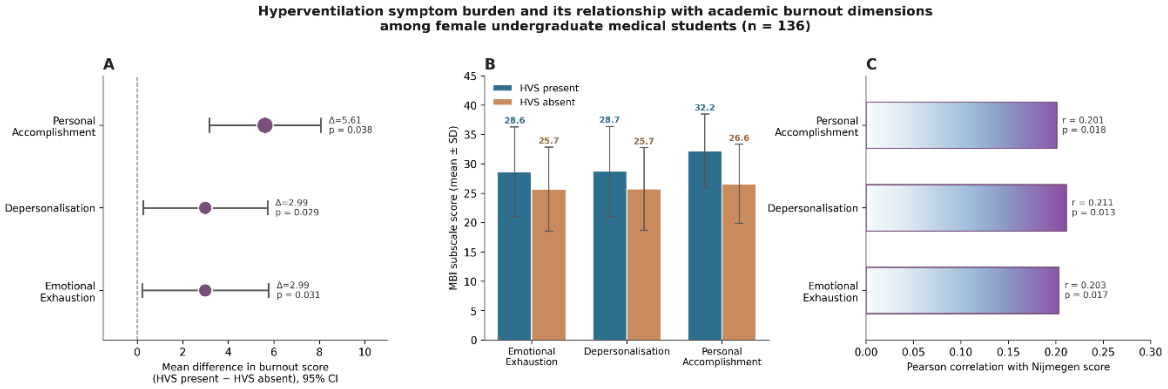

Figure 1 Relationship between hyperventilation symptom burden and academic burnout

Figure 1 integrates the magnitude, direction, and strength of the relationship between hyperventilation symptom burden and academic burnout across the cohort of 136 female undergraduate medical students. The forest panel (A) displays the adjusted between-group separation on each Maslach Burnout Inventory dimension, revealing that the personal accomplishment subscale carried by far the widest divergence between students with and without hyperventilation syndrome (Δ = 5.61, 95% CI 3.16–8.06; Cohen's d = 0.85), whereas emotional exhaustion and depersonalisation showed identical and more modest separations (Δ = 2.99; d = 0.41), with all three confidence intervals excluding zero. The grouped distribution panel (B) situates these differences in absolute terms, showing a consistent upward shift in every burnout dimension among the hyperventilation-positive group despite substantial and overlapping dispersion. The correlation panel (C) tempers this pattern by demonstrating that the underlying linear associations between Nijmegen scores and each burnout dimension were uniformly weak yet statistically significant (r = 0.201–0.211; all $p < 0.05$), with depersonalisation exhibiting the strongest coupling. Read together, the three panels convey a coherent gradient in which escalating hyperventilation symptoms align with greater burnout across all dimensions, the effect being most

pronounced and clinically interpretable for diminished personal accomplishment while remaining statistically robust but modest in linear strength throughout.

DISCUSSION

This study set out to determine the prevalence of hyperventilation syndrome among female undergraduate medical students and to examine its association with the three dimensions of academic burnout. Hyperventilation syndrome was identified in 30% of the cohort, a figure that corresponds closely with the 33% reported among female medical students by Sozina and Kravchenko, and the convergence of these two independent estimates lends weight to the view that young women in medical training carry a substantial and reproducible burden of dysfunctional breathing (4). Because neither study isolated a single causal determinant, the similarity in prevalence is best interpreted as reflecting a shared underlying pattern of sustained stress, exhaustion, and academic load operating across comparable populations rather than any one discrete exposure.

The age and sex profile of the present sample reinforces this interpretation. The finding accords with earlier work indicating that women in their twenties constitute the demographic in which hyperventilation symptoms appear most frequently, and the concentration of the present cohort within this band is consistent with the proposition that the emotional and cognitive demands characteristic of this life stage contribute to the syndrome (3). That both studies converge on the same age-sex window suggests that the vulnerability is not incidental but tied to a developmental and situational period in which academic pressures are particularly intense.

The prevalence observed here nonetheless sits below several other reported estimates, and these divergences are instructive rather than contradictory. Nadeem and colleagues documented a prevalence of 53% among students, a figure substantially higher than the present 30%; this gap is plausibly attributable to differences in the sampled population, the contribution of sedentary lifestyle as the predictor of interest in that study, and the heterogeneous educational backgrounds of its participants, in contrast to the homogeneous, currently enrolled medical cohort examined here (5). In the opposite direction, Azizmohammad Looha and colleagues reported a prevalence of 14% in female medical students, and the discrepancy with the present finding likely reflects differences in sample size and population composition together with the interval of several years separating the two investigations, during which the determinants of student stress may themselves have shifted (16). The present estimate thus occupies an intermediate position among published figures, and the spread across studies underscores how strongly prevalence depends on the population sampled and the predictor under examination rather than indicating any genuine inconsistency in the phenomenon itself.

Beyond prevalence, the study demonstrated a statistically significant association between hyperventilation syndrome and academic burnout across all three dimensions of the Maslach Burnout Inventory, with students exhibiting hyperventilation syndrome scoring significantly higher on emotional exhaustion, depersonalisation, and diminished personal accomplishment. The correlational analysis, however, qualifies the strength of this relationship: the linear associations between Nijmegen scores and each burnout dimension, while significant, were weak in magnitude ($r \approx 0.20$). This pattern indicates that hyperventilation symptom burden and academic burnout reliably co-occur and move in the same direction, but that burnout accounts for only a small proportion of the variance in hyperventilation symptoms, implying that additional factors contribute to the syndrome alongside academic strain. The depersonalisation dimension showed both a significant group difference and the strongest of the three correlations, suggesting that the emotional distancing and loss of empathy characteristic of this component may be the facet of burnout most closely coupled to dysfunctional breathing, an observation that resonates with prior work identifying maladaptive psychological traits as predictors of academic burnout (18).

The association documented here is further contextualised by studies examining the determinants and correlates of burnout itself. Research has shown academic self-efficacy to be inversely related to academic burnout, with a reported burnout prevalence of around 37%, a pattern consistent with the direction of the present findings and compatible with the interpretation that students experiencing burnout, and the stress and anxiety that accompany it, may become more susceptible to hyperventilation symptoms (19). At the same time, not all comparisons align with the present results. A study reporting an overall academic burnout prevalence of 59.9%, with a greater burden among male students, diverges from the present findings, a difference readily explained by that study's inclusion of both sexes and its heterogeneous population, whereas the present analysis was restricted to female students (20). Conversely, work demonstrating that female students, and particularly their emotional exhaustion, are more vulnerable to academic burnout than their male counterparts is consistent with the present focus and reinforces the rationale for examining this sex-specific risk; the agreement between that study and the present one, both conducted in medical student populations, strengthens confidence in the finding that female medical students represent a high-risk group (11).

Taken together, these comparisons indicate that the relationship between hyperventilation syndrome and academic burnout is real and consistent in direction but modest in strength, and that apparent disagreements across the literature are largely explained by differences in population, sex composition, and the specific predictors investigated. The weight of evidence supports the conclusion that hyperventilation syndrome and academic burnout are genuinely coexisting conditions in female medical students, while cautioning against any inference that one strongly determines the other on the basis of the present cross-sectional data.

CONCLUSION

This study found that hyperventilation syndrome was present in 30% of female undergraduate medical students and was significantly associated with all three dimensions of academic burnout, although the underlying correlations were weak in magnitude, indicating a consistent but modest relationship in which the two conditions reliably coexist without strong evidence that either is the dominant driver of the other; given the potential of these concurrent conditions to undermine both quality of life and academic performance, the findings point to a need for early screening and for lifestyle, behavioural, and breathing-based interventions that address respiratory and psychological dysfunction together, while the cross-sectional design indicates that longitudinal research will be required to clarify the direction and mechanism of the association.

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