Atopic dermatitis – Impact on sleep, work performance and its associated costs: A cross-sectional study

Dear Editor,

The impact of atopic dermatitis (AD) on sleep disturbance, work performance, and its economic burden has not been adequately described. We conducted this study to uncover the relationships between sleep quality, work performance, predictive factors, and the cost of work performance loss across AD severity.

All patients with AD who visited our centre from March to August 2023 were screened in this cross-sectional study. Participants included were employed and English-proficient adults. Exclusion criteria were non-AD sleep disorder, memory disorder, and medications that affect sleep like antidepressive agents and antipsychotics. Validated Pittsburgh Sleep Quality Index (PSQI) and World Health Organisation Health and Work Performance Questionnaire (WHO-HPQ) were used.[1,2] AD severity was assessed using the Eczema Area and Severity Index (EASI). A score of 7 or less indicates mild AD, while a score greater than 21 indicates severe AD.

Out of a total of 402 patients, 78 that fulfilled the study criteria were recruited. The mean age was 31.7 ± 9.2 years with 73.1% being females . Early onset and higher caffeine intake were significantly associated with increasing AD severity. Sleep quality was poor even in mild AD (Global PSQI score 6.65 ± 3.85, 12.32 ± 5.96, 16.63 ± 3.44 for mild, moderate, and severe AD, respectively) [Table 1]. All seven components of sleep (quality, latency, duration, efficiency, disturbance score, daytime dysfunction), absenteeism, and presenteeism were significantly affected across AD severity ($p < 0.001$) [Figure 1]. Apart from the itch, skin pain and feeling too hot or too cold were among the main causes of sleep disturbance.

Absenteeism and presenteeism were calculated using the WHO-HPQ protocol.[3] Absenteeism is the total hours off work, while presenteeism refers to performance at work. Absolute presenteeism measures performance from 0 (no performance) to 100 (full performance) and relative presenteeism is a ratio from 0 to 1. The estimated costs, outlined in the formula in Box 1, were adjusted for purchasing power parity and presented in 2024 U.S. dollars ($).[2,4,5]

The estimated cost of absenteeism per year was $123 ± 626, $2563 ± 6819, $6712 ± 11,731 for mild, moderate, and severe AD respectively ($p < 0.001$). The estimated cost of presenteeism per year were $3344 ± 3242, $7644 ± 6379, $11,824 ± 9157 for mild, moderate, and severe AD respectively ($p < 0.001$). The estimated annual cost of work impairment was $3405 ± 3317 for mild AD, $9355 ± 9708 for moderate AD, and $14,303 ± 12,529 for severe AD ($p < 0.001$). This corresponded to 11%, 37%, and 59% of the mean annual salary for mild, moderate, and severe AD respectively. This is comparable to developed countries, where the annual indirect cost of AD is approximately $11,807.90 (equivalent to 24.2% of the US annual salary) and ranges from $11,089.39 to $21,694.17 across Europe in the 2024 US dollars.[5,6] Additionally, the economic burden of AD is comparable to that of psoriasis.[5]

Linear regression analyses on the effects of sleep on work and its indirect cost are shown in Table 1. Absenteeism, presenteeism, overall work impairment, and its associated cost were significantly affected by the severity of sleep disturbance across AD severity [Figure 2a-c]. One unit increase in sleep impairment (PSQI) score increased absenteeism by 2.50 times while worsening presenteeism by 2.48 times. Moreover, one unit increase in PSQI score

Box 1: The formula to calculate costs of work impairment

Cost of overall work impairment per month = [rA + (RHW) (10 – Es)/10] × monthly income
Relative absenteeism, rA = (hours absent/ total expected hours of work) per month
Relative hours of work, RHW = 1 – rA
Es = Self-rated work performance (0–10 scales) on days worked during the past four weeks as per the WHO-HPQ questionnaire A12

How to cite this article: Lim JA, Jamil A, Arumugam M, Kueh YC. Atopic dermatitis – Impact on sleep, work performance and its associated costs: A cross-sectional study. Indian J Dermatol Venereol Leprol. doi: 10.25259/IJDVL_892_2024

Received: June, 2024 **Accepted:** September, 2024 **Epub Ahead of Print:** December, 2024

DOI: 10.25259/IJDVL_892_2024

Table 1: Assessing the impact of atopic dermatitis severity on sleep, work performance, and its associated costs

	AD severity Mean ± SD or n (%)			P-value[a]
	Mild n = 26	Moderate n = 28	Severe n = 24	
Global PSQI sleep score	6.65 ± 3.85	12.32 ± 5.96	16.63 ± 3.44	< 0.001
Caffeine intake, mg/week	43.8 ± 70.0	70.3 ± 61.3	116.7 ± 71.7	0.001
Age AD diagnosed	16.4 ± 12.0	14.4 ± 14.7	7.8 ± 9.8	0.045
Absenteeism				
Absolute absenteeism, hours/month	1.92 ± 9.81	11.57 ± 19.35	42.86 ± 49.44	< 0.001
Relative absenteeism	0.01 ± 0.05	0.06 ± 0.11	0.25 ± 0.31	< 0.001
Presenteeism				
Absolute Presenteeism, %	87.31 ± 11.16	70.00 ±13.61	48.75 ± 22.52	< 0.001
Relative Presenteeism	1.00 ± 0.09	0.86 ± 0.19	0.62 ± 0.27	< 0.001
Overall work impairment, %	13.19 ± 13.03	34.18 ± 15.84	60.75 ± 25.07	< 0.001
Annual cost of work impairment				
Cost of absenteeism, $	123 ± 626	2563 ± 6819	6712 ± 11731	< 0.001
Cost of presenteeism, $	3344 ± 3242	7644 ± 6379	11824 ± 9157	< 0.001
Cost of overall work impairment, $	3405 ± 3317	9355 ± 9708	14303 ± 12529	< 0.001
Sleep impact on work and cost				
PSQI score as independent variable	Regression coefficient, *b*	95% CI	t-stat	*P-value*[b]
Absenteeism	2.50	1.35 – 3.64	4.34	< 0.001
Presenteeism	2.48	3.08 – 1.87	8.14	< 0.001
Overall work impairment	0.03	0.02 – 0.04	8.64	< 0.001
Estimated annual cost of absenteeism, $	495.24	218.71 – 771.77	3.57	< 0.001
Cost of presenteeism, $/year	606.19	369.79 – 842.59	5.11	< 0.001
Cost of overall work performance, $/year	810.79	482.69 – 1138.90	4.92	< 0.001
Factors associated with poor work performance				
Univariate logistic regression				
Independent variables	**OR (95% CI)**		***P-value***	
Occupation	1.334 (1.031 – 1.724)		0.028	
Caffeine	1.019 (1.010 – 1.028)		< 0.001	
Alcohol	7.986 (1.186 – 53.772)		0.033	
EASI score	1.166 (1.094 – 1.244)		<0.001	
Itch score	1.975 (1.422 – 2.745)		< 0.001	
Antihistamine used frequency	4.339 (1.786 – 10.542)		0.001	
PSQI global score	1.473 (1.232 – 1.760)		< 0.001	
Sleep quality	4.223 (2.170 – 8.218)		< 0.001	
Sleep latency	4.656 (2.215 – 9.784)		< 0.001	
Sleep duration	3.201 (1.671 – 6.130)		< 0.001	
Sleep efficiency	3.234 (1.953 – 5.356)		< 0.001	
Sleep disturbance	11.785 (3.610 – 38.480)		< 0.001	
Medication to sleep	4.688 (1.936 – 11.353)		< 0.001	
Daytime dysfunction	2.445 (1.426 – 4.192)		0.001	
Multivariable logistic regression (Final model for predictors of poor work performance)				
Independent variables	**AOR (95% CI)**		***P-value***	
EASI score	1.144 (1.057 – 1.238)		< 0.001	
Caffeine	1.018 (1.005 – 1.031)		0.006	
Sleep quality	2.716 (1.061 – 6.950)		0.037	

Receiver Operator Characteristic (ROC) = 94.6%, Hosmer-Lemeshow test p = 0.685, 84.6% of cases classified correctly

[a] One-way ANOVA test; [b] Linear regression analysis

AD: atopic dermatitis; AOR: adjusted odd's ratio; BMI: body mass index; CI: confidence interval; EASI: eczema area and severity index; OR: crude odd's ratio; PSQI: Pittsburgh sleep quality index; SD: standard deviation; $: US Dollar

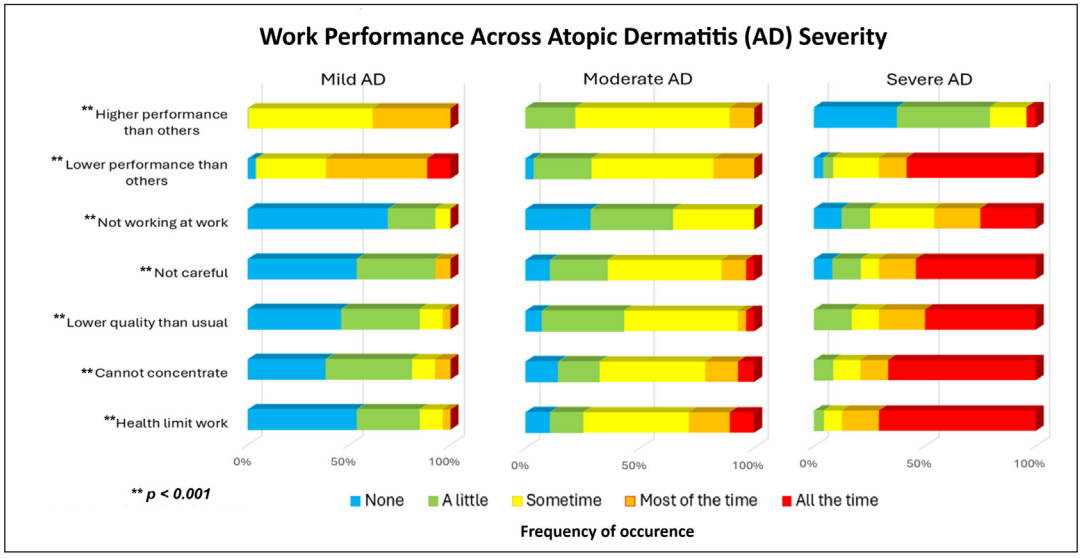

Figure 1: Components of work performance across atopic dermatitis severity.

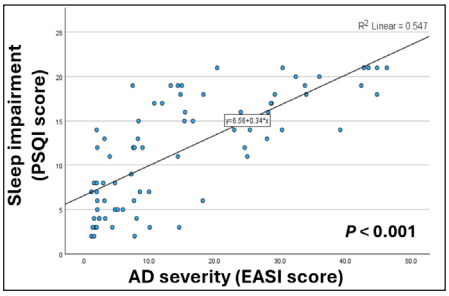

Figure 2a: The effects of atopic dermatitis (AD) severity based on eczema area and severity index (EASI) score, on sleep.

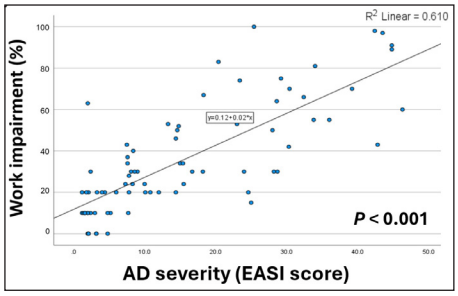

Figure 2b: The effects of atopic dermatitis (AD) severity based on eczema area and severity index (EASI) score, on work impairment.

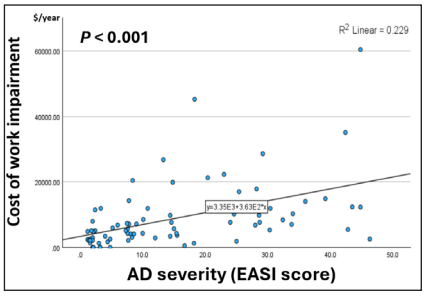

Figure 2c: The effects of atopic dermatitis (AD) severity based on eczema area and severity index (EASI) score, on cost.

corresponded to an estimated increase in absenteeism cost by $495.24, presenteeism cost by $606.19, and overall work impairment cost by $810.79 respectively ($p < 0.001$).

Univariate logistic regression analysis identified several factors significantly associated with poor work performance in AD patients. Multivariable logistic regression showed significance for EASI score (aOR: 1.14, 95% CI 1.057–1.238), caffeine intake (aOR: 1.02, 95% CI 1.005–1.031), and sleep quality (aOR: 2.72, 95% CI 1.061–6.950). This final model is an excellent predictor for poor work performance which has a Receiver Operating Characteristic curve of 0.946, Hosmer-Lemeshow test of $p = 0.685$, and accurately classifies 84.6% of cases.

In this study, caffeine intake is associated with AD severity, poorer sleep score, and poorer work performance. While caffeine is often used to boost cognitive performance during sleep deprivation, it has been shown to reduce sleep quality, especially if consumed within 8.8 hours of bedtime.[7] A cause-and-effect relationship cannot be confirmed as this was a cross-sectional study. However, the finding is noteworthy, and AD patients are advised to be cautious and avoid caffeine nine hours before bedtime.

In our study, AD affects presenteeism more than absenteeism, aligning with the previous research.[5,6] This reflects the nature of AD which carries both physical and psychological aspects. Patients may not be ill enough for sick leave, but yet not well enough for optimum performance. Uncontrolled AD from a young age may lead to poor academic performance and limited educational opportunities. Consequently, individuals may find themselves confined to outdoor occupations during adulthood, which, in turn, could trigger AD flares.

In conclusion, poor sleep quality is prevalent across all AD severity. Presenteeism has a greater impact on work performance than absenteeism. Independent predictors of poor work performance include greater AD severity, poorer sleep quality, and elevated caffeine intake. This underscores the urgent need for patients, employers, and treating doctors in forming a comprehensive management strategy to address the physical symptoms of AD and its detrimental effects on sleep and work.

Ethical approval: The research/study was approved by the Institutional Review Board at the Research Ethic Committee, The National University of Malaysia, number JEP-2023-135, dated 16/3/2023.
Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship: This research was funded by the Universiti Kebangsaan Malaysia Medical Faculty Fundamental Grant FF-2023-097, Persatuan Dermatologi Malaysia Research Grant Award and Hoe Pharmaceuticals. The funding bodies have no role in the study design, data collection, analysis, interpretation, or in writing the manuscript.
Conflicts of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: AI-assisted technology has been utilised to enhance the grammatical accuracy of this manuscript, ensuring clarity without any manipulation of results or analysis.

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