Received: 27 September 2022 | Revised: 21 March 2023 | Accepted: 26 April 2023

DOI: 10.1002/smi.3263

RESEARCH ARTICLE

WILEY

Psychosocial stress affects the change of mental distress under dermatological treatment—A prospective cohort study in patients with psoriasis

Gloria-Beatrice Wintermann[1] | Antonie Louise Bierling[1,2,3] | Eva M. J. Peters[4,5] | Susanne Abraham[6] | Stefan Beissert[6] | Kerstin Weidner[1]

[1]Department of Psychotherapy and Psychosomatic Medicine, Faculty of Medicine, Technische Universität Dresden, Dresden, Germany

[2]Department of Clinical Psychology, Friedrich-Schiller-Universität, Jena, Germany

[3]Institute for Materials Science, Technische Universität Dresden, Dresden, Germany

[4]Psychoneuroimmunology Laboratory, Department of Psychosomatic Medicine and Psychotherapy, Justus-Liebig University Giessen, Giessen, Germany

[5]Department of Psychosomatic Medicine and Psychotherapy, Charité Center 12 Internal Medicine and Dermatology, Charité - Universitätsmedizin Berlin, Berlin, Germany

[6]Department of Dermatology, Faculty of Medicine, Technische Universität Dresden, Dresden, Germany

Correspondence

Gloria-Beatrice Wintermann, Fetscherstr. 74, Dresden 01307, Germany.
Email: Gloria.Wintermann@uniklinikum-dresden.de

Funding information

Robert-Pfleger-Stiftung, Grant/Award Number: 060_4967

Abstract

Psoriasis is a chronic-inflammatory, immune-mediated disease leading to a state of increased systemic inflammation. Mental comorbidities often occur in the patients and may additionally affect the therapy outcome. Currently, it is unknown whether the disease severity, psychosocial stress or health-related quality of life determines the manifestation of anxiety/depression, or vice versa, in psoriasis. The interplay between these variables during the dermatological treatment of psoriasis remains to be elucidated in order to initiate appropriate psychological interventions and to identify patients at risk for comorbid anxiety/depression. In a prospective cohort study, the impact of disease severity, health-related quality of life and psychosocial stress on anxiety/depression were examined during the dermatological treatment in patients with moderate to severe psoriasis (patients with psoriasis = PSO). Patients were examined before (T1) and about 3 months after (T2) the beginning of a new treatment episode, in most cases by means of systemic therapy. Data were analysed, exploratory, using Bivariate Latent Change Score Models and mediator analyses. Assessments included patient-reported outcomes (Hospital Anxiety and Depression Scale/HADS, Perceived Stress Scale/PSS, Childhood Trauma Questionnaire/CTQ, Dermatology Life Quality Index-DLQI, Body Surface Area-BSA), at both T1 and T2. 83 PSO patients (37.3% women, median age 53.7, IQR 37.8–62.5, median BSA 18.0, IQR 9.0–40.0) with complete data of HADS and DLQI were included. In the total group, a higher anxiety/depression at T1 was associated with a lower improvement in psoriasis severity in the course of the dermatological treatment ($\gamma_{BSA} = 0.50$, $p < 0.001$). In subgroups of PSO with low/high CTQ scores, anxiety/depression at T1 had no impact on the change in psoriasis severity. Only by tendency, in CTQ subgroups, a higher psoriasis severity at T1 was linked with a higher improvement in anxiety/depression at T2 (low/high CTQ, $\gamma_{HADS} = -0.16/-0.15$, $p = 0.08$). An improvement in the health-related quality of life was positively associated with an improvement in anxiety/depression (Pearson's $r = 0.49$, $p = 0.02$). Here, the

reduction of acute psychosocial stress seems to be a decisive factor, mediating this association (β = 0.20, t [2,60] = 1.87; p = 0.07, 95% CI −0.01, 0.41). The results allude, that the initial severity of anxiety/depression may presumably have an impact on the treatment outcome in the total group. In contrast, analysing subgroups of patients with high/low childhood trauma, the impact of the initial disease severity on the course of anxiety/depression after a switch to a new dermatological treatment could not be conclusively ruled out. The latter results from the latent change score modelling should be treated cautiously because of the small sample size. A common aetiopathological mechanism for psoriasis and anxiety/depression might be assumed with impact of dermatological treatment on both. The change in perceived stress seems to play an important role in the manifestation of anxiety/depression, substantiating the need for adequate stress management in patients with increased psychosocial stress during their dermatological treatment.

KEYWORDS
anxiety, depression, latent change score modelling (LCSM), mediator analysis, psoriasis, psychosocial stress, systemic therapy

1 | INTRODUCTION

Psoriasis is a chronic-inflammatory, immune-mediated disease with typical erythematous, indurated, scaly, puritic, often painful skin plaques, affecting about 125 million people, worldwide (Korman, 2020). As underlying pathophysiology, an increased secretion of certain pro-inflammatory cytokines have been proven, leading to a state of increased systemic inflammation and risk for numerous somatic comorbidities, for example, psoriatic arthritis, cardiovascular and metabolic diseases (Bu et al., 2022; Grozdev et al., 2014; Purzycka-Bohdan et al., 2022), which in turn display independent and additional risk factors for mental comorbidities in psoriasis (Geale et al., 2020). In about every second to fifth patient, clinically relevant symptoms of anxiety and depression occur as major mental comorbidities (Dalgard et al., 2015; Pollo et al., 2021; Sondermann et al., 2021). Even though generally, a higher disease severity and pruritus go along with higher depressiveness, patients with mild psoriasis also show an increased risk (Gupta & Gupta, 2003; Pollo et al., 2021). Until now, it has not been proven whether psoriasis predisposes the evolvement of comorbid anxiety and depression or vice versa (Lukmanji et al., 2021). On the one hand, the impact of psoriasis on the activities of daily life, general psychophysical functioning and well-being may lead to mental impairments, such as increased anxiety or depression, for example, when patients feel stigmatised by others or ashamed by their appearance, suffer from pain, pruritus, sexual dysfunctions, with major impact on their physical activity and work performance (Augustin & Radtke, 2014; Homayoon et al., 2020; Jaworecka et al., 2021; Lakuta & Przybyla-Basista, 2017; Molina-Leyva et al., 2019; Nowowiejska et al., 2022; Orbai et al., 2021). On the other hand, evidence hints towards similar secretion patterns of pro-inflammatory cytokines, for example, tumour necrosis factor (TNF)-alpha (α) and a dysfunction of the serotonin metabolism in both, psoriasis and certain mental disorders such as major depression, suggesting a common aetiopathogenetic mechanism (Holsken et al., 2021; Krishnadas et al., 2016). This may be corroborated by the positive effect of TNF-α antagonists (e.g. Adalimumab) on depression symptoms (Menter et al., 2010). Moreover, it has been shown that depression may increase the risk for the evolvement of psoriasis arthritis (Lada et al., 2022; Lewinson et al., 2017).

It is well-known that the health-related quality of life, indicating the impact of a chronic skin disease on the patients´ everyday life, depends not only on the disease severity, but also on other factors, such as experiences of stigmatisation, skin shame, visibility of psoriatic lesions and mental distress (Geale et al., 2017; Heydendael et al., 2004; Homayoon et al., 2020; Pollo et al., 2021; Schmitt & Ford, 2007; Vardy et al., 2002). Patients with increased depressiveness also report a diminished health-related quality of life, even under minor psoriasis severity (Pollo et al., 2021; Schmitt & Ford, 2007). On the other hand, it is well-known that a decrease in the severity of the disease is accompanied by an improvement in the skin-related quality of life (Mattei et al., 2014).

Besides the influence of psoriasis severity on mental health outcomes in PSO, there is large evidence, that psychosocial stressors play a pivotal role in the manifestation and exacerbation of psoriasis, especially in patients with high worrying and scratching (Al' Abadie, 1994; Verhoeven et al., 2009; Zachariae et al., 2004). For instance, studies have shown a positive impact of cognitive-behavioural interventions, including stress management techniques, on the reduction of mental distress, psoriasis severity and improvement of the health-related quality of life (Fortune et al., 2004; Fortune, Richards, Kirby, et al., 2002; Nagarajan & Thappa, 2018). Moreover, evidence hints towards increased traumatic stress experiences during childhood in PSO, which may predispose them to a

chronic inflammatory state, higher diseases severity and psychological disorders (Erfanian, 2018; Sahiner et al., 2014; Simonic et al., 2010, 2013; Wintermann et al., 2022).

Currently, evidence is needed in order to better understand the bidirectional interactions between somatic and psychological factors in this so-called 'psychosomatic skin disease' like psoriasis (Sahi et al., 2020). The interplay between certain variables during the dermatological treatment of psoriasis (e.g. disease severity, mental distress, psychosocial stress) remains to be further elucidated. This is of clinical relevance in order to better understand the underlying aetiopathogenesis, identify risk patients for both psoriasis and comorbid mental disorders at an early stage, and to initiate optimal dermatological treatment and adequate, adjunct psychological interventions for patients in need and with an increased risk for comorbid anxiety and/or depressive disorders (Koo et al., 2019; Vasilakis-Scaramozza et al., 2020).

The present prospective cohort study therefore investigates: Firstly, (1) whether the improvement of the disease severity is accompanied by an improvement in anxiety and depression, and whether this depends either on the initial severity or mental distress or the extent of traumatic childhood experiences; Secondly, (2) whether the improvement in the health-related quality of life is accompanied by an improvement in anxiety/depression, and whether this depends either on the initial health-related quality of life or the initial mental distress. For these purposes, bivariate latent change score modelling was used in order to analyse individual differences regarding changes during the dermatological treatment. Lastly, (3), it is of interest whether the associations described under (1) and (2) are mediated by changes in the perceived psychosocial stress during the dermatological treatment.

2 | METHODS

The present study was conducted in accordance with the declaration of Helsinki and approved by the local Ethic Committee of the Technische Universität Dresden. All patients gave an informed consent before study participation. The study was supported with a research fund by the Robert-Pfleger-Stiftung (Fonds number: 060_4967).

2.1 | Participants and procedure

The study design and enrolment of study participants have already been published (Wintermann et al., 2022). 136 patients with psoriasis (abbreviated as PSO) were enroled during their visit at a dermatological outpatient or inpatient unit, specialised on the diagnostic and treatment of psoriasis. Both units belong to the Department of Dermatology, located at a large University hospital in Saxony, Germany. PSO had to meet the following *inclusion criteria* for study participation: diagnosis of psoriasis, planned switch to systemic therapy and/or to intensified local therapy, adequately long wash out period (at least 12 weeks, in case of a switch from one systemic to another systemic therapy), sufficient German language skills, age between 18 and 75 years, complete data with respect to Hospital Anxiety and Depression Scale (HADS) and Dermatology Life Quality Index (DLQI). *Exclusion criteria* were: refusal of study participation, inability to give informed consent (e.g. in case of mental disability or insufficient German language abilities).

Patients were asked to rate the severity of psoriasis and fill in several questionnaires concerning anxiety/depression, health-related quality of life, perceived stress, childhood trauma, among others, at two time points. The first assessment took place before the beginning of a new treatment episode (T1) (e.g. the switch to systemic therapy and/or intensified local therapy), the second assessment (T2) about 12 to 16 weeks after T1, between January 2016 and March 2020. Before the second time point, the patients were contacted via telephone call and the postal delivery of a questionnaire was announced. Patients who could not be followed up at T2 (with respect to HADS and DLQI) were defined as drop outs. Out of the originally 136 enrolled patients, a sample of 83 patients could be followed up, with complete data of both HADS and DLQI.

2.2 | Measures

A dermatologist assessed the patient's medical history, comorbidities (e.g. psoriasis arthritis) at T1, and severity of psoriasis, using the Psoriasis Area and Severity Index (PASI), at T1 and, if possible, also at T2. Since at T2 most patients were treated by an outpatient dermatologist outside our Dermatology Department, objective PASI were not accessible for these patients at T2. The patients were asked to rate the severity of psoriasis using the Body Surface Area (BSA) and subjective PASI (SAPASI) (range: 0–72), both at T1 and T2. A PASI score >10 can be evaluated as moderate to severe (Mrowietz et al., 2011). A SAPASI score between 3 and 15 was classified to be moderate (Feldman et al., 1996). At T1, the number of patients with an objective PASI were missing in six cases, at T2 in 55 cases. SAPASI values were missing in eleven cases at T2. Because of missing values, we only considered the BSA as outcome variable.

Additionally, the patients were asked to fill out several questionnaires at two time points. (1) At both T1 and T2, each patient, using a body silhouette (front and back), marked the body surface area (BSA) with skin affected by psoriatic lesions. The area of one hand corresponds to 1% of the body surface. Moderate to severe forms of psoriasis reach values higher than 10% (total range: 0%–100%; inter-rater reliability Spearman's rho = 0.98) (Mrowietz et al., 2011). The BSA was applied as patient-reported outcome instead of an evaluation by a trained evaluator because the latter was not routinely assessed by a dermatologist at our Department of Dermatology. (2) The intensity of anxiety and depression was rated using the *Hospital Anxiety and Depression Scale* (HADS) (Herrmann et al., 1995) (14 items, range: 0–3, min-max: 0–21, internal consistency Cronbach's $\alpha = 0.88$ for T1/0.91 for T2 in the present study), both at T1 and T2. (3) The perceived stress during the last month was estimated using the *Perceived Stress Scale* (PSS) (Cohen et al., 1983)

(14 items, range: 0–4, min-max: 0–56), both at T1 and T2. The internal consistency of the PSS was unsatisfactory in the present study (Cronbach's $\alpha = 0.54$ for T1/0.55 for T2). (4) The *Childhood Trauma Questionnaire* (CTQ) (Klinitzke et al., 2012) (31 items, range: 0–4, min-max: 0–96) was used in order to assess the extent of perceived childhood maltreatment (physical -, emotional -, sexual abuse, physical -, emotional neglect). A total sum score was calculated and a median-split was chosen in order to examine subgroups of PSO with low/high extent of childhood trauma. Internal consistency was good in the present study (Cronbach's $\alpha = 0.85$). (5) At both T1 and T2, the *health-related quality of life* (Dermatology Life Quality Index, DLQI) (Finlay & Khan, 1994) was used to rate the impact of psoriasis on the everyday life (10 items, range: 0–3, min-max: 0–30, internal consistency Cronbach's $\alpha = 0.90$ for T1/0.92 for T2 in the present study).

2.3 | Sample size calculation

The sample size calculation was based on the primary goal to assess psychological predictors of the therapy outcome in patients with psoriasis. For this purpose, a multiple regression analysis with up to nine regressors, a Type I error probability of 5%, a statistical power (1-β) of 80% and a small effect size Cohen's f^2 of 0.14 was assumed. According to Scharloo et al. (2000), a drop out rate of 25% was considered and resulted in a sample size of at least 74 patients. A post-hoc power analysis for the Bivariate Latent Change Score Models (BLCSM) was applied, using a R-syntax as suggested by Zhang and Liu (2018). It revealed a high power for the estimation of the β-model parameters (power > 0.96) and a low power for the estimation of the γ-model parameters (between 0.04 and 0.36).

2.4 | Statistical analyses

Only cases with complete data for HADS and DLQI were included. Patients with missing HADS/DLQI-values at follow-up (T2) were defined as drop outs. The number of missing values of the further outcome parameters (e.g. BSA, PSS, CTQ) and sociodemographic variables were outlined in the captions of the tables. Whether values were missing completely at random (MCAR) or not was analysed using MCAR tests. It could be proven that all missing values were missing completely at random (all p values > 0.05). Following, analyses were realised using incomplete cases. Categorical variables are displayed as frequencies and percentages, and non-normally distributed or ordinal data as medians and interquartile ranges. Group differences between PSO and drop outs are tested using chi-squared or Fisher's exact tests, for categorical variables, and Mann-Whitney *U*-Tests in case of non-normally distributed or ordinal data. Mean values and standard deviations were calculated for normally-distributed continuous variables. Correlations between the main outcome variables were calculated using Spearman's rho (in case of ordinal or non-normally distributed data) or Pearson's correlation coefficients (in case of continuous and normally distributed data).

Additionally, Latent Change Score Modelling (LCSM) was used in order to exploratory model the impact of psoriasis severity (BSA), health-related quality of life (DLQI) and perceived stress (PSS) on the psychopathology (HADS), at two time points. In LCSM, longitudinal data of dependent variables, for example, at T1 and T2, are modelled using an autoregressive structure (Kievit et al., 2018; McArdle, 2009; McArdle & Nesselroade, 1994). A change score between T1 and T2 (Δ T2-T1) was calculated, which can be regarded as residuum of the perfect correlation between both measurement time points (Newsom, 2015). For BSA/DLQI/PSS/HADS, a change score between the two time points (ΔT2-T1) was modelled as latent variable by the dependent variable at T1, with a factor loading of 1. A regression parameter β was added to the change score, which allows investigating whether the degree of change depends on the respective scores at T1. Of interest was to determine, whether there was a reliable average change from T1 to T2; estimate the variance in the change factor σ^2 ΔT2-T1 (respectively to determine to what extent individuals differ in the change they manifest over time); specify either a covariance or an autoregressive parameter β which determines to what extent change is dependent on, or proportional to the scores at T1 (Kievit et al., 2018).

In a bivariate LCS model, the following was considered: the impact of psoriasis severity (BSA) and health-related quality of life (DLQI) at T1 on the change score of anxiety/depression (ΔHADS), and vice versa, and the impact of anxiety/depression (HADS) at T1, on the change score of psoriasis severity (ΔBSA)/health-related quality of life (ΔDLQI). In another bivariate LCS model, the following was considered: the impact of perceived stress (PSS) at T1 on the course of HADS (ΔHADS), and vice versa, and the HADS at T1 and its impact on the course of perceived stress (ΔPSS) from T1 to T2. Bivariate LCS modelling was realised using the R package lavaan and adapted R-scripts, based on the tutorial by Kievit et al. (2018) (https://osf.io/4bpmq/, visited 20th of March 2023).

Mediator analyses were conducted, regarding the association between the health-related quality of life (ΔDLQI) and anxiety/depression (ΔHADS), controlling for the change in perceived psychosocial stress from T1 to T2 (ΔPSS). For this purpose, the macro model Process, version 4.0 by Hayes (2018) (https://www.processmacro.org/download.html, visited 20th of March 2023) with bootstrapping (n = 5000 bootstrap samples) and a heteroscedasticity-consistent inference were applied.

p-values were adapted for multiple testing using Bonferroni-corrected *p*-values (*p*/number of statistical tests), where appropriate. Otherwise, results were considered significant at $p \leq 0.05$ as significance level.

3 | RESULTS

Patients with psoriasis (PSO), included in the present study, showed significantly higher HADS total, HADS anxiety subscores ($U = 1504.500$, $p = 0.008$/$U = 1514.000$, $p = 0.009$) and a lower health-related quality of life ($U = 1440.000$, $p = 0.003$), than dropped

out patients. Compared with the final sample, significantly more dropped out patients were smokers (χ^2 = 4.478, p = 0.034). With respect to the other main study characteristics, there were no significant differences between both groups (Table 1, Supporting Information Table S1). Of the PSO, 70 patients had a psoriasis vulgaris (International Classification of Diseases: L40.0), one patient psoriasis pustulosa generalista (L40.1), six patients psoriasis pustulosa palmoplantaris/plantaris (L40.3), four patients had both psoriasis vulgaris and psoriasis pustulosa palmoplantaris, two patients had psoriasis guttata (L40.4). About every third to fourth patient (n = 23, 27.7%) had a comorbid psoriasis arthritis (Supporting Information Table S1).

Concerning the dermatological treatment, 34 (41.0%) patients were treated with conventional systemic therapy (e.g. with methotrexate, cyclosporine, Acitretin, Apremilast) with/without intensified local therapy or phototherapy; 56 patients (67.5%) received treatment with a biologic (e.g. IL-17-/IL-23/TNF-α inhibitor) with/without intensified local therapy and 10 patients (12.0%) intensified local therapy with/without phototherapy.

During the course of the dermatological treatment, median severity of psoriasis, as rated using the BSA, was 18.0 (IQR 9.0–40.0) at T1 and 5.0 (IQR 2.0–10.0) at T2 (BSA: Z = −6.480, p < 0.001). At T1, the objective PASI score of 13.8 (IQR 10.4–20.1) confirmed the moderate to severe intensity of psoriasis in 50% of the patients. According to the SAPASI, a median score of 15.6 (IQR 7.4–24.2) hinted towards a severe intensity of psoriasis. While at T1, 54 (67.5%) patients displayed severe psoriasis as measured by the BSA, this rate significantly reduced at T2 to 23 (27.7%) patients (McNemar χ^2 = 21.951, p < 0.001). The PSS, perceived stress (Z = −2.279, p = 0.023), and DLQI, health-related quality of life (Z = −6.229, p < 0.001), also significantly decreased from T1 to T2. HADS anxiety/depression did not change significantly (Z = −0.467, p = 0.641).

At T1 (but not at T2), anxiety and depression were negatively correlated with the BSA (T1/T2: Spearman's rho = −0.265/0.142, p = 0.018/0.200, not significant at Bonferroni-corrected p-value of 0.01). At both T1 and T2, anxiety/depression was positively correlated with DLQI (T1/T2: Spearman's rho = 0.351/0.328, $p \leq$ 0.001/0.002, significant at Bonferroni-corrected p-value of 0.01) and PSS (T1/T2: Spearman's rho = 0.639/0.720, p < 0.001/0.001, significant at Bonferroni-corrected p-value of 0.01).

3.1 | Exploratory results from the latent change score model

3.1.1 | Interaction between psoriasis severity and anxiety/depression

For the latent change score models, we were able to prove that higher HADS initial values at T1 were associated with a lower change in the BSA at T2 (higher ΔT2-T1) (γBSA = 0.50, p < 0.001). Other parameters were not significant or could not be estimated because of low model fit. The model showed unsatisfactory model fit indices (χ^2 = 60.86, df = 6, p < 0.001, CFI = 0.66, TLI = 0.15, NNFI = 0.15, RMSEA = 0.33 [0.26, 0.41], SRMR = 0.21, AIC = 3265, BIC = 3316) (see Supporting Information Figure S1). Splitting the model into two patient groups with low/high CTQ values, psoriasis severity at T1 and improvement of anxiety/depression (lower ΔT2-T1) under dermatological treatment were only associated by tendency (low CTQ: γHADS = −0.16, p = 0.08, high CTQ: γHADS = −0.15, p = 0.08). Higher initial values for anxiety/depression (HADS T1) went along with a higher improvement of anxiety/depression (lower ΔT2-T1) under dermatological treatment, in both CTQ subgroups (low CTQ: βHADS = −0.62, p < 0.001, high CTQ: βHADS = −0.46, p < 0.001). There was no impact of initial HADS on the change of psoriasis severity in both subgroups (see Figure 1a,b). The model showed satisfactory model fit indices (χ^2 = 1.68, df = 3, p = 0.64; CFI = 1.000, TLI = 1.15, NNFI = 1.14, RMSEA = 0.00 [0.00, 0.11], SRMR = 0.03, AIC = 2605.51, BIC = 2665.99).

3.1.2 | Interaction between anxiety/depression and health-related quality of life

Higher DLQI initial values at T1 were associated with a higher change in the DLQI at T2 (higher ΔT2-T1) (βBSA = −0.62, p < 0.001). This could be also observed in the psychological outcome parameter HADS (βHADS = −0.61, p < 0.001). The initial health-related quality of life had no significant impact on the course of the psychological outcome parameter (γHADS = 0.12, p = 0.42). Vice versa, anxiety/depression (HADS) at T1 (baseline) had no impact on the course of the health-related quality of life (γDLQI = −0.22, p = 0.59) (see Figure 2). The model showed good model fit parameters (χ^2 = 10.71, df = 6, p = 0.10; CFI = 0.97, TLI = 0.94, NNFI = 0.94, RMSEA = 0.10 [0.00, 0.19], SRMR = 0.04, AIC = 2608, BIC = 2659).

3.1.3 | Interaction between anxiety/depression and perceived psychosocial stress

Higher initial PSS values at T1 were associated with a higher change (decrease) in the PSS at T2 (βPSS = −0.51, p ⟨ 0.001). This could be also observed in the psychological outcome parameter HADS (βHADS = −0.71, p < 0.001) (see Figure 3). The initial perceived stress level did not go along with a change of anxiety/depression (γHADS = 0.26, p = 0.23). Similarly, anxiety/depression at T1 had no impact on the change of perceived stress under the dermatological treatment (γPSS = 0.14, p = 0.51). A change in the perceived stress level over the dermatological treatment period was accompanied by a significant change in anxiety/depression (r = 0.80, p < 0.001). The model showed a good overall fit to the data (χ^2 = 8.81, df = 6, p = 0.18; CFI = 0.99, TLI = 0.98, NNFI = 0.98, RMSEA = 0.08 [0.00, 0.17], SRMR = 0.04, AIC = 2630, BIC = 2681).

TABLE 1 Characteristics of the sample of patients with psoriasis (PSO) and dropped out patients (not followed-up at T2).

	PSO (included) $n = 83$	Drop outs $n = 53$	$t/H/U/\chi^2$ (p)
Sociodemographic variables			
Men, *n* (%)	52 (62.7)	31 (58.5)	$\chi^2 = 0.235$ (0.628)
Women, *n* (%)	31 (37.3)	22 (41.5)	
Age, years, median (IQR)	53.7 (37.8–62.5)	51.4 (35.3–61.2)	$U = 2073.000$ (0.572)
Family status, *n* (%)[a]			
Single	15 (18.1)	14 (28.0)	$\chi^2 = 2.418$
Married	36 (43.4)	22 (44.0)	(0.298)
Cohabited	32 (38.6)	14 (28.0)	
Education, *n* (%)[b]			
<10 years	13 (15.7)	7 (16.3)	$\chi^2 = 2.823$ (0.244)
=10 years	52 (62.7)	21 (48.8)	
>10 years	18 (21.7)	15 (34.9)	
Medical variables			
BSA (T1)[c]/BSA (T2)[c], median (IQR)	18.0 (9.0–40.0)/5.0 (2.0–10.0)	21.0 (11.0–47.5)	$U = 1798.000$ (0.431)
PASI (T1)[d]/PASI (T2)[d], median (IQR)	13.8 (10.4–20.1)/3.3 (1.4–7.1)	13.9 (8.4–21.1)	$U = 1759.500$ (0.797)
SAPASI (T1)[e]/SAPASI (T2)[e], median (IQR)	15.6 (7.4–24.2)/2.4 (0.8–6.6)	15.2 (10.2–30.7)	$U = 1537.000$ (0.573) (T1)
Number of body areas affected, median (IQR)[f]	9.0 (6.0–11.0)	9.0 (5.0–12.0)	$U = 1962.000$ (0.712)
Body areas affected, *n* (%)[g]			
Head	46 (55.4)	29 (56.9)	$\chi^2 = 0.002$ (0.968)
Hands	49 (59.0)	29 (55.8)	0.140 (0.708)
Arms	62 (74.7)	42 (82.4)	0.666 (0.414)
Legs	69 (83.1)	43 (84.3)	0.004 (0.947)
Genital region	31 (37.3)	28 (54.9)	3.323 (0.068)
Duration of psoriasis (years), median (IQR)[h]	18.0 (6.7–27.2)	16.1 (3.6–25.2)	$U = 1962.000$ (0.376)
Onset of psoriasis (age), mean (SD)[h]	30.6 (15.0)	32.0 (15.1)	$T = 0.544$ (0.587)
Regular sport, yes, *n* (%)[i]	22 (26.5)	15 (30.0)	$\chi^2 = 0.338$ (0.561)
Smokers, *n* (%)[j]	22 (26.5)	21 (42.0)	$\chi^2 = 4.478$ (**0.034**)
Number of cigarettes/day (mean, SD)[k]	12.3 (5.7)	11.5 (4.9)	$T = -0.486$ (0.630)
Regular alcohol, yes, *n* (%)[l]	39 (47.0)	26 (52.0)	$\chi^2 = 0.455$ (0.500)
Body Mass Index, BMI (kg/m^2), mean (SD)[m]	28.1 (5.8)	29.0 (6.6)	$T = 0.877$ (0.382)
Psychopathological variables			
HADS total, (T1)/HADS total (T2), median (IQR)[n]	10.0 (5.0–15.0)/10.0 (5.0–14.0)	14.0 (9.8–16.0)	$U = 1504.500$ (**0.008**)
HADS anxiety (T1)/HADS anxiety (T2), median (IQR)[n]	5.0 (2.0–8.0)/6.0 (3.0–8.0)	6.0 (4.8–9.0)	$U = 1514.000$ (**0.009**)
HADS depression (T1)/HADS depression (T2), median (IQR)[n]	5.0 (2.0–8.0)/4.0 (1.0–7.0)	6.5 (4.0–9.0)	$U = 1661.000$ (0.054)
PSS (T1)[n]/PSS (T2), median (IQR)[o]	30.0 (25.0–34.0)/27.0 (21.3–32.0)	33.0 (26.5–38.0)	$U = 1169.500$ (0.075)

TABLE 1 (Continued)

	PSO (included) $n = 83$	Drop outs $n = 53$	$t/H/U/\chi^2$ (p)
CTQ total, median (IQR)[p]	15.5 (12.0, 23.8)	18.0 (13.0–26.0)	$U = 1445.000$ (0.179)
DLQI (T1)/DLQI (T2), median (IQR)[q]	7.0 (3.0–13.0)/2.0 (0.0–5.0)	13.0 (7.0–16.3)	$U = 1440.000$ (**0.003**)

Note: Categorical data are given as n and percentage of total numbers, continuous data as median and interquartile range (IQR) (in case of ordinal or non-normally distributed data) or mean and standard deviation (SD) (in case of normally distributed data). For HADS total and subscales: significance at Bonferroni-corrected level $p \leq 0.02$; otherwise significance at $p \leq 0.05$.

Abbreviations: DLQI, Dermatology Life Quality Index; HADS, Hospital Anxiety Depression Scale; IQR, Interquartile Range; PSS, Perceived Stress Scale; SD, Standard Deviation.

Number of missing values

[a]Drop Outs: $n = 3$

[b]Drop Outs: $n = 10$

[c]T1:Drop Outs: $n = 4$, included: $n = 3$; T2: Drop Outs: $n = 51$

[d]T1: Drop Outs/included: $n = 6$, T2: Drop Outs: $n = 51$, included: $n = 55$

[e]T1: Drop Outs: $n = 12$, included: $n = 3$, T2: Drop Outs: $n = 52$, Included: $n = 11$

[f]Drop Outs: $n = 2$, included: $n = 3$

[g]Drop Outs: $n \leq 3$, included: $n = 1$

[h]Drop Outs: $n = 1$

[i]Drop Outs: $n = 5$

[j]Drop Outs = 6

[k]Drop Outs/included: $n = 1$

[l]Drop Outs: $n = 4$

[m]Drop Outs: $n = 6$

[n]T1: Drop Outs: $n = 3$; T2: Drop Outs: $n = 44$

[o]T1: Drop Outs: $n = 8$, included: $n = 18$, T2: Drop Outs: $n = 44$, included: $n = 3$

[p]Drop Outs: $n = 6$; included: $n = 11$

[q]T1: Drop Outs: $n = 3$, T2: Drop Outs: $n = 44$

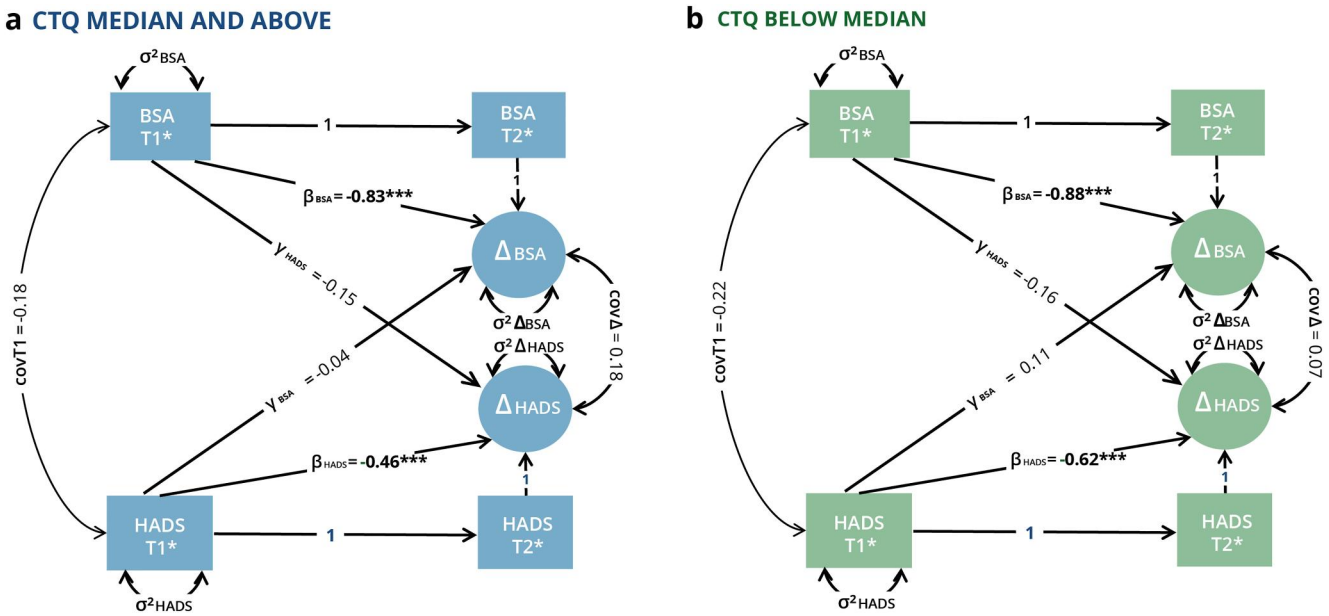

FIGURE 1 ((a) and (b)) Latent Change Score Model, taking into consideration baseline values for BSA (Body Surface Area) and anxiety/depression (HADS) in two subgroups of patients with CTQ values at CTQ median and above (subgroup 1, Figure 1a) and CTQ values below CTQ median (subgroup 2, Figure 2b). BSA, Body Surface Area, CTQ, Childhood Trauma Questionnaire, HADS, Hospital Anxiety and Depression Scale, $^*p \leq 0.05$, $^{***}p \leq 0.001$; Model fit indices: $\chi^2 = 1.68$, df = 3, $p = 0.64$, CFI (Comparative Fit Index) = 1.000, TLI (Tucker-Lewis-index) = 1.15, NNFI (Non-Normed Fit Index) = 1.14, RMSEA (Root Mean Square Error of Approximation) = 0.00 (0.00, 0.11), SRMR (Standardised Root Mean Square Residual) = 0.03, AIC (Akaike Information Criterion) = 2605.51, BIC (Bayesian Information Criterion) = 2665.99.

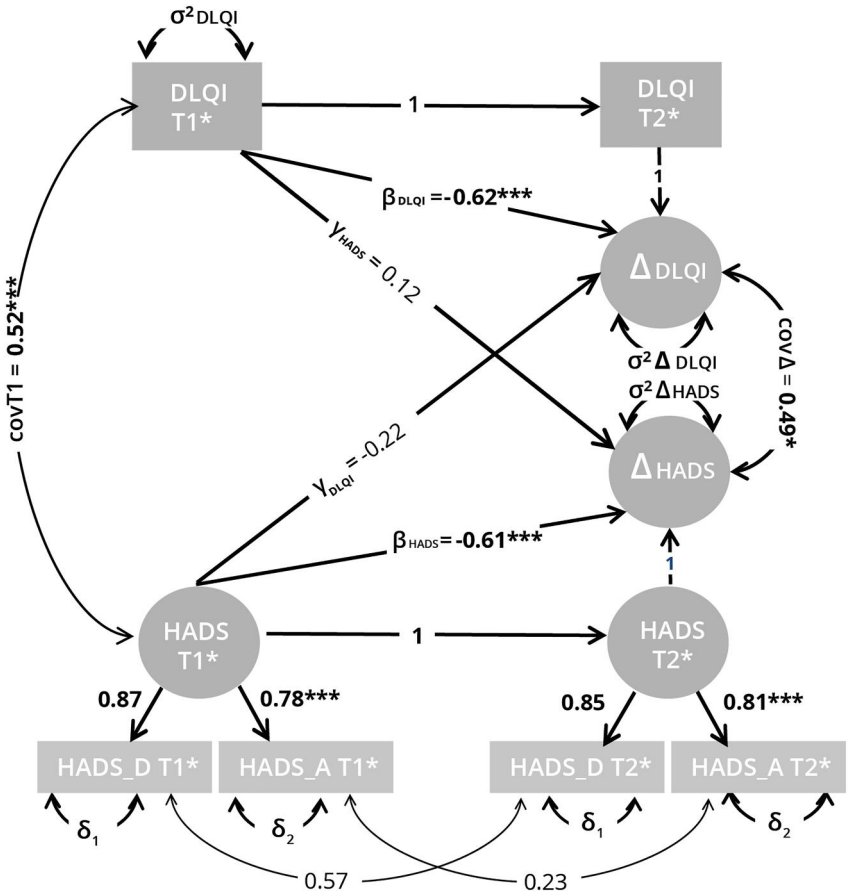

FIGURE 2 Latent Change Score Model, taking into consideration baseline values for health-related quality of life (DLQI) and anxiety/depression (HADS). DLQI, health-related quality of life, HADS, Hospital Anxiety and Depression Scale, $^{*}p \leq 0.05$, $^{***}p \leq 0.001$; Model fit indices: $\chi^2 = 10.71$, df = 6, $p = 0.10$, CFI (Comparative Fit Index) = 0.97, TLI (Tucker-Lewis-index) = 0.94, NNFI = 0.94, RMSEA (Root Mean Square Error of Approximation) = 0.10 (0.00, 0.19), SRMR (Standardised Root Mean Square Residual) = 0.04, AIC (Akaike Information Criterion) = 2608, BIC (Bayesian Information Criterion) = 2659.

3.1.4 | Mediator analysis

In order to test whether changes in the perceived stress mediate the relationship between the course of health-related quality of life and anxiety/depression during the dermatological treatment, mediation analyses were used (Hayes, 2018). A higher ΔDLQI was associated with higher ΔHADS ($\beta = 0.39$, t [1,61] = 2.82; $p = 0.007$, 95% 0.11, 0.66) and ΔPSS ($\beta = 0.33$, t [1,61] = 2.80; $p = 0.007$, 95% CI 0.09, 0.56). ΔPSS was significantly related to ΔHADS ($\beta = 0.58$, t [2,60] = 6.03; $p < 0.001$, 95% CI 0.38, 0.77). After controlling for ΔPSS, the relationship between ΔDLQI and ΔHADS was reduced to ($\beta = 0.20$, t [2,60] = 1.87, $p = 0.07$, 95% CI −0.01, 0.41), indicating full mediation. The mediation effect was statistically significant according to the Sobel test: $Z = 2.48$; $p = 0.01$ and Aroian test: $Z = 2.46$, $p = 0.01$, indicating that the effect of the health-related quality of life was accounted for by the perceived psychosocial stress. 43.5% of the variance in anxiety/depression could be explained (F [2, 60] = 19.76, $p < 0.001$) (see Figure 4).

When the reversed model was tested (impact of ΔHADS on ΔDLQI, controlling for ΔPSS), the Sobel test/Aroian test ($Z = 0.92$/ $Z = 0.91$, $p = 0.36$/$p = 0.36$) did not reach statistical significance and only 16.4% of the model was explained (F [2, 60] = 5.64, $p = 0.006$). No mediation effects for the other models (impact of ΔBSA on ΔHADS/ΔDLQI) were tested, since ΔBSA and ΔPSS were not significantly associated.

4 | DISCUSSION

In order to better understand the interaction of psoriasis severity, the health-related quality of life with anxiety and depression, we examined these outcome parameters before and after the switch to a new treatment episode in patients with psoriasis (PSO). Of utmost interest was to determine to what extent psychosocial stress is a mediator between these interactions. Up until now, it remains unclear whether mental distress such as clinically relevant anxiety/depression increases the risk for psoriasis as major agent or, vice versa, psoriasis increases the risk for anxiety/depression. In order to unravel this research question, a longitudinal study design and appropriate statistical methods taking into consideration the initial values at T1 regarding its impact on the change scores, for example, using latent change score models, were applied.

The results allude, that initial anxiety/depression may presumably have an impact on the improvement of psoriasis severity in the total group. In the present study we found a negative impact of the initial anxiety and depression at T1 on the course of the psoriasis severity during the dermatological treatment. This finding may be attributed to the fact that patients with higher anxiety and depression showed less severe psoriatic skin lesions and thus, had less chance for improvement of the skin disease. This present finding has to be treated cautiously, because model fit parameters turned out to be insufficient. One may assume that patients with higher anxiety/depression,

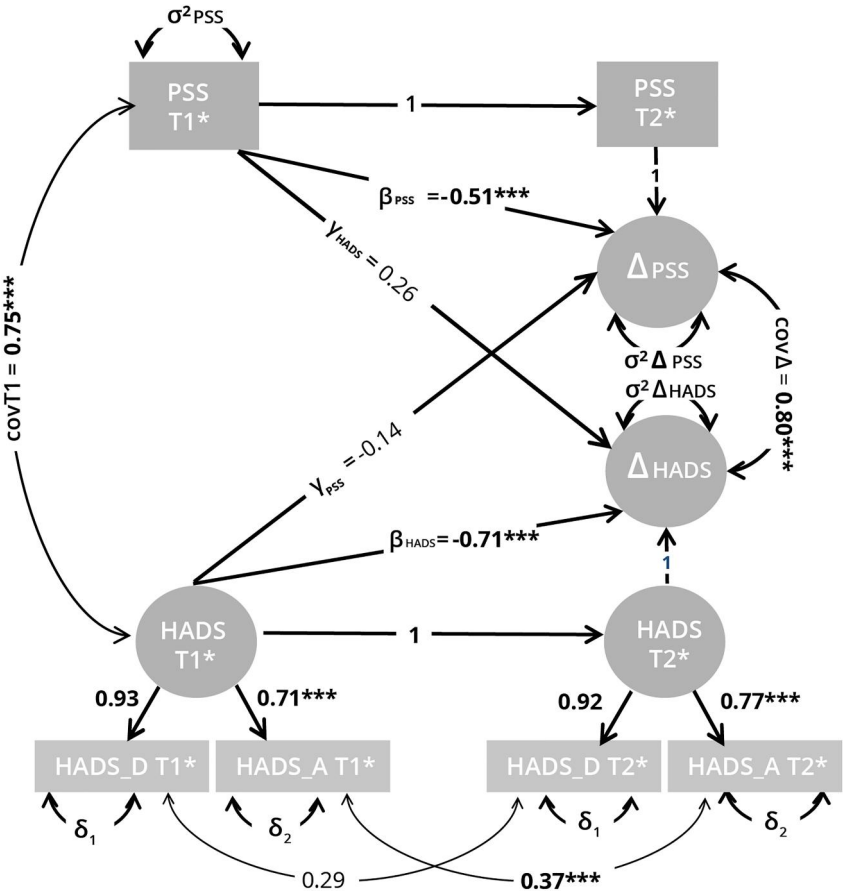

FIGURE 3 Latent Change Score Model, taking into consideration baseline values for perceived psychosocial stress (PSS) and anxiety/depression (HADS). BSA, Body Surface Area, HADS, Hospital Anxiety and Depression Scale, PSS, Perceived Social Stress, $^{*}p \leq 0.05$; Model fit indices: $\chi^2 = 8.81$, df = 6, $p = 0.18$, CFI (Comparative Fit Index) = 0.99, TLI (Tucker-Lewis-index) = 0.98, NNFI (Non-Normed Fit Index) = 0.98, RMSEA (Root Mean Square Error of Approximation) = 0.08 (0.00, 0.17), SRMR (Standardised Root Mean Square Residual) = 0.04, AIC (Akaike Information Criterion) = 2630, BIC (Bayesian Information Criterion) = 2681.

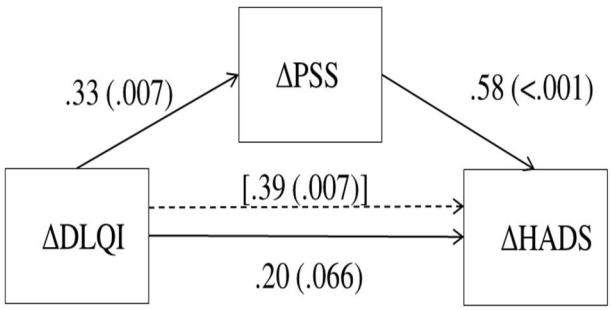

FIGURE 4 Impact of perceived stress (ΔPSS) as a mediator between the change of health-related quality of life (ΔDLQI) and change of anxiety/depression (ΔHADS) ($N = 63$). Direct effect (c′ path) in brackets.

even with a less severe psoriasis, are more worried and seek medical help more often than patients with lower anxiety and depression. This is in line with the evidence, that patients with more severe psoriasis were less likely to be depressed, and vice versa (Pollo et al., 2021; Schmitt & Ford, 2007). Accordingly, the latter finding underlines, that not the severity of psoriasis determines the extent of anxiety and depression, but the perceived disability and distress in everyday life (Schmitt & Ford, 2007). Also in line are findings showing no consistent correlation between increased psoriasis severity and decreased health-related quality of life (Heydendael et al., 2004; Homayoon et al., 2020; Vardy et al., 2002). These findings emphasise that even a mild psoriasis can be accompanied by a significant subjective distress and that considering the health-related quality of life as a primary outcome parameter would be more beneficial for determining the psoriasis severity than the mere use of the body surface affected (Bhosle et al., 2006). Finally, one may conclude that the assessment of psoriasis severity should include both clinical and psychological measures (Joseph et al., 2021). Following, the combined use of DLQI and BSA or PASI would be more beneficial for determining psoriasis severity than the use of BSA or PASI, alone. This way, the impact of psoriasis on the perceived stigmatisation by others and thus, on psychological measures like anxiety and depression may be better evaluated and understood.

On the other side, investigating subgroups of patients with low/high childhood trauma experiences, showed a tendency towards a negative association between psoriasis severity before the beginning of a new dermatological treatment episode and improvement of anxiety and depression under the new dermatological treatment. This finding alludes a mechanistic and functional link between pathophysiological processes, presumably certain inflammatory cytokine and neurotransmitter concentrations. At least in the patients with higher initial psoriasis severity, the modulation of pro-inflammatory cytokines via systemic therapies (e.g. IL-17A-, TNF-α blockers) may also lead to an improvement of psychological symptoms. In line, a former study has proven correlations between TNF-α and the 5-HTT

serotonin transporter availability in neurologically healthy women and patients with psoriasis and psoriasis arthritis (Krishnadas et al., 2016). Thus, one may cautiously conclude that, at least in the present sample of patients with moderate to severe psoriasis, pro-inflammatory processes underlying the psoriasis may also lead to psychological symptoms like anxiety and depression. Studies in mice could also confirm the association between IL-17A and depression-like behaviour via NFκB signalling and its modulation by anti-IL17A antibodies (Nadeem et al., 2017).

Furthermore, we found that the extent of psychosocial stress perception did not correlate with psoriasis severity, but rather with decreased health-related quality of life and increased anxiety and depression (O'Leary et al., 2004). The lacking finding of the well-known association between stress and the clinical severity of psoriasis may be attributed to differences in the assessment of stress (stressful events vs. perceived psychosocial stress, prospective vs. retrospective assessment), the time period considered (6 months vs. one month), whether the onset of psoriasis or the onset of psoriatic flares/exacerbation of psoriasis were taken into account, among others (for a systematic review: Rousset & Halioua, 2018). However, our present finding allude that the positive relationship between the health-related quality of life (ΔDLQI) and anxiety/depression (ΔHADS) is mediated by a reduction of perceived psychosocial stress. Following, one may conclude, that the evolvement of depression may be prevented when adequate stress management techniques are applied (Fortune, Kirby, Griffiths, et al., 2002; Richards et al., 2001). Future studies should take into account certain moderating and mediating variables for further exploring the impact of the health-related quality of life on the evolvement of anxiety and depression, among them for example, emotional reactivity, emotion-focused coping and stress susceptibility (Ak et al., 2012; Kilic et al., 2008; Remrod et al., 2015).

4.1 | Strengths and limitations

The present results should be interpreted in the context of methodological strengths and shortcomings of the present study. We consecutively assessed a cohort of patients with psoriasis, using a longitudinal design and applying a profound statistical analysis strategy, which takes initial values into account.

However, the sample size for using BLCSM was quite small, which may have caused the insufficient model fit parameters in some models. A small sample size limits the number of parameters that can be considered in a model. While, in principal, even small sample sizes can result in acceptable model fits (Curran et al., 2010), a more complex model with many parameters for few observations can easily result in non-convergence of the model (Kievit et al., 2018). However, if important relationships are not taken into account, the model fit and validity of the model are impeded. Thus, a larger sample size enables more power to investigate more complex relationships. For instance, the poor model fit indices based on modelling the interaction between psoriasis severity and anxiety/depression in the whole sample allude, that the results are presumably not valid, given the small number of parameters considered. However, as can be seen, when potentially relevant parameters (such as the perceived childhood trauma) were added to the original model, the model fit indices could be improved, despite lowering of cases. Thus, the results should be treated with caution and replicated in another study with a thorough sample size calculation.

Another limitation concerns the enrolment of patients with different types of psoriasis, resulting in a quite inhomogeneous group of psoriatic patients. Besides patients with psoriasis vulgaris as main group, also ten patients with psoriasis pustulosa palmoplantaris/plantaris, two patients with psoriasis guttata and one patient with psoriasis pustulosa generalista were included. In the present study, subgroup analyses were not realised because of the different and small sample sizes. In the literature, patients with psoriasis palmoplantaris showed a greater impairment of the health-related quality of life compared with moderate to severe plaque psoriasis (Chung et al., 2014). Additionally, different inflammatory circuits are supposed to be involved in certain psoriasis subtypes, for example, in particular neutrophil-associated activity in psoriasis pustulosa palmoplantaris (Wang et al., 2023). Following, future studies should investigate different psoriasis subtypes more in detail. In particular, for psoriasis pustulosa palmoplantaris the Palmoplantar Pustulosis Psoriasis Area Severity Index, differing risk profiles (e.g. smoking) and the impact on pruritus should be considered, among others (Benzian-Olsson et al., 2020; Jaworecka et al., 2021; Sarikaya Solak et al., 2022).

Additionally, with respect to major shortcomings of the present study, psoriasis severity and psychological distress (e.g. anxiety/depression, quality of life, childhood trauma) were parameters self-reported by the patients, which may have led to socially desired answering or response bias, with tendencies towards aggravation or trivialisation. Following, future studies should rather use the objective PASI instead of BSA or SAPASI, in order to assess the psoriasis severity. In the present study, the BSA was applied because of largely complete data, whereas PASI scores were missing in six cases at the initial assessment (T1) and in 55 cases at T2. Also, SAPASI scores were missing in eleven cases at T2.

Moreover, a causative inference regarding the impact of stress reduction on the improvement of anxiety and depression or health-related quality of life cannot be made, since the outcome parameters were assessed concurrently.

4.2 | Conclusions and clinical implications

To summarise, our findings allude that higher anxiety and depression go along with a lower therapy outcome in patients with psoriasis. It can be assumed that more anxious and depressed patients, even in case of a low psoriasis severity, are distressed and bothered, and seek dermatological treatment. Vice versa, subgroup analyses give hints, that patients with a higher psoriasis severity show higher improvement of anxiety/depression than patients with lower

psoriasis severity. Following, an impact of dermatological treatment (systemic therapy in particular) on both, pro-inflammatory cytokines and neurotransmitters, also involved in the aetiopathogenesis of anxiety and depression, may be assumed. Finally, the impact of the psoriasis in everyday life on anxiety and depression seems to be mediated by the perceived psychosocial stress. Therefore, patients in need who show high everyday distress caused by their skin disease should be offered appropriate adjuvant stress coping programs.

ACKNOWLEDGEMENTS

We would like to kindly thank the Robert-Pfleger-Stiftung supporting the present study with a research fund (Fonds number: 060_4967). Above, we thank Ann-Kristin Balding, Natalia Kibenko and Martin Hoy for their dedicated support in patient enrolment. We also appreciate proof-reading of the present manuscript as provided by Petra Chladkova.

Open Access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTEREST STATEMENT

The authors declare that they do not have any conflicts of interest.

DATA AVAILABILITY STATEMENT

The data files generated for this study are available on request to the corresponding author. In case of considering the present manuscript for publication, the data files will be made available on Open Science Framework and a doi-number in order to access the public repository will be assigned.

ORCID

Gloria-Beatrice Wintermann https://orcid.org/0000-0002-6292-0852

REFERENCES

Ak, M., Haciomeroglu, B., Turan, Y., Lapsekili, N., Doruk, A., Bozkurt, A., & Akar, A. (2012). Temperament and character properties of male psoriasis patients. *Journal of Health Psychology*, *17*(5), 774–781. https://doi.org/10.1177/1359105311423863

Al' Abadie, M. S., Kent, G. G., & Gawkrodger, D. J. (1994). The relationship between stress and the onset and exacerbation of psoriasis and other skin conditions. *British Journal of Dermatology*, *130*(2), 199–203. https://doi.org/10.1111/j.1365-2133.1994.tb02900.x

Augustin, M., & Radtke, M. A. (2014). Quality of life in psoriasis patients. *Expert Review of Pharmacoeconomics & Outcomes Research*, *14*(4), 559–568. https://doi.org/10.1586/14737167.2014.914437

Benzian-Olsson, N., Dand, N., Chaloner, C., Bata-Csorgo, Z., Borroni, R., Burden, A. D., Cooper, H. L., Cornelius, V., Cro, S., Dasandi, T., Griffiths, C. E. M., Kingo, K., Koks, S., Lachmann, H., McAteer, H., Meynell, F., Mrowietz, U., Parslew, R., Patel, P., …, & Capon, F. (2020). Association of clinical and demographic factors with the severity of palmoplantar pustulosis. *JAMA Dermatology*, *156*(11), 1216–1222. https://doi.org/10.1001/jamadermatol.2020.3275

Bhosle, M. J., Kulkarni, A., Feldman, S. R., & Balkrishnan, R. (2006). Quality of life in patients with psoriasis. *Health and Quality of Life Outcomes*, *4*(1), 35. https://doi.org/10.1186/1477-7525-4-35

Bu, J., Ding, R., Zhou, L., Chen, X., & Shen, E. (2022). Epidemiology of psoriasis and comorbid diseases: A narrative review. *Frontiers in Immunology*, *13*, 880201. https://doi.org/10.3389/fimmu.2022.880201

Chung, J., Callis Duffin, K., Takeshita, J., Shin, D. B., Krueger, G. G., Robertson, A. D., Troxel A. B., Van Voorhees A. S., Edson-Heredia E., Gelfand, J. M. (2014). Palmoplantar psoriasis is associated with greater impairment of health-related quality of life compared with moderate to severe plaque psoriasis. *Journal of the American Academy of Dermatology*, *71*(4), 623–632. https://doi.org/10.1016/j.jaad.2014.04.063

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396. https://doi.org/10.2307/2136404

Curran, P. J., Obeidat, K., & Losardo, D. (2010). Twelve frequently asked questions about growth curve modeling. *Journal of Cognition and Development*, *11*(2), 121–136. https://doi.org/10.1080/15248371003699969

Dalgard, F. J., Gieler, U., Tomas-Aragones, L., Lien, L., Poot, F., Jemec, G. B. E., Misery, L., Szabo, C., Linder, D., Sampogna, F., Evers, A. W., Halvorsen, J. A., Balieva, F., Szepietowski, J., Romanov, D., Marron, S. E., Altunay, I. K., Finlay, A. Y., Salek, S. S., …, & Kupfer, J. (2015). The psychological burden of skin diseases: A cross-sectional multicenter study among dermatological out-patients in 13 European countries. *Journal of Investigative Dermatology*, *135*(4), 984–991. https://doi.org/10.1038/jid.2014.530

Erfanian, M. (2018). Childhood trauma: A risk for major depression in patients with psoriasis. *Psychiatry and Clinical Psychopharmacology*, *28*(4), 378–385. https://doi.org/10.1080/24750573.2018.1452521

Feldman, S. R., Fleischer, A. B., Jr., Reboussin, D. M., Rapp, S. R., Exum, M. L., Clark, A. R., & Nurre, L. (1996). The self-administered psoriasis area and severity index is valid and reliable. *Journal of Investigative Dermatology*, *106*(1), 183–186. https://doi.org/10.1111/1523-1747.ep12329912

Finlay, A. Y., & Khan, G. K. (1994). Dermatology Life Quality Index (DLQI)--a simple practical measure for routine clinical use. *Clinical and Experimental Dermatology*, *19*(3), 210–216. https://doi.org/10.1111/j.1365-2230.1994.tb01167.x

Fortune, D. G., Richards, H. L., Griffiths, C. E. M., & Main, C. J. (2002). Psychological stress, distress and disability in patients with psoriasis: Consensus and variation in the contribution of illness perceptions, coping and alexithymia. *British Journal of Clinical Psychology*, *41*(2), 157–174. https://doi.org/10.1348/014466502163949

Fortune, D. G., Richards, H. L., Griffiths, C. E. M., & Main, C. J. (2004). Targeting cognitive-behaviour therapy to patients' implicit model of psoriasis: Results from a patient preference controlled trial. *British Journal of Clinical Psychology*, *43*(1), 65–82. https://doi.org/10.1348/014466504772812977

Fortune, D. G., Richards, H. L., Kirby, B., Bowcock, S., Main, C. J., & Griffiths, C. E. M. (2002). A cognitive-behavioural symptom management programme as an adjunct in psoriasis therapy. *British Journal of Dermatology*, *146*(3), 458–465. https://doi.org/10.1046/j.1365-2133.2002.04622.x

Geale, K., Henriksson, M., Jokinen, J., & Schmitt-Egenolf, M. (2020). Association of skin psoriasis and somatic comorbidity with the development of psychiatric illness in a Nationwide Swedish Study. *JAMA Dermatology*, *156*(7), 795–804. https://doi.org/10.1001/jamadermatol.2020.1398

Geale, K., Henriksson, M., & Schmitt-Egenolf, M. (2017). How is disease severity associated with quality of life in psoriasis patients? Evidence from a longitudinal population-based study in Sweden. *Health and Quality of Life Outcomes*, *15*(1), 151. https://doi.org/10.1186/s12955-017-0721-x

Grozdev, I., Korman, N., & Tsankov, N. (2014). Psoriasis as a systemic disease. *Clinical Dermatology*, *32*(3), 343–350. https://doi.org/10.1016/j.clindermatol.2013.11.001

Gupta, M. A., & Gupta, A. K. (2003). Psychiatric and psychological comorbidity in patients with dermatologic disorders. *American Journal of Clinical Dermatology*, *4*(12), 833–842. https://doi.org/10.2165/00128071-200304120-00003

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. (Methodology in the social sciences)* (Vol. 2nd ed.). The Guilford Press.

Herrmann, C., Buss, U., & Snaith, R. (1995). *HADS-D hospital anxiety and depression Scale*. Huber.

Heydendael, V. M. R., de Borgie, C. A. J. M., Spuls, P. I., Bossuyt, P. M. M., Bos, J. D., & de Rie, M. A. (2004). The burden of psoriasis is not determined by disease severity only. *Journal of Investigative Dermatology - Symposium Proceedings*, *9*(2), 131–135. https://doi.org/10.1111/j.1087-0024.2004.09115.x

Holsken, S., Krefting, F., Schedlowski, M., & Sondermann, W. (2021). Common fundamentals of psoriasis and depression. *Acta Dermato-Venereologica*, *101*(11), adv00609. https://doi.org/10.2340/actadv.v101.565

Homayoon, D., Hiebler-Ragger, M., Zenker, M., Weger, W., Unterrainer, H., & Aberer, E. (2020). Relationship between skin shame, psychological distress and quality of life in patients with psoriasis: A pilot study. *Acta Dermato-Venereologica*, *100*(14), adv00205. https://doi.org/10.2340/00015555-3563

Jaworecka, K., Kwiatkowska, D., Marek, L., Tamer, F., Stefaniak, A., Szczegielniak, M., Chojnacka-Purpurowicz, J., Matławska, M., Gulekon, A., Szepietowski, J. C., Narbutt, J., Owczarczyk-Saczonek, A., & Reich, A. (2021). Characteristics of pruritus in various clinical variants of psoriasis: Results of the multinational, multicenter, cross-sectional study. *Life (Basel)*, *11*(7), 623. https://doi.org/10.3390/life11070623

Joseph, D. M., Binitha, M. P., Jithu, V., Vasudevan, B., & Jishna, P. (2021). Determinants of quality of life in patients with psoriasis attending the dermatology outpatient clinic in a tertiary care center: A cross-sectional study. *Journal of Skin and Sexually Transmitted Diseases*, *3*, 156–161. https://doi.org/10.25259/jsstd_56_2020

Kievit, R. A., Brandmaier, A. M., Ziegler, G., van Harmelen, A. L., de Mooij, S. M. M., Moutoussis, M., Goodyer, I. M., Bullmore, E., Jones, P. B., Fonagy, P., Lindenberger, U., & Dolan, R. J. (2018). Developmental cognitive neuroscience using latent change score models: A tutorial and applications. *Developmental Cognitive Neuroscience*, *33*, 99–117. https://doi.org/10.1016/j.dcn.2017.11.007

Kiliç, A., Güleç, M. Y., Gül, U., & Güleç, H. (2008). Temperament and character profile of patients with psoriasis. *Journal of the European Academy of Dermatology and Venereology*, *22*(5), 537–542. https://doi.org/10.1111/j.1468-3083.2007.02460.x. Epub 2008 Mar 7

Klinitzke, G., Romppel, M., Hauser, W., Brahler, E., & Glaesmer, H. (2012). The German version of the childhood trauma questionnaire (CTQ): Psychometric characteristics in a representative sample of the general population. (Die deutsche Version des Childhood Trauma Questionnaire (CTQ) - psychometrische Eigenschaften in einer bevolkerungsreprasentativen Stichprobe.). *Psychotherapie, Psychosomatik, Medizinische Psychologie*, *62*(2), 47–51. https://doi.org/10.1055/s-0031-1295495

Koo, J., Ho, R. S., & Thibodeaux, Q. (2019). Depression and suicidality in psoriasis and clinical studies of brodalumab: A narrative review. *Cutis*, *104*(6), 361–365.

Korman, N. J. (2020). Management of psoriasis as a systemic disease: What is the evidence? *British Journal of Dermatology*, *182*(4), 840–848. https://doi.org/10.1111/bjd.18245

Krishnadas, R., Nicol, A., Sassarini, J., Puri, N., Burden, A. D., Leman, J., Cavanagh, J., Pimlott, S., Hadley, D., & McInnes, I. B. (2016). Circulating tumour necrosis factor is highly correlated with brainstem serotonin transporter availability in humans. *Brain, Behavior, and Immunity*, *51*, 29–38. https://doi.org/10.1016/j.bbi.2015.08.005

Lada, G., Chinoy, H., Heal, C., Warren, R. B., Talbot, P. S., & Kleyn, C. E. (2022). Depression and suicidality in patients with psoriasis and the role of psoriatic arthritis: A cross-sectional study in a tertiary setting. *Journal of the Academy of Consultation-Liaison Psychiatr 63*(4), 372–383. https://doi.org/10.1016/j.jaclp.2021.12.007

Lakuta, P., & Przybyla-Basista, H. (2017). Toward a better understanding of social anxiety and depression in psoriasis patients: The role of determinants, mediators, and moderators. *Journal of Psychosomatic Research*, *94*, 32–38. https://doi.org/10.1016/j.jpsychores.2017.01.007

Lewinson, R. T., Vallerand, I. A., Lowerison, M. W., Parsons, L. M., Frolkis, A. D., Kaplan, G. G., Barnabe, C., Swain, M. G., & Patten, S. B. (2017). Depression is associated with an increased risk of psoriatic arthritis among patients with psoriasis: A population-based study. *Journal of Investigative Dermatology*, *137*(4), 828–835. https://doi.org/10.1016/j.jid.2016.11.032

Lukmanji, A., Basmadjian, R. B., Vallerand, I. A., Patten, S. B., & Tang, K. L. (2021). Risk of depression in patients with psoriatic disease: A systematic review and meta-analysis. *Journal of Cutaneous Medicine and Surgery*, *25*(3), 257–270. https://doi.org/10.1177/12034754209 77477

Mattei, P. L., Corey, K. C., & Kimball, A. B. (2014). Psoriasis area severity index (PASI) and the dermatology life quality index (DLQI): The correlation between disease severity and psychological burden in patients treated with biological therapies. *Journal of the European Academy of Dermatology and Venereology*, *28*(3), 333–337. https://doi.org/10.1111/jdv.12106

McArdle, J. J. (2009). Latent variable modeling of differences and changes with longitudinal data. *Annual Review of Psychology*, *60*(1), 577–605. https://doi.org/10.1146/annurev.psych.60.110707.163612

McArdle, J. J., & Nesselroade, J. R. (1994). Using multivariate data to structure developmental change. In *Life-span developmental psychology: Methodological contributions* (pp. 223–267). Lawrence Erlbaum Associates, Inc.: Cohen, S. H. & Reese, H. W.

Menter, A., Augustin, M., Signorovitch, J., Yu, A. P., Wu, E. Q., Gupta, S. R., Bao Y., Mulani, P. (2010). The effect of adalimumab on reducing depression symptoms in patients with moderate to severe psoriasis: A randomized clinical trial. *Journal of the American Academy of Dermatology*, *62*(5), 812–818. https://doi.org/10.1016/j.jaad.2009.07.022

Molina-Leyva, A., Salvador-Rodriguez, L., Martinez-Lopez, A., Ruiz-Carrascosa, J. C., & Arias-Santiago, S. (2019). Association between psoriasis and sexual and erectile dysfunction in epidemiologic studies: A systematic review. *JAMA Dermatology*, *155*(1), 98–106. https://doi.org/10.1001/jamadermatol.2018.3442

Mrowietz, U., Kragballe, K., Reich, K., Spuls, P., Griffiths, C. E., Nast, A., Franke, J., Antoniou, C., Arenberger, P., Balieva, F., Bylaite, M., Correia, O., Daudén, E., Gisondi, P., Iversen, L., Kemény, L., Lahfa, M., Nijsten, T., Rantanen, T., …, & Yawalkar, N. (2011). Definition of treatment goals for moderate to severe psoriasis: A European consensus. *Archives of Dermatological Research*, *303*(1), 1–10. https://doi.org/10.1007/s00403-010-1080-1

Nadeem, A., Ahmad, S. F., Al-Harbi, N. O., Fardan, A. S., El-Sherbeeny, A. M., Ibrahim, K. E., & Attia, S. M. (2017). IL-17A causes depression-like symptoms via NFκB and p38MAPK signaling pathways in mice: Implications for psoriasis associated depression. *Cytokine*, *97*, 14–24. https://doi.org/10.1016/j.cyto.2017.05.018

Nagarajan, P., & Thappa, D. M. (2018). Effect of an educational and psychological intervention on knowledge and quality of life among patients with psoriasis. *Indian Dermatology Online Journal*, *9*(1), 27–32. https://doi.org/10.4103/idoj.IDOJ_111_17

Newsom, J. T. (2015). *Longitudinal structural equation modeling: A comprehensive introduction*. Routledge.

Nowowiejska, J., Baran, A., Grabowska, P., Lewoc, M., Kaminski, T. W., & Flisiak, I. (2022). Assessment of life quality, stress and physical

activity among patients with psoriasis. *Dermatologic Therapy*, *12*(2), 395–406. https://doi.org/10.1007/s13555-021-00662-1

O'Leary, C. J., Creamer, D., Higgins, E., & Weinman, J. (2004). Perceived stress, stress attributions and psychological distress in psoriasis. *Journal of Psychosomatic Research*, *57*(5), 465–471. https://doi.org/10.1016/j.jpsychores.2004.03.012

Orbai, A. M., Reddy, S. M., Dennis, N., Villacorta, R., Peterson, S., Mesana, L., Chakravarty, S. D., Lin, I., Karyekar, C. S., Wang, Y., Pacou, M., & Walsh, J. (2021). Work absenteeism and disability associated with psoriasis and psoriatic arthritis in the USA-a retrospective study of claims data from 2009 TO 2020. *Clinical Rheumatology*, *40*(12), 4933–4942. https://doi.org/10.1007/s10067-021-05839-9

Pollo, C. F., Miot, H. A., Matos, T. D. S., de Souza, J. M., Jorge, M. F. S., Miot, L. D. B., & Meneguin, S. (2021). Prevalence and factors associated with depression and anxiety in patients with psoriasis. *Journal of Clinical Nursing*, *30*(3–4), 572–580. https://doi.org/10.1111/jocn.15577

Purzycka-Bohdan, D., Kisielnicka, A., Zablotna, M., Nedoszytko, B., Nowicki, R. J., Reich, A., Samotij, D., Szczęch, J., Krasowska, D., Bartosińska, J., Narbutt, J., Lesiak, A., Barasińska, P., Owczarczyk-Saczonek, A., Czerwińska, J., Szepietowski, J. C., Batycka-Baran, A., Czajkowski, R., Górecka-Sokołowska, M., …, & Szczerkowska-Dobosz, A. (2022). Chronic plaque psoriasis in Poland: Disease severity, prevalence of comorbidities, and quality of life. *Journal of Clinical Medicine*, *11*(5), 1254. https://doi.org/10.3390/jcm11051254

Remrod, C., Sjostrom, K., & Svensson, A. (2015). Pruritus in psoriasis: A study of personality traits, depression and anxiety. *Acta Dermato-Venereologica*, *95*(4), 439–443. https://doi.org/10.2340/00015555-1975

Richards, H. L., Fortune, D. G., Griffiths, C. E., & Main, C. J. (2001). The contribution of perceptions of stigmatisation to disability in patients with psoriasis. *Journal of Psychosomatic Research*, *50*(1), 11–15. [pii]. https://doi.org/10.1016/S0022-3999(00)00210-5

Rousset, L., & Halioua, B. (2018). Stress and psoriasis. *International Journal of Dermatology*, *57*(10), 1165–1172. https://doi.org/10.1111/ijd.14032

Sahi, F. M., Masood, A., Danawar, N. A., Mekaiel, A., & Malik, B. H. (2020). Association between psoriasis and depression: A traditional review. *Cureus*, *12*(8), e9708. https://doi.org/10.7759/cureus.9708

Sahiner, I., Taskintuna, N., Sevik, A., Kose, O., & Atas, H. (2014). The impact role of childhood traumas and life events in patients with alopecia aerate and psoriasis. *JAMA Psychiatry*, *17*(6). https://doi.org/10.4172/1994-8220.1000162

Sarikaya Solak, S., Kara Polat, A., Kilic, S., Oguz Topal, I., Saricaoglu, H., Karadag, A. S., Canpolat, F., Kartal, S. P., Deveci, B. N., Kacar, N., Polat Ekinci, A., Guner, R., Polat, M., Dogan, G., Guler Ozden, M., Bulbul Baskan, E., Ozaydin Yavuz, G., Adisen, E., Gulekon, A., …, & Alpsoy, E. (2022). Clinical characteristics, quality of life and risk factors for severity in palmoplantar pustulosis: A cross-sectional, multicentre study of 263 patients. *Clinical and Experimental Dermatology*, *47*(1), 63–71. https://doi.org/10.1111/ced.14829

Scharloo, M., Kaptein, A. A., Weinman, J., Bergman, W., Vermeer, B. J., & Rooijmans, H. G. (2000). Patients' illness perceptions and coping as predictors of functional status in psoriasis: A 1-year follow-up. *British Journal of Dermatology*, *142*(5), 899–907. https://doi.org/10.1046/j.1365-2133.2000.03469.x

Schmitt, J. M., & Ford, D. E. (2007). Role of depression in quality of life for patients with psoriasis. *Dermatology*, *215*(1), 17–27. https://doi.org/10.1159/000102029

Simonic, E., Kastelan, M., Peternel, S., Pernar, M., Brajac, I., Roncevic-Grzeta, I., & Kardum, I. (2010). Childhood and adulthood traumatic experiences in patients with psoriasis. *Journal of Dermatology*, *37*(9), 793–800. https://doi.org/10.1111/j.1346-8138.2010.00870.x

Simonic, E., Peternel, S., Stojnic-Sosa, L., Roncevic-Grzeta, I., Prpic-Massari, L., Massari, D., Periša, D., Čabrijan, L., & Kastelan, M. (2013). Negative and positive life experiences in patients with psoriatic arthritis. *Rheumatology International*, *33*(6), 1587–1593. https://doi.org/10.1007/s00296-012-2569-z

Sondermann, W., Fiege, O., Korber, A., & Scherbaum, N. (2021). Psychological burden of psoriatic patients in a German university hospital dermatology department. *The Journal of Dermatology*, *48*(6), 794–806. https://doi.org/10.1111/1346-8138.15721

Vardy, D., Besser, A., Amir, M., Gesthalter, B., Biton, A., & Buskila, D. (2002). Experiences of stigmatization play a role in mediating the impact of disease severity on quality of life in psoriasis patients. *British Journal of Dermatology*, *147*(4), 736–742. https://doi.org/10.1046/j.1365-2133.2002.04899.x

Vasilakis-Scaramozza, C., Persson, R., Hagberg, K. W., & Jick, S. (2020). The risk of treated anxiety and treated depression among patients with psoriasis and psoriatic arthritis treated with apremilast compared to biologics, DMARDs and corticosteroids: A cohort study in the United States MarketScan database. *Journal of the European Academy of Dermatology and Venereology*, *34*(8), 1755–1763. https://doi.org/10.1111/jdv.16231

Verhoeven, E. W., Kraaimaat, F. W., de Jong, E. M., Schalkwijk, J., van de Kerkhof, P. C., & Evers, A. W. (2009). Individual differences in the effect of daily stressors on psoriasis: A prospective study. *British Journal of Dermatology*, *161*(2), 295–299. https://doi.org/10.1111/j.1365-2133.2009.09194.x

Wang, C. Q., Haxhinasto, S., Garcet, S., Kunjravia, N., Cueto, I., Gonzalez, J., Rambhia, D., Harari, O., Sleeman, M. A., Hamilton, J. D., Lim, W. K., Freudenberg, J., Kalliolias, G. D., Thakker, P., Bissonnette, R., & Krueger, J. G. (2023). Comparison of the inflammatory circuits in psoriasis vulgaris, non–pustular palmoplantar psoriasis, and palmoplantar pustular psoriasis. *Journal of Investigative Dermatology*, *143*(1), 87–97. e14. https://doi.org/10.1016/j.jid.2022.05.1094

Wintermann, G.-B., Bierling, A. L., Peters, E. M. J., Abraham, S., Beissert, S., & Weidner, K. (2022). Childhood trauma and psychosocial stress affect treatment outcome in patients with psoriasis starting a new treatment episode [original research]. *Frontiers in Psychiatry*, *13*. https://doi.org/10.3389/fpsyt.2022.848708

Zachariae, R., Zachariae, H., Blomqvist, K., Davidsson, S., Molin, L., Mørk, C., & Sigurgeirsson, B. (2004). Self-reported stress reactivity and psoriasis-related stress of Nordic psoriasis sufferers. *Journal of the European Academy of Dermatology and Venereology*, *18*(1), 27–36. https://doi.org/10.1111/j.1468-3083.2004.00721.x

Zhang, Z., & Liu, H. (2018). Sample size and measurement occasion planning for latent change score models through Monte Carlo simulation 1. In E. Ferrer, S. M. Boker, & K. J. Grimm (Eds.), *Longitudinal multivariate psychology*. Taylor & Francis. https://doi.org/10.4324/9781315160542-10

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Wintermann, G.-B., Bierling, A. L., Peters, E. M. J., Abraham, S., Beissert, S., & Weidner, K. (2024). Psychosocial stress affects the change of mental distress under dermatological treatment—A prospective cohort study in patients with psoriasis. *Stress and Health*, *40*(1), e3263. https://doi.org/10.1002/smi.3263