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IMPACT OF ACADEMIC STRESS AND CIRCADIAN RHYTHM DISTURBANCE ON ADOLESCENT INFLAMMATORY SKIN DISORDERS

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Abstract

Background

Inflammatory skin disorders among adolescents are increasingly recognized as multifactorial conditions influenced by psychological, environmental, endocrine, and behavioral determinants. Academic stress and circadian rhythm disturbance are emerging contributors to dermatological morbidity in adolescents, particularly in urban and semi-urban populations exposed to prolonged screen time, irregular sleep patterns, and intense academic competition.

To evaluate the association between academic stress, circadian rhythm disturbance, and the severity of inflammatory skin disorders among adolescents.

A hospital-based cross-sectional observational study was conducted among 220 adolescents aged 13–19 years attending pediatric and dermatology outpatient departments at a tertiary care teaching hospital in Uttar Pradesh, India, over 12 months. Academic stress was assessed using the Educational Stress Scale for Adolescents (ESSA), while circadian rhythm disturbance and sleep quality were evaluated using the Pittsburgh Sleep Quality Index (PSQI). Dermatological severity was assessed clinically using standardized disease-specific scoring systems including Global Acne Grading System (GAGS), SCORAD for atopic dermatitis, and Psoriasis Area Severity Index (PASI). Statistical analysis was performed using SPSS version 27.0.

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Among the participants, 61.4% demonstrated moderate-to-severe academic stress, while 57.7% had poor sleep quality. Acne vulgaris was the most prevalent inflammatory dermatosis (52.7%), followed by atopic dermatitis (24.1%) and psoriasis (10.5%). Higher academic stress scores were significantly associated with increased inflammatory skin disease severity ($p<0.001$). Circadian rhythm disturbance showed a strong positive correlation with disease exacerbation, particularly among adolescents reporting screen exposure exceeding 5 hours/day. Multivariate regression analysis demonstrated that poor sleep quality, elevated stress scores, and reduced sleep duration independently predicted higher inflammatory skin severity scores.

Conclusion

Academic stress and circadian rhythm disturbance significantly influence the severity of adolescent inflammatory skin disorders. Early psychosocial intervention, sleep hygiene promotion, and integrated dermatological-psychological management strategies may improve adolescent dermatological outcomes.

Keywords: Adolescent; Circadian Rhythm; Academic Stress; Acne Vulgaris; Sleep Disturbance; Inflammatory Dermatoses; Psychodermatology

Introduction

Adolescence represents a critical developmental phase characterized by substantial physiological, hormonal, emotional, and psychosocial transitions. During this period, the prevalence of inflammatory dermatological disorders significantly increases owing to endocrine alterations, immune modulation, genetic predisposition, and environmental influences (1). Inflammatory skin diseases such as acne vulgaris, atopic dermatitis, psoriasis, seborrheic dermatitis, and urticaria are highly prevalent among adolescents and frequently contribute to impaired self-esteem, anxiety, social withdrawal, and reduced quality of life (2).

Globally, acne vulgaris affects approximately 85% of adolescents, making it one of the most common dermatological disorders in this age group (3). Similarly, atopic dermatitis and psoriasis continue to demonstrate rising prevalence trends, particularly in urbanized populations exposed to altered lifestyle patterns and psychosocial stressors (4). In India, increasing academic competition, digital dependency, and sleep disruption among adolescents have emerged as important contributors to psychosomatic disorders, including inflammatory skin diseases (5).

The interaction between psychological stress and skin inflammation is mediated through the complex neuro-immuno-cutaneous-endocrine axis. Stress activates the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system, resulting in increased secretion of cortisol, catecholamines, and pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-alpha (6). Chronic activation of these pathways disrupts epidermal barrier function, enhances

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sebaceous gland activity, and promotes inflammatory cascades that exacerbate cutaneous disease severity (7).

Academic stress is a significant psychosocial burden among adolescents. Excessive academic expectations, examination pressure, parental competition, peer comparison, and prolonged study hours contribute substantially to psychological distress (8). Previous studies have shown that chronic academic stress may precipitate inflammatory responses, alter immune function, and worsen dermatological manifestations including acne flare-ups and eczema exacerbations (9).

Circadian rhythm disturbance constitutes another increasingly relevant factor influencing adolescent health. Circadian rhythms regulate sleep-wake cycles, hormonal secretion, cellular repair mechanisms, immune activity, and epidermal homeostasis (10). Modern lifestyle behaviors including excessive screen exposure, late-night digital engagement, irregular sleep schedules, and reduced physical activity disrupt normal circadian physiology (11). Disturbed circadian rhythms impair melatonin secretion and alter inflammatory regulation, thereby contributing to skin barrier dysfunction and increased susceptibility to inflammatory dermatoses (12).

Sleep deprivation has been independently associated with elevated oxidative stress, increased systemic inflammation, impaired collagen synthesis, and delayed skin recovery (13). Adolescents experiencing chronic sleep disruption often exhibit worsening acne severity, increased pruritus in atopic dermatitis, and more frequent psoriasis flare episodes (14). Moreover, sleep deprivation itself may intensify psychological stress, creating a bidirectional cycle between stress, circadian dysfunction, and skin inflammation.

Psychodermatology, an evolving interdisciplinary field, emphasizes the intricate relationship between emotional health and skin disorders (15). Despite growing evidence linking psychological factors with dermatological disease activity, limited Indian studies have comprehensively evaluated the combined effects of academic stress and circadian rhythm disturbance on adolescent inflammatory skin disorders. Most available studies focus solely on acne or isolated sleep parameters without integrating multidimensional psychophysiological assessment.

The increasing burden of adolescent mental stress and digital lifestyle disturbances in India necessitates further exploration of their dermatological implications. Understanding these relationships may facilitate development of integrated preventive and therapeutic strategies involving dermatologists, pediatricians, psychologists, and school health systems.

The present study was therefore undertaken to evaluate the impact of academic stress and circadian rhythm disturbance on inflammatory skin disorders among adolescents attending a tertiary care teaching hospital.

Materials and Methods

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This hospital-based cross-sectional observational study was conducted jointly in the Departments of Pediatrics and Dermatology at Venkateshwara Institute of Medical Sciences over a period of 12 months from January 2025 to December 2025. The study included adolescents aged 13–19 years presenting with clinically diagnosed inflammatory skin disorders including acne vulgaris, atopic dermatitis, psoriasis, seborrheic dermatitis, and chronic urticaria.

The sample size was calculated using prevalence estimates from previous psychodermatology studies reporting approximately 50% prevalence of stress-associated inflammatory dermatoses among adolescents, with 95% confidence interval and 5% margin of error. The minimum estimated sample size was 196; however, considering potential non-response and incomplete data, 220 participants were enrolled. Participants were selected using consecutive sampling after obtaining written informed consent from parents or guardians and assent from adolescents where applicable. Adolescents with chronic systemic diseases, diagnosed psychiatric illness under active treatment, endocrine disorders, immunodeficiency states, or those receiving systemic corticosteroids or immunomodulators were excluded from the study. Academic stress was assessed using the validated Educational Stress Scale for Adolescents (ESSA), which evaluates pressure from study, workload, academic worry, self-expectation, and despondency. Circadian rhythm disturbance and sleep quality were evaluated using the Pittsburgh Sleep Quality Index (PSQI). A detailed questionnaire documenting screen exposure duration, sleep timing, physical activity, dietary habits, and social media usage was administered.

Clinical dermatological examination was performed by experienced dermatologists. Acne severity was graded using the Global Acne Grading System (GAGS), atopic dermatitis severity was assessed using the SCORAD index, and psoriasis severity was evaluated using the Psoriasis Area Severity Index (PASI). Disease exacerbation history during examination periods and examination-related stress episodes was also recorded. Ethical approval for the study was obtained from the Institutional Ethics Committee of Venkateshwara Institute of Medical Sciences. Confidentiality and anonymity of all participants were strictly maintained throughout the study. Data were entered into Microsoft Excel and analyzed using SPSS version 27.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as percentages. Chi-square test, independent t-test, Pearson correlation analysis, and multivariate linear regression analysis were used to determine statistical significance. A p-value <0.05 was considered statistically significant.

Table1. Materials and Methods (Master Flow)

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Parameter	Details
Study Design	Cross-sectional observational study
Study Setting	Departments of Pediatrics & Dermatology, Venkateshwara Institute of Medical Sciences
Study Duration	12 months
Study Population	Adolescents (13–19 years) with inflammatory skin disorders
Sample Size	220 participants
Sampling Method	Consecutive sampling
Stress Assessment Tool	Educational Stress Scale for Adolescents (ESSA)
Sleep/Circadian Assessment	Pittsburgh Sleep Quality Index (PSQI)
Disease Severity Assessment	GAGS, SCORAD, PASI
Additional Variables	Screen time, sleep duration, lifestyle habits
Inclusion Criteria	Adolescents with diagnosed inflammatory dermatoses
Exclusion Criteria	Chronic systemic illness, psychiatric disorders, immunodeficiency
Statistical Software	SPSS version 27.0
Statistical Tests	Chi-square test, t-test, Pearson correlation, multivariate regression
Significance Level	$p < 0.05$
Ethical Approval	Institutional Ethics Committee approval obtained

Results

A total of 220 adolescents were included in the study, comprising 124 females (56.4%) and 96 males (43.6%). The mean age of participants was 16.2 ± 1.8 years.

Table 2. Distribution of Inflammatory Skin Disorders Among Participants

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Skin Disorder	Number (n)	Percentage (%)
Acne vulgaris	116	52.7
Atopic dermatitis	53	24.1
Psoriasis	23	10.5
Seborrheic dermatitis	18	8.2
Chronic urticaria	10	4.5

Acne vulgaris was the most common inflammatory skin disorder observed among adolescents, followed by atopic dermatitis and psoriasis.

Table 3. Association Between Academic Stress and Disease Severity

Academic Stress Level	Mild Disease	Moderate Disease	Severe Disease
Low Stress	48	16	4
Moderate Stress	30	42	18
High Stress	8	24	30

A statistically significant association was observed between higher academic stress levels and increased disease severity ($p<0.001$).

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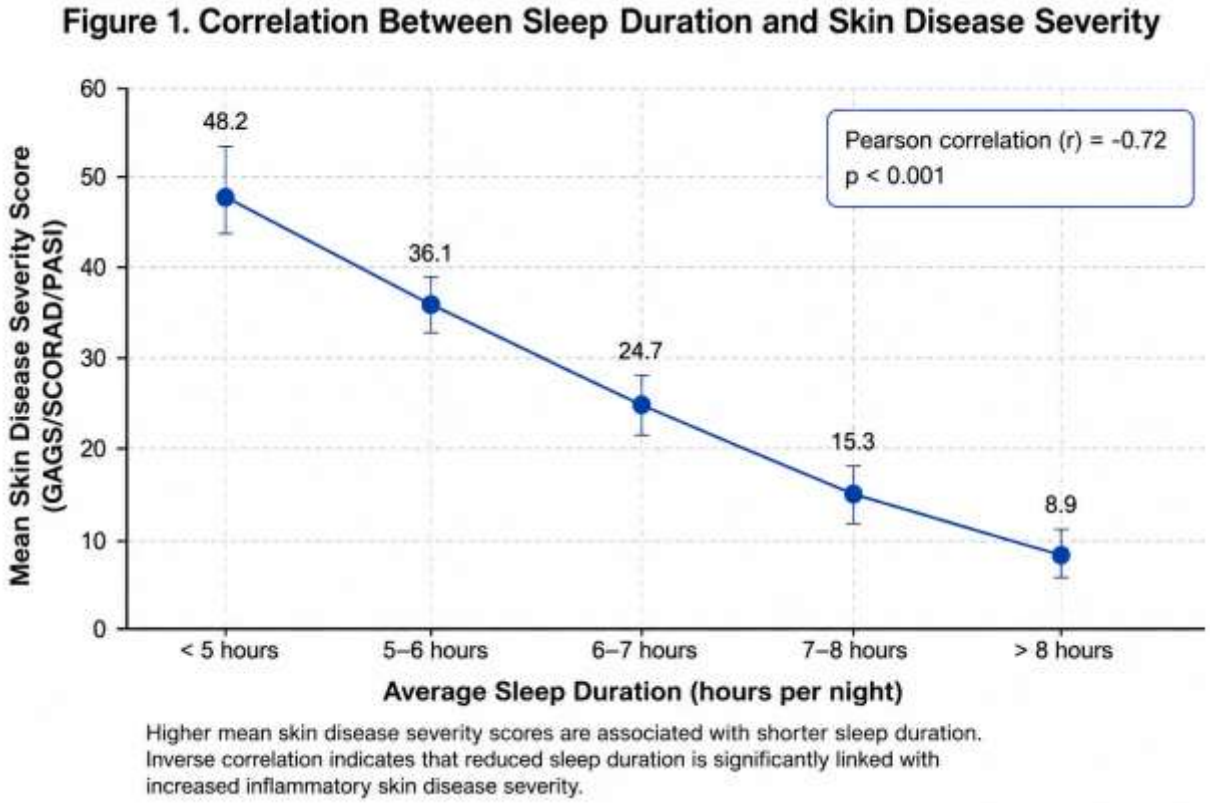

Figure 1. Correlation Between Sleep Duration and Skin Disease Severity

The graphical trend demonstrated progressive increase in inflammatory disease severity scores with decreasing sleep duration. Adolescents sleeping less than 6 hours daily exhibited the highest inflammatory severity indices.

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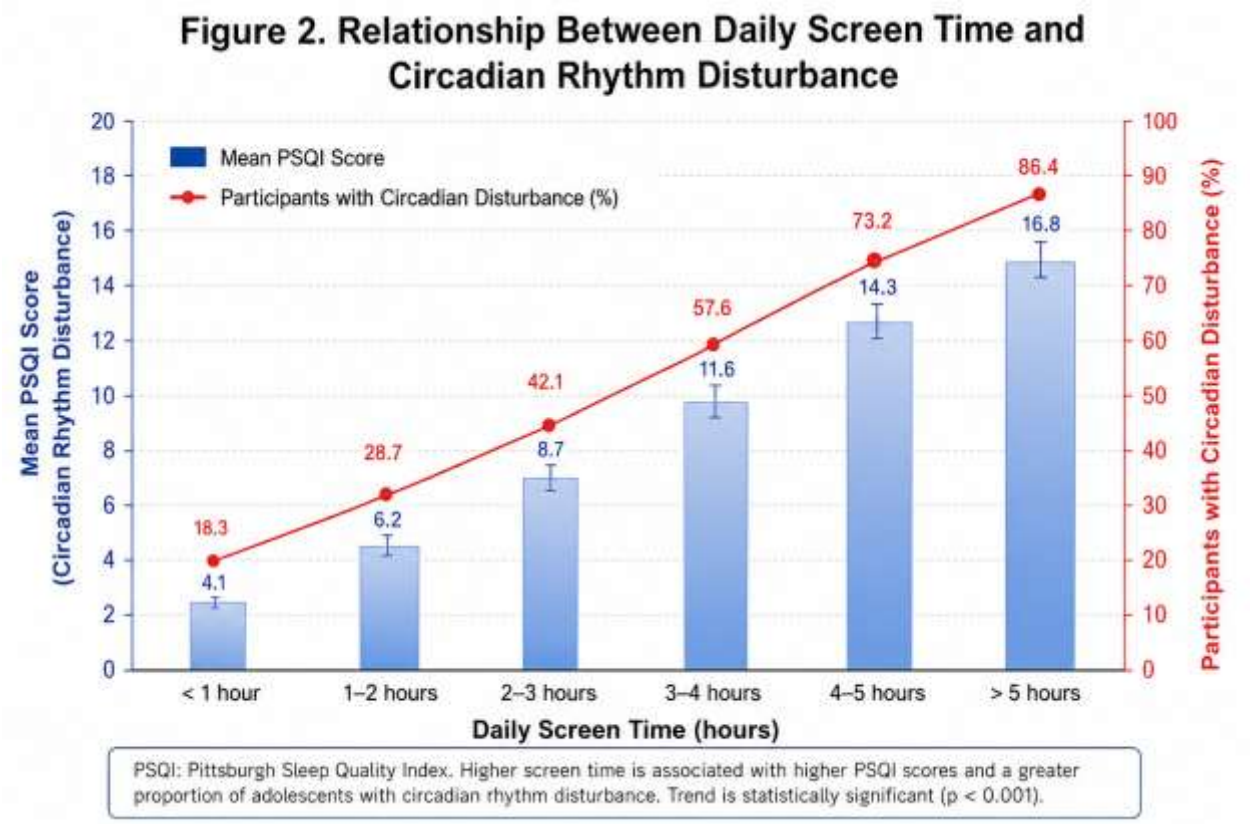

Figure 2. Relationship Between Daily Screen Time and Circadian Rhythm Disturbance

Participants reporting screen exposure exceeding 5 hours/day demonstrated markedly elevated PSQI scores and increased frequency of disease flare episodes.

Among all participants, 127 adolescents (57.7%) had poor sleep quality according to PSQI scores. Approximately 64.5% reported late-night mobile phone usage beyond 11 PM. Mean academic stress scores were significantly higher among participants with moderate-to-severe inflammatory dermatoses compared with those having mild disease manifestations ($p<0.001$).

Multivariate regression analysis revealed that academic stress score ($\beta=0.42$), poor sleep quality ($\beta=0.38$), and screen time duration ($\beta=0.31$) independently predicted inflammatory skin severity scores.

Discussion

The present study demonstrated a significant association between academic stress, circadian rhythm disturbance, and inflammatory skin disorder severity among adolescents. These findings support the growing evidence highlighting the multidimensional relationship between psychological stress, sleep dysregulation, and cutaneous inflammation.

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Acne vulgaris emerged as the most prevalent inflammatory dermatosis in the study population, consistent with global epidemiological data demonstrating acne prevalence exceeding 80% during adolescence (3). The increased prevalence among academically stressed adolescents may be attributed to stress-induced androgenic stimulation and increased sebaceous gland activity mediated through cortisol and neuropeptide pathways (16). The observed relationship between academic stress and disease severity aligns with previous studies conducted by Yosipovitch et al. and Chiu et al., who reported significant worsening of inflammatory skin conditions during periods of psychological stress and academic examinations (17,18). Chronic stress promotes immune dysregulation through activation of inflammatory cytokines including IL-1, IL-6, and TNF-α, all of which contribute to inflammatory dermatoses pathogenesis.

Circadian rhythm disturbance emerged as another major determinant of dermatological severity. Adolescents reporting poor sleep quality and prolonged screen exposure exhibited significantly higher disease severity scores. Circadian dysregulation adversely affects epidermal barrier repair, oxidative stress balance, and melatonin secretion, thereby exacerbating inflammatory pathways (19). Sleep deprivation has increasingly been recognized as an important modifiable risk factor in psychodermatology. The present study observed that participants sleeping less than six hours daily had significantly higher inflammatory disease activity. Similar findings were reported by Oyetakin-White et al., who demonstrated impaired skin barrier recovery and increased transepidermal water loss among sleep-deprived individuals (20).

The role of excessive screen exposure deserves particular attention in the current adolescent era. Digital device dependency contributes not only to sleep disruption through blue light-mediated melatonin suppression but also indirectly intensifies academic and social stress (21). The current study found that adolescents with screen exposure exceeding five hours daily demonstrated greater circadian disruption and higher inflammatory severity scores. Atopic dermatitis patients in the present study exhibited particularly strong associations between sleep disturbance and disease exacerbation. Chronic pruritus associated with eczema significantly impairs sleep quality, while sleep deprivation further aggravates cutaneous inflammation, establishing a vicious inflammatory cycle (22). Similar observations have been documented in pediatric dermatology literature.

The psychoneuroimmunological mechanisms underlying these findings are increasingly well established. Stress activates the hypothalamic-pituitary-adrenal axis and sympathetic-adrenal-medullary system, leading to release of cortisol, catecholamines, and substance P. These mediators influence mast cell activation, epidermal permeability, and inflammatory cytokine production, ultimately worsening dermatological disease activity (23).

The findings of this study also carry substantial public health implications. Indian adolescents increasingly experience intense academic competition, coaching culture, digital overexposure, and reduced sleep duration. These lifestyle changes may contribute significantly to rising

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psychodermatological morbidity. Integrating mental health screening and sleep hygiene counseling into dermatological practice could therefore improve treatment outcomes. An important strength of the present study is its multidimensional assessment incorporating validated stress scales, sleep quality indices, and standardized dermatological severity scoring systems. Additionally, the inclusion of multiple inflammatory dermatoses rather than isolated acne evaluation provides broader psychodermatological insight.However, certain limitations should be acknowledged. The cross-sectional design limits causal inference. Self-reported stress and sleep parameters may introduce recall bias. Furthermore, the study was conducted at a single tertiary care center, potentially limiting generalizability. Longitudinal multicentric studies with objective sleep monitoring and inflammatory biomarker assessment may provide more definitive evidence. Despite these limitations, the present study highlights the significant influence of psychosocial and circadian factors on adolescent inflammatory skin disorders. These findings emphasize the need for interdisciplinary collaboration involving dermatologists, pediatricians, psychiatrists, psychologists, and school health authorities.

Conclusion

Academic stress and circadian rhythm disturbance significantly contribute to the severity and exacerbation of inflammatory skin disorders among adolescents. Poor sleep quality, prolonged screen exposure, and elevated educational stress independently predict worsening dermatological outcomes. Early identification of psychosocial stressors and implementation of integrated behavioral, psychological, and dermatological interventions may substantially improve adolescent skin health and overall quality of life.

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