

## ORIGINAL ARTICLE

### Sleep and quality of life in adults with atopic dermatitis: cross sectional study.

#### *Sleep and quality of life in adults with atopic dermatitis*

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#### **Summary**

**Background.** Atopic dermatitis (AD) is a chronic pruritic inflammatory skin disease that causes sleep disturbances and worsens quality of life. However, few studies have been conducted on sleep in adults with atopic dermatitis. This study aimed to evaluate sleep and quality of life in adults with AD. **Methods.** A cross-sectional study was conducted with 36 adults diagnosed with AD and 21 healthy volunteers (controls), who completed questionnaires on sleep, itching, and quality of life. Disease severity was estimated using SCORing Atopic Dermatitis (SCORAD). All participants wore actigraphy watches for one week to objectively assess sleep quality. **Results.** Adults with AD slept worse than controls as measured by self-report (Global Pittsburgh Sleep Quality Index, mean  $\pm$  SD,  $9.33 \pm 3.59$  vs  $5.00 \pm 2.30$ ,  $p < 0.001$ ) and by actigraphy (sleep efficiency, SE), mean  $\pm$  SD,  $74.48 \pm$

11.63 vs  $85.6 \pm 6.53$ ,  $p < 0.001$ ). Actigraphy showed that adults with AD slept, on average, almost one hour less ( $p = 0.010$ ), stayed awake during sleep for almost 44 minutes more ( $p < 0.001$ ), and woke up 25% more than the controls ( $p = 0.047$ ). In the AD group, SE and total sleep time were significantly inversely correlated with SCORAD ( $r_s = -0.601$ ,  $p < 0.001$  and  $r_s = -0.604$ ,  $p < 0.001$ , respectively), but no significant correlation was found between itch and SE. A decreased quality of life was observed in adults with AD (DLQI, mean  $\pm$  SD,  $8.75 \pm 6.7$ ). **Conclusions.** Adults with AD slept worse than the controls and had a diminished quality of life. Actigraphy is a useful tool to objectively measure sleep quality in adults with AD especially those with moderate to severe disease.

#### KEY WORDS

Atopic dermatitis; actigraphy; quality of life; sleep; questionnaires.

#### Impact statement

We suggest that actigraphy should be performed in every adult with moderate to severe AD to objectively assess sleep quality.

## Introduction

Atopic dermatitis (AD) is a common, chronic, relapsing inflammatory skin disease (1). Pruritus is a cardinal symptom that leads to scratching and sleep disturbance (2, 3). AD is mostly seen in children but can also affect adults (2). The prevalence of AD in adults can change significantly from country to country and has been estimated to range from 2% to 10%. Among adult patients with AD, 34–46% present with moderate or severe disease (4,5). The prevalence of AD in adults in Brazil is estimated at 7%, of which 35% is moderate and 30% is severe (6, 7). AD is associated with a higher risk of other atopic disorders including asthma, allergic rhinitis (AR), and food allergies (8).

AD has been found to be associated with sleep disturbances in 47% to 80% of children and 33% to 90% of adults (9).

Eczema has been associated with higher odds of fatigue, regular daytime sleepiness and regular insomnia (10, 11).

Sleep is essential for recovering physiological functions, and the National Sleep Foundation recommends 7–9 h per day for adults (12).

Some studies have highlighted significant associations and demonstrated causal pathways between sleep and circadian disruptions and disease risk (13,14).

Previous research has found that AD, mainly moderate and severe, is

associated with poor health-related quality of life, sleep disturbances, depression, anxiety, and a higher cardiovascular risk. Sleep disturbances were greater with more severe AD and were found to adversely affect patients' daily activities and productivity at work, leading to a huge burden on their lives (4, 15-21).

Sleep assessment is essential to diagnose and monitor sleep disorders in adults with AD (9, 22, 23). Experts at the National Sleep Foundation agree that sleep latency, number of awakenings > 5 min, time awake after sleep onset (WASO), and sleep efficiency are appropriate indicators of good sleep quality across the lifespan (12).

Although polysomnography (PSG) is considered the gold standard for assessing sleep quality, it has various limitations such as high cost and technical difficulties. A wrist actigraph is a simple device that is easy to use. It can be used in the home environment to discriminate between sleep and wakefulness (22, 24, 25). Few studies have been conducted on sleep in adults with atopic dermatitis, particularly those using objective measurements.

## **Materials and methods**

This was a prospective single-center cross-sectional study. This study was submitted and approved by the Research Ethics Committee of the Clementino Fraga Filho University Hospital at the Federal University of Rio

de Janeiro (HUCFF/UFRJ) (CAE 05379419.7.0000.5257) and conducted in accordance with the Declaration of Helsinki. Written informed consent was acquired from all subjects.

### ***Study sample***

We recruited a convenience sample of 36 adults diagnosed with AD ( $\geq 18$  years) who were followed up in the outpatient clinic of the HUCFF, and 21 healthy volunteers ( $\geq 18$  years) connected to the same hospital. To be eligible for the study, patients had to have an AD diagnosis made by a dermatologist or allergist according to the Hanifin and Rajka criteria (26). The participants with sleep disorders, psychiatric illness that may interfere with responses to the questionnaire, other dermatological diseases that course with eczema and/or itching, uncompensated comorbidities and using sedative medication were excluded from the study.

At regular visits, informed consent was obtained and the itch scale score, Body Mass Index (BMI), and AD severity were measured. Participants were instructed to wear the actigraph on the non-dominant wrist at night to collect actigraphy data until the second visit one week later. At the second visit, an actigraph was collected, questionnaires were completed, and the subjects were reassessed. They were also asked to complete sleep diaries. Subjects were required to have controlled asthma

(Asthma Control Test score > 19) and controlled AR using the Visual Analogue Scale (VAS).

## ***Measures***

### ***Skin assessment***

At the patient's clinic visit, the dermatologist/allergist assessed disease severity using SCORing Atopic Dermatitis (SCORAD) (27, 28).

### ***Itch severity***

Itch was measured using the Itch Numerical Rating Scale (NRS) (29, 30).

### ***Quality of sleep***

The Pittsburgh Sleep Quality Index (PSQI), a 19 items validated self-administered questionnaire, was used to measure the sleep quality and disturbances in the previous month. The PSQI is composed of 7 components that evaluate sleep in adults: 1) subjective sleep quality, 2) sleep latency, 3) sleep duration, 4) habitual sleep efficiency, 5) sleep disturbance, 6) use of sleeping medication, and 7) daytime dysfunction.

The sum of scores for these 7 components (each of which has a range of 0-3 points) yields one global score (ranging from 0 to 21 points). A global PSQI score  $\leq 5$  is associated with good sleep quality, and a total PSQI score > 5 is associated with poor sleep quality. A higher PSQI score

is indicative of more disturbed sleep (31, 32).

### ***Quality of life***

Patient's quality of life (QoL) was assessed using the Dermatology Life Quality Index (DLQI), higher scores are related to a greater impact on QoL (33, 34).

### ***Actigraphy***

The actigraphy was performed with an ActTrust 2 actigraph (Condor Instruments, Brazil) (35, 36) between November 2021 and November 2022. The data collected by the actigraph were extracted using the ActStudio software (Condor Instruments, Brazil). The following parameters were examined: time in bed (min); total sleep time (TST, min), defined as the number of minutes spent sleeping during the time spent in bed; sleep onset latency (min), defined as the number of minutes between bedtime and fall asleep; sleep efficiency (SE, %), defined as the ratio between TST and time spent in bed; time awake after sleep onset (WASO, min), defined as the number of minutes awake after sleep onset and number of awakenings (n) (35, 36).

### ***Sample characteristics.***

Demographic data (age, sex, and race) as well as BMI, treatment, and comorbidities at baseline were collected. Groups were constructed to ensure comparability based on sex, age, race, and BMI.

Demographic characteristics were analyzed using descriptive statistics.

Comparisons between groups were performed using the Mann-Whitney

U test for numerical data and Fisher's exact test for categorical data.

Spearman's correlation coefficient was used to analyze the association between numeric variables.

All data were analyzed using IBM SPSS software version 21, and statistical significance was set at  $p < 0.05$ .

## **Results:**

### ***Data analysis of socio-demographic and clinical characteristics of the participants***

We recruited a convenience sample of 36 adults with AD and 21 healthy adults (controls); male  $n$  (%) 11 men (30.6%) vs. 10 (47.6%) ( $p=0.258$ ); white  $n$  (%) 16 (44.4%) vs. 12 (57.1%) ( $p=0.417$ ); age mean  $\pm$  SD  $27.1 \pm 12.8$  vs.  $26.2 \pm 6.4$  years ( $p=0.281$ ) and, BMI (mean  $\pm$  SD)  $24.8 \pm 5.2$  vs.  $25.1 \pm 4.5$  kg/m<sup>2</sup> ( $p=0.791$ ), respectively.

We found a mean DLQI (mean  $\pm$  SD) of  $8.75 \pm 6.7$  and a mean SCORAD (mean  $\pm$  SD) of  $36.83 \pm 18.66$ .

Demographic and clinical characteristics of AD patients are summarized in **table I**.

### ***Actigraphy sleep measurement***

On average, adults with AD slept less ( $p=0.010$ ), woke up more often ( $p=0.047$ ), spent more time awake during sleep ( $p<0.001$ ), and had a lower SE than controls ( $p<0.001$ ) (**figure 1**). No differences in sleep onset latency or time spent in bed were observed between the patients with AD and controls (**table II**).

### ***Self-reported sleep measurement***

As summarized in **table II**, on average, patients with AD reported lower sleep quality and SE than the controls. They also had longer sleep latency, more sleep disturbances, and daytime dysfunction than controls. The Global PSQI score was higher in adults with AD than in controls ( $p<0.001$ ).

### ***Correlations***

Correlations between the 14 sleep measures (self-report and actigraphy) and the itch NRS, SCORAD, and DLQI scores were generated (**table III**).

The Global PSQI had a fair correlation with itch NRS and SCORAD ( $r_s=0.549$ ,  $p=0.001$  and  $r_s=0.539$ ;  $p=0.001$ , respectively) and a moderately strong correlation with DLQI ( $r_s=0.623$ ,  $p<0.001$ ). Actigraphy sleep measures, such as TST, were negatively correlated with Itch NRS and DLQI ( $r_s=-0.399$ ,  $p=0.016$  and  $r_s=-0.357$ ,  $p=0.032$ , respectively). A fair correlation was also found between the WASO and SCORAD

scores ( $r_s = 0.413$ ,  $p = 0.012$ ).

Interestingly, we also observed that SE (**figure 2**) and TST had a moderately strong negative correlation with SCORAD ( $r_s = -0.601$ ,  $p < 0.001$  and  $r_s = -0.604$ ,  $p < 0.001$ , respectively).

Correlations between the Global PSQI and actigraphy sleep measures were also evaluated (**table IV**). The Global PSQI was significantly negatively correlated with SE, TST, and time in bed ( $r_s = -0.382$ ,  $p = 0.021$ ;  $r_s = -0.423$ ,  $p = 0.010$ ; and  $r_s = -0.344$ ,  $p = 0.040$ , respectively). However, it did not correlate with the onset latency, awakening, or WASO.

## Discussion and conclusions

This study showed that adults with AD slept worse, both qualitatively and quantitatively, than the controls, as measured by self-reporting and actigraphy. Sleep impairment depends on the severity of AD. Almost 70% of our patients had moderate-to-severe disease, with a mean SCORAD of 36.83.

Actigraphy showed that patients with AD slept on average almost one hour less and stayed awake during sleep time almost 44 minutes more than controls; on average, sleep efficiency was approximately 13% less and woke up 25% more than controls. In the AD group, we observed a SE (mean  $\pm$  SD)  $74.48\% \pm 11.63$  and as much as 72% of AD patients had

SE lower than 85%, which is the target considered an appropriate indicator of good sleep quality (12).

To the best of our knowledge, this is the first study in adults with AD that demonstrates that these patients have a mean SE well below the ideal level for healthy sleep. Interestingly, we did not find a significant correlation between itching and SE.

There was no difference between the groups in terms of sleep latency or total amount of time spent in bed. Comparing self-reported questionnaires with actigraphy, the Global PSQI did not correlate with awakening or WASO, which are related to sleep fragmentation.

Although the participants appeared to be able to judge frequent awakenings, poor sleep quality, and daytime fatigue through self-report questionnaires, actigraphy generated more accurate estimates of the number of minutes slept each night, precise counts of movement, and awakenings. Actigraphy provides more discriminating information about sleep fragmentation in patients with AD than self-reporting as it collects unbiased data (22).

In a French study of patients with moderate-to-severe AD and healthy volunteers using self-reported electronic questionnaires twice a day for 14 days with an experimental smartphone application to collect information about pruritus via a numerical rating scale, DLQI, subjective

sleep characteristics, and an actigraph for 14 nights, it was found that the WASO score was significantly higher, TST and SE were lower than that of the controls (37) as we observed in our research.

In our study we found a shorter sleep duration in adults with AD compared to healthy controls and according to a US population study, adult eczema is linked to both short and long sleep duration. Long length is probably caused by ineffective sleep, excessive fatigue, and sleepiness, whereas short duration may be caused by trouble falling asleep and premature awakening secondary to itching (10).

We observed that adults with AD had subjective and objective diminished sleep quality compared to healthy controls, our findings are in line with a case-control study of 14 adults with AD and 14 controls without skin disease, that self-reported sleep impairment was assessed using the PSQI and objective sleep measures were assessed using actigraphy. The PSQI showed poorer sleep quality, more frequent and prolonged awakenings, and daytime dysfunction in AD patients. Likewise, actigraphy revealed that patients with AD wake up more often and spend more time awake during waking episodes, with lower overall sleep efficiency (22).

Another study using questionnaires, actigraphy, and PSG in 20 adult patients with AD revealed that more severe AD is associated with poorer

sleep quality (11). This study found that sleep measured by actigraphy and PSG was strongly associated with each other and that decreased sleep efficiency was associated with increased disease severity as we also saw in our study.

They also observed that self-reported sleep quality and quality of life were not significantly correlated with either objective sleep measure (11).

Our study analyzed objective variables using actigraphy. We found no significant difference in sleep latency or time spent in bed between the groups; however, a higher number of awakenings and WASO were observed in the AD group. The SE was significantly lower in patients with AD. SCORAD was inversely correlated with SE, total sleep time, and time in bed and was significantly correlated with WASO. Our study confirms the impact of the severity of AD on sleep quality.

Sleep disruption was found to be highly linked with a reduction in QoL using the DLQI in a study of 384 adults with AD (38). We observed in our study that itch and DLQI were inversely correlated with TST but not with SE, number of awakenings, or WASO.

A multicenter questionnaire-based study of 1,098 adults from The International Study of Life with Atopic Eczema (ISOLATE) found that a typical AD flare disrupts sleep for an average of 8.4 nights per flare (39), this is very concerning. In our study we didn't analyze patients during

flare.

Objective sleep assessment provides more details on sleep timing, WASO, SE, sleep fragmentation, and assessments that are not accurately obtained via self-reported questionnaires (40).

In both pediatric and adult AD, actigraphy and infrared video data revealed fragmented sleep with increased scratch time and restless nocturnal movement (41-43).

A meta-analysis of objective sleep studies in AD patients involving 122 controls and 173 AD patients in a total of seven trials revealed that compared to controls, patients with AD exhibited longer WASO and sleep latency, along with significantly reduced total sleep duration and SE. Objective sleep was worse in patients with AD, especially in those with severe AD. AD appears to affect sleep maintenance more than falling asleep (44). We found no significant differences in sleep latency between the two groups, but we also observed that sleep quality in adults with AD decreases as the severity of the disease increases, and that is related to sleep fragmentation that compromises sleep maintenance.

Poor sleep hygiene and an itch-scratch cycle that interferes with sleep initiation and maintenance are some of the proposed mechanisms of the connection between AD and sleep disturbances (45). Disturbance of the circadian rhythm induces modification of itching and upregulation of

inflammatory cytokines implicated in sleep regulation (46). Our findings shown inversely correlation between itching an TST as measured by actigraphy.

In the present study, we observed an association (91,6%) between AD and other allergic diseases. This finding was similar to those of previous studies in which most patients with AD had an associated allergic disease (47–50).

An important limitation of studies on sleep in patients with AD is the lack of control of comorbid asthma and rhinoconjunctivitis, which can independently cause sleep disturbances (51). In our study, both diseases were controlled during the research period, and the impact of AD on sleep was observed.

Quality of life was decreased in our patients, and we found a mean DLQI (mean  $\pm$  SD) of  $8.75 \pm 6.7$ , which represents a moderate effect on their lives. Many international studies related AD with decreased quality of life.

An US study in adults with AD, confirmed that AD has a noticeable influence on HRQOL and that the HRQOL of patients with AD is worse than that of individuals with other chronic skin conditions such as psoriasis (4).

A European study of 1.189 adult patients with moderate to severe AD from nine European countries using the DLQI showed moderate to

extremely large impairments in 55% of patients (52).

US adults with AD frequently report sleep disturbances and fatigue, especially those with moderate/severe AD. Sleep disturbance was associated with worse Health-Related Quality of Life (HRQOL), poor mental health, and comorbid health disorders in adults with AD (53).

A multicenter prospective epidemiological study of 172 adults with AD showed that AD affects HRQOL and reported that 87.1% of adults had difficulty sleeping (19).

A cross-sectional study of 200 adult patients with AD using the Objective SCORAD (oSCORAD), DLQI, and PSQI found mean DLQI global, PSQI, and oSCORAD scores of 12.15, 8.65, and 27.56, respectively (54). They analyzed the PSQI components and correlated to DLQI and oSCORAD, they found that all components showed significant correlations with the DLQI but only four components showed significant correlations with the oSCORAD score, including subjective sleep quality, sleep latency, sleep disturbance, and daytime dysfunction. Despite we didn't use the oSCORAD, our findings show significant correlation between SCORAD and PSQI, not only in the Global PSQI but also in three components: subjective sleep quality, sleep latency, sleep disturbance. We also observed a correlation between Global PSQI and DLQI but only three components correlate with DLQI: sleep latency, sleep disturbance, and

daytime dysfunction.

Some studies evaluating the burden of AD in Latin America also have shown a significant impact on the quality of life (6, 7, 50, 55).

Some methodological limitations should be observed in this study seeing as sleep quality is influenced by some of environmental and socioeconomic factors as climate, home condition, parental status and occupational context of the subjects, which were not analyzed in the present study.

Despite the limitations observed, this study highlights the significant and relevant effects of AD on sleep and quality of life in adults, especially in those with moderate-to-severe disease. This also indicates that accurate objective sleep measures are available, which may better reflect sleep fragmentation. Given the reciprocal association between sleep and AD, it is crucial to routinely test adults with moderate-to-severe AD for sleep disturbances by using actigraphy.

## **Statement of Ethics**

IRB approval status: The study was reviewed and approved by the Research Ethics Committee of the Clementino Fraga Filho University Hospital at the Federal University of Rio de Janeiro (HUCFF-UFRJ), Brazil (certificate number: CAE 05379419.7.0000.5257).

Written informed consent was acquired from all subjects.

## **Funding**

None.

## **Contributions**

MHB: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. SORV, OL: Conceptualization, Methodology, Supervision, Validation, Visualization, Writing – review & editing. SDDJ: Conceptualization, Methodology, Validation, Visualization, Writing – review & editing. RRL: Formal Analysis, Writing – review & editing.

## **Conflict of interests**

The authors declare that they have no conflict of interest to declare with the current article.

During the preparation of this work the author(s) used Paperpal to improve readability and language of the work. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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Manuscript accepted for publication

**Table I - Socio-demographic and clinical characteristics AD adult patients.**

| Variable                                             | AD adult patients (n=36) |         |
|------------------------------------------------------|--------------------------|---------|
| <b>Sex, n (%)</b>                                    |                          |         |
| Male                                                 | 11                       | (30.6)  |
| Female                                               | 25                       | (69.4)  |
| <b>Age, mean (SD)</b>                                | 27.1                     | (12.8)  |
| <b>Race, n (%)</b>                                   |                          |         |
| Black                                                | 20                       | (55.6)  |
| White                                                | 16                       | (44.4)  |
| <b>Age group, n (%)</b>                              |                          |         |
| 18-19 years                                          | 10                       | (27.8)  |
| 20-29 years                                          | 18                       | (50.0)  |
| 30-39 years                                          | 3                        | (8.3)   |
| 40-49 years                                          | 2                        | (5.6)   |
| 50-59 years                                          | 1                        | (2.8)   |
| ≥60 years                                            | 2                        | (5.6)   |
| <b>Allergic comorbidities, n (%)</b>                 |                          |         |
| Asthma                                               | 11                       | (30.6)  |
| Allergic rhinitis                                    | 29                       | (80.6)  |
| Food allergy                                         | 9                        | (25.0)  |
| Allergic conjunctivitis                              | 2                        | (5.6)   |
| None                                                 | 3                        | (8.3)   |
| <b>Therapies during the study, n (%)</b>             |                          |         |
| Non sedative Antihistamine                           | 15                       | (41.7)  |
| Topical corticosteroid/calcineurin inhibitors        | 24                       | (66.7)  |
| Systemic immunosuppressant/Immunobiologic agents     | 23                       | (63.9)  |
| Phototherapy                                         | 1                        | (2.8)   |
| Allergen immunotherapy                               | 3                        | (8.3)   |
| <b>Body mass index (kg/m<sup>2</sup>), mean (SD)</b> | 24.8                     | (5.2)   |
| <b>Disease severity (SCORAD), n (%)</b>              | 36.8                     | (18.7)  |
| Mild                                                 | 11                       | (30.6)  |
| Moderate                                             | 16                       | (44.4)  |
| Severe                                               | 9                        | (25.0)  |
| <b>SCORAD, mean (SD)</b>                             | 36.83                    | (18.66) |
| <b>Itch numeric scale (NRS), mean (SD)</b>           | 4.68                     | (3.14)  |
| <b>Global PSQI, mean (SD)</b>                        | 9.3                      | (3.6)   |
| <b>Global PSQI, n (%)</b>                            |                          |         |
| Good sleeper (≤ 5)                                   | 6                        | (16.7)  |
| Poor sleeper (> 5)                                   | 30                       | (83.3)  |
| <b>DLQI, mean (SD)</b>                               | 8.75                     | (6.7)   |
| <b>Efficiency (≥85%) actigraphy measure, n (%)</b>   |                          |         |
| Yes                                                  | 10                       | (27.8)  |
| No                                                   | 26                       | (72.2)  |
| <b>Efficiency (≥85%) self-report measure, n (%)</b>  |                          |         |
| Yes                                                  | 17                       | (47.2)  |
| No                                                   | 19                       | (52.8)  |

Abbreviations: SCORAD, SCORing Atopic Dermatitis; PSQI, Pittsburgh Sleep Quality Index; DLQI, Dermatology Life Quality Index.

**Table II** - Descriptive statistics and *P* values for comparisons of self-report and objective sleep measures between 2 groups: AD and control.

| Variable                              | AD (n=36) |        |       | Control (n=21) |        |       | P-value |
|---------------------------------------|-----------|--------|-------|----------------|--------|-------|---------|
|                                       | Median    | Mean   | SD    | Median         | Mean   | SD    |         |
| <b>Objective Sleep</b>                |           |        |       |                |        |       |         |
| Sleep efficiency (%)                  | 73.37     | 74.48  | 11.63 | 85.94          | 85.61  | 6.53  | <0.001  |
| Sleep onset latency in minutes        | 4.92      | 7.05   | 6.21  | 7.57           | 8.53   | 5.88  | 0.250   |
| Wake After Sleep Onset (WASO) minutes | 105.87    | 100.52 | 44.83 | 50.57          | 56.68  | 31.19 | <0.001  |
| Number of awakenings                  | 13.36     | 12.92  | 4.76  | 9.43           | 10.32  | 5.18  | 0.047   |
| Time in bed in minutes                | 450.70    | 451.1  | 78.03 | 474.33         | 463.72 | 46.59 | 0.585   |
| Total Sleep Time (TST) minutes        | 348.49    | 338.43 | 89.42 | 396.00         | 394.78 | 39.22 | 0.010   |
| <b>Self-report</b>                    |           |        |       |                |        |       |         |
| Sleep quality                         | 2         | 1.64   | 0.76  | 1              | 0.81   | 0.51  | <0.001  |
| Sleep latency                         | 2         | 1.75   | 0.97  | 1              | 0.76   | 0.70  | <0.001  |
| Sleep duration                        | 1         | 1.33   | 0.86  | 1              | 1.24   | 0.77  | 0.704   |
| Sleep efficiency (%)                  | 81.67     | 80.26  | 15.79 | 91.67          | 89.43  | 9.87  | 0.047   |
| Sleep efficiency                      | 1         | 1.11   | 1.19  | 0              | 0.33   | 0.66  | 0.010   |
| Sleep disturbance                     | 2         | 1.58   | 0.60  | 1              | 0.91   | 0.54  | <0.001  |
| Hypnotic medication                   | 0         | 0.36   | 0.68  | 0              | 0.14   | 0.65  | 0.072   |
| Daytime dysfunction                   | 1         | 1.56   | 1.05  | 1              | 0.81   | 0.68  | 0.009   |
| Global PSQI score                     | 9.50      | 9.33   | 3.59  | 5              | 5.00   | 2.30  | <0.001  |

PSQI= Pittsburgh sleep quality index

Bold P-values indicate statistically significant. SD=standard deviation

**Table III - Correlation between itch (NRS), SCORAD, quality of life (DLQI) and sleep measure (self-report and actigraphy) in AD adult patients (n=36).**

|          |                | Self-report  |               |               |                |                  |                   |                     | Actigraphy sleep measures |                  |               |            |                  |             |        |
|----------|----------------|--------------|---------------|---------------|----------------|------------------|-------------------|---------------------|---------------------------|------------------|---------------|------------|------------------|-------------|--------|
| Variable |                | Global PSQ I | Sleep quality | Sleep latency | Sleep duration | Sleep efficiency | Sleep disturbance | Hypnotic medication | Daytime dysfunction       | Sleep efficiency | Onset latency | Awakenings | Total sleep time | Time in bed | WASO   |
| Itch NRS | r <sub>s</sub> | 0.549*       | 0.380*        | 0.415*        | 0.336*         | 0.083            | 0.363*            | 0.079               | 0.491**                   | -0.306           | 0.148         | 0.081      | -0.399*          | -0.273      | 0.215  |
|          | p-value        | 0.001        | 0.022         | 0.012         | 0.045          | 0.629            | 0.030             | 0.645               | 0.002                     | 0.070            | 0.389         | 0.639      | 0.016            | 0.107       | 0.208  |
| SCORAD   | r <sub>s</sub> | 0.539*       | 0.439*        | 0.463**       | 0.258          | 0.296            | 0.374*            | 0.018               | 0.218                     | -0.601**         | 0.296         | 0.095      | -0.604**         | -0.415*     | 0.413* |
|          | p-value        | 0.001        | 0.007         | 0.004         | 0.129          | 0.080            | 0.025             | 0.918               | 0.201                     | <0.001           | 0.080         | 0.583      | <0.001           | 0.012       | 0.012  |
| DLQI     | r <sub>s</sub> | 0.623*       | 0.322         | 0.510**       | 0.255          | 0.261            | 0.498**           | 0.144               | 0.419*                    | -0.222           | 0.234         | 0.001      | -0.357*          | -0.286      | 0.112  |
|          | p-value        | <0.001       | 0.055         | 0.001         | 0.134          | 0.124            | 0.002             | 0.401               | 0.011                     | 0.193            | 0.170         | 0.998      | 0.032            | 0.091       | 0.515  |

Abbreviations: WASO, Wake After Sleep Onset; SCORAD, SCORing Atopic Dermatitis Index; NRS= Numerical Rating Scale; PSQI= Pittsburgh Sleep Quality Index; DLQI, Dermatology Life Quality Index; \*p≤0.05, \*\*p≤0.01.

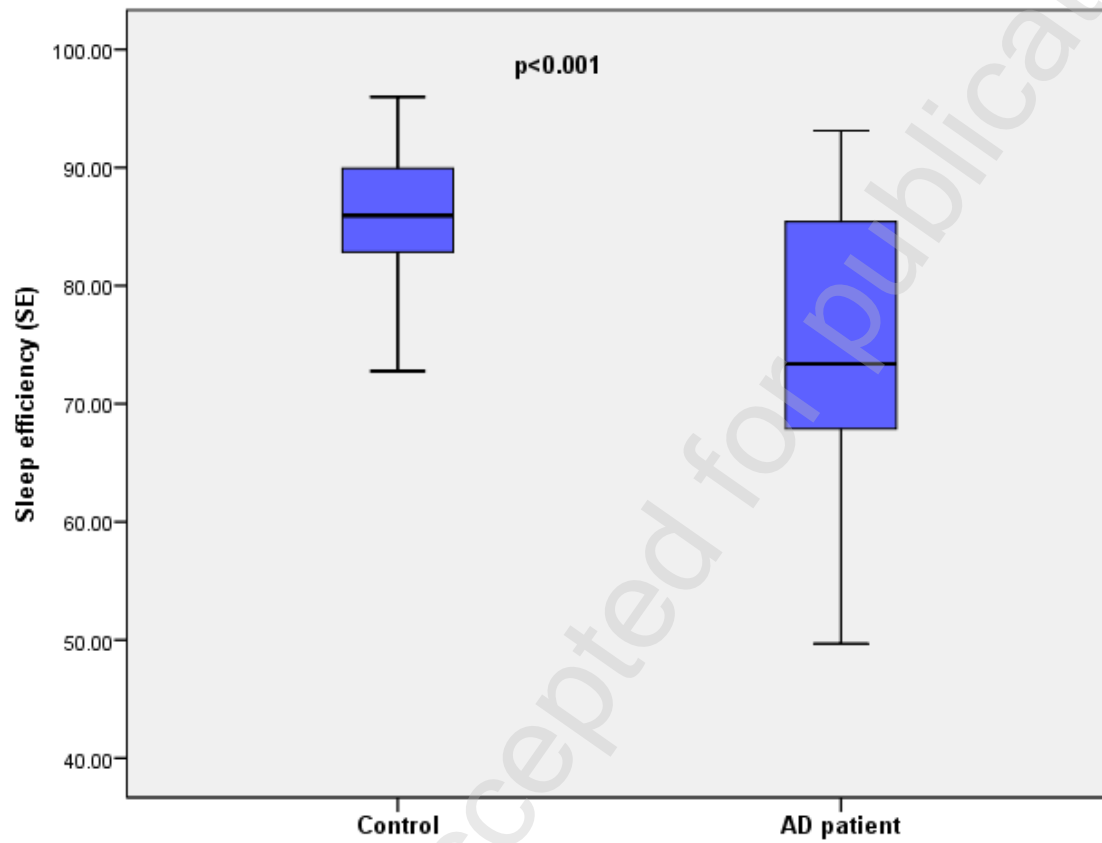
**Table IV** - Spearman correlation between Global PSQI and actigraphy sleep measures in AD adult patients (n=36).

|             |                | Actigraphy sleep measures |               |            |                  |                |       |
|-------------|----------------|---------------------------|---------------|------------|------------------|----------------|-------|
|             |                | Sleep efficiency          | Onset latency | Awakenings | Total sleep time | Time in bed    | WASO  |
| Global PSQI | r <sub>s</sub> | <b>-0.382*</b>            | 0.209         | -0.059     | <b>-0.423*</b>   | <b>-0.344*</b> | 0.135 |
|             | p value        | 0.021                     | 0.221         | 0.733      | 0.010            | 0.040          | 0.434 |
|             | n              | 36                        | 36            | 36         | 36               | 36             | 36    |

Abbreviations: WASO, Wake After Sleep Onset; PSQI, Pittsburgh Sleep Quality Index; \* $p \leq 0.05$  \*\* $p \leq 0.01$

**Figure 1** - Data collected via actigraphy: distribution of sleep efficiency (SE)

compared between AD patients and controls. SE was significantly lower in AD patients: 74.48% vs. 85.61% ( $p < 0.001$ ).



**Figure 2** - Correlation of SCORing Atopic Dermatitis (SCORAD) with objective actigraphy, sleep efficiency (SE) in AD patients. As the severity of atopic dermatitis increases, the SE decreases.

