

ORIGINAL ARTICLE

Factors associated with drug adherence in psoriasis: a single-center, retrospective, questionnaire-based exploratory study in Bavaria

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Summary

Background and Objectives: Achieving sustained drug adherence in psoriasis remains challenging despite effective therapies. This exploratory study aims to investigate the care situation and factors associated with drug adherence in patients with moderate-to-severe psoriasis vulgaris (PsO).

Patients and Methods: A single-center study was conducted at the University Medical Center Regensburg, Germany, comprising a retrospective analysis of 312 patient records of individuals treated between 01/2023 and 06/2023 and a prospective questionnaire-based cross-sectional survey of 62 patients treated between 10/2023 and 03/2024. Sociodemographic, clinical, and treatment-related variables and quality of life (QoL) were analyzed descriptively and explored using inferential statistics.

Results: Most patients resided outside the urban care center (82.1% retrospective, 81.0% prospective). Approximately three quarters were adherent (75.0% and 72.4%, respectively). Non-adherence was associated with occupational status, medication class, adverse events, and nicotine use. Patient-reported reasons included administrative barriers (43.8%), financial burden, and adverse events (18.8% each). Non-adherent patients tended to report higher disease burden and lower QoL.

Conclusions: Drug adherence in moderate-to-severe PsO is associated with socioeconomic and therapy-related factors. Targeted patient-centered strategies may help improve long-term adherence, particularly in vulnerable patient groups, optimize overall outcomes, and reduce financial burden on the healthcare system.

KEYWORDS

compliance, drug adherence, psoriasis, quality of life, socioeconomic factors

INTRODUCTION

Psoriasis vulgaris (PsO) is a chronic inflammatory autoimmune skin disease characterized by erythematous, scaly plaques in typical predilection sites (e.g., scalp, elbows, knees, and lower back).¹ The condition is relatively common, with a prevalence of 2%–3% in Western countries.²

Systemic inflammatory processes may affect not only the skin but also musculoskeletal and vascular structures. These are associated with comorbidities including psoriatic arthritis, cardiovascular diseases, and mental disorders, resulting in a shortened lifespan, socioeconomic and psychological burden, and consequently a reduced quality of life (QoL).^{3–6} Optimized management of moderate-to-severe PsO aims to reduce disease burden and associated comorbidities. In addition to conventional non-biologic systemic treatments

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such as methotrexate, dimethyl fumarate, acitretin, and ciclosporin, various biologic agents are available, including monoclonal antibodies targeting tumor necrosis factor alpha (TNF α), interleukin (IL)-17 or the IL-17 receptor, as well as IL-12/23 (p40 subunit) and IL-23 (p19 subunit). Furthermore, targeted small molecules have expanded therapeutic options, including phosphodiesterase 4 (PDE4) inhibitors and selective inhibitors of the Janus kinase family, such as tyrosine kinase 2 (TYK2) inhibitors.

Generally, several factors affect treatment and drug adherence, including sociodemographic, socioeconomic and sociocultural, as well as disease-associated aspects and different treatment modalities.⁶ There is a distinction between compliance, which describes the passive adherence to a physician's instructions, and adherence, which involves the active engagement of the patient in therapeutic decisions and conformity to the physician's prescription.⁷ In this analysis, we focused on behavioral adherence as reflected by treatment persistence.

While systemic therapeutics are highly efficacious in managing symptoms of PsO, adherence may represent a limiting factor for disease control.⁸ Independent of disease type or severity, adherence in chronic dermatoses is estimated at 55%–60%.⁹ For PsO, adherence is higher for systemic therapies (84%–95%) compared with topical treatments (44%–72%).¹⁰

In addition, significant variations exist in the prevalence and management of PsO on both a global and regional scale.¹¹ Potential barriers that may contribute to these variations include factors such as patient age, rural residence, financial and educational status, nationality, disease awareness, and the presence of mental illness.^{12,13}

While the pathophysiology of PsO is well studied, there are still unanswered questions regarding optimization of treatment adherence. For instance, the importance of gender or medication class for treatment adherence is unclear,^{5,14,15} as is how differences in patient characteristics and demographics affect adherence and QoL, particularly in the context of residence in a large urban care center versus surrounding smaller municipalities.¹⁶ In this study, we assessed the current care situation among patients with PsO in Eastern Bavaria, Germany, where the University Medical Center Regensburg (UKR) represents the only hospital within a radius of approximately 100 kilometers providing specialized dermatological care. We further aimed to identify predictors associated with treatment adherence.

PATIENTS AND METHODS

This monocentric, non-interventional, cross-sectional study was designed as an exploratory, hypothesis-generating analysis. The primary aim was to descriptively characterize the care situation, drug adherence, and QoL of patients with moderate-to-severe PsO treated at a University Medical Center. Secondary exploratory aims assessed associations between adherence and sociodemographic, clinical, and

treatment-related factors. Adherence was operationalized as full concordance with the prescribed dosing schedule, with no missed doses, treatment interruptions, or discontinuations during the observation period. Drug adherence and QoL were the primary outcomes. Sociodemographic variables (age, gender, educational level, occupational status, income, residence), clinical characteristics (nicotine abuse, comorbidity, disease severity), and therapy-related variables (medication class, adverse events) were analyzed as potential factors associated with adherence and QoL. Due to the exploratory design, no predefined effect modifiers were specified, and no formal adjustment for potential confounders was performed. This study involved two cohorts of patients, with data collected retrospectively for the first cohort and prospectively for the second (see below). All patient data were collected at UKR, a tertiary academic teaching hospital in Eastern Bavaria, Germany. Patients included in this study were between 18 and 90 years of age and had a dermatologist-confirmed diagnosis of moderate-to-severe PsO. For the retrospective analysis, all patients with the respective diagnosis treated during the retrospective study period were included, provided that sufficient clinical documentation was available for data extraction. For the prospective questionnaire-based analysis, patients were excluded from participation if they were unable to provide informed consent or if cognitive restrictions precluded meaningful involvement due to alcohol or substance abuse. Data for the retrospective cohort were collected through chart review, whereas data for the prospective cohort were collected through questionnaires. Due to the nature of the cross-sectional study design, no subsequent follow-up was conducted. To reduce bias, predefined variables and standardized data extraction from medical records were used in the retrospective cohort, and validated patient-reported outcome measures (PROMs) were applied in the prospective cohort. Prior to the initiation of the study, the approval of the local institutional ethics committee was obtained (reference number 23-3474-101).

Retrospective cohort

The retrospective cohort comprised all patients with the diagnosis of moderate-to-severe PsO (defined as a Psoriasis Area and Severity Index [PASI] > 10 or meeting upgrade criteria) treated and documented between January and June 2023 at UKR. Study data were collected through manual analysis of patient chart records. If multiple patient visits were recorded, only data from the first visit were included in the analysis. Data included sociodemographic and socioeconomic information, as well as disease- and treatment-associated variables, if available. Drug adherence was assessed using routinely maintained clinical records. Adherence-related parameters included documented treatment discontinuations, interruptions, delayed follow-up visits, therapy switches attributed to

non-adherence, and administrative reasons affecting treatment continuation. These parameters were used as proxy measures of behavioral adherence. Direct measures of medication intake were not available in the retrospective dataset. Patients were categorized according to their place of residence in a large urban care center versus residence in surrounding areas, including smaller cities, suburban areas, and rural communities, based on their postal code. The large urban care center comprised the City of Regensburg ($\geq 150,000$ inhabitants), while all other patient residences were located in smaller municipalities. Educational level and occupational status were determined by provided information on the highest graduation qualification achieved and current occupation. Therapy-related variables included experience with systemic therapies, the type of prescribed medication, adverse events (AEs), and potential factors associated with non-adherence. In addition, disease-specific factors, including smoking status and existing cardiovascular or psychiatric comorbidities, were recorded.

Prospective cohort

A cross-sectional questionnaire-based survey was conducted between October 2023 and March 2024. During this predefined period, consecutive patients attending the specialized psoriasis outpatient clinic for consultation or routine care were invited to participate and were enrolled after providing written informed consent. Given the exploratory design and the absence of a predefined primary endpoint, no *a priori* sample size calculation or formal power analysis was performed. The size was therefore determined by the number of eligible patients presenting to the outpatient clinic during the study period. In addition to collecting the same core variables as in the retrospective analysis, the objective of the prospective study was to record in detail the factors associated with drug adherence. Patients were given the opportunity to mark areas of skin affected by psoriasis, answer yes/no questions, choose from predefined answer options, or give subjective assessments of their perceived disease severity on a scale from 0 to 10. Subjective symptom burden was assessed using the *Peak Pruritus Numerical Rating Scale* (PP-NRS) and the *Skin Pain Numerical Rating Scale* (SP-NRS). The study design was based on previous healthcare research projects at UKR,¹⁷ and was supplemented with standardized PROMs regarding QoL using the *Dermatology Life Quality Index* (DLQI), the *WHO-5 Well-Being Index*, and the *EuroQol 5-Dimensions Visual Analog Scale* (EQ-5D-VAS) questionnaires.

Statistical analysis

The data were processed using REDCap software (Vanderbilt University), electronically masked with plausibility checks, and analyzed using IBM SPSS Version 29 (Armonk,

New York, USA). Descriptive statistics were used to describe the data set. Categorical variables were expressed in absolute and relative frequencies. Normally distributed quantitative variables were expressed as mean values with standard deviation (SD), whereas non-normally distributed variables were reported as median values with interquartile range (IQR). QoL scores were presented as mean values with SD to ensure comparability with previously published studies (Table 3). Categorization of variables was guided by previously used questionnaires and predefined clinically meaningful cut-off values.¹⁷ All category boundaries are specified in the corresponding tables (Tables 1,2). Subgroup analyses were performed by comparing adherent and non-adherent patients across sociodemographic, clinical, and treatment-related variables. No formal interaction analyses were performed. Missing data were handled by available-case analysis. For inferential statistics, significance tests were performed for categorical variables using the chi-square test. Quantitative variables were analyzed using Student's t-test when normally distributed and the Mann-Whitney U test when not normally distributed. A significance level of $p < 0.05$ was set for all tests. Only unadjusted estimates based on descriptive and univariable analyses were reported. Due to the exploratory nature of the study and the limited sample size, no confounder-adjusted estimates were calculated, and no correction for multiple testing was applied; therefore, p-values should be interpreted rather descriptively than inferentially.

RESULTS

Retrospective cohort

Study population and clinical characteristics

General characteristics are shown in Table 1. A total of 323 patient records were reviewed. Eleven patients did not meet the inclusion criteria and were subsequently excluded. Therefore, 312 patients were analyzed, with a higher proportion of patients being male ($n = 202$, 64.7%) versus female ($n = 110$, 35.3%). The mean age was 53.5 years (SD 15.5). Most patients resided in surrounding areas ($n = 256$, 82.1%), while a smaller proportion lived in the large urban care center ($n = 56$, 17.9%) (Figure 1). Among the patients with available data ($n = 105$), active or prior smoking was documented in 76 patients (72.4%). Comorbidity was present in 86.7% of patients ($n = 158$), with the rate of cardiovascular diseases at 69.0% and that of mental disorders at 31.0%.

Socioeconomic and treatment-related factors (Table 1)

Information on educational status was available for 189 patients: 38 had no formal education (20.1%), 28 had the

TABLE 1 Sociodemographic, socioeconomic, clinical, and therapy-associated characteristics of the population studied in the retrospective cohort: comparison of the adherent and non-adherent subgroup.

Characteristics	Total	Therapy-adherent	Non-adherent	p-value
Sociodemographic characteristics	N = 312	n = 247	n = 65	
Age in years, mean (SD)	53.5 (15.5)	52.9 (15.3)	55.9 (15.8)	0.084
Gender, n (%)				0.545
Male	202 (64.7)	162 (65.6)	40 (61.5)	
Female	110 (35.3)	85 (34.4)	25 (38.5)	
Residence, n (%)				0.629
Large urban care center	56 (17.9)	43 (17.4)	13 (20.0)	
Surrounding areas	256 (82.1)	204 (82.6)	52 (80.0)	
Clinical characteristics				
Smoking habit, n (%)	n = 105	n = 79	n = 26	
Active	76 (72.4)	53 (67.1)	23 (88.5)	0.035
PASI, median (IQR)	n = 215	n = 165	n = 50	
Current Score	3.0 (1.0, 4.8)	3.0 (1.0, 5.0)	2.2 (1.0, 3.0)	0.540
Comorbidity ^a , n (%)	n = 158	n = 123	n = 35	0.820
≥ 1	137 (86.7)	107 (87.0)	30 (85.7)	
Cardiovascular diseases	109 (69.0)	87 (70.7)	22 (62.9)	
Mental disorders	49 (31.0)	36 (29.3)	13 (37.1)	
Socioeconomic characteristics				
Educational status, n (%)	n = 189	n = 151	n = 38	0.723
No formal graduation	38 (20.1)	29 (19.2)	9 (23.7)	
Middle/ secondary school graduation	123 (65.1)	98 (64.9)	25 (65.8)	
Highest education graduation	28 (14.8)	24 (15.9)	4 (10.5)	
Occupational status, n (%)	n = 225	n = 180	n = 45	0.036
Working	161 (71.6)	131 (72.8)	30 (66.7)	
Retired	50 (22.2)	35 (19.4)	15 (33.3)	
Unemployed	14 (6.2)	14 (7.8)	0	
Therapy-associated characteristics	n = 260	n = 195	n = 65	
Systemic medication class ^b , n (%)				
Conventional non-biologic systemic therapies	46 (17.7)	29 (14.9)	17 (26.2)	0.039
TNF- α inhibitors	28 (10.8)	18 (9.2)	10 (15.4)	0.167
IL-17/ IL-17-receptor inhibitors	99 (38.1)	73 (37.4)	26 (40.0)	0.714
IL-12/23-inhibitors or IL-23 inhibitors	73 (28.1)	61 (31.3)	12 (18.5)	0.047
Small molecules	19 (7.3)	17 (8.7)	2 (3.1)	0.131
Adverse events during current therapy, n (%)				
Yes	18 (6.9)	5 (2.7)	13 (20.0)	< 0.010
No	242 (93.1)	190 (97.3)	52 (80.0)	

Abbr.: IL, interleukin; IQR, interquartile range; PASI, Psoriasis Area and Severity Index; SD, standard deviation; TNF, tumor necrosis factor.

^aMultiple responses were possible.

^bSome patients may have been on more than one medication.

A significance level of $p < 0.05$ was set for all tests.

TABLE 2 Sociodemographic, socioeconomic, clinical, and therapy-associated characteristics of the population studied in the prospective cohort: comparison of the adherent and non-adherent subgroup.

Characteristics	Total (N = 58)	Therapy-adherent (n = 42)	Non-adherent (n = 16)	p-value
Sociodemographic characteristics				
Age in years, mean (SD)	51.1 (15.9)	52.6 (15.6)	47.0 (16.4)	0.288
Gender, n (%)				0.089
Male	25 (43.1)	21 (50.0)	4 (25.0)	
Female	33 (56.9)	21 (50.0)	12 (75.0)	
Residence, n (%)				0.980
Large urban care center	11 (19.0)	8 (19.0)	3 (18.7)	
Surrounding areas	47 (81.0)	34 (81.0)	13 (81.3)	
Travel distance from UKR, n (%)				0.293
Up to 5 km	8 (13.8)	6 (14.3)	2 (12.5)	
6–10 km	7 (12.1)	3 (7.1)	4 (25.0)	
11–30 km	12 (20.7)	9 (21.4)	3 (18.8)	
31–50 km	7 (12.1)	5 (11.9)	2 (12.5)	
51–70 km	7 (12.1)	5 (11.9)	2 (12.5)	
More than 70 km	17 (29.3)	14 (33.3)	3 (18.8)	
Clinical characteristics				
Smoking habit, n (%)				
Active	31 (53.4)	23 (54.8)	8 (50.0)	0.750
BMI, mean (SD)	29.5 (7.7)	28.7 (7.6)	31.5 (8.0)	0.446
Comorbidity ^a , n (%)	32 (55.2)	25 (59.5)	7 (43.8)	0.288
Cardiovascular diseases	25 (43.2)	20 (47.6)	5 (31.3)	
Mental disorders	13 (22.4)	10 (23.8)	3 (18.8)	
Upgrade criteria ^b , n (%)	27 (46.6)	21 (50.0)	6 (37.5)	0.403
Socioeconomic characteristics				
Educational status, n (%)				0.527
No formal graduation	2 (3.4)	2 (4.8)	0	
Middle/ secondary school graduation	44 (75.9)	32 (76.2)	12 (75.0)	
Highest education graduation	12 (20.7)	8 (19.0)	4 (25.0)	
Occupational status, n (%)				0.254
Working	38 (65.5)	25 (59.5)	13 (81.3)	
Retired	17 (29.3)	14 (33.3)	3 (18.7)	
Unemployed	3 (5.2)	3 (7.1)	0	
Monthly net household income, n (%)				0.565
≤ 2000€	29 (50.0)	20 (47.6)	9 (56.3)	
> 2000€	29 (50.0)	22 (52.4)	7 (43.7)	
Receipt of welfare benefits, n (%)				0.114
Yes	6 (10.3)	6 (14.3)	0	
No	52 (89.7)	36 (85.7)	16 (100.0)	
Incapacity to work due to psoriasis, n (%)				0.092
Yes	16 (27.6)	9 (21.4)	7 (43.7)	
No	42 (72.4)	33 (72.6)	9 (56.3)	

(Continues)

TABLE 2 (Continued)

Characteristics	Total (N = 58)	Therapy-adherent (n = 42)	Non-adherent (n = 16)	p-value
<i>Monthly investments for disease-related activities, n (%)</i>				0.043
<€50	35 (60.3)	22 (52.4)	13 (81.3)	
≥€50	23 (39.7)	20 (47.6)	3 (18.7)	
Therapy-associated characteristics				
<i>Systemic medication class, n (%)</i>				
Conventional non-biologic systemic therapies	7 (12.1)	3 (7.1)	4 (25.0)	0.064
TNF- α inhibitors	4 (6.9)	2 (4.8)	2 (12.5)	0.307
IL-17/ IL-17-receptor inhibitors	23 (39.7)	16 (38.1)	7 (43.8)	0.700
IL-12/23 inhibitors or IL-23 inhibitors	17 (29.3)	14 (33.3)	3 (18.8)	0.284
Small molecules	7 (12.1)	7 (16.7)	0	0.208
<i>Subjective treatment satisfaction, n (%)</i>				0.161
Very satisfied	34 (58.6)	27 (64.3)	7 (43.8)	
Satisfied or moderately satisfied ^c	24 (41.4)	15 (35.7)	9 (56.2)	
<i>Adverse events during current therapy, n (%)</i>				0.016
Yes	17 (29.3)	8 (19.0)	9 (56.3)	
No	41 (70.3)	34 (81.0)	7 (43.7)	

Abbr.: BMI, body mass index; IL, interleukin; km, kilometers; SD, standard deviation; TNF, tumor necrosis factor; UKR, University Medical Center Regensburg.

^aMultiple responses were possible.

^bUpgrading of psoriasis severity due to e.g., facial, nail, and genital involvement.

^cNo patient rated the experience below satisfied or unsatisfied.

A significance level of $p < 0.05$ was set for all tests.

TABLE 3 Information on quality of life using different measurement instruments and subjective characterization of disease-specific aspects of the study cohort surveyed.

Characteristics	Total (n = 58)	Therapy-adherent (n = 42)	Non-adherent (n = 16)	p-value
Impact on Quality of Life, mean (SD)				
WHO Well-Being	60.7 (23.6)	59.0 (23.2)	65.3 (24.9)	0.369
DLQI	4.6 (5.0)	4.5 (5.4)	5.0 (5.5)	0.367
EQ-5D-VAS	69.8 (21.1)	71.1 (21.3)	65.0 (20.4)	0.143
Subjective assessment of disease-specific aspects^a, mean (SD)				
PP-NRS	2.6 (2.8)	2.5 (2.8)	3.0 (2.8)	0.390
SP-NRS	2.2 (2.9)	2.0 (2.6)	2.6 (3.4)	0.598
"How stressed do you feel because of the therapy (e.g., injections, constant medication)?"	1.9 (2.2)	1.7 (2.1)	2.4 (2.5)	0.528
"How severe do you consider your illness to be?"	4.6 (3.0)	4.5 (3.0)	5.0 (3.1)	0.479

Abbr.: DLQI, Dermatology Life Quality Index; EQ-5D-VAS, EuroQol 5-Dimensions Visual Analog Scale; PP-NRS, Peak Pruritus Numerical Rating Scale; SD, standard deviation; SP-NRS, Skin Pain Numerical Rating Scale; WHO, World Health Organization.

^aOriginal questions from the survey on a scale of 0–10 for characterization, ranging from 0 (no effect) to 10 (maximum severity).

Scores are reported as mean values with SD for consistency with the existing literature and comparability with reference data, despite non-normal distribution. A significance level of $p < 0.05$ was set for all tests.

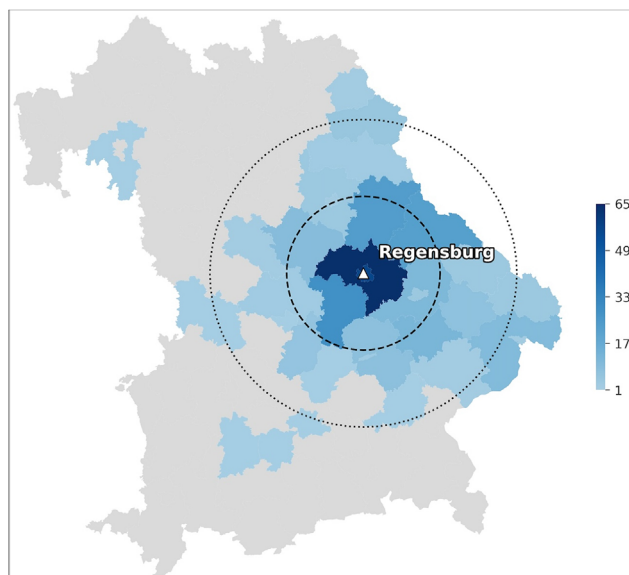


FIGURE 1 Geographical distribution of patients' residences in the retrospective cohort. Map of Eastern Bavaria showing the location of Regensburg (white triangle), the number of patients residing in each area (blue scale), and the surrounding 50- and 100-kilometer radial distance zones (black circles), representing the primary referral region of the University Medical Center Regensburg.

highest level of education (university entrance degree or comparable) (14.8%), and 123 had an intermediate or other level of education (secondary or middle school degree) (65.1%). The occupational status/position was available for 225 patients: 161 were employed (71.6%), 50 were retired (22.2%), and 14 were unemployed (6.2%). Out of 260 patients currently receiving systemic therapy, 46 received conventional non-biologic treatments (17.7%), 28 TNF α inhibitors (10.8%), 99 IL-17/ IL-17-receptor inhibitors (38.1%), 73 IL-12/23/ IL-23 inhibitors (28.1%), and 19 small molecules including PDE4 inhibitors and TYK2 inhibitors (7.3%). AEs were overall rare; 18 patients had documented AEs related to their current medication (6.9%).

Documented factors for non-adherence (Table 4)

Overall, most of the patients receiving systemic therapy adhered to their medication regimen ($n = 195$, 75.0%). Among the 65 non-adherent patients, the most frequently documented factors were COVID-19 and other infections ($n = 20$, 30.8%), AEs ($n = 14$, 21.5%), and treatment-related administrative challenges ($n = 12$, 18.5%). Treatment discontinuation at the patient's request was recorded in nine patients (13.8%). Other documented factors comprised heterogeneous, infrequently recorded circumstances (each occurring in one or two cases) and were therefore grouped into a single category (Table 4). Barriers related to infrastructural or financial issues as well as difficulties in language comprehension were documented in three patients each (4.6% each).

Comparison between therapy-adherent and non-adherent patients (Table 1)

The mean age, male-female ratio, and the area of residence did not differ significantly between adherent and non-adherent patients. Smoking was significantly higher among non-adherent patients compared to adherent patients (88.5% vs. 67.1%; $p = 0.035$). Occupational status differed significantly between adherent and non-adherent patients ($p = 0.036$): adherent patients were more likely to be employed (72.8% vs. 66.7%) and less likely to be retired (19.4% vs. 33.3%). The medication class significantly impacted non-adherence versus adherence: conventional non-biologic systemic therapy was associated with treatment non-adherence (26.2% vs. 14.9%; $p = 0.039$); conversely, IL-12/23 or IL-23 inhibitors were associated with treatment adherence (31.3% vs. 18.5%; $p = 0.047$). A significantly higher incidence of AEs was observed in patients who did not adhere to the prescribed regimen (20.0% vs. 2.7%; $p < 0.010$).

Prospective cohort

Study population and clinical characteristics

General characteristics are shown in Table 2. Of the 62 patients surveyed, four were excluded due to missing information regarding adherence, therefore, 58 questionnaires were used for subsequent analyses. In this cohort there were more female ($n = 33$, 56.9%) than male patients ($n = 25$, 43.1%). The average age was 51.1 years (SD 15.9), and the average patient was overweight with a body mass index (BMI) of 29.5 (SD 7.7). As illustrated in Figure 2, 81.0% of the patients reported a residence in surrounding areas, and about one third of patients (29.3%) had to travel more than 70 kilometers to the dermatological department of UKR (Table 2). Approximately half of patients had at least one comorbidity (55.2%), comprising cardiovascular diseases (43.2%) and mental disorders (22.4%). In addition, 27 met the upgrade criteria for difficult-to-treat/high-impact areas (46.6%),¹⁸ and 31 reported an ongoing smoking habit (53.4%).

Socioeconomic and treatment-related factors (Table 2)

Of the 58 patients, two had no formal education (3.4%), twelve had the highest (or comparable) school education (20.7%), and 44 had an intermediate or other level of education (75.9%). Almost two-thirds of patients were employed ($n = 38$, 65.5%), 17 were retired (29.3%), and three were unemployed (5.2%); some of them were recipients of social welfare benefits ($n = 6$, 10.3%). When assessing the financial burden of treatment, more than half of the patients reported disease-related out-of-pocket spending of less

TABLE 4 Documented factors associated with non-adherence in the retrospective cohort and patient-reported reasons for non-adherence in the prospective cohort.

Factors associated with/reported reasons for non-adherence (n,%) ^a	Retrospective population of non-adherent, n = 65 (out of 260 patients)	Prospective population of non-adherent, n = 16 (out of 58 patients)
Adverse events	14 (21.5)	3 (18.8)
Administrative difficulties	12 (18.5)	7 (43.8)
Circumstances due to infections (total)	20 (30.8)	0
COVID-19	10 (15.4)	0
Other infectious diseases	10 (15.4)	0
Independent discontinuation	9 (13.8)	2 (12.5)
Infrastructural or financial barriers	3 (4.6)	3 (18.8)
Linguistic or content-related comprehension problems	3 (4.6)	1 (6.3)
Other factors/reasons ^b	9 (13.8)	7 (43.8)

^aNote that multiple responses were possible.

^bAdditional factors/reasons than those provided in the table include insufficient patient education regarding medication use, forgetfulness, and reduced motivation/compliance.

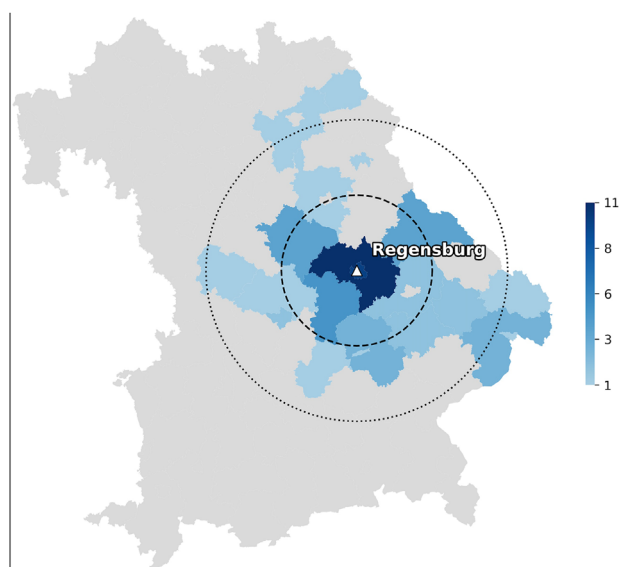


FIGURE 2 Geographical distribution of patients' residences in the prospective cohort. Map of Eastern Bavaria showing the location of Regensburg (white triangle), the number of patients residing in each area (blue scale), and the surrounding 50- and 100-kilometer radial distance zones (black circles), representing the primary referral region of the University Medical Center Regensburg.

than €50 per month ($n = 35$, 60.3%), whereas 39.7% spent €50 or more. Seven patients were treated with conventional non-biologic systemic therapy (12.1%), four with TNF α inhibitors (6.9%), 23 with IL-17/ IL-17-receptor inhibitors (39.7%), 17 with IL-12/23/ IL-23 inhibitors (29.3%), and seven with small molecules (12.1%). Almost one-third of patients had experienced AEs with their current medication ($n = 17$, 29.3%).

Reasons for non-adherence (Table 4)

Overall, more than two-thirds of patients ($n = 42$, 72.4%) adhered to their medication consistently. Among the 16

patients who were not adherent, the primary causes were listed as administrative difficulties as well as other reasons than those provided ($n = 7$, 43.8% each), detailed in Table 4. AEs and infrastructural or financial barriers were each reported as reasons for non-adherence by three patients (18.8% each). Independent treatment discontinuation was performed by two patients (12.5%), and one patient reported language comprehension difficulties.

Comparison between therapy-adherent and non-adherent patients (Table 2)

Patients who adhered to their medication had a numerically higher mean age (52.6 years, SD 15.6 vs. 47.0 years, SD 16.4) and a slightly lower BMI (28.7, SD 7.6 vs. 31.5, SD 8.0). Treatment adherence was associated with a higher prevalence of comorbidity (59.5% vs. 43.8%) and was more likely to be associated with meeting upgrade criteria (50.0% vs. 37.5%). There was little difference between adherent and non-adherent patients in tobacco use (54.8% vs. 50.0%) or place of residence (81.0% vs. 81.3%). Despite a numerically higher level of education among non-adherent patients (25.0% vs. 19.0%) and a higher likelihood of employment (81.3% vs. 59.5%), reported monthly net household income was lower ($\leq$ €2,000: 56.3% vs. 47.6%) and they were more likely to be unable to work due to PsO (43.7% vs. 21.4%). Non-adherent patients reported a significantly lower monthly expenditure on disease-related activities ($<$ €50: 81.3% vs. 52.4%; $p = 0.043$) and a significantly higher incidence of AEs (65.3% vs. 19.0%; $p = 0.016$).

Impact of therapy adherence on QoL and disease-related factors (Table 3)

Therapy adherence was associated with a numerically higher QoL compared with non-adherence ("very satisfied" response: 64.3% vs. 43.8%, $p = 0.161$). While it did not reach

statistical significance, there was a trend toward worsening of pruritus and pain, an increased burden of treatment, and a higher perceived disease severity among non-adherent patients. A numerically higher DLQI (5.0, SD 5.5 vs. 4.5, SD 5.4) as well as WHO-5 Well-Being Index (65.3, SD 24.9 vs. 59.0, SD 23.2) and lower EQ-5D-VAS values (65.0, SD 20.4 vs. 71.1, SD 21.3) were also associated with non-adherence.

DISCUSSION

This study provides a descriptive overview of drug adherence and QoL in a typical patient cohort of a specialized dermatological treatment center in Germany and identifies several sociodemographic, clinical, and treatment-related factors associated with adherence/non-adherence. Despite existing research on treatment adherence in patients with PsO,⁶ there are still research gaps regarding specific factors and regional differences. The findings of this study indicate that approximately 25% of patients do not regularly comply with their systemic therapy, consistent with previous reports of an adherence rate of approximately 61% for biologicals, although reported figures vary across studies.¹⁵ In our retrospective cohort, documented factors for non-adherence were diverse and included both medical and non-medical (e.g., administrative) aspects, supporting the results of earlier studies that highlighted time effort, AEs, and loss of efficacy as the main reasons.^{19,20} Additionally, smoking was significantly associated with non-adherence. There is a known link between addiction diseases and PsO. These behaviors not only contribute to disease development but may also negatively influence patients' perception of their condition and their response to treatment, which can lead to non-adherence.^{6,21,22}

The present study revealed no statistically significant discrepancy in treatment adherence between patients from a large urban care center and surrounding areas. Since the UKR, where the study was conducted, serves a significant proportion of patients from surrounding areas, it was hypothesized that their place of residence and accessibility of care might be a factor affecting adherence. The observed similarity in adherence rates may be indicative of comparable conditions in terms of access to medical care and treatment in both proximate and distant regions. However, this finding is not consistent with the results obtained by Radtke et al. (2010), who identified regional disparities in access to healthcare due to economic and regulatory factors.²³

The results of this study indicate that 75.9% of patients in the prospective cohort had obtained a secondary school graduation, while 20.7% had attained the highest school qualification. In comparison with national reference data obtained from the Statista database (2023), this cohort shows a higher proportion of individuals with lower educational attainment than the national average.²⁴ Despite the absence of a direct correlation between educational level and adherence, previous studies have suggested that a low level of education is associated with reduced health

literacy and, consequently, poorer treatment adherence.²⁵ Conversely, a higher level of education has been shown to correlate positively with adherence.²⁶ It is conceivable that the individual's comprehension of illness exerts a greater influence in this context than formal education.

As reported by the *Federal Agency for Civic Education of Germany* (2018), the net monthly income of only 29.6% of the German population was less than €2,000; however, this figure was 50.0% in our cohort.²⁷ According to data provided by the *Federal Statistical Office of Germany*, there is also a close correlation between educational attainment and income.²⁸ Several studies have demonstrated that low socioeconomic status (SES) – including lower income and educational attainment – is significantly associated with increased PsO severity (e.g., higher PASI and DLQI scores) and poorer treatment access. A study in Bologna (n = 300) showed that low SES independently predicted moderate-to-severe PsO.²⁹ A French cohort (n = 903) confirmed that low SES correlates with higher disease severity and less frequent systemic therapy use.³⁰ Consequently, healthcare professionals should pay particular attention to patients from disadvantaged backgrounds, as they may not only present with more advanced disease but also face greater barriers to effective treatment adherence and access.

A significant correlation was identified between occupational status and adherence. In the retrospective cohort, non-adherent patients were more frequently retired than adherent patients, indicating greater difficulties with treatment regimens among elderly patients. The prospective cohort also demonstrated a higher incidence of incapacity to work among non-adherent patients, as shown in Table 2. Kardas et al. (2013) noted in a systematic review that social welfare benefits, low SES, and household income are significant barriers to continuous therapy.³¹ Similarly, Zaghloul and Goodfield (2004) reported higher adherence among employed patients with psoriasis.⁵ Non-adherent patients reported significantly lower monthly expenditure on disease-related activities, considering the differences in patient co-payment systems for systemic psoriasis therapies across countries. In many healthcare systems, patients are required to pay a percentage of the total cost of their medication, which can result in substantial financial burden, particularly for biologics and other high-cost treatments. In Germany, however, patients are typically subject to a fixed prescription fee of only €10 per quarter. In the study by Lebwohl et al. (2014), it was noted that high out-of-pocket costs can negatively impact adherence.³² In addition to the income gap, this could explain why patients with a lower level of education, income, and health literacy invest less in their health and therefore have lower adherence to treatment.⁷

As also confirmed in the literature, the drug class had a significant influence on treatment adherence in the retrospective group.^{33,34} Patients receiving conventional non-biologic systemic therapy had significantly lower adherence rates, while those receiving IL-12/23 or IL-23 inhibitors

demonstrated significantly higher adherence rates. The occurrence of AEs was found to be a significant factor in both study groups, as they occurred with a significantly higher frequency in non-adherent patients. Compared to conventional non-biologic systemic therapies, biologics show a subjectively lower burden, higher efficacy, and thus higher patient satisfaction. Concurrently, they are associated with a reduced incidence of severe AEs, which in turn promotes their adherence rate.^{5,25,35} In this context, biologic agents have consistently shown superior drug survival compared to conventional non-biologic systemic treatments. For example, Mastorino et al. (2024) reported higher drug survival rates among patients treated with biologics, highlighting their balance of high efficacy and low AEs.³⁴ However, the complexity of the medication and the time required for its administration are positively correlated with the probability of non-adherence.^{36,37}

In contrast to the findings of Augustin et al. (2005), who reported a mean DLQI score of 8.9 (moderate effect on QoL) among patients with moderate-to-severe PsO ($n = 227$) in German practices, the present study observed a lower mean score of 4.6 (small effect on QoL).³⁸ This difference may reflect variations in the study populations as well as the implementation of more effective treatment strategies, as all patients in this cohort received systemic therapy. Compared to data from the general population, which reports an average EQ-5D-VAS score of 77.1 for Germany,³⁹ our results demonstrate a marginally lower mean score of 69.8, indicating a reduced perception of health status and, consequently, a potentially lower QoL. Non-adherence was found to be associated with a diminished EQ-5D-VAS score in this study (65.0), thereby emphasizing the significance of continuous therapy to maintain patients' QoL. In contrast to the POSITIVE study (Augustin et al., 2023), which reported significant improvements in well-being alongside sustained adherence to systemic therapy, the present study found that non-adherent patients had higher WHO-5 Well-Being Index scores than adherent patients.⁴⁰ Psychological factors – such as lower illness perception or body image concerns – might reduce perceived need for treatment while preserving self-reported well-being.⁴¹ A diminished perception of illness severity, often resulting from limited health literacy, has been shown to contribute to poorer adherence in patients with lower educational and socioeconomic status.^{25,42}

Study limitations

The monocentric retrospective study design and the relatively small sample size, particularly within the non-adherent subgroup, may limit the statistical power and generalizability of the results. Since the retrospective design relies on routinely documented information from patient medical records, reports may be incomplete and there-

fore limit the accuracy of adherence-related assessments. In particular, documentation-based proxy measures may underestimate non-adherence. The prospective questionnaire is based on subjective self-reports, which are prone to social desirability bias, and it does not include objective measurement methods. Given the subjective nature of self-reported non-adherence, the true prevalence is likely underestimated, as some cases may go unreported due to forgotten doses or incorrect medication intake. Moreover, social desirability may lead individuals to embellish their statements. Additionally, selection bias must be considered, as the survey was conducted in a hospital setting. Consequently, the sample may disproportionately include patients who are more engaged with their treatment and, therefore, more adherent. Although the exact magnitude of these biases cannot be quantified, they should be taken into account when interpreting the findings. Conducting the survey at a single time and location limits its validity to patients with mild disease, to non-university outpatient settings, or to healthcare systems with different reimbursement structures, but provides valuable information on the care situation and QoL of patients with PsO in Eastern Bavaria in Germany. Overall, the findings should be interpreted cautiously, particularly in light of the exploratory design.

CONCLUSIONS

The present study underlines that adherence to therapy for chronic diseases depends on various aspects. The type of medication and corresponding AEs, as well as the associated cost investment, represent some of the most important factors related to successful treatment adherence. Financial resources, level of education and demographic factors were also found to be associated with adherence. Improving treatment adherence therefore requires not only the selection of more efficacious and better tolerated medications, but also the consideration of socioeconomic and regional factors to ensure more comprehensive and equitable care for patients with PsO. Understanding the complex causes of treatment adherence may not only improve patient-related outcomes but also reduce healthcare costs and enable the use of highly effective therapies to their full potential. In daily practice, particular attention should be paid to vulnerable patient groups, such as individuals with lower educational or socioeconomic status, reduced QoL, or those receiving conventional non-biologic systemic therapies. Integrating individualized, patient-centered strategies – including targeted patient education, simplified treatment regimens, and regular follow-up visits – may help improve long-term adherence. These findings complement existing evidence regarding adherence and highlight the need for future multicenter studies with larger samples to increase the utility of the data and capture more specific regional differences.

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