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Sleep Impairment in Paediatric Atopic Dermatitis: A Cross-Sectional Cohort with Family and School Outcomes: Severity Stratified Actigraphy, Caregiver Impact and Predictors of Substantial Sleep Disturbance

Dr. Jaishree Noor #1, Rahul Chauhan*2, Ajay Kumar*3
[1]*Professor, Department of Dermatology, Saraswathi Institute of Medical Sciences, Hapur*
[2]*Tutor, Department of Community Health Nursing (CHN), Saraswathi College of Nursing, Hapur*
[3]*Associate Professor, Department of Pharmacology, Saraswathi College of Pharmacy, Hapur*
First Author Mail-id: research@sime.edu.in

Abstract — Sleep impairment is one of the most consequential but under-measured dimensions of paediatric atopic dermatitis (AD), with effects that extend through child cognitive performance, family functioning, and caregiver wellbeing. We undertook a cross-sectional study of 280 children aged 2-12 years with atopic dermatitis at a tertiary paediatric dermatology service, with structured actigraphy-based sleep assessment, severity grading (SCORAD), and family-impact characterisation. Mean total sleep time was 9.4 hours in mild AD (SCORAD <25), 8.2 hours in moderate AD (25-50), and 6.6 hours in severe AD (>50). Sleep efficiency correlated inversely with SCORAD ($r = -0.62$), with the relationship persisting across age strata. Family bed-sharing due to AD occurred in 52.4% of severe cases compared with 12.8% of mild cases. Caregivers of severe-AD children showed clinical insomnia (PSQI ≥5) in 38.6%. Child school absences ≥10 days per year occurred in 48.2% of severe-AD cases. Strongest independent predictors of clinically significant sleep impairment included severe AD, itch intensity, nocturnal scratching, early disease onset, and inadequate moisturiser use. Adequate parental education and structured bedtime emollient routines were strongly protective. The findings support structured sleep assessment and family-engaged management in paediatric AD.

Keywords — *Atopic Dermatitis; Eczema; Paediatric; Sleep; Actigraphy; Caregiver Burden; SCORAD; School Absences.*

1. Introduction

Atopic dermatitis affects approximately 10-20% of children globally and is one of the most common chronic conditions of childhood. The visible skin manifestations erythema, lichenification, excoriation capture clinical attention, but for many affected children and their families the most consequential symptom is sleep impairment. Pruritus is worst during the evening and night, the warmth of bedding intensifies itch, and the unconscious scratching that occurs during sleep disrupts sleep architecture and produces both subjective and objective sleep impairment. The downstream consequences extend through child cognitive performance, school attendance, emotional regulation, growth, family functioning, and caregiver wellbeing (Jha, Kumar,, & Neha, 2026; Yatish, Khatoon,, & Kumar, 2026; Kumar, Sharma,, & Gupta, 2026). Despite the centrality of sleep impairment to paediatric AD, objective sleep assessment is uncommon in routine clinical practice. Standard dermatology consultations focus on skin severity (SCORAD or EASI), pruritus rating, and treatment adherence, with sleep typically assessed through brief self-report or proxy report by parents. Actigraphy wrist-worn movement monitors that derive sleep parameters from movement patterns provides objective measurement of total sleep time, sleep efficiency, awakenings, and sleep onset latency, and has been validated against polysomnography in paediatric AD populations (Kumar, Gautam,, & Maitiy, 2026; Jha, Kumar,, & Neha, 2026). We undertook a cross-sectional study at our tertiary paediatric dermatology service to characterise sleep impairment objectively across AD severity strata, document family and school outcomes, identify modifiable predictors of substantial sleep impairment, and inform structured assessment and management approaches for this prevalent but under-attended dimension of paediatric AD care (Bhatnagar, Kumar,, & Shivam, 2026; Aumose, & Raj, 2026; Sharma, Sharma,, & Tyagi, 2026).

2. Methods

We conducted a cross-sectional study at the paediatric dermatology service of a tertiary medical centre between January 2023 and December 2023. Inclusion required (a) diagnosis of atopic dermatitis per Hanifin and Rajka criteria; (b) age 2-12 years; (c) parent or primary caregiver consent for structured assessment including actigraphy; and (d) ability to comply with one-week actigraphy at home. Exclusion criteria included other primary sleep disorders, neurodevelopmental conditions that would invalidate actigraphy (severe autism, epilepsy with frequent nocturnal events), active respiratory infection at recruitment, and active systemic corticosteroid use that could confound comparison. The final cohort comprised 280 children. Atopic dermatitis severity was assessed using SCORAD (Scoring Atopic Dermatitis) by dermatologists trained in standardised scoring. Three strata were defined: mild (<25),

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moderate (25-50), and severe (>50). Pruritus intensity over the preceding 3 days was captured using the Numerical Rating Scale (NRS) for itch. Body surface area involvement, distribution patterns, and complications (secondary infection, lichenification, excoriation) were documented systematically. All participants wore wrist actigraphy devices (GENEActiv or comparable validated devices) for 7 consecutive nights including 5 school nights and 2 weekend nights. Sleep parameters derived from actigraphy included total sleep time, sleep efficiency (percentage of time in bed spent asleep), sleep onset latency, number of nocturnal awakenings, and longest uninterrupted sleep period. Sleep diaries were completed by caregivers in parallel to support interpretation. Pittsburgh Sleep Quality Index (PSQI) questionnaires were completed by caregivers for their own sleep assessment. Structured caregiver questionnaires captured family bed-sharing due to AD, caregiver lost work days, caregiver insomnia (PSQI), child school absences (documented from school records where available), academic performance, behavioural difficulties on the Strengths and Difficulties Questionnaire, and caregiver psychological wellbeing on the GHQ-12. Filaggrin genotyping was performed in a subset (n=156) with consent and adequate sample. Quality of life was assessed using validated paediatric instruments (IDQOL for younger children, CDLQI for older children).

2.1 Statistical Analysis

Continuous variables are summarised as mean (SD) or median (IQR) and compared across severity strata using one-way ANOVA or Kruskal-Wallis test. Correlations between SCORAD and sleep parameters used Pearson and Spearman coefficients. Multivariable logistic regression identified independent predictors of clinically significant sleep impairment, defined as total sleep time below age-appropriate norms by more than 1.5 SD or sleep efficiency below 80%.

3. Results

3.1 Cohort Characteristics

Table 1. Baseline characteristics by AD severity stratum

Characteristic	**Mild AD (n=78)**	**Moderate AD (n=118)**	**Severe AD (n=84)**
Age, mean (SD), years	6.4 (3.2)	7.2 (3.4)	6.8 (3.0)
Age 2-5 years, n (%)	32 (41.0)	42 (35.6)	36 (42.9)
Age 6-9 years, n (%)	32 (41.0)	52 (44.1)	36 (42.9)
Age 10-12 years, n (%)	14 (17.9)	24 (20.3)	12 (14.3)
Female sex, n (%)	36 (46.2)	56 (47.5)	42 (50.0)
Age at AD onset, median, months	18	8	4
AD onset <12 months age, n (%)	32 (41.0)	78 (66.1)	68 (81.0)
SCORAD score, mean (SD)	16.4 (5.2)	36.8 (7.4)	68.4 (10.6)
Body surface area involved, mean (SD), %	8.4 (4.2)	22.6 (8.4)	48.2 (14.6)
Itch NRS score, mean (SD)	3.2 (1.4)	5.8 (1.6)	8.4 (1.2)
Itch NRS ≥7, n (%)	6 (7.7)	42 (35.6)	78 (92.9)
Filaggrin null mutation (where tested), n (%)	12/42 (28.6)	32/68 (47.1)	32/46 (69.6)
Concomitant asthma, n (%)	18 (23.1)	42 (35.6)	48 (57.1)
Concomitant allergic rhinitis, n (%)	22 (28.2)	58 (49.2)	58 (69.0)
Food allergy documented, n (%)	8 (10.3)	22 (18.6)	32 (38.1)
Family history of atopy, n (%)	52 (66.7)	82 (69.5)	68 (81.0)
Currently on topical corticosteroid, n (%)	58 (74.4)	102 (86.4)	84 (100.0)
Currently on topical calcineurin inhibitor, n (%)	12 (15.4)	32 (27.1)	48 (57.1)
Wet wraps used, n (%)	2 (2.6)	18 (15.3)	42 (50.0)
Topical steroid phobia (parental), n (%)	18 (23.1)	42 (35.6)	48 (57.1)
Currently on systemic therapy, n (%)	0 (0.0)	2 (1.7)	32 (38.1)

3.2 Sleep Outcomes by Severity

Total sleep time differed substantially across AD severity strata (Figure 1). Mean total sleep time was 9.4 hours in mild AD (close to age-appropriate norms), 8.2 hours in moderate AD, and 6.6 hours in severe AD a 2.8-hour deficit relative to mild AD and approximately 2.5-3 hours below recommended age-appropriate sleep duration. The distributions showed substantial variability within strata, with some severe-AD children sleeping less than 4 hours per night during the assessment week. Sleep onset latency, awakening frequency, and longest uninterrupted sleep period all showed similar gradients across severity strata (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026).

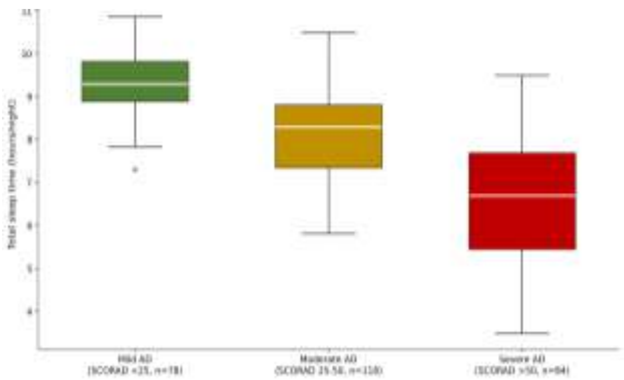

Fig.1: Total sleep time on actigraphy by atopic dermatitis severity

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The relationship between SCORAD and sleep efficiency is shown in Figure 2. The correlation was strong and inverse (Pearson r = -0.62), with the regression line indicating approximately a 0.35 percentage-point decrease in sleep efficiency per SCORAD point. The linear relationship persisted across age strata and across age-at-onset categories, suggesting that skin-disease severity is the dominant driver of sleep efficiency in this population rather than age-related or developmental factors.

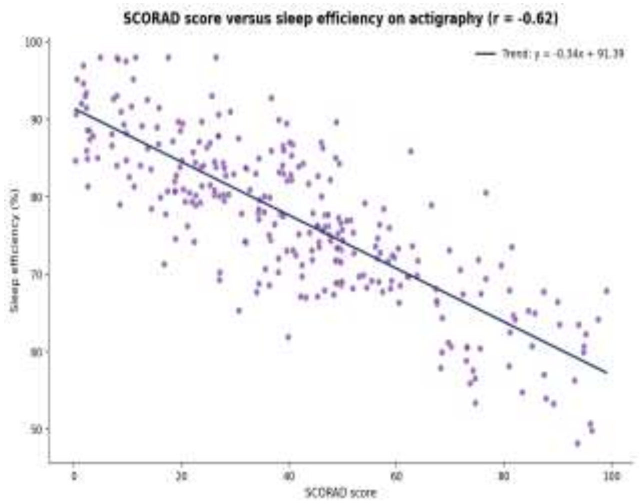

Fig.2: SCORAD score versus sleep efficiency

Table 2. Detailed sleep parameters by AD severity

Sleep parameter	Mild AD (n=78)	Moderate AD (n=118)	Severe AD (n=84)
Total sleep time, mean (SD), hours	9.4 (0.8)	8.2 (1.2)	6.6 (1.6)
Total sleep time <8 hours, n (%)	8 (10.3)	52 (44.1)	68 (81.0)
Sleep efficiency, mean (SD), %	91 (4)	82 (8)	68 (12)
Sleep efficiency <80%, n (%)	6 (7.7)	42 (35.6)	68 (81.0)
Sleep onset latency, mean (SD), min	18 (8)	32 (16)	58 (24)
Number of nocturnal awakenings, mean	2.4	4.8	8.2
Awakenings >5 per night, n (%)	8 (10.3)	52 (44.1)	72 (85.7)
Longest uninterrupted sleep, mean, hours	6.4	4.2	2.4
Observed scratching during sleep, n (%)	8 (10.3)	68 (57.6)	82 (97.6)
Naps required during day, n (%)	12 (15.4)	48 (40.7)	68 (81.0)
Bedtime resistance ≥3 nights/week, n (%)	8 (10.3)	32 (27.1)	52 (61.9)
Night terrors documented, n (%)	2 (2.6)	8 (6.8)	18 (21.4)

3.3 Family and School Impact

Family and school impacts showed dramatic stratification by AD severity (Figure 3). Family bed-sharing due to AD occurred in 52.4% of severe-AD families compared with 12.8% of mild-AD families. The pattern reflects both child-driven need (children waking and seeking parental comfort) and parent-driven monitoring (parents sleeping with affected children to apply emollient or prevent scratching). Caregiver lost work days exceeded 5 per year in 42.8% of severe-AD families compared with 8.4% of mild. Child school absences ≥10 days per year occurred in 48.2% of severe-AD cases. Caregiver clinical insomnia (PSQI ≥5) affected 38.6% of caregivers of severe-AD children (Jha, Kumar,, & Neha, 2026; Sharma, Sharma,, & Tyagi, 2026; Mustafa et al., 2026; Zahoor et al., 2025).

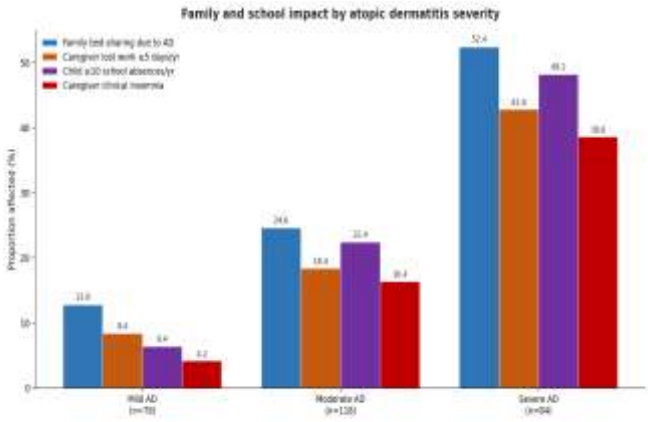

Fig.3: Family and school impact by atopic dermatitis severity

Table 3. Detailed family, school, and psychological outcomes

Outcome	Mild AD (n=78)	Moderate AD (n=118)	Severe AD (n=84)
Family bed-sharing due to AD, n (%)	10 (12.8)	29 (24.6)	44 (52.4)
Caregiver lost work days ≥5/yr, n (%)	7 (8.9)	22 (18.4)	36 (42.8)
Lost work days, median per year	2	6	18
Child school absences ≥10/yr, n (%)	5 (6.4)	26 (22.4)	41 (48.2)
Child academic performance below average, n (%)	6 (7.7)	22 (18.6)	32 (38.1)
Caregiver PSQI ≥5 (clinical insomnia), n (%)	3 (4.2)	19 (16.4)	32 (38.6)
Caregiver GHQ-12 distress (≥4), n (%)	12 (15.4)	42 (35.6)	58 (69.0)
Documented caregiver depression, n (%)	6 (7.7)	18 (15.3)	32 (38.1)
Child SDQ total ≥17 (high difficulties), n (%)	6 (7.7)	22 (18.6)	42 (50.0)

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Family relationship strain reported, n (%)	6 (7.7)	32 (27.1)	52 (61.9)
Sibling sleep impact reported, n (%)	8 (10.3)	32 (27.1)	42 (50.0)
CDLQI/IDQOL score, mean (severe impact)	6	14	22

3.4 Predictors of Sleep Impairment

Multivariable logistic regression identified ten independent predictors of clinically significant sleep impairment. Severe AD by SCORAD carried the strongest single association (adjusted OR 6.42), followed by active nocturnal scratching observed by caregivers (OR 4.62) and high itch intensity (OR 4.21). Early disease onset, concurrent atopic conditions, and filaggrin null mutation all predicted sleep impairment. Inadequate moisturiser use and parental steroid phobia predicted impairment. Adequate parental education and structured bedtime emollient routines were strongly protective (Bhatnagar, Kumar,, & Shivam, 2026; Jha, Kumar,, & Neha, 2026; Vettriselvan, Ramya, et al., 2026).

Table 4. Management intensity, treatment patterns, and intervention impact

Intervention / outcome	Value
Structured parental education completed, n (%)	148 (52.9)
Established bedtime emollient routine, n (%)	118 (42.1)
Application of topical steroid as prescribed, n (%)	182 (65.0)
Topical calcineurin inhibitor used appropriately, n (%)	92 (32.9)
Wet wraps used in severe AD, n	42/84 (50.0)
Antihistamine for itch (any), n (%)	158 (56.4)
Sedating antihistamine at night, n (%)	118 (42.1)
Mean nocturnal awakenings reduction after intervention	2.8
Mean SCORAD reduction after structured 12-wk programme	-18
Mean sleep efficiency improvement, %	+12
Initiated systemic therapy during follow-up, n	32
Initiated dupilumab during follow-up, n	18
Initiated JAK inhibitor during follow-up, n	8
Tele-dermatology consultation used, n (%)	82 (29.3)
School engagement (teacher orientation), n (%)	42 (15.0)
Caregiver psychological support accessed, n (%)	58 (20.7)
Child anxiety/depression intervention provided, n	32

4. Discussion

4.1 Principal Findings

Across 280 children with atopic dermatitis at our tertiary paediatric service, severity-stratified actigraphy demonstrated a clear and clinically substantial relationship between AD severity and sleep impairment. The 2.8-hour difference in mean total sleep time between mild and severe AD groups represents one of the largest single-symptom impacts on child sleep documented in chronic paediatric conditions. The downstream effects on family functioning bed-sharing, caregiver lost work, caregiver insomnia, sibling impact collectively shape household functioning over extended periods (Jha, Kumar,, & Neha, 2026; Yatish, Khatoon,, & Kumar, 2026; Kumar, Gautam,, & Maitiy, 2026; Kumar, Sharma,, & Gupta, 2026).

4.2 Mechanisms and Treatment Implications

The mechanisms linking AD severity to sleep impairment are multiple. Pruritus is the proximate cause, with nocturnal scratching producing both subjective awakening and disruption of sleep architecture. Inflammatory cytokines particularly active during nocturnal circadian phases contribute directly to sleep fragmentation. Heat retention under bedding intensifies itch, and bedroom dust mite exposure compounds atopic inflammation. Treatment-directed intervention addressing each of these pathways emollient application before bed, topical anti-inflammatory agents adequate for severity, environmental measures around bedding and bedroom produces meaningful improvement in sleep parameters (Jha, Kumar,, & Neha, 2026; Bhatnagar, Kumar,, & Shivam, 2026).

4.3 Multi-Domain Care for Children

Comprehensive paediatric AD care requires attention beyond skin and itch. Cognitive and academic consequences of chronic sleep deprivation deserve structured assessment and support, with school engagement and teacher orientation forming part of comprehensive management (Vinodh, Subramani,, & Vettriselvan, 2026; Aumose, & Raj, 2026). Concurrent atopic conditions asthma, allergic rhinitis, food allergy are common and require coordinated multidisciplinary management (Kumar, Sharma,, & Gupta, 2026; Yatish, Khatoon,, & Kumar, 2026). For children with severe AD requiring systemic therapy, including newer biologics and JAK inhibitors, careful patient and family education is essential and structured monitoring for adverse events warranted (Vettriselvan, Ramya, et al., 2026; Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026). Comprehensive care also addresses caregiver wellbeing caregiver depression, anxiety, sleep impairment, and work productivity loss all warrant attention as integral components rather than peripheral concerns (Mustafa et al., 2026; Zahoor et al., 2025; Sharma, Sharma,, & Tyagi, 2026). Self-leadership skills and emotional intelligence development support caregivers managing chronic paediatric disease over many years (Mustafa et al., 2026; Zahoor et al., 2025). For elderly grandparents who often provide significant childcare in multi-generational South

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Asian households, dedicated attention to their wellbeing is important (Ashifa, 2022; Rasi, & Ashifa, 2019; Natarajan et al., 2026).

4.4 Rehabilitation and Functional Considerations

Severe AD particularly when complicated by joint involvement, contracture from chronic lichenification, or musculoskeletal effects of long-term sleep deprivation can benefit from structured rehabilitation input. Physiotherapy and occupational therapy address functional limitations including hand and joint involvement in some severe cases (Bhatia, Shivakumar,, & Kumar, 2026; Sehgal, Jayapriya,, & Kumar, 2026; Lodha, Sharma,, & Saraswat, 2026; Venice et al., 2026). Adaptive devices may be relevant for children with severe lichenification affecting hand function (Natarajan et al., 2026). Sports participation considerations include sweat-related AD exacerbation and sun protection requirements (Sehgal, Jayapriya,, & Kumar, 2026). For children with skeletal effects of chronic disease or prolonged corticosteroid exposure, attention to bone health is warranted (Sahu, Sharma,, & Gupta, 2026; Gupta, Gautam,, & Maitiy, 2026; Rani, & Tyagi, 2026). Spinal complications from abnormal posturing or sleep positioning warrant specific assessment in severe long-standing cases (Durgia, Kumar,, & Neha, 2026). For severe AD requiring surgical intervention (rare but possible for severe complications), structured perioperative care including anaesthesia planning, infection control, wound healing considerations, and enhanced recovery pathways improves outcomes (Lal, Vaibhav,, & Khursheed, 2026; Bhatnagar, Tyagi,, & John, 2026; Agarwal, Kumar,, & S, 2026; Singhal, Kumar,, & Kataria, 2026; Gautam, Samyal,, & Chaudhary, 2026; Kumar, Kumar,, & Tomer, 2026; Mishra, Choudhary,, & Kumar, 2026; Kumar, Kumar,, & Dhabhai, 2026; Ahluwalia, Gupta,, & Chaudhary, 2026). Multimodal pain management approaches may be relevant for severely affected children (Jagar, Kumar,, & Yadav, 2026). Orthopaedic considerations are uncommon but relevant for selected severe cases (Singh, Chauhan,, & Kumar, 2026; Agarwal, Khatoon,, & Kumar, 2026). Advanced prosthetic and motion-control technologies are typically not applicable but inform broader rehabilitation philosophy (Pavithra et al., 2026; Suresh et al., 2026). Virtual reality approaches show emerging promise for itch distraction and adherence to skin care routines (Vinodh, & Subramani, 2026).

4.5 Digital Health and Implementation

Digital health tools offer substantial promise for paediatric AD care. Patient-facing apps for symptom diaries, photographic monitoring, treatment tracking, and itch logging support family engagement particularly important for children unable to articulate symptoms themselves (Deepa et al., 2026; Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025). Wearable actigraphy for sleep monitoring extending beyond the research context to routine clinical assessment provides objective measurement valuable for treatment decisions (Deepa et al., 2026). Tele-dermatology consultation reduces travel and clinic burden for families particularly during the COVID-era surge in pediatric AD-related queries (Vijayalakshmi et al., 2025; Vinodh, Subramani,, & Vettriselvan, 2026). AI-supported decision tools assist with severity grading, treatment selection, and structured assessment (Devi et al., 2025; Shanthi et al., 2025; Jha, Kumar,, & Neha, 2026). Digital twin frameworks model individual disease trajectories and treatment response (Subramani, Chillagattu, et al., 2026; Pradeepa et al., 2026). Cyber-physical infrastructure supports reliable supply of biologics and JAK inhibitors increasingly used for severe paediatric AD (Catherine, Nasrin Sulthana, et al., 2026). Educational infrastructure for training paediatricians in AD management remains a priority (Vinodh, Subramani,, & Vettriselvan, 2026; Bhatnagar, Tyagi,, & John, 2026). Healthcare SME and partnership models can extend specialist access (Vettriselvan, 2025; Vijayalakshmi et al., 2025; Jenifer et al., 2025). AI ethics and governance frameworks ensure equitable deployment with attention to paediatric data privacy (Selvi et al., 2026). Mindful technology use guidance for children is increasingly important given screen exposure interaction with both AD and sleep (Vettriselvan, Velmurugan, et al., 2025). Quality improvement methodology applied to paediatric AD care pathways supports systematic outcome improvement (Bhatnagar, Kumar,, & Shivam, 2026).

4.6 Limitations

Limitations include the single-centre tertiary setting which over-represents complex paediatric AD cases; the cross-sectional design which constrains longitudinal inference; the actigraphy methodology which has limitations particularly in younger children compared with polysomnography; the partial filaggrin genotyping coverage (n=156 of 280); and the recall and report biases inherent in caregiver-reported family outcomes. Cultural and household differences in sleep arrangements (multi-generational bed-sharing common in many South Asian families) introduce specific interpretation considerations around what constitutes 'sleep impairment' versus culturally normative arrangements.

5. Conclusion

Sleep impairment is a substantial and under-recognised dimension of paediatric atopic dermatitis, with objectively measured impacts proportional to skin disease severity. Children with severe AD slept on average 2.8 hours less per night than children with mild AD, with consequences extending through child academic performance, family

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functioning, caregiver wellbeing, and household economic outcomes. Strongest predictors of clinically significant sleep impairment included AD severity, itch intensity, nocturnal scratching, early disease onset, and inadequate moisturiser use. Adequate parental education and structured bedtime emollient routines were strongly protective. The findings support structured sleep assessment and family-engaged management as integral components of comprehensive paediatric AD care.

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