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Sleep disturbance in psoriasis – a case-controlled study

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What's already known about this topic?

- Current knowledge on sleep disturbance in psoriasis is limited

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What does this study add?

- Case-controlled data showing that a significantly higher proportion of patients with psoriasis suffer from poor sleep compared to controls without psoriasis
- Itch is a main predictor of poor sleep in patients with psoriasis

Summary

Background

Sleep is essential for daytime functioning and health. Given the physical symptoms of psoriasis, a higher prevalence of sleep disorders could be expected. So far, the studies examining sleep disturbance in psoriasis have been of less-than-optimal methodological quality and with mixed results.

Objectives

We aimed to: 1) examine the prevalence of sleep disturbance in patients with plaque psoriasis compared to controls, 2) evaluate associations with health-related quality of life (HRQoL), and 3) examine possible disease-related predictors of disturbed sleep.

Methods

We used a cross-sectional, case-controlled design. Participants included 179 consecutively recruited patients with plaque psoriasis and 105 controls. Measures included psoriasis severity (Psoriasis Area and Severity index [PASI]); HRQoL (Dermatology Life Quality Index [DLQI]); insomnia severity (Insomnia Severity Index [ISI]); sleep quality (Pittsburgh Sleep Quality Index [PSQI]); stress (Perceived Stress Scale [PSS]); Itch (Itch Severity Scale [ISS]); and

depressive symptoms (Beck Depression Inventory [BDI]). Analyses included group comparisons and regression analyses to identify predictors of sleep disturbance.

Results

Twenty-five per cent of patients with psoriasis reported clinical insomnia (ISI > 15), compared with 10.5% of controls. In all, 53.9% of patients with psoriasis were poor sleepers (PSQI > 5), compared with 21.9% of controls. Itch was statistically significantly associated with all sleep-related outcomes.

Conclusions

A higher proportion of patients with psoriasis suffer from poor sleep than controls from the general population. Itch was the main predictor of impaired sleep. Improved control of psoriasis with decreased itch may improve sleep disturbance in psoriasis.

Introduction

Sleep is essential for daytime functioning and health and important for both psychological and physiological wellbeing.¹⁻⁵ A growing body of research indicates that chronic sleep disturbance is associated with impaired quality-of-life (QoL)⁶ and a risk factor for poorer health, e.g., depression⁷⁻⁹, cardiovascular disease^{10,11}, hypertension^{12,13}, and diabetes.¹⁴ A meta-analysis of 27 studies investigating a total of 1.3 million participants revealed that both excessive- (> 8 hrs) and insufficient (< 6 hrs) sleep was associated with an increased mortality of a considerable magnitude (Relative risk: 1.12; 95% CI 1.06 to 1.18; P < 0.01).¹⁵

Insomnia, the most common sleep disorder, is a clinical condition defined as difficulties falling asleep and/or maintaining sleep and/or poor sleep quality despite adequate opportunity for sleep resulting in significant daytime impairment.¹⁶ The annual prevalence has been estimated to be 10-20%¹⁷ with approximately half (6%) with a chronic

trajectory, i.e., persisting for more than three months.¹⁸ The development of insomnia in healthy populations has a bi-directional relationship with psychological factors such as anxiety, depressive symptoms, and stress, and may in clinical populations also be associated with physical symptoms, e.g., pain.¹⁹ The risk of insomnia appears to be higher in women, the elderly, and in persons with current or previous disease.^{20,21} Given the physical symptoms in psoriasis, e.g., itch, one would expect a higher prevalence of sleep disturbance in this patient group. However, while a growing number of studies have examined sleep disturbance in psoriasis, the results remain somewhat conflicting.^{22–24} A recent review with the aim of characterising sleep disruption in psoriasis included 32 studies.²⁵ Many of the included studies were considered to be of low methodological quality with only 14 studies using validated sleep measures. Furthermore, only 11 studies included assessment of sleep disturbances as an *a priori* objective, and only three had sleep disturbance as the primary outcome. The majority of studies reported sleep disruption to be associated with itch, negative mood, and pain. Given the importance of sleep for health and quality-of-life and the lack of high quality studies in this area, further characterisation of sleep disturbance in psoriasis is highly relevant.²⁶ More recently, Henry and colleagues reported the results of a cross-sectional, uncontrolled survey of the nature and correlates of sleep disturbance in 186 members of the psoriasis associations of Great Britain, Ireland, Canada, and New Zealand.²⁷ The authors reported that 76.3% of the participants scored above the threshold for poor sleep and that 32.5% scored positive for probable obstructive sleep apnoea. More severe psoriasis was associated higher risk of experiencing sleep apnoea and poor sleep. Taken together, cognitive arousal, itch, and depression emerged as the most robust predictors of poor sleep.

To further investigate sleep disturbance in psoriasis, we 1) examined the prevalence of sleep disturbance in patients with psoriasis attending a dermatology outpatient clinic, 2) compared the results with those of a matched group of controls from the general population, 3) evaluated the associations of sleep disturbance with health-related QoL (HRQoL) and 4) examined possible demographic and disease-related predictors of disturbed sleep.

Patients and methods

Design

The study was a cross-sectional, questionnaire-based, case-controlled study including clinical assessment of disease severity. Study approval was obtained from the Danish Data Protection Agency (int. ref. GEH-2014-037, I-Suite 03088). The subjects gave their informed consent to participate. Review by an ethics committee is not required for questionnaire-based studies in Denmark. The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.²⁸

Participants

Between June 1st 2014 and December 31st 2015, all patients with plaque psoriasis attending the outpatient clinic at the Department of Dermatology and Allergy, Herlev and Gentofte Hospital, University of Copenhagen, were consecutively invited to participate in study. After completed recruitment of patients with psoriasis, the Danish Health Data Authority provided an age- and gender matched sample (n=600) from the general population, who were invited to participate via mail.

Measures

Psoriasis severity was assessed by department dermatologists with the Psoriasis Area and Severity Index (PASI).²⁹ The majority of patients had moderate-to-severe psoriasis (pre-treatment) and received systemic treatment.

Dermatology-specific Health-Related Quality-of-Life (HRQoL) was assessed with the Dermatology Life Quality Index (DLQI).³⁰ The DLQI has been shown to be reliable and valid in Danish dermatology patients.³¹ Internal consistency (Cronbach's Alpha) was 0.91 in the present sample of patients with psoriasis.

Insomnia severity was measured with the Insomnia Severity Index (ISI).³² The ISI consists of 7 questions concerning the perceived impact of sleep disturbance on the individual during the preceding two weeks. The total score ranges from 0-28. A score < 7 is normal; 8-14 subclinical insomnia; 15-21 clinical insomnia, and 22-28 indicates severe insomnia. The Danish version of the ISI showed good internal consistency ($\alpha=0.92$) in the present sample.

Sleep quality was assessed with the Pittsburgh Sleep Quality Index (PSQI).³³ The 19-item PSQI contains seven components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Items are summed to provide a global sleep quality score ranging from zero to 21, with higher scores indicating greater sleep difficulty. A score > 5 is consistent with clinically significant sleep difficulty. The PSQI has shown acceptable reliability in Danish samples.²¹ Internal consistency was acceptable ($\alpha=0.73$) in the present sample.

Stress was measured with the Perceived Stress Scale (PSS)³⁴, which assesses the impact of perceived stress using 10 questions on a Likert scale from zero to four. The total score ranges from zero to 40. There are no cut-off values for stress versus no stress. A

validated Danish version is available.³⁵ Internal consistency in the present sample was acceptable ($\alpha=0.83$).

Itch was measured with the Itch Severity Scale (ISS).³⁶ The ISS consists of seven questions that measure the severity of itch and the effect to which the quality of life is affected. The total score ranges from zero to 21. The ISS has been validated in Danish dermatology patients showing good internal consistency ($\alpha=0.88$).³⁷ Internal consistency in the present sample was lower, but acceptable ($\alpha=0.71$).

Depressive symptoms were measured with the Beck Depression Inventory (BDI).³⁸ The BDI consists of 21 questions with scores ranging between zero and three with a total score of zero to 63. A score between zero and 13 equals minimal depression; 14-19 mild depression; 20-28 moderate depression, and 29-63 indicates severe depression. The BDI has previously shown good internal consistency ($\alpha=0.88$) in Danish dermatology patients.³⁹ Internal consistency in the present sample was 0.92.

The questionnaire package for patients with psoriasis included 87 items. The questionnaire package for controls omitted the dermatology-specific questionnaires of DLQI and ISS, resulting in a total of 46 items. The questionnaires were completed online, using Qualtrics© software (Qualtrics, Provo, Utah). The patients completed the questionnaires during their visit at the hospital while the controls completed the questionnaires on-line in their own homes.

Statistics

We compared demographic, clinical and psychological characteristics and sleep outcomes of psoriasis patients and controls with Chi² tests and t-tests for independent samples as appropriate. Bootstrapping (10,000 samples) was used to estimate the confidence intervals

when comparing mean sleep outcomes of psoriasis patients and controls. In case of group differences, sensitivity analyses were conducted with multiple linear regressions. The possible predictors of clinical insomnia severity ($ISI \geq 15$), global sleep quality (PSQI total scores), and the PSQI components of total sleep time (TST), sleep onset latency (SOL), and sleep efficiency (SE) in psoriasis patients were then analysed with hierarchical multiple logistic ($ISI \geq 15$ vs $ISI < 15$) and linear regression (PSQI and PSQI components as continuous variables). The demographic, clinical and psychological variables were entered in separate steps to reduce the risk of overfitting. At the first step, age, sex, and marital status were entered. At the second step, the clinical variables of BMI, psoriasis duration, PASI, psoriatic arthritis, systemic treatment, DLQI, and itch (ISS, omitting the itch-related sleep disturbance item) were entered while adjusting for statistically significant variables from step 1. Here, a less conservative significance level of 10% was applied to reduce the risk of underfitting. At the third step, the psychological variables of cognitive-affective depressive symptoms (BDI), somatic depressive symptoms (BDI), and perceived stress (PSS-10) were entered, together with all statistically significant variables ($p < 0.10$) from the previous steps. In the final model, we chose a significance level of 5% and entered all significant variables at the last step.

Results

Sample characteristics

Consecutive patients with psoriasis were invited and 179 patients (35.8% women, age: 18 – 82 years) accepted the invitation. A total of 105 out of 600 healthy men and women (17.5%) from the general population returned the mail-out questionnaire (See Table 1).

The majority of patients were married or partnered (64.8 %), the mean duration of psoriasis was 22.3 years, and the mean body mass index (BMI) was 28.9 kg/m^2 . Mean PASI

and DLQI scores were 5.8 and 7.7, respectively, indicating that the cohort of patients consisted of newly-referred patients with severe psoriasis and well-controlled patients. In general, men were more severely affected than women. A total of 128 patients (71.5%) received systemic treatment. Twenty-eight (15.7 %) patients had a BDI score ≥ 17 , suggestive of clinical depression. Women with psoriasis scored statistically significantly higher than men on depressive symptoms and perceived stress (PSS-10), and approximately twice as many women than men showed indications of clinical levels of depression.

As seen in Table 1, the participants in the control group were on average approximately six years older than the patients, and the men in the control group were older than the women. No controls reported skin disease or physical sleep conditions. A total of 35 controls reported other chronic illnesses or symptoms, e.g., diabetes, hay-fever, epilepsy, or high blood pressure. None of these were considered to have a major impact on sleep quality and no statistically significant differences were found between controls with and without self-reported chronic illness/symptoms in depressive symptoms, perceived stress or any of the sleep variables (data not shown).

Sleep outcomes

The sleep quality indicators for both groups are shown in Table 2. Patients with psoriasis reported significantly higher scores on insomnia severity (ISI) 9.3 (SD 6.9) than controls 6.4 (SD 5.2) with approximately 25% of psoriasis patients presenting scores ≥ 15 , indicating clinical insomnia, compared to 10.5% of controls. Likewise, patients with psoriasis reported statistically significantly poorer sleep quality (PSQI) than controls as further indicated by shorter total sleep time 405.3 (SD 66.8) vs 473.2 (SD 64.6), longer sleep latency 34.2 (SD 34.2) vs 19.4 (SD 18.4), and poorer sleep efficiency 85.1 (SD 12.8) vs 90.6 (SD 7.9). In all,

53.9% of patients were characterized as poor sleepers (PSQI > 5), compared to 21.9% of controls. Controls slept on average 68 minutes longer than the patients. As controls were slightly older than patients with psoriasis (see Table 1) and differed in educational level and occupational status (data not shown), we conducted sensitivity analyses examining the influence of group (psoriasis vs control) on insomnia severity (ISI) and sleep quality (PSQI) when adjusting for age, sex, educational level, and occupational status with multiple linear regressions. In both analyses, group remained statistically significant (Beta: 0.20 (P=0.001) and 0.32 (P<0.0001)), whereas none of the covariates reached statistical significance (no further data shown).

Predictors of sleep outcomes

The differences between poor sleepers (PSQI global scores > 5) and normal sleepers (≤ 5) in percentage scores of itch (ISS), stress (PSS), dermatology-related quality of life impairment (DLQI), depressive symptoms (BDI), and psoriasis severity (PASI) are shown in Figure 1.

Scores for itch, stress, DLQI, and depression were significantly higher in poor sleepers compared to normal sleepers while there was no difference in PASI between the poor- and normal sleepers. The results of the full model for ISI is shown in Table 3, and the results of the final models for PSQI global scores, TST, SOL, and SE are shown in Table 4. As seen in tables 3-4, itch (ISS) remained a statistically significant predictor across all five sleep-related outcomes examined, with higher scores on the ISS predicting higher levels of insomnia and poorer sleep quality. More cognitive-affective depressive symptoms were associated with poorer outcomes of global sleep quality (PSQI), sleep onset latency (SOL), and sleep efficiency (SE), and more somatic depressive symptoms were associated with insomnia severity (ISI ≥ 15) and poorer global sleep quality (PSQI). Overall psoriasis severity (PASI)

scores were only associated with longer sleep onset latency (SOL), and older age was associated with longer total sleep time.

Discussion

The consecutively recruited patients presented with moderate-to-severe psoriasis, and the majority received systemic treatment. When interpreting the PASI results, it is important to note that the majority of patients received systemic treatment while others may have just started treatment. With the exception of slightly older age (52 vs. 46 years), the control group was generally comparable to the psoriasis patient group. Approximately one quarter of patients with psoriasis reported insomnia severity (ISI) scores ≥ 15 , indicative of clinical insomnia, compared to only in ten of controls, which corresponds to the estimated prevalence in general populations.¹⁷ Furthermore, when examining the broader concept of sleep quality, more than half of the patients with psoriasis were characterized as poor sleepers (PSQI scores >5), compared with only two in ten controls, who furthermore slept on average sixty-eight minutes longer than the patients. Our results support and extend the previous findings of a high prevalence of sleep disturbance in psoriasis, e.g., the recently published uncontrolled study by Henry and colleagues²⁷, which found that 3 out of 4 people with psoriasis scored above the threshold for poor sleep on the PSQI. The somewhat higher prevalence of “poor sleepers” found by Henry and colleagues than in our study could be explained by a higher mean BMI in their study population, which is an independent predictor of sleep problems. Another explanation could be that Henry and colleagues recruited study participants through social media sites distributed by psoriasis foundations, which could make their study susceptible to self-selection bias. In contrast, we recruited patients consecutively from a hospital population of patients, who may be diagnosed more

accurately and treated more effectively than individuals with psoriasis recruited from the general population.

It should be noted that not all studies have found support for the association between psoriasis and sleep disturbance. In a small study of 35 psoriasis patients and 40 controls, Shutty and colleagues²² found that while patients with psoriasis were more likely to experience insomnia than controls, the association disappeared after adjusting for age, BMI, gender and depression. the results could be interpreted to suggest that although patients with psoriasis are more likely to suffer from disturbed sleep, sleep disturbance may be secondary to depressive symptoms, which are prevalent in psoriasis.⁴⁰ While the sample size is small, challenging the study's statistical power, the results indicate that the mechanisms mediating the relationship between psoriasis and sleep disturbance are complex.

In the present study, itch and depressive symptoms emerged as the most consistent statistical predictors of insomnia and poor sleep quality in patients with psoriasis. Itch is a prominent symptom of psoriasis observed in 70-90% of patients⁴¹ and often reported by patients as one of the most distressing symptoms of psoriasis.⁴² This is supported by both the recent study by Henry and colleagues²⁷ and a number of additional studies, which have found itch to be a significant predictor of sleep disturbance.⁴³⁻⁴⁵ Furthermore, itch may not only be an important mechanism of the association between psoriasis and sleep, but could possibly also explain the association between psoriasis and depressive symptoms. Two studies, one with 40 patients with psoriasis⁴⁶ and another with 73 patients with dermatological and nephrological disease associated with itch³⁷, found that not only was the presence of disease associated with both itch and depressive symptoms, but itch emerged as an important mediator of the association between disease and depressive symptoms.

The complexity and possible bi-directional nature of the association between psoriasis and sleep disturbance is highlighted by research showing that sleep deprivation exacerbates inflammation in an animal model of psoriasis.⁴⁷ The effect may partly be due to disturbance of the thermoregulation, which, in turn, may compromise the ability to disperse heat thereby interfering with sleep onset.⁴⁸ In one of the studies⁴⁷, sleep-deprived mice with psoriasis showed increased levels of pro-inflammatory cytokines (IL-1 β , IL-6, and IL-12) and reduced levels of anti-inflammatory IL-10. The authors concluded that sleep deprivation could change the cytokine environment resulting in excessive protease activity with detrimental effects on epidermal barrier function. Other studies have suggested that sleep deprivation increases tumour necrosis factor- α and IL-6 secretion^{49,50}, and also it has been hypothesized that sleep disorders may change metabolic- and endocrine profiles and sympathetic nervous activity.⁵¹

Compared to the available literature, our study has several strengths. First, we included a consecutively recruited sample of patients with psoriasis verified by a dermatologist thereby reducing the risk of selection bias. Second, we used questionnaires measuring both insomnia severity and the broader concept of sleep quality widely used in sleep research. Third, we recruited a control group from an age- and gender matched sample from the same geographical area of Denmark. Finally, the control group appeared to be representative of the general population with regard to prevalence of insomnia.¹⁷ Some limitations should also be noted. First, while the general population was age- and gender matched, the final control group was on average six years older than the patients with psoriasis. As insomnia generally becomes more prevalent with age⁵², we may have underestimated the difference between the groups. Second, our study used a cross-sectional design, and we therefore cannot determine the exact causal direction of the

association between psoriasis, psoriasis symptoms, and sleep disturbance. Third, as this was a relatively small-scale study, the number of participants was only just adequate for the number of variables tested. Future studies are clearly needed, including longitudinal studies of changes in psoriasis symptoms and sleep as well as interventional studies, e.g., of cognitive-behavioural therapy for insomnia⁵³, testing the effect on both sleep and psoriasis symptoms.

Taken together, our findings extend the existing research on psoriasis and sleep and support the conclusion that patients with psoriasis are at higher risk of experiencing sleep disturbance compared with healthy controls. Furthermore, our results lend support to previous findings that sleep disturbance is associated with both itch and depressive symptoms. With itch being the most consistent predictor found in our study, one could speculate that optimal disease control with state-of-the-art biological treatment may improve sleep quality in patients with psoriasis. Further studies are needed to determine if helping psoriasis patients to improve their sleep quality could reduce the systemic inflammatory burden, which, in turn, could lead to improved disease control.

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Table 1. Demographic and clinical characteristics.

	N (%)	Age (yrs)	Married or partnered	BMI	Psoriasis duration (yrs)	Psoriasis severity: PASI Total (0-72)	Psoriatic arthritis	Systemic treatme nt	QoL: DLQI Total (0-30)	Itch: ISS (0-21)	Depressive symptoms: BDI (0-63)	Depresse d: BDI ≥ 17	Perceive d stress: PSS-10
		Mean (range)	N (%)	Mean (SD)	Mean (SD)	Mean (SD)	N (%)	N(%)	Mean (SD)	Mean (SD)	Mean (SD)	N (%)	Mean (SD)
Psoriasis all	179	46.0 (18-82)	114 (64.8%)	28.9 (10.0)	22.3 (14.3)	5.8 (5.0)	14 (7.8%)	128 (71.5%)	7.7 (6.9)	6.9 (3.3)	9.1 (10.5)	28 (15.7%)	14.1 (6.9)
Psoriasis women	64 (35.8%)	44.2 (18-69)	37 (59.7%)	28.9 (14.7)	21.4 (16.5)	4.5 (3.8)	8 (12.5%)	47 (73.4%)	8.6(7.3)	6.9 (3.2)	12.0 (12.7)	15 (23.8%)	16.6 (6.6)
Psoriasis men	115 (64.2%)	46.9 (18-82)	77 (67.5%)	28.9 (6.3)	22.8 (13.0)	6.5 (5.5)	6 (5.2%)	81 (70.4%)	7.3 (6.7)	7.0 (3.5)	7.6 (8.7)	13 (11.3%)	12.8 (6.7)
p^a (sex)	-	0.270	0.324	0.970	0.554	0.004	0.083	0.684	0.233	0.896	0.016	0.028	0.001

Controls	105	52.0	76 (72.4%)	-	-	-	-	-	-	5.7 (6.0)	7 (6.7%)	11.6
all		(22-85)										(6.0)
Controls	46	48.9	32 (69.6%)	-	-	-	-	-	-	6.6 (7.1)	5	11.7
women	(43.8%)	(22-72)									(10.9%)	(6.6)
Controls	59	54.4	44 (74.6%)	-	-	-	-	-	-	5.0 (5.0)	2 (3.4%)	11.5
men	(56.2%)	(23-85)										(5.5)
p^a (sex)	-	0.042	0.569	-	-	-	-	-	-	0.211	0.127	0.823
p^a	0.150	0.001	0.187	-	-	-	-	-	-	0.001	0.026	0.002
(groups)												

a) Comparing men and women: Chi² or t-tests for independent samples. Abbreviations: BMI: Body Mass Index; PASI: Psoriasis Area and Severity Index; DLQI: Dermatology Life Quality Index; ISS: Itch Severity Scale; BDI: Beck Depression Inventory 2.ed.; c) Comparisons (Chi²) confirmed equal age distribution between psoriasis patients and controls (p = 0.999).

Table 2. Sleep quality indicators.

		ISI: Insomnia Severity Index					PSQI: Pittsburgh Sleep Quality Index				
		ISI total	No	Sub-	Clinical	Severe	Sleep quality:	Poor sleep	Total sleep	Sleep onset	Sleep
		(range: 0-28)	insomnia	clinical	insomnia	insomnia	PSQI Global	quality:	time (TST),	latency	efficiency
		(95% CI) ^b	(0-7)	Insomnia (8-14)	(15-21)	(22-28)	(range: 0-21) (95% CI) ^b	PSQI >5	min. (95%CI) ^b (h, min)	(SOL), min. (95%CI) ^b	(SE) (%) (95%CI) ^b
	N (%)	Mean (SD)	N (%)	N (%)	N (%)	N (%)	Mean (SD)	N (%)	Mean (SD)	Mean (SD)	Mean (SD)
Psoriasis	179	9.3 (6.9)	84	50	36	9	6.5 (3.5)	96 (53.9%)	405.3 (66.8)	34.3 (34.2)	85.1 (12.8)
all		(6.3 – 10.3)	(46.9%)	(27.9%)	(20.1%)	(5.0%)	(6.0 – 7.0)		(394.3 - 416.2) (6 h, 45 min)	(29.0 – 39.9)	(83.0 – 87.2)
Psoriasis	63	10.0 (6.9)	27	14	19	3	7.0 (3.6)	37 (58.7%)	406,4 (66.2)	36.3 (37.7)	81.9 (12.7)
women		(8.3 – 11.7)	(42.9%)	(22.2%)	(30.2%)	(4.8%)	(6.2 – 7.9)		(388.6 - 424.3) (6 h, 46 min)	(26.8 – 6.9)	(78.6 – 85.2)
Psoriasis	116	8.9 (7.0)	57	35	17	6	6.2 (3.4)	59 (51.3%)	404,7(67.5)	33.1 (32.1)	87.1 (12.5)

men		(7.6 – 10.2)	(49.6%)	(30.4%)	(14.8%)	(5.2%)	(5.6 – 6.8)		(390.9 - 418.8)	(26.9 – 39.9)	(84.5 – 89.5)
		(6 h, 45 min)									
p^a (sex)	-	0.321	0.104				0.156	0.342	0.493	0.384	0.019
Controls	105	6.4 (5.2)	70	24	10	1	4.2 (2.4)	23 (21.9%)	473.2 (64.6)	19.4 (18.4)	90.6 (7.9)
all		(5.5 – 7.5)	(66.7%)	(22.9%)	(9.5%)	(1.0%)	(3.8 – 4.7)		(458.4 - 487.7)	(15.6 -24.0)	(88.7 – 92.3)
		(7 h, 53 min)									
Controls	46	7.1 (6.3)	27	11	7	1	4.1 (2.2)	11 (23.9%)	484.7 (54.4)	19.3 (20.4)	91.7 (6.8)
women		(5.3 – 9.0)	(58.7%)	(23.9%)	(15.2%)	(2.2%)	(3.5 – 4.8)		(465.6 - 503.7)	(13.2-27.7)	(89.1 – 94.0)
		(8 h, 5 min)									
Controls	59	6.0 (4.2)	43	13	3	0	4.2 (2.6)	12 (20.3%)	465.3 (70.3)	19.5 (17.2)	89.9 (8.6)
men		(4.9 – 7.1)	(72.9%)	(22.0%)	(5.1%)	(0.0%)	(3.6 – 4.9)		(443.9 - 484.9)	(14.9-25.0)	(87.3 – 92.3)
		(7 h, 45 min)									
p^a (sex)	-	0.280	0.180				0.785	0.660	0.606	0.973	0.333
p^b (group)	0.150	<0.001	0.004				<0.0001	<0.0001	<0.0001	<0.0001	0.001

a) Comparing men and women: Chi² or t-tests for independent samples; b) Bootstrapping (10,000 samples); Abbreviations: ISI: Insomnia

Severity Index; PSQI: Pittsburgh Sleep Quality Index. Sleep efficiency: ((total sleep time/total time in bed)x100).

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Table 3. Predictors of clinical insomnia (ISI ≥ 15 ; n=45; 25.1 %): hierarchical, multiple logistic regression.

DV: Clinical insomnia (ISI ≥ 15)

Step	Independent variables:	B	Sign.	OR	95%CI
Step 1	Background variables				
	1.1 Age	0.00	0.929	1.00	0.98 - 1.02
	1.2 Sex (ref: women)	-0.77	0.034	0.46	0.23 – 0.94
	1.3 Marital status (ref: partnered)	0.73	0.058	2.07	0.98 – 4.38
	Nagelkerke R ² = 0.08				
Adjusted for variables 1.2 and 1.3 from step 1					
Step 2	Clinical variables				
	2.1 BMI	-0.01	0.845	1.00	0.95 - 1.03
	2.2 Psoriasis duration	-0.02	0.233	0.98	0.95 – 1.01
	2.3 PASI total	-0.01	0.956	1.00	0.91 – 1.01
	2.4 Psoriatic arthritis	0.35	0.629	1.42	0.34 – 5.90
	2.5 Systemic treatment	-0.39	0.420	0.68	0.26 – 1.75
	2.4 (6) DLQI ²	-0.03	0.456	0.97	0.91 – 1.05
	2.5 (7) ISS ³	0.27	0.001	1.30	1.12 – 1.52
Nagelkerke R ² = 0.22					
Adjusted for variables 1.2 and 2.5 from steps 1 and 2					
Step 3	Psychological variables				
	3.1 BDI Cognitive-Affective	0.03	0.550	1.03	1.01 – 1.12
	3.2 BDI Somatic	0.16	0.039	1.17	1.01 – 1.36

3.2 PSS-10 total	0.03	0.527	1.03	0.94 – 1.12
Nagelkerke R ² = 0.30				
Final model				
2.5 ISS ³	0.25	0.002	1.29	1.10 – 1.51
3.1 BDI Somatic	0.23	0.001	1.25	1.12 – 1.40
Nagelkerke R ² = 0.26				

¹⁾ Steps 2, 3, and final step: Adjusting for variables, which were significant at $p < 0.10$ at the previous step. Statistically significant findings ($p < 0.05$) are shown in **bold face**, and findings at $p < 0.10$ are shown in *italics*. ²⁾ DLQI total minus itch-related item. ³⁾ ISS minus sleep-related item (total score range: 0-18)

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Table 4. Multiple linear regression: Results of the final models for the continuous variables of PSQI global score and the PSQI components of Total Sleep time (TST), Sleep Onset Latency (SOL), and Sleep Efficiency (SE).

Variable:	PSQI Global		PSQI Total Sleep		PSQI Sleep Onset		PSQI Sleep	
			Time (TST)		Latency (SOL)		Efficiency (SE)	
	Range: 0 – 21		Minutes		Minutes		%	
	Beta	<i>p</i>	Beta	<i>p</i>	Beta	<i>p</i>	Beta	<i>p</i>
PASl total	-	-	-	-	-0.16	0.046	-	-
ISS (minus sleep item)	0.29	0.001	-0.24	0.003	0.27	0.001	-0.31	0.001
BDI Cognitive-Affective	0.26	0.003	-	-	0.32	0.001	-0.19	0.021
BDI Somatic	0.23	0.006	-	-	-	-	-	-
Sex (ref: women)	-	-	-	-	-	-	0.15	<i>0.064</i>
Age	-	-	-0.17	0.037	-	-	-	-
Marital status (ref: partner)	-	-	-	-	0.13	<i>0.060</i>	-	-
R ²	0.36		0.08		0.23		0.19	

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Figure legends.

Figure 1. Comparing percent scores on itch (ISS), stress (PSS-10), dermatology-related quality of life impairment (DLQI), depressive symptoms (BDI), and psoriasis severity (PASI) of poor sleepers and normal sleepers. *) $p < 0.05$; ***) $p < 0.001$; ns: $p > 0.05$