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ARTICLE

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Impairment in work and activities of daily life in patients with psoriasis: results of the prospective BioCAPTURE registry

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ABSTRACT

Background: Little is known about the extent of impairments in work and activities of daily life (ADL) in patients with psoriasis, and the influence of contextual factors such as disease-related characteristics and treatment. Therefore, this study aimed to assess these impairments in patients with psoriasis who started using biologicals/small molecule inhibitors.

Methods: Using data from the prospective BioCAPTURE registry, we collected patient, disease, and treatment parameters, as well as work/ADL impairments at baseline, 6 and 12 months. Changes in impairment parameters and correlations between impairment and patient/disease characteristics were assessed using generalized estimating equations.

Results: We included 194 patients in our analysis. After biological initiation, disease activity decreased significantly (PASI 11.2 at baseline versus 3.9 at 12 months, $p<0.001$). Work-for-pay in this cohort was lower than in the Dutch general population (53% versus 67%, $p=0.01$). In patients who had work-for-pay, presenteeism improved over time (5% at baseline versus 0% at 12 months, $p=0.04$). Up to half of the patients reported impairments in ADL, which did not change over time. Associations between impairments and contextual factors varied, but all impairments were associated with worse mental/physical general functioning.

Conclusion: Patients with psoriasis using biologicals are less likely to have work-for-pay. Treatment improves the work productivity of employed patients, but we were unable to detect changes in ADL performance.

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KEYWORDS
Psoriasis; work; activities of daily living

Introduction

Psoriasis is an immune-mediated inflammatory disease of skin and nails, which can impact a patient's life in several ways. Sensations of pain, burning, or itching can affect the physical well-being of a patient, while the stigma of (visible) skin lesions can have an impact on psychological well-being (1). Moreover, treatment of psoriasis can be time-consuming (e.g. application of topicals multiple times a day, or multiple hospital visits for UV therapy) or have side effects (e.g. nausea or injection site reactions) (2). All these burdens can culminate in impairments in a patient's personal and professional daily life.

Patients with psoriasis mention that pain and fatigue disrupt their normal family roles (3). Moreover, patients experience a negative influence of the disease on work performance (4, 5). Sick leave has shown to be more common in psoriasis patients when

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compared to the US general population: during one year, 56% of psoriasis patients took sick leave, versus 42% of the general population (6). Moreover, impairments in work and daily life activities increase with increased severity of psoriasis (4, 7, 8), and diminish after successful treatment (9–11).

While we know that the impact of psoriasis on work and activities of daily life (ADL) is an important theme for patients, we know little about the different areas of ADL affected by the disease (12, 13). Also, the influence of contextual factors such as sex, relationship status, educational level, and comorbidity on these impairments of ADL is unknown. Moreover, most data on treatment effects on work and ADL impairment are based upon (secondary outcomes of) randomized clinical trials, where real-world data is lacking (9, 14–21).

Therefore, we assessed the extent of impairments in work and ADL in a daily practice cohort of patients with plaque psoriasis treated with biologicals/small molecule inhibitors (smi). In addition, we examined the effect of 6–12 months of treatment on these impairments and explored associations between impairment and contextual factors and treatment success.

Patients and methods

Study design and population

For this study, we used data from the Continuous Assessment of Psoriasis Treatment Use Registry with Biologics (BioCAPTURE registry – www.biocapture.nl). In short, this prospective, multicenter registry records data of adult patients with plaque psoriasis using biologicals/smi from 4 academic and 17 nonacademic dermatology centers in the Netherlands. Under Dutch law, this non-interventional study is exempt from ethics review by the medical ethical committee. Informed consent was obtained from all patients before inclusion in the study, and it was performed in accordance with Good Clinical Practice Guidelines and the Declaration of Helsinki.

Data collection

We collected data from patients from inclusion in the BioCAPTURE registry from 2010–2021, with a per-patient follow-up time of one year. Patients were included for the present analysis from the start of their first biological therapy registered in BioCAPTURE on, and data were collected every three months up to one year after initiation (regardless of treatment switch within this first year). For this analysis, we used all data of patients who completed questionnaires about work participation and/or ADL impairment at baseline assessment and at least one follow-up timepoint. Patients who discontinued their biological or switched to another biological, but continued to provide data, were also included. Patients who did not provide follow-up data were excluded from the analysis.

Data collected included information about contextual factors and disease-related characteristics. Contextual factors included were age, sex, relationship status, education, and comorbidity (using the Charlson Comorbidity Index (CCI)) (22). Comorbidity was further categorized into low (CCI 0 points), intermediate (CCI 1-2 points), and high (CCI 3 or more). Disease-related characteristics included were disease duration, presence of concomitant psoriatic arthritis -PsA-, current biological use, and disease activity assessed with the Psoriasis Area and Severity Index (PASI) (23). Current biological use was categorized per mode of action: TNFα-inhibitors (i.e. etanercept, adalimumab, infliximab, certolizumab), IL-17 inhibitors (i.e. secukinumab, ixekizumab, brodalumab), IL23-inhibitors (i.e. guselkumab, risankizumab), IL12/23 p40 inhibitors (i.e. ustekinumab), and PDE4-inhibitors (apremilast).

Other patient-reported outcomes included skin-related quality of life assessed with the Dermatological Life Quality Index (DLQI) (24), and physical and mental wellbeing assessed with the component scores of the Short Form 36 (PCS/MCS) (25).

Primary outcomes were impairments in work participation and ADL. Data about work participation were collected using the PROductivity and DISease Questionnaire (PRODISQ) (26). Work participation parameters were: having work-for-pay, absenteeism (percentage of time being away from work), and presenteeism (percentage of estimated "productivity loss" while at work). Absenteeism and presenteeism can be combined into overall work impairment as follows: Absenteeism + ((1-Absenteeism) * Presenteeism). All work parameters are reported in percentage of maximum work output as reported by patients, usually in median percentage reported and interquartile ranges (IQR).

Data about impairments in ADL were collected from the TIC-P questionnaire (27). Patients were asked if they experienced any impairments in four ADL domains: household chores (i.e. cooking, cleaning), grocery shopping (outside of the home), home maintenance and childcare. Answers were dichotomized into ADL impairment present or not for each domain.

Statistical analysis

Continuous data were described with mean (standard deviation, SD) or median (interquartile ranges, IQR). Categorical data were described as absolute frequencies (percentages).

We used generalized estimating equations (GEE) to explore differences in disease-related and patient-reported outcomes (i.e. PASI, DLQI, PCS, MCS, work and ADL impairment) at different timepoints, and to explore associations of work/ADL impairments with disease-related characteristics and contextual factors. GEE allows the estimation of the average effect of an independent variable on a specific outcome at the population level (28). For example, we can estimate the average effect of a change in PASI on the likelihood of having work-for-pay. Since GEE makes use of all available data, missing data was not imputed.

First, differences in disease-related and patient-reported outcomes between different timepoints were tested. For continuous outcomes (e.g. PASI, DLQI, presenteeism) a linear GEE model was used, while for binary outcomes (e.g. work-for-pay, ADL impairment) a logistic GEE model was used. Timepoints (baseline, 6 months – M6, 12 months – M12) were entered as independent variables. Baseline values were regarded as the default state, and statistical significance of values at M6 and M12 were tested in comparison to baseline.

Second, we assessed the extent of work impairment in the study patients. Also, we compared the work-for-pay status (proportion with paid work) of the BioCAPTURE cohort with the Dutch general population by using an age- and sex-matched model based on data from the Central Bureau of Statistics (CBS) of the Netherlands (29). The CBS provides yearly data on employment rates, stratified for sex and age groups per ten years of age. Data were available from 2013 onwards. BioCAPTURE patients included before 2013 were matched to the general population of 2013. Differences between the proportions of patients with work for pay in the BioCAPTURE cohort vs. the general population were tested by a Chi-square test.

Third, we used four separate logistic GEE models to test associations of work/ADL impairments with disease-related characteristics and contextual factors. Work-for-pay (yes/no), impairment in household chores (yes/no), impairment in grocery shopping (yes/no), and impairment in home maintenance (yes/no) were the dependent variable in each of the models. To explore the influence of disease-related characteristics and contextual factors on presenteeism, we used a linear GEE model. Independent variables entered in the models were: age, sex, relationship status, education (primary/secondary versus tertiary), presence of PsA, disease duration of psoriasis, PASI over-time, DLQI over-time, MCS over-time, PCS over-time, and whether the biological/smi used at baseline was still used after 6/12 months.

Last, to assess the association of work/ADL impairments with treatment success, we compared the parameters of work/ADL impairment (work-for-pay, presenteeism, and impairments in household chores, grocery shopping, and home maintenance) at different timepoints between patients who did and did not have treatment success. As a proxy for treatment success, we used PASI ≤ 1.0 at 6/12 months, PASI ≤ 3.0 at 6/12 months, or whether the biological/smi used at baseline was still used after 6/12 months. Proportions were compared using a Chi-square or Fisher's exact test where appropriate. Non-parametrical data were compared using a Mann-Whitney U test.

$p < 0.05$ was considered statistically significant. All analyses were performed in SPSS Statistics software, version 25.0 (IBM, Armonk, NY, USA).

Table 1. Sample characteristics at baseline.

N	194
Demographics	
Age	
Mean, SD	52 (13)
Sex, female[a]	
Mean, SD	79/189 (42%)
Relationship state[b]	
Single	54/186 (28%)
In a relationship	132/186 (71%)
Education level[c]	
Primary	9/191 (5%)
Secondary	127/191 (66%)
Tertiary	55/191 (29%)
Charlson Comorbidity Index	
Low (0)	84/194 (43%)
Intermediate (1–2)	85/194 (44%)
High (≥3)	23 (13%)
Disease characteristics	
Disease duration (years)[d]	
Median, IQR	19 (11, 35)
Concomitant PsA[e]	53/185 (29%)
Current biological/smi	
TNFa-inhibitors	110/194 (57%)
IL17-inhibitors	21/194 (11%)
IL23-inhibitors	13/194 (7%)
IL12/IL23 p40 inhibitors	44/194 (23%)
PDE4-inhibitors	6/194 (3%)

Parameters are expressed in number/percentages unless indicated otherwise.
Relationship status was dichotomized into having a partner, or being single, regardless of marital status. Education was categorized into primary, secondary and tertiary education. Primary education represents primary school only, tertiary education represents college or university, and secondary education represents high school or community college.
a = missing in 6 patients, b = missing in 8 patients; c = missing in 3 patients; d = missing in 17 patients; e = missing in 9 patients.
IL = interleukin; IQR = interquartile range; PDE = phosphodiesterase; PsA = psoriatic arthritis; TNFa = tumor necrosis factor alpha; SD = standard deviation; smi = small molecule inhibitor.

Results

Patient and disease characteristics

Table 1 shows the patient characteristics ($n = 194$). Mean age of patients was 52 years (SD 13), and 79/189 was female (42%). A majority was in a relationship (132/186, 71%), and almost all had secondary or higher education (182/191, 95%). Mean disease duration was 19 years (IQR 11-35 years), and one in three patients had concomitant PsA (53/185, 29%). Most patients had low to intermediate comorbidity scores (low 84/197, 43%; intermediate 85/194, 44%; high 25/194, 13%). Dispersion of patient data throughout time points, including explanation of missing data, is shown in Figure 1.

Disease characteristics and health status during 12 months follow-up

Table 2 shows the follow-up data of the cohort, where timepoint differences were tested using GEE with the different timepoints as independent variables. At M12, the number of patients using the same biological/smi as at baseline had dropped significantly (M6 159/169 – 94%, M12 99/127 – 78%, $p < 0.001$). Both objective skin disease activity, as well as skin-specific QoL, improved in comparison to baseline (PASI: baseline 11.2 ± 7.2; M6 3.9 ± 4.6, $p < 0.001$; M12 3.9 ± 4.0, $p < 0.001$; DLQI: baseline 4, IQR 1-10; M6 1, IQR 0-4, $p < 0.001$; M12 2, IQR 2-5, $p < 0.001$). Moreover, also general physical and mental functioning improved significantly (PCS: baseline 43.6 ± 10.2; M6 46.1 ± 10.3, $p < 0.001$; M12 45.4 ± 11.0, $p = 0.01$; MCS: baseline 48.1 ± 11.4; M6 50.1 ± 10.8, $p = 0.01$; 12 months 51.0 ± 10.0, $p = 0.01$).

Work-for-pay and work impairment during 12 months follow-up

Table 2 shows the course of work-related parameters over a 12-month period, again using GEE with the different timepoints as independent variables to test for differences between timepoints. At baseline, 110/94 (57%) had work-for-pay. When comparing the baseline percentage of work-for-pay between the study population to the general Dutch population, the study population showed a lower employment rate than expected (work-for-pay BioCAPTURE 53% versus general population 67%, χ^2 test, $p = 0.01$). The percentage of patients with work-for-pay did not change during follow-up (M6 53%, $p = 0.09$; M12 52%, $p = 0.13$).

Regarding work impairment, absenteeism was low throughout the entire follow-up (baseline 0% of maximum work hours, IQR 0-5; M6 0%, IQR 0-0, $p = 0.01$; M12 0%, IQR 0-5, $p = 0.76$), whereas presenteeism showed a statistically significant improvement at 12 months, but not at 6 months (baseline 5% of maximum theoretical productivity, IQR 0-18; M6 0%, IQR 0-15, $p = 0.17$; M12 0%, IQR 0-10, $p = 0.04$). Overall work impairment showed improvement over time, which was significant at 6 months but not 12 months (baseline 14%, IQR 0-26; M6 months 3%, IQR 0-20, $p = 0.01$; M12 2%, IQR 0-23, $p = 0.49$).

Associations between work impairment and disease-related characteristics/contextual factors

Table 3 shows the results of the GEE, exploring relationships for work impairment with disease-related characteristics and contextual factors. In a logistic GEE model, being in a relationship (OR 2.12, 95%CI 1.04-4.33, $p = 0.04$) and remaining on the same

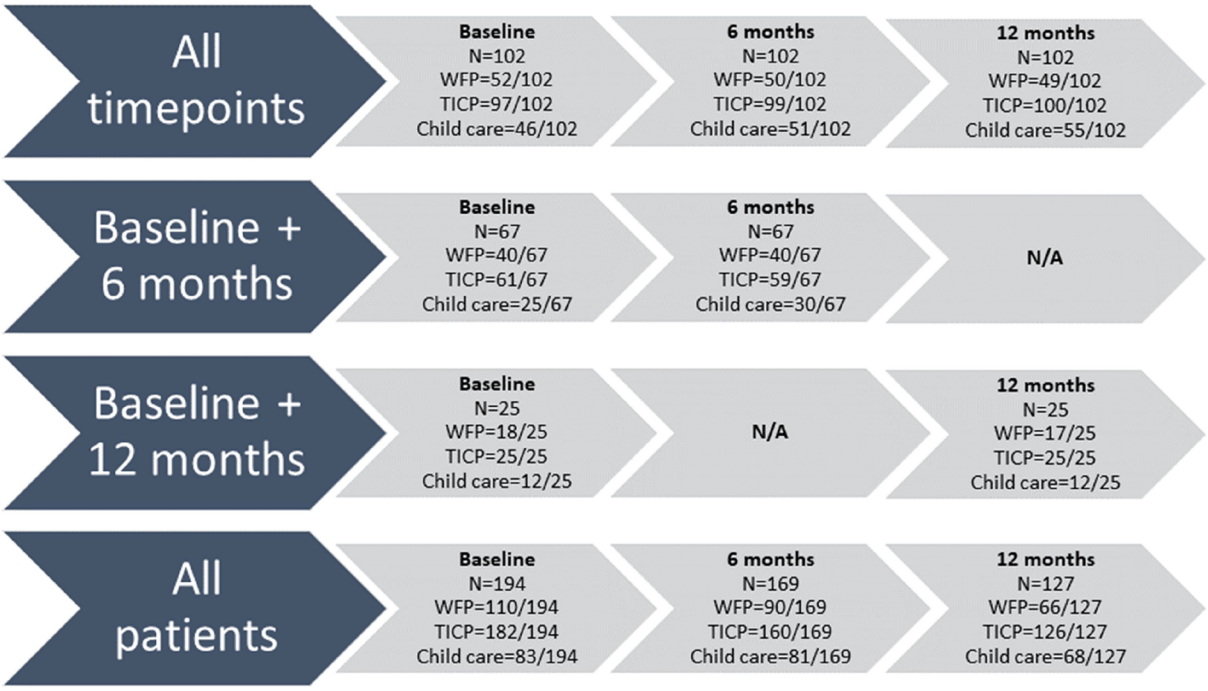

Figure 1. Inclusion of patients and explanation of missing data.
Patients were included if they had filled out a PRODISQ questionnaire at baseline and at least 1 follow-up timepoint (i.e. 6 or 12 months). 102 patients provided data for all three timepoints, 67 patients provided data on baseline and 6 months only, and 25 patients provided data on baseline and 12 months only.
All patients provided data on their work-for-pay (WFP) status (inclusion criteria). Only patients with WFP could provide information on presenteeism and overall work impairment. Not all patients filled in the TIC-P questionnaire, and therefore not all patients provided data on impairment in activities of daily living (ADL). Only patients with a filled in TICP, who were taking care of underage children, could provide data about child care.
N/A = not applicable; WFP = work-for-pay.

biological/smi (OR 3.22, 95%CI 1.00-10.39, $p = 0.05$) were positively associated with the likelihood of having work-for-pay. However, female sex (OR 0.48, 95%CI 0.25-0.93, $p = 0.03$), a higher age (OR 0.89, 95%CI 0.86-0.92, $p < 0.001$), and a higher amount of comorbidity (low vs high OR 0.22, 95%CI 0.07-0.67, $p = 0.01$) were negatively associated with the likelihood of having work-for-pay. Disease activity and QoL parameters showed no significant relationship with work-for-pay status.

Next, we explored relationships for presenteeism (a quantitative marker of work impairment) with disease-related characteristics and contextual factors using a linear GEE model. Remaining on the same biological/smi ($B = 13.20$, 95%CI 2.52, 23.89, $p = 0.02$) and a higher amount of comorbidity (low vs intermediate $B = 5.75$, OR 1.04-10.46, $p = 0.02$) showed a positive association with a higher presenteeism (more impairment at work). Skin-related QoL (DLQI: $B = 0.42$, 95%CI 0.06-0.79, $p = 0.02$), and physical and mental functioning (PCS: B= −0.64, 95% CI −0.87 to −0.41, $p < 0.001$; MCS: B= −0.57, 95% CI −0.78 to −0.37, $p < 0.001$) showed a negative association with a higher presenteeism. In other words, deterioration of skin-related QoL by 1 point is associated with an increase in presenteeism of 0.4%, on a population level.

ADL impairment during 12 months follow-up

Table 2 and Figure 2 show the baseline and follow-up data of the ADL-related parameters, using GEE with the different timepoints as independent variables to test for differences between timepoints. A substantial part of patients reported impairment in their ADL at baseline, of which home maintenance was most affected (impairment in household chores 37%; impairment in grocery shopping 31%; impairment in home maintenance 48%; impairment in child-care 28%). None of the ADL impairments changed during follow-up.

Associations between ADL impairment and disease-related characteristics/contextual factors

Table 3 shows the results of the GEE, exploring relationships for ADL impairment with disease-related characteristics and contextual factors. Being in a relationship showed a negative relation with being impaired in household chores (OR 0.40, 95%CI 0.18-0.87, $p = 0.02$). Disease activity showed a negative association with being impaired in household chores (OR 0.95, 95%CI 0.91-1.00, $p = 0.05$) and being impaired in home maintenance (OR 0.94, 95%CI 0.89-0.99, $p = 0.02$). A higher amount of comorbidity showed a positive association with being impaired in grocery shopping (low vs intermediate OR 3.95, 95%CI 1.70-9.17, $p = 0.001$). Physical and mental functioning showed a negative association with being impaired in all ADL domains (e.g. household chores: PCS OR 0.85, 95%CI 0.82-0.89, $p < 0.001$; MCS OR 0.94, 95%CI 0.91-0.97; $p < 0.001$).

Association between treatment success and work/ADL impairment

Supplemental Table 1 shows the percentage of patients with work/ADL impairment, split per timepoint. Comparisons were made between patients with and without treatment success, where treatment success was defined as PASI ≤ 1.0, PASI ≤ 3.0, or retainment of the same biological/smi as used at baseline. Reaching PASI ≤ 1.0 after 12 months of treatment was associated

Table 2. Disease characteristics, work and ADL impairment at baseline and during follow-up.

	Baseline	6 months	12 months
N	194	169	127
Disease characteristics			
Same biological/smi	194/194 (100%)	159/169 (94%)[a] $p>0.05$	**99/127 (78%)**[b] **$p<0.001$**
PASI			
Mean, SD	11.2 (7.2)[c]	**3.9 (4.6)**[d] **$p<0.001$**	**3.9 (4.0)**[e] **$p<0.001$**
DLQI			
Median, IQR	4 (1, 10)[f]	**1 (0, 4)**[g] **$p<0.001$**	**2 (0, 5)**[h] **$p<0.001$**
SF36			
PCS			
Mean, SD	43.6 (10.2)[i]	**46.1 (10.3)**[j] **$p<0.001$**	**45.4 (11.0)**[k] **$p=0.04$**
MCS			
Mean, SD	48.1 (11.4)[i]	**50.1 (10.8)**[j] **$p=0.01$**	**51.0 (10.0)**[k] **$p=0.01$**
Work impairment			
Work for pay	110/194 (57%)	90/169 (53%) $p=0.09$	66/127 (52%) $p=0.13$
Absenteeism			
Median, IQR	0 (0,5)[l]	**0 (0, 0)**[m] **$p=0.01$**	0 (0, 5)[n] $p=0.76$
Presenteeism			
Median, IQR	5 (0, 18)[o]	0 (0, 15)[p] $p=0.17$	**0 (0, 10)**[f] **$p=0.04$**
Overall work impairment			
Median, IQR	14 (0,26)[l]	**3 (0, 20)**[m] **$p=0.01$**	2 (0, 23)[q] $p=0.49$
ADL impairment			
Household chores			
Impaired	71/183 (37%)[r]	60/160 (38%)[t] $p=0.74$	41/126 (32%)[o] $p=0.13$
Grocery shopping			
Impaired	57/184 (31%)[s]	48/160 (30%)[t] $p=0.75$	35/126 (28%)[o] $p=0.44$
Home maintenance			
Impaired	89/184 (48%)[s]	73/160 (46%)[t] $p=0.43$	53/126 (42%)[o] $p=0.13$
Childcare			
Impaired	23/83 (28%)[u]	18/83 (22%)[v] $p=0.28$	16/68 (23%)[y] $p=0.50$

Values are given in number and percentage unless stated otherwise. Differences were tested using generalized estimating equations (GEE). P-values are expressed in comparison to baseline. Significant differences are highlighted in bold.
a = missing in 25 patients; b = missing in 67 patients; c = missing in 19 patients; d = missing in 84 patients; e = missing in 110 patients; f = missing in 3 patients; g = missing in 27 patients; h = missing in 71 patients; i = missing in 14 patients; j = missing in 29 patients; k = missing in 72 patients; l = missing in 36 patients; m = missing in 32 patients; n = missing in 24 patients; o = missing in 1 patient; p = missing in 2 patients; q = missing in 25 patients; r = missing in 11 patients; s = missing in 10 patients; t = missing in 34 patients; u = missing in 12 patients, not applicable in 99 patients; v = missing in 33 patients, not applicable in 78 patients; y = missing in 1 patient, not applicable in 57 patients.
ADL = activities of daily life; DLQI = dermatology life quality index; IQR = interquartile range; MCS = mental component summary scale; PASI = psoriasis area and severity index; PCS = physical component summary scale; SD = standard deviation; SF36 = short form 36; smi = small molecule inhibitor.

with higher likelihood of having work-for-pay. Having treatment success was not associated with any of the outcomes on ADL impairment.

Discussion

Using prospective, longitudinal data from the BioCAPTURE cohort, we show that Dutch patients with plaque psoriasis who use biologicals/smi are less likely to have work-for-pay than the general Dutch population. Those who had work-for-pay reported a low percentage of overall work impairment, and this improved further over a 12 month period. Work-for-pay status was related to demographic variables (i.e. sex, age, and relationship status), while presenteeism was related to retainment of the first biological/smi, comorbidity, and mental/physical functioning. Moreover, up to half of patients report impairments in ADL. Improvement of objective disease activity was associated with improvement in ADL impairments. However, despite treatment success, the percentage of patients who experience impairments in ADL did not improve in the first year.

Regarding work-for-pay, patients with psoriasis were less likely to have paid employment than the Dutch general population. Although in this study we did not ask for the reason for not having work-for-pay, a survey in the United States showed that 92% of patients with psoriasis who did not have work-for-pay reported that having psoriasis was the main reason for their unemployment (4). Interestingly, patients with longstanding PsA are also less likely to have work-for-pay than the general population, while this is not the case for patients with early PsA (30, 31). Note that patients in the BioCAPTURE cohort had a disease duration of 19 years on average, before initiating the biological. Hypothetically, as in PsA, it could also be the case that patients with long-standing psoriasis are less likely to have work-for-pay than patients with early disease, i.e. that patients with Pso become unemployed during their disease. In the future, the possible relationship between disease duration and employment deserves future exploration in a psoriasis cohort with less longstanding disease to see if loss of work-for-pay arises during the disease, and to see if effective treatment could be protective against loss of work-for-pay.

In patients who have work-for-pay, we found an overall work impairment of 14% at baseline. This is comparable to other observational psoriasis cohort studies (8, 32–35), while interventional studies with psoriasis patients report a higher level of overall work impairment up to 34% (15, 18, 20, 36). This discrepancy between observational and interventional studies may be explained by a difference in the studied populations. In interventional studies, patients with a more pronounced disease are usually selected to ascertain that the intervention can achieve a beneficial effect; while in observational studies a more representative cross-selection of all patients is studied. Thus, interventional studies usually select patients with worse disease status, who presumably might have more work impairment. Indeed, previous studies have shown that a higher disease activity is associated with more work impairment (34, 37–39).

During follow-up, we saw an improvement in both presenteeism and overall work impairment after treatment, which is in line with other interventional studies (14, 15, 18–21, 36, 40). Although we found no association of presenteeism over-time with disease activity over-time, several studies did report that a larger treatment effect (e.g. a larger decrease in disease activity) was associated with more improvement in work impairment (9, 16, 17), while another study found no significant correlation (14). This difference may be partly explained by group size, differences in study setting (clinical trial versus registry), or by differences between countries (32). In conclusion, the relationship between presenteeism and disease activity needs further exploration.

Up to half of the patients in our study reported impairment in ADL. This is in line with other international cohorts (14, 33, 41). During 12 month follow-up, we found no change in the percentage of patients who felt impaired in ADL over time. However,

Table 3. Associations between work-for-pay status, presenteeism, impairments in ADL, and disease-related characteristics/contextual factors.

	Work-for-pay		Presenteeism		Household chores		Grocery shopping		Home maintenance	
	OR (95% CI)	P-value	B (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Female sex	**0.48 (0.25, 0.93)**	***p* = 0.03**	−1.77 (−6.39, 2.86)	*p* = 0.45	1.17 (0.56, 2.41)	*p* = 0.68	1.12 (0.51, 2.42)	*p* = 0.78	1.31 (0.62, 2.78)	*p* = 0.48
Age	**0.89 (0.86, 0.92)**	***p* = <0.001**	−0.01 (−0.25, 0.23)	*p* = 0.94	1.01 (0.98, 1.04)	*p* = 0.40	0.97 (0.94, 1.01)	*p* = 0.11	1.00 (0.97, 1.03)	*p* = 0.84
Being in a relationship	**2.12 (1.04, 4.33)**	***p* = 0.04**	3.78 (−1.05, 8,63)	*p* = 0.13	**0.40 (0.18, 0.87)**	***p* = 0.02**	0.53 (0.24, 1.18)	*p* = 0.12	0.51 (0.22, 1.18)	*p* = 0.11
Higher Education	1.87 (0.93, 3.79)	*p* = 0.08	1.19 (03.31, 5.69)	*p* = 0.60	0.88 (0.40, 1.96)	*p* = 0.76	0.87 (0.37, 2.04)	*p* = 0.74	1.15 (0.50, 2.64)	*p* = 0.74
Disease duration Pso	1.02 (1.00, 1.04)	*p* = 0.10	0.03 (−0.15, 0.20)	*p* = 0.79	1.00 (0.98, 1.03)	*p* = 0.98	0.99 (0.97, 1.02)	*p* = 0.57	1.02 (0.99, 1.04)	*p* = 0.20
Presence of PsA	1.32 (0.68, 2.56)	*p* = 0.41	−0.23 (05.14, 4.68)	*p* = 0.93	1.47 (0.67, 3.21)	*p* = 0.33	1.95 (0.85, 4.47)	*p* = 0.12	1.53 (0.68, 3.46)	*p* = 0.31
Comorbidity Low vs intermediate	0.54 (0.28, 1.04)	*p* = 0.07	**5.75 (1.04, 10.46)**	***p* = 0.02**	1.57 (0.73, 3.39)	*p* = 0.25	**3.95 (1.70, 9.17)**	***p* = 0.001**	2.01 (0.04, 4.51)	*p* = 0.07
Comorbidity Low vs High	**0.22 (0.07, 0.67)**	***p* = 0.01**	−5.40 (−17.20, 6.40)	*p* = 0.37	1.22 (0.37, 4.00)	*p* = 0.74	2.45 (0.69, 8.76)	*p* = 0.17	3.39 (0.93, 12.33)	*p* = 0.06
Same biological	**3.22 (1.00, 10.39)**	***p* = 0.05**	**13.20 (2.52, 23.89)**	***p* = 0.02**	2.38 (0.63, 9.01)	*p* = 0.20	1.63 (0.40, 0.64)	*p* = 0.50	2.09 (0.52, 8.43)	*p* = 0.30
PASI	0.99 (0.95, 1.04)	*p* = 0.74	−0.25 (−0.54, 0.05)	*p* = 0.10	**0.95 (0.91, 1.00)**	***p* = 0.05**	0.96 (0.92, 1.01)	*p* = 0.13	**0.94 (0.89, 0.99)**	***p* = 0.01**
DLQI	0.97 (0.93, 1.03)	*p* = 0.33	**0.42 (0.06, 0.79)**	***p* = 0.02**	1.00 (0.94, 1.06)	*p* = 0.94	1.04 (0.98, 1.10)	*p* = 0.11	1.00 (0.97, 1.03)	*p* = 0.84
PCS	1.00 (0.97, 1.04)	*p* = 0.95	**−0.64 (−0.87, −0.41)**	***p* < 0.001**	**0.85 (0.82, 0.89)**	***p* < 0.001**	**0.85 (0.81, 0.89)**	***p* < 0.001**	**0.82 (0.78, 0.87)**	***p* < 0.001**
MCS	1.02 (0.99, 1.05)	*p* = 0.32	**−0.57 (−0.78, 0.37)**	***p* < 0.001**	**0.94 (0.91, 0.97)**	***p* < 0.001**	**0.94 (0.91, 0.98)**	***p* < 0.001**	**0.94 (0.90, 0.97)**	***p* < 0.001**

This table shows associations between work-for-pay status, presenteeism, impairments in ADL, and disease/patient characteristics over all time points. Associations were explored using generalized estimating equations (GEE). Significant associations are highlighted in bold ($p < 0.05$). Education was defined as primary/secondary versus tertiary education.

B = regression coefficient; CI = confidence interval; DLQI = dermatology life quality index; MCS = mental component summary scale; OR = odds ratio; PASI = psoriasis area and severity index; PsA = psoriatic arthritis; Pso = psoriasis; PCS = physical component summary scale.

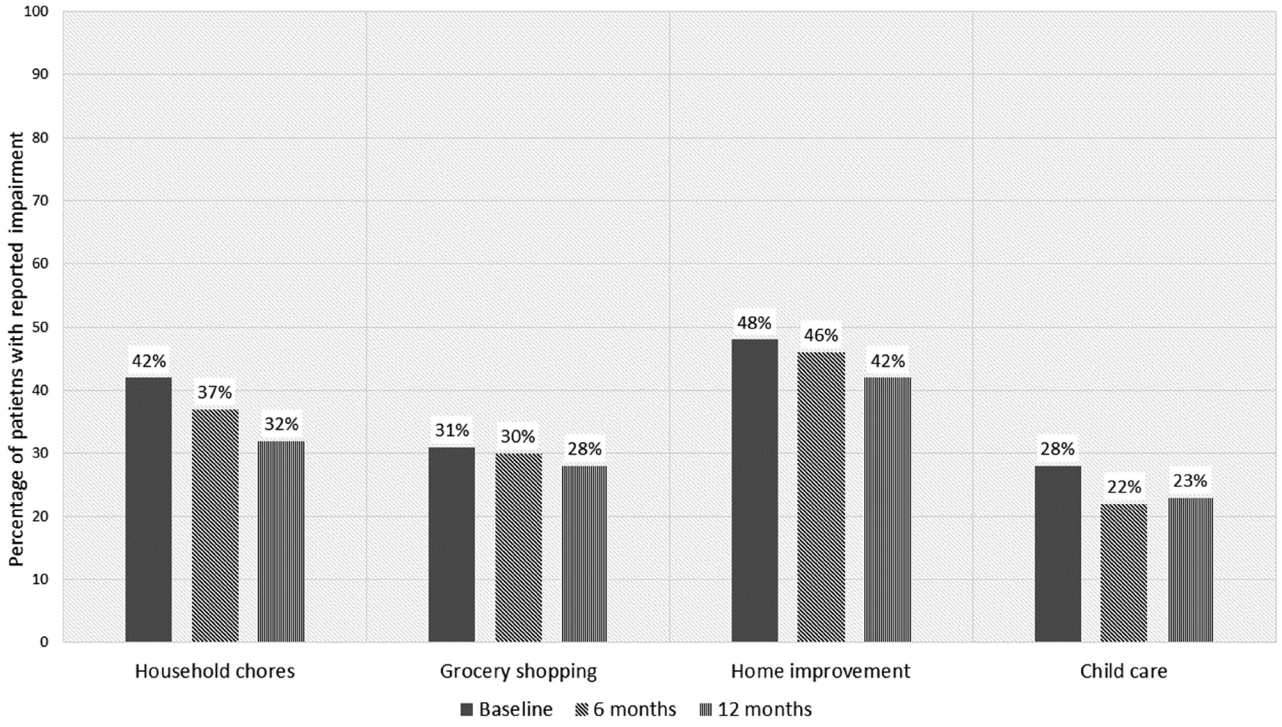

Figure 2. Impairments in ADL, from baseline to one year after start of biologicals/SMI.
The bar charts depict the amount of patients who report any impairment in the mentioned area of activities of daily life.

other studies do report a decrease in the "amount" of impairment in ADL per person (14, 15, 19–21, 36). We did observe a significant positive relationship between disease activity and ADL impairment. Tentatively, this suggests that while ADL impairment can improve after treatment, a significant number of patients do not reach a disease status in which they feel no ADL impairments at all.

Limitations of our study are the missing data in the registry, and the dichotomous way in which we measured ADL impairments. Perhaps, a more sensitive scale (i.e. Likert-scale, visual analogue scale or numerical rating scale) would have revealed differences in ADL impairments between baseline and follow-up. Moreover, our BioCAPTURE registry only contains patients with moderate-to-severe psoriasis treated with biologicals/smi, which may hamper external validity in patients with less severe psoriasis.

Strengths of our study are the exploration of different aspects of ADL impairment, identifying home maintenance as one of the most affected areas. Moreover, our study is the first to report changes in work impairment in patients with psoriasis after treatment with biologicals/smi in a non-trial, real-world setting. This setting may make our results more transferable to daily clinical practice.

In conclusion, our BioCAPTURE registry data revealed that Dutch psoriasis patients who are treated with biologicals/smi are less likely to have work-for-pay than the general population. During one year of treatment with biologicals/smi, we saw improvements in presenteeism and overall work impairment. Moreover, we saw a significant relationship between less disease activity and less ADL impairment, suggesting that effective treatment has a positive influence on the daily life of patients. Since patients state that one of their main treatment goals is "to experience less influence of psoriasis on daily activities, such as working, studying or sports" (12), future research should be aimed at unraveling what causes these perceived impairments, with the ultimate goal to diminish them. We suggest that mapping out work and ADL impairments in a cohort with shorter disease duration would be a good starting point for this exploration, where a possible early intervention might have a protective effect against these impairments.

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Ethics approval and informed consent

Under Dutch law, this non-interventional study is exempt from ethics review by the medical ethical committee. Informed consent was obtained from all patients before inclusion in the study.

Disclosure statement

TvH received personal fees from Eli Lily and Novartis, and non-financial support from UCB, outside the submitted work. JvdR carried out clinical trials for AbbVie, Celgene and Janssen and has received speaking fees/attended advisory boards from AbbVie, Janssen, BMS, Almirall, LEO Pharma and Eli Lilly and reimbursement for attending a symposium from Janssen, Pfizer, Celgene and AbbVie. All funding is not personal but goes to the independent research fund of the department of dermatology of Radboud University Medical Center Nijmegen, the Netherlands. MO has acted as consultant for Eli Lilly. MT has carried out clinical trials for Abbvie, Amgen, Novartis, Eli Lilly, Leo Pharma, Cellgene. All trial funding is not personal but goes to the independent research fund of the department of dermatology of Bravis Hospital Bergen op Zoom, the Netherlands. He has received speaking fees/attended advisory boards from Novartis, UCB and Pfizer and reimbursement for attending a symposium from UCB. SD has attended advisory boards for Abbvie, Janssen and Leo Pharma, and has received a congress fee from Abbvie. MvD has received consulting fees or honorarium from Novartis, Abbvie, Pfizer, Leopharma, Sanofi, Lilly, Janssen and Celgene, has received a grant and payment for lectures including service on speakers bureaus from Novartis, Sanofi and Janssen outside the submitted work. JJM attended an advisory board for Novartis. RT has attended advisory boards from Leo Pharma and Eli Lilly Netherlands.

PvL has received funding from Wyeth for research; carried out clinical trials for Abbott, Janssen; has received speaking and consulting fees from Wyeth, Schering-Plough; has received reimbursement for attending a symposium from Schering-Plough, Pfizer; has attended advisory boards for Abbvie, Leo Pharma, Novartis and UCB. JV had received speaker fee from Galapagos Netherland b.v. outside the submitted work. EdJ has received research grants for the independent research fund of the department of dermatology of the Radboud university medical center Nijmegen, the Netherlands from AbbVie, BMS, Janssen Pharmaceutica, Leo Pharma, Lilly, Novartis, and UCB for research on psoriasis and has acted as consultant and/or paid speaker for and/or participated in research sponsored by companies that manufacture drugs used for the treatment of psoriasis or eczema including AbbVie, Amgen, Almirall, Celgene, Galapagos, Janssen Pharmaceutica, Lilly, Novartis, Leo Pharma, Sanofi and UCB. All funding is not personal but goes to the independent research fund of the department of dermatology of Radboud University medical center Nijmegen, the Netherlands. All other authors have no conflicts of interest to declare.

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Data availability statement

The data underlying this article will be shared on reasonable request to the corresponding author.

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