

# Economic Burden of Joint Disease in Psoriasis: US Claims Analysis

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**P** soriasis (PSO) is a chronic immune disorder that causes scaly, red skin patches<sup>1</sup> and affects about 3% of the adult US population.<sup>2</sup> Approximately 30% of patients with PSO develop psoriatic arthritis (PsA),<sup>3</sup> an inflammatory disease that causes inflammation and swelling of the joints and entheses in addition to skin symptoms.<sup>4</sup> Patients with concomitant joint disease face more severe reductions in quality of life and increased functional disability compared with patients with PSO alone.<sup>5</sup> PsA is costly for patients and the health care system<sup>6,7</sup> and often goes undiagnosed and untreated, leading to poor functional outcomes and joint damage.<sup>8-10</sup>

Common comorbidities in PSO, such as hyperlipidemia, hypertension, obesity, and diabetes, have been associated with increased health care resource utilization (HCRU) and costs compared with PSO without comorbidities.<sup>11</sup> Furthermore, analyses of electronic health records (EHRs) and medical claims have shown that patients with PsA have higher rates of these comorbidities than patients with PSO alone.<sup>12-15</sup> Therefore, concomitant joint disease may be associated with higher HCRU and health care costs than PSO alone. Indeed, a MarketScan database analysis found that US patients with PsA have greater health care costs than those with PSO alone, due to the use of more inpatient and outpatient services, including more emergency department (ED) visits and prescriptions.<sup>16</sup> However, this previous 2017 study did not control for clinical characteristics or health care costs before PSO or PsA diagnosis.<sup>16</sup>

The primary objective of the current study was to compare HCRU and health care costs in propensity score (PS)-matched cohorts of patients with PSO alone or PsA using EHR-linked medical claims data.

## METHODS

### Study Design

This was a retrospective cohort study of commercially insured patients with PSO in the United States with EHR-linked claims data from January 1, 2007, to March 31, 2018. Patient information was collected from Optum's deidentified Integrated Claims–Clinical data set. UCB Pharma funded this study, was involved in the

## ABSTRACT

**OBJECTIVES:** Few studies have assessed the economic burden of concomitant joint disease in patients with psoriasis (PSO). This analysis compared health care resource utilization (HCRU) and health care costs in patients with PSO vs those with psoriatic arthritis (PsA).

**STUDY DESIGN:** This was a retrospective database analysis of US commercially insured patients with PSO or PsA.

**METHODS:** Electronic health records (EHRs) and claims in Optum's deidentified Integrated Claims–Clinical data set from 2007 to 2018 were analyzed. Patients were followed up from the first PSO or PsA diagnosis for up to 5 years. Patients with claims or diagnosis codes in EHR data for PSO ("PSO only") were propensity score matched to patients with claims/diagnosis codes for both PSO and PsA ("PSO-PsA").

**RESULTS:** The matching algorithm generated 4418 matched patient pairs. During follow-up, PSO-PsA patients had greater HCRU than PSO-only patients, including more cumulative all-cause outpatient claims ( $P \leq .05$  at each year of follow-up). Mean total annual health care costs per patient were higher in PSO-PsA patients than PSO-only patients (PSO only: \$14,546-\$15,800 vs PSO-PsA: \$21,581-\$22,868;  $P < .05$  at each year of follow-up). All-cause outpatient and pharmacy costs were also higher in the PSO-PsA cohort ( $P < .05$  at each year of follow-up).

**CONCLUSIONS:** Comorbid joint disease in PSO is associated with greater costs and use of health care resources than PSO alone. These findings underscore the need for dermatologists to be vigilant about detection and treatment of joint symptoms. Early PsA diagnosis and therapy are crucial to improve patient outcomes and reduce the potential economic burden.

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analysis and interpretation of data, and had the right to approve or disapprove publication of the finished manuscript. Data from noninterventional studies are outside of UCB's data sharing policy.

The index date was the first record of a diagnostic code for PSO (PSO-only group) or PsA (PSO-PsA group) during the identification period (January 1, 2010–December 31, 2014). The baseline preindex period was 365 days prior to the index date, and patients were followed up until the first occurrence of disenrollment from the health plan, death, end of available data, or end of the follow-up period. There was no minimum follow-up (**eAppendix Figure 1** [eAppendix available at [ajmc.com](http://ajmc.com)]); results are reported by year for patients with at least 1, 2, 3, 4, or 5 years of follow-up data.

## Participants

Eligible patients were aged 18 to 64 years with at least 1 year of continuous medical and pharmacy coverage prior to the first PSO or PsA diagnosis.

PSO-only patients had at least 2 claims for PSO 30 to 365 days apart between January 1, 2010, and December 31, 2014, and the first occurrence of a PSO diagnosis code during this period was the index date. PSO diagnosis was identified by *International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM)* codes (696, 696.1) or *International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM)* codes (L40, L40.0, L40.1, L40.2, L40.3, L40.4, L40.8, L40.9) in EHR or medical claims. Patients could not have a claim for PsA any time pre- or post index (January 2007–March 2018).

PSO-PsA patients were required to have a PsA diagnosis between January 1, 2010, and December 31, 2014; the first occurrence of a PsA diagnosis code during this period was the index date. At least 2 claims for PSO 30 to 365 days apart at any time before or after the PsA claim (January 2007–March 2018) were also required. PsA diagnosis was confirmed by *ICD-9-CM* (696.0) or *ICD-10-CM* (L40.52, L40.53, L40.54, L40.51, L40.59) codes in EHR or medical claims or a provider note for “psoriatic arthritis” or “psoriatic arthropathy.”

Patients with claims for Crohn disease, ulcerative colitis, osteoarthritis, or ankylosing spondylitis during the 12-month period before the index date were excluded. PSO-only and PSO-PsA patients were 1:1 PS matched.

## Baseline Characteristics, Resource Utilization, and Health Care Costs

Baseline demographic characteristics (age, gender, race, and geographic region), HCRU (numbers of inpatient admissions, ED visits, and outpatient visits), and costs were assessed in the 365 days prior to the index date, before PS matching. In addition, baseline overall Charlson–Deyo comorbidity scores<sup>17</sup> and prevalence of the following comorbidities were assessed before matching: obesity,

## TAKEAWAY POINTS

This was a retrospective analysis of commercially insured patients. Using a claims database, we compared the economic burden of psoriatic arthritis with that of psoriasis alone, including health care resource utilization and costs.

- ▶ Psoriatic arthritis was associated with greater health care resource utilization than psoriasis alone, particularly all-cause outpatient claims.
- ▶ Annual total health care costs, as well as outpatient and pharmacy costs, were also greater in patients with psoriatic arthritis than those with psoriasis alone.
- ▶ Early diagnosis and treatment of joint symptoms in patients with psoriasis are crucial to improve patient outcomes and potentially reduce the economic burden on the health care system.

infections, HIV/AIDS, hepatitis, tuberculosis, allergies, fatigue, cardiovascular disease, hyperlipidemia, cancer, congestive heart failure, diabetes (mild, severe, and total), cerebrovascular disease, myocardial infarction, hypertension, chronic pulmonary disease, renal disease, depression or anxiety, and obesity and/or hyperlipidemia (*ICD-9-CM/ICD-10-CM* codes listed in **eAppendix Table 1**).

Among the PS-matched cohorts, baseline medication usage and rates of dermatologist and rheumatologist visits (proportions of patients with visits and mean visits per patient) were assessed based on occurrences of medical services or prescription claims.

## Evaluation of Economic Burden During Follow-up

All-cause HCRU (inpatient admissions, ED visits, outpatient claims, physical or occupational therapy, and joint injections or arthrocentesis) and health care costs were assessed in the PS-matched PSO-only and PSO-PsA cohorts. Disease-related HCRU and costs were also assessed, including use of PSO/PsA-related treatments (**eAppendix Table 2**) and medical services with primary or secondary diagnosis codes for PSO or PsA. Specialist visits or prescriptions were identified by the occurrence of medical services or prescriptions with codes for dermatologist/dermatology or rheumatologist/rheumatology.

## Statistical Analysis

Propensity scores were estimated using logistic regression and were used to match PSO-only patients 1:1 with PSO-PsA patients. Nearest neighbor 1:1 PS matching without replacement was employed to match patients with a conservative caliper of 0.01. Diagnosis of PSO alone or PSO-PsA was the dependent variable. Independent variables included demographics (age, gender, race, region, and health maintenance organization [HMO]/point of service [POS] vs non-HMO/POS plan type); comorbidities (Charlson–Deyo comorbidity score, myocardial infarction, hypertension, chronic pulmonary disease, mild diabetes, severe diabetes, renal disease, depression or anxiety, and obesity and/or hyperlipidemia); and HCRU and cost characteristics (counts of inpatient admissions, ED visits, outpatient visits, and total costs). After matching, outcomes were assessed each year, respectively, from the balanced populations without further adjustment. Patients who met the required enrollment in each year were rematched. No imputations for missing data were performed.

## CLINICAL

**TABLE 1.** Prematch Patient Demographics and Comorbidities at Baseline

	PSO only (n = 18,515)	PSO-PsA (n = 4430)	P <sup>a</sup>
Age in years, mean (SD)	44.6 [12.2]	45.8 [10.8]	<b>&lt;.05</b>
Gender, n (%)			
Female	4823 (26.0)	1228 (27.7)	<b>&lt;.01</b>
Male	3972 (21.5)	1057 (23.9)	<b>&lt;.05</b>
Missing	9720 (52.5)	2145 (48.4)	–
Race, n (%)			
White	7172 (38.7)	1928 (43.5)	<b>&lt;.05</b>
African American	266 (1.4)	41 (0.9)	<b>&lt;.05</b>
Asian	256 (1.4)	51 (1.2)	.26
Other/unknown/missing	10,821 (58.4)	2410 (54.4)	<b>&lt;.05</b>
Region, n (%)			
Midwest	3783 (20.4)	850 (19.2)	.07
South	2535 (13.7)	763 (17.2)	<b>&lt;.05</b>
West	803 (4.3)	253 (5.7)	<b>&lt;.05</b>
Northeast	1360 (7.3)	325 (7.3)	>.99
Other/unknown/missing	10,034 (54.2)	2239 (50.5)	<b>&lt;.05</b>
Comorbidities, n (%) <sup>b</sup>			
Hypertension	4720 (25.5)	1289 (29.1)	<b>&lt;.05</b>
Obesity and/or hyperlipidemia <sup>c</sup>	4498 (24.3)	1201 (27.1)	<b>&lt;.01</b>
Hyperlipidemia	4337 (23.4)	1129 (25.5)	<b>&lt;.05</b>
Depression or anxiety	3131 (16.9)	878 (19.8)	<b>&lt;.01</b>
Fatigue	2290 (12.4)	791 (17.9)	<b>&lt;.05</b>
Allergies	2423 (13.1)	603 (13.6)	.37
Infections	2191 (11.8)	544 (12.3)	.43
Diabetes	1859 (10.0)	556 (12.6)	<b>&lt;.05</b>
Diabetes, mild <sup>d</sup>	1822 (9.8)	542 (12.2)	<b>&lt;.05</b>
Chronic pulmonary disease	1738 (9.4)	472 (10.7)	<b>&lt;.05</b>
Cardiovascular disease	952 (5.1)	252 (5.7)	.15
Charlson-Deyo comorbidity score, <sup>e</sup> mean (SD)	0.43 (0.97)	0.59 (1.00)	<b>&lt;.05</b>
HCRU, mean count (SD)			
Inpatient admissions	0.08 (0.37)	0.10 (0.44)	<b>&lt;.05</b>
ED visits	0.48 (1.85)	0.61 (1.95)	<b>&lt;.05</b>
Outpatient visits	31.22 (38.51)	45.3 (45.21)	<b>&lt;.05</b>
Total costs (\$), mean (SD)	9240 [26,974]	17,392 [30,524]	<b>&lt;.05</b>

ED, emergency department; HCRU, health care resource utilization; PsA, psoriatic arthritis; PSO, psoriasis.

<sup>a</sup>Significance testing was performed using 2-sample *t* tests allowing for unequal variances for continuous variables, and 2-sample comparison of independent proportions using the normal distribution with a continuity correction for categorical variables. Bold indicates *P* < .05.

<sup>b</sup>Data are not reported for comorbidities occurring in less than 5% of patients.

<sup>c</sup>Obesity was combined with hyperlipidemia due to low counts for obesity.

<sup>d</sup>Defined as diabetes without chronic complications.

<sup>e</sup>Score was calculated by summing the following components based on diagnosis codes in medical services or electronic health record diagnosis tables: congestive heart failure, chronic obstructive pulmonary disease, myocardial infarction, peripheral vascular disease, rheumatologic disease, stroke, peptic ulcer disease, dementia, diabetes, liver disease, cancer, renal disease, hemiplegia/paraplegia, and AIDS.

Categorical variables (baseline demographics, comorbidities, medication use, and number of specialist visits) are reported as number and percentage of patients in each category. Mean and SD are provided for continuous variables (Charlson-Deyo comorbidity score, baseline HCRU and health care costs, and number of specialist visits per patient). Mean differences in all-cause and disease-related HCRU measures are provided for years 1 to 5 with 95% CIs. Rates of patients with at least 1 specialist visit or prescription are reported per 1000 person-years.

Statistical significance testing was performed using 2-sample *t* tests allowing for unequal variances for continuous variables, and 2-sample comparison of independent proportions using the normal distribution with a continuity correction for categorical variables. Averaged numeric variable CIs were calculated by a 2-sample comparison of means allowing for unequal variances, using the *t* distribution and Satterthwaite's formula for the degrees of freedom. Proportion CIs were calculated from the Wald method using the normal distribution and continuity correction.<sup>18</sup> For statistical comparisons of subgroups of patients, separate nonindependent comparisons of proportions were conducted. Statistical significance was defined as *P* < .05.

Data were loaded into the Aetion Evidence Platform (Aetion, Inc) for analysis and cross-checked against the original data.

## RESULTS

### Patient Baseline Characteristics

The final population comprised 22,945 patients, including 18,515 PSO-only patients and 4430 PSO-PsA patients (eAppendix Figure 2). From these, the matching algorithm generated 4418 PS-matched pairs. Before matching, PSO-only demographic characteristics differed from the PSO-PsA cohort, including age, race, gender, and geographic region (Table 1). Of the 4430 PSO-PsA patients, 87.7% had a PSO diagnosis at baseline.

Comorbidities were generally more prevalent in PSO-PsA patients than PSO-only patients before PS matching. The most common comorbidities (those present in ≥25% of either group) were hypertension (PSO only: 25.5% vs PSO-PsA: 29.1%; *P* < .05), obesity and/or hyperlipidemia (24.3% vs 27.1%; *P* < .01), and hyperlipidemia alone (23.4% vs 25.5%; *P* < .05) (Table 1). Comorbidities occurring in less than 5% of patients are reported in eAppendix Table 3.

The most common HCRU type in both groups was outpatient visits, which were more frequent in the PSO-PsA cohort than the PSO-only group (mean of 45.3 visits during baseline vs 31.2 visits; *P* < .05) (Table 1).

In the PS-matched population, a greater proportion of PSO-PsA patients used medications at baseline than PSO-only patients, including methotrexate (PSO only: 2.0% of patients vs PSO-PsA: 13.5% of patients; *P* < .05), nonsteroidal anti-inflammatory drugs/cyclooxygenase 2 inhibitors (10.9% vs 21.0%; *P* < .05), and nonsteroidal topical therapy (13.0% vs 15.7%; *P* < .05). All biologics were used by significantly more PSO-PsA patients than PSO-only patients (*P* < .05, with the exception of ustekinumab [*P* = .26]) (Table 2).

At baseline, 2.7% of PSO-only patients visited a rheumatologist compared with 40.6% of PSO-PsA patients ( $P < .05$ ) in the PS-matched population. Dermatologist visits were also more common in the PSO-PsA group than the PSO-only cohort (PSO only: 43.8% vs PSO-PsA: 51.2%;  $P < .05$ ) at baseline. In addition, PSO-PsA patients had more rheumatologist visits on average than PSO-only patients ( $P < .05$ ) (Table 2).

### HCRU and Health Care Costs During Follow-up

Among PS-matched cohorts, PSO-PsA patients had more all-cause and disease-related outpatient claims ( $P < .05$  at each year of follow-up). By year 5, the mean number of cumulative all-cause outpatient claims was 241.7 for PSO-only patients and 259.2 for PSO-PsA patients. By year 5, PSO-only patients had 21.6 disease-related outpatient claims, compared with 58.3 claims for PSO-PsA patients (Table 3). Numbers of all-cause claims for joint injections or arthrocentesis were also higher in PSO-PsA patients than in PSO-only patients ( $P < .05$  at each year of follow-up), as were all-cause ED visits ( $P < .05$  at year 3 of follow-up). PSO-PsA patients also had more disease-related physical or occupational therapy visits ( $P < .05$  for years 2-5 of follow-up) (Table 3).

Mean annual total health care costs were consistent each year (PSO only: \$14,546-\$15,800 per patient vs PSO-PsA: \$21,581-\$22,868 per patient) and were higher in PSO-PsA patients than in PSO-only patients ( $P < .05$  at each year of follow-up) (Figure 1). Costs were driven by all-cause outpatient and pharmacy costs, which were both higher in PSO-PsA patients than PSO-only patients in years 1 to 5 ( $P < .05$  at each year of follow-up). ED costs were also greater in the PSO-PsA cohort at years 1 and 2 of follow-up ( $P < .05$ ). Finally, annual health care costs specifically related to PSO or PsA were greater in the PSO-PsA group ( $P < .05$  at each year of follow-up) (eAppendix Figure 3).

During follow-up, the rate of PSO-PsA patients visiting a dermatologist (494 patients per 1000 person-years) was lower than in the PSO-only cohort (1735 patients per 1000 person-years) (Figure 2 [A]). The rate of patients with rheumatologist visits, however, was 23 times higher in the PSO-PsA group during follow-up (PSO only: 28 patients per 1000 person-years vs PSO-PsA: 644 patients per 1000 person-years) (Figure 2 [A]), and the rate of patients receiving prescriptions from rheumatologists was 16 times higher (3 vs 49 patients per 1000 person-years) (Figure 2 [B]).

**TABLE 2.** Medication Use<sup>a</sup> and Specialist Visits<sup>b</sup> at Baseline Among PS-Matched Patients

	PSO only (n = 4418)	PSO-PsA (n = 4418)	Difference [95% CI] (PSO-only vs PSO-PsA) <sup>c</sup>	P <sup>d</sup>
Nonbiologic therapy, n (%)				
Methotrexate	87 [2.0]	596 [13.5]	11.5% [10.4%-12.6%]	<b>&lt;.05</b>
NSAIDs/COX-2 inhibitors	482 [10.9]	929 [21.0]	10.1% [8.6%-11.7%]	<b>&lt;.05</b>
Corticosteroids	481 [10.9]	446 [10.1]	-0.8% [-2.1% to 0.5%]	.24
Nonsteroidal topical therapy <sup>e</sup>	573 [13.0]	695 [15.7]	2.8% [1.3%-4.2%]	<b>&lt;.05</b>
Biologic therapy, n (%)				
Certolizumab pegol	0 [0.0]	9 [0.2]	0.2% [0.0%-0.4%]	<b>&lt;.05</b>
Etanercept	167 [3.8]	557 [12.6]	8.8% [7.7%-10.0%]	<b>&lt;.05</b>
Adalimumab	138 [3.1]	464 [10.5]	7.4% [6.3%-8.4%]	<b>&lt;.05</b>
Infliximab	14 [0.3]	214 [4.8]	4.5% [3.8%-5.2%]	<b>&lt;.05</b>
Golimumab	0 [0.0]	42 [1.0]	1.0% [0.6%-1.3%]	<b>&lt;.05</b>
Ustekinumab	84 [1.9]	100 [2.3]	0.4% [-0.3% to 1.0%]	.26
Abatacept	4 [0.1]	18 [0.4]	0.3% [0.1%-0.5%]	<b>&lt;.05</b>
Dermatologist/rheumatologist visits				
n (%) with dermatologist visit	1937 [43.8]	2264 [51.2]	7.4% [5.3%-9.5%]	<b>&lt;.05</b>
n (%) with rheumatologist visit	119 [2.7]	1792 [40.6]	37.9% [36.3%-39.4%]	<b>&lt;.05</b>
Dermatologist: number of visits, mean (SD)	3.80 (11.89)	3.24 (8.02)	-0.56 [-0.99 to -0.14]	<b>&lt;.05</b>
Rheumatologist: number of visits, mean (SD)	0.32 [3.56]	4.95 [12.66]	4.63 [4.24-5.02]	<b>&lt;.05</b>

COX-2, cyclooxygenase 2; NSAID, nonsteroidal anti-inflammatory drug; PS, propensity score; PsA, psoriatic arthritis; PSO, psoriasis.

<sup>a</sup>Data for nonbiologic medications used in at least 5% of patients in either subgroup are reported, and data for all biologics used by at least 1 patient are shown; n (%) patients with prescription claims for each medication are reported.

<sup>b</sup>The n (%) of patients with specialist visits and mean number of visits per patient are reported; specialist visits were determined by the occurrence of medical services with codes for dermatologist or rheumatologist.

<sup>c</sup>Values represent PSO-PsA minus PSO-only (PS-matched cohort).

<sup>d</sup>P values indicate comparisons between the PSO-only vs PSO-PsA subgroups. Significance testing was performed using 2-sample t tests allowing for unequal variances for continuous variables, and 2-sample comparison of independent proportions using the normal distribution with a continuity correction for categorical variables. Averaged numeric variable CIs were calculated by a 2-sample comparison of means allowing for unequal variances, using the t distribution and Satterthwaite's formula for the degrees of freedom. Proportion CIs were calculated from the Wald method using the normal distribution and continuity correction. For statistical comparisons of subgroups of patients, separate nonindependent comparisons of proportions were conducted. Bold indicates  $P < .05$ .

<sup>e</sup>Nonsteroidal topical therapy: calcipotriene, calcipotriene and betamethasone dipropionate, tazarotene, calcitriol, or anthralin.

## DISCUSSION

This retrospective study analyzed EHR and medical claims to assess the economic burden of concomitant joint disease in patients with PSO. Patients with PsA had greater HCRU and health care costs than patients with PSO alone over 5 years of follow-up. The larger economic burden was driven by higher rates of outpatient claims and greater outpatient and pharmacy costs.

During the baseline period (prior to the first occurrence of a PSO or PsA diagnosis code), a larger proportion of PSO-PsA patients used nonbiologic and biologic therapies than PSO-only patients. This difference in medication usage may be due to more severe skin and/or early joint symptoms in patients with PsA than those with PSO alone at baseline, although disease severity was not assessed

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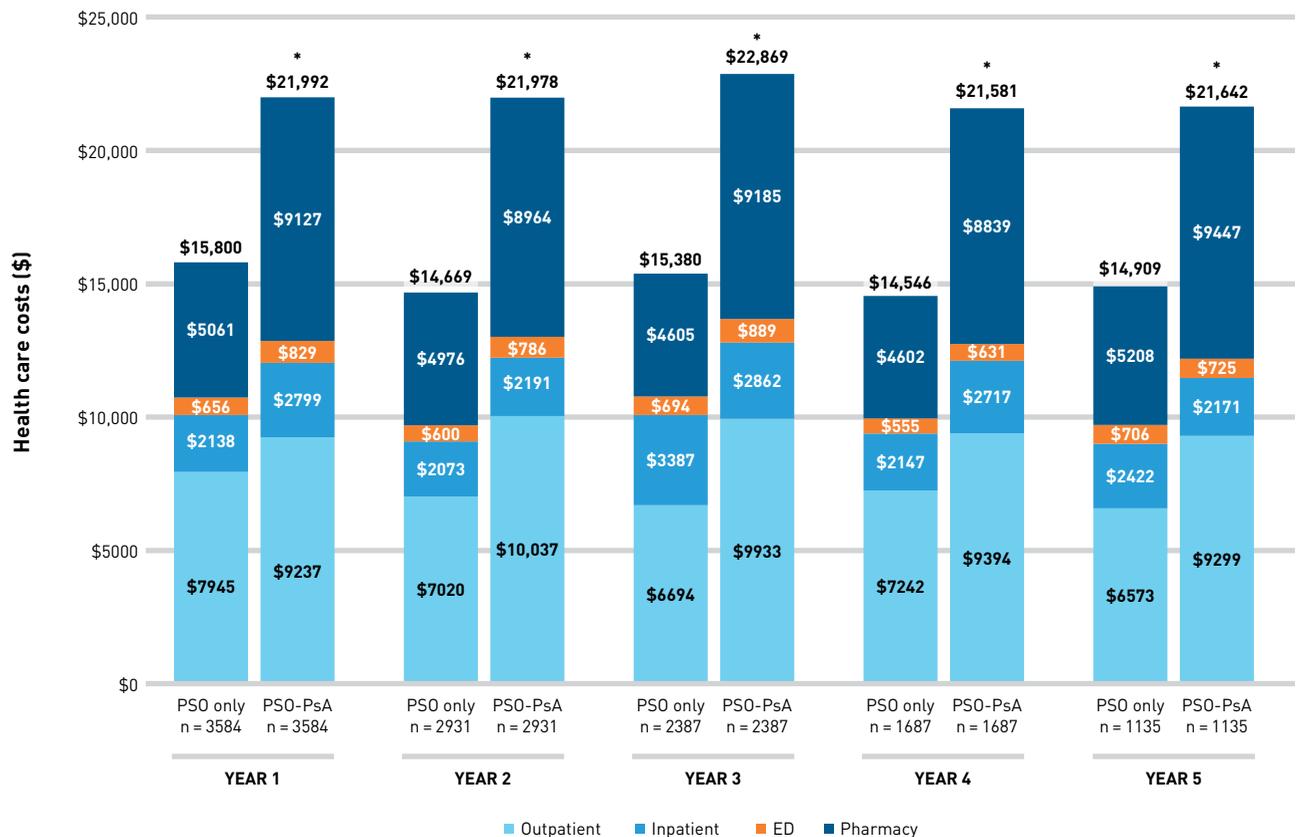
**TABLE 3.** Mean Difference in HCRU Claims During Follow-up in PS-Matched Patients, PSO Only vs PSO-PsA<sup>a</sup>

	Year 1 of follow-up (n = 3584)	Year 2 of follow-up (n = 2931)	Year 3 of follow-up (n = 2387)	Year 4 of follow-up (n = 1687)	Year 5 of follow-up (n = 1135)
<b>Cumulative all-cause HCRU, mean difference in number of claims, PSO-PsA minus PSO only (95% CI)</b>					
Total outpatient claims	<b>6.6 (4.2-9.1)</b>	<b>12.2 (7.3-17.0)</b>	<b>15.2 (7.9-22.5)</b>	<b>21.7 (10.1-33.3)</b>	<b>17.4 (-0.1 to 34.9)</b>
Total inpatient visits	0.0 (-0.0 to 0.0)	0.0 (-0.0 to 0.1)	0.0 (-0.0 to 0.1)	0.0 (-0.1 to 0.1)	-0.1 (-0.2 to 0.1)
Total physical or occupational therapy visits	-0.7 (-1.6 to 0.2)	1.1 (-2.6 to 0.5)	<b>-3.5 (-6.1 to -0.9)</b>	0.9 (-2.4 to 4.3)	5.1 (-11.1 to 0.9)
Total ED claims	0.1 (-0.0 to 0.2)	0.0 (-0.3 to 0.3)	<b>0.4 (0.1-0.7)</b>	0.2 (-0.1 to 0.6)	-0.5 (-1.7 to 0.8)
Total joint injections or arthrocentesis	<b>0.1 (0.1-0.2)</b>	<b>0.3 (0.2-0.3)</b>	<b>0.4 (0.3-0.4)</b>	<b>0.5 (0.4-0.6)</b>	<b>0.6 (0.4-0.8)</b>
<b>Cumulative disease-related HCRU, mean difference in number of claims, PSO-PsA minus PSO only (95% CI)</b>					
Total outpatient claims	<b>8.4 (7.6-9.2)</b>	<b>15.5 (14.0-17.0)</b>	<b>21.1 (18.9-23.4)</b>	<b>28.3 (24.8-31.7)</b>	<b>36.7 (31.7-41.7)</b>
Total inpatient visits	0.0 (-0.0 to 0.0)	0.0 (0.0-0.0)	0.0 (-0.0 to 0.0)	0.0 (-0.0 to 0.0)	0.0 (-0.0 to 0.0)
Total physical or occupational therapy visits	0.1 (-0.0 to 0.1)	<b>0.2 (0.1-0.3)</b>	<b>0.2 (0.1-0.3)</b>	<b>0.2 (0.0-0.3)</b>	<b>0.2 (0.0-0.3)</b>
Total ED claims	0.0 (-0.0 to 0.0)				

ED, emergency department; HCRU, health care resource utilization; PS, propensity score; PsA, psoriatic arthritis; PSO, psoriasis.

<sup>a</sup>Columns represent patients with at least 1, 2, 3, 4, and 5 years of follow-up. Cohorts were rematched each year. Values represent PSO-PsA minus PSO only (matched cohort). Bold indicates  $P < .05$ .

**FIGURE 1.** All-Cause Health Care Costs During Follow-up (PS-matched cohorts)<sup>a</sup>



ED, emergency department; PS, propensity score; PsA, psoriatic arthritis; PSO, psoriasis.

<sup>a</sup> $P < .05$  (total health care costs per patient, PSO only vs PSO-PsA).

<sup>a</sup>Mean total annual health care costs per patient were calculated over the time period indicated and are reported in 2018 US\$. Data are shown for PS-matched patients. Values above the bars indicate total all-cause annual health care costs per patient. Cohorts were rematched each year.

in this study. Indeed, patients with severe PSO are more likely to develop joint symptoms than those with mild or moderate disease.<sup>19,20</sup> However, this difference may also be due to longer PSO disease duration in PSO-PsA patients than PSO-only patients, which was not assessed.

In addition, although rheumatologist visits were rare for PSO-only patients at baseline, 15 times more PSO-PsA patients had visits with rheumatologists in the baseline year prior to a PsA claim. This result may indicate early joint symptoms before PsA diagnosis, although the first PsA claim may not have corresponded to the first diagnosis. PSO-PsA patients were also more likely to be seeing a dermatologist than PSO-only patients at baseline, which was expected given that most PSO-PsA patients had a PSO claim at baseline. However, the current study did not assess whether dermatologists were managing joint symptoms at baseline.

The HCRU and health care costs presented here align with previous US claims analyses. A 2018 MarketScan analysis reported \$26,883 in annual direct health care costs and \$9860 in outpatient costs per patient with PSO-PsA.<sup>21</sup> Similarly, PSO-PsA patients in the present analysis incurred approximately \$22,000 and \$9000 in annual health care and outpatient costs per patient, respectively. A 2017 analysis of MarketScan data,<sup>16</sup> however, reported that PSO-PsA patients incurred more than double the all-cause costs compared with PSO-only patients (\$23,427 vs \$10,965 per year), whereas the current analysis estimated a smaller cost difference (PSO-PsA: approximately \$22,000 vs PSO only: approximately \$15,000 in annual health care costs). This discrepancy may be explained by the lack of patient matching in the previous study. PS matching likely eliminated patients with very mild or severe disease in the present study who could not be matched. Similar to the current study, however, cost differences in the 2017 MarketScan study were primarily due to pharmacy costs, which accounted for 49% of total costs in the previous study<sup>16</sup> and approximately 40% in the current analysis in PSO-PsA patients. The previous analysis also reported higher all-cause HCRU, including outpatient services and ED visits, in PSO-PsA patients, which is consistent with the present findings.<sup>16</sup> Finally, another 2017 MarketScan study reported higher rates of outpatient and ED visits in PSO-PsA patients than PSO-only patients.<sup>22</sup> Direct annual costs were \$25,036 per year for PSO-PsA patients and \$13,376 for PSO-only patients,<sup>22</sup> a larger cost difference than in the current study. This discrepancy may be due to the use of a 2-part regression model to predict adjusted health care costs and the lack of patient matching in the previous study.<sup>22</sup> The use of PS matching in the current study addresses a key limitation in the existing literature: This study has demonstrated that health care costs in patients with PsA

are higher than in patients with PSO, even when controlling for baseline differences in demographics, comorbidities, and health care costs before PSO or PsA diagnosis.

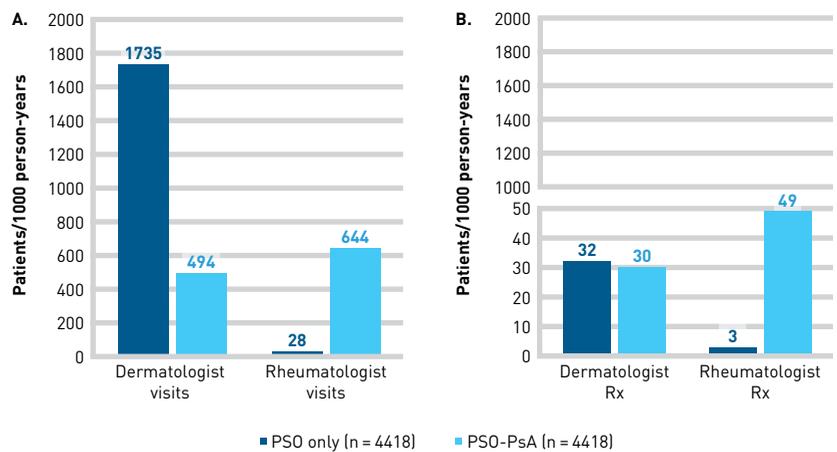
The increased costs in patients with PSO-PsA may result from a need for additional medical care for both joint and skin symptoms. Early treatment with biologic therapy is recommended and may improve joint symptoms, although biologics may also increase the pharmacy costs for these patients.<sup>23</sup> In addition, PsA is associated with higher rates of comorbidities, such as metabolic conditions and depression, than PSO alone.<sup>12-15</sup> Increased comorbidities in PsA compared with PSO may contribute to greater HCRU and costs.<sup>11</sup>

During follow-up, rates of patients with dermatologist visits or dermatologist prescriptions were higher in the PSO-only cohort than in the PSO-PsA group. Rates of patients with rheumatologist visits or rheumatologist prescriptions, however, were higher in PSO-PsA patients. This confirms that patients in the United States with PSO tend to see dermatologists, whereas patients with PsA generally see rheumatologists.<sup>24</sup> Given the high risk of joint disease in patients with PSO, however,<sup>3</sup> it is important for dermatologists and rheumatologists to be aware of symptoms and treatment strategies for both conditions. Regular monitoring by dermatologists of patients for joint involvement could reduce diagnostic delay, slow disease progression, and reduce the burden on the health care system and patients.<sup>10,22,23</sup>

### Limitations

This analysis may underestimate the economic burden associated with PsA. PS matching may have eliminated low-cost patients with mild disease and high-cost patients with severe disease. Including

**FIGURE 2. Specialist Visits and Prescriptions During Follow-up (PS-matched cohorts)\***



PS, propensity score; PsA, psoriatic arthritis; PSO, psoriasis; Rx, prescriptions.

\*Rates of patients (per 1000 person-years) with at least 1 specialist visit or at least 1 prescription from a specialist were observed over the 5-year follow-up period. Specialist visits or prescriptions were determined by the occurrence of medical services or prescriptions with codes for dermatologist/dermatology or rheumatologist/rheumatology.

these patients may have resulted in a larger gap in HCRU and costs. Furthermore, costs to patients outside of claims, such as OTC medications, were not considered and likely constitute a substantial burden to patients with PsA. This analysis also did not account for the indirect burden to patients, such as short-term disability, lost time at work, and treatment for comorbidities.

There are inherent limitations in retrospective database studies. The accuracy of diagnosis codes could not be verified. Although provider notes helped to identify patients with PsA, cases may have been missed due to inaccurate records. Furthermore, although the matching algorithm was robust, it could not control for characteristics that were not documented in EHRs or claims. Information about PSO and PsA severity, for example, was unavailable. Future studies should take disease severity into account when evaluating HCRU and cost. Furthermore, only insured patients were included, which limits the generalizability of the results to patients without private insurance.

Despite these limitations, the Optum database provided access to a large cohort of patients and allowed for a relatively long follow-up period. This study also employed rigorous statistical methods and controlled for potential confounders, such as baseline comorbidities.

## CONCLUSIONS

Concomitant joint disease in patients with PSO is associated with greater HCRU and health care costs than PSO alone. These findings underscore the need for dermatologists to identify early joint symptoms in patients with PSO. Early diagnosis and treatment for PsA are crucial to improve patient outcomes and potentially reduce the economic burden on the health care system. ■

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**Authorship Information:** Concept and design (PP, MS, RS, EL, AL); acquisition of data (PP, MS, AL); analysis and interpretation of data (PP, MS, RS, EL, AL);

drafting of the manuscript (PP, MS, RS, EL, AL); critical revision of the manuscript for important intellectual content (PP, MS, RS, EL, AL); statistical analysis (PP, MS, AL); administrative, technical, or logistic support (PP, MS, RS, EL, AL); and supervision (RS, EL, AL).

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**SUPPLEMENTARY MATERIAL**

**Economic Burden of Joint Disease in Psoriasis: US Claims Analysis**

**eAppendix Table 1. Comorbidity Diagnosis Codes**

Characteristic	Definition
Infections (streptococcus, earache, bronchitis, tonsillitis or a respiratory infection)	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “041.0”, “041.00”, “041.01”, “041.02”, “041.03”, “041.04”, “041.05”, “041.09”, “381.0”, “381.00”, “381.01”, “381.02”, “381.03”, “381.04”, “381.05”, “381.06”, “382.0”, “382.00”, “382.01”, “382.02”, “463”, “474.0”, “474.00”, “474.02”, “465”, “465.8”, “465.9” }</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: { “B95”, “B95.0”, “B95.1”, “B95.3”, “B95.4”, “B95.5”, “H65.0”, “H65.00”, “H65.01”, “H65.02”, “H65.03”, “H65.04”, “H65.05”, “H65.06”, “H65.07”, “H65.1”, “H65.11”, “H65.111”, “H65.112”, “H65.113”, “H65.114”, “H65.115”, “H65.116”, “H65.117”, “H65.119”, “H65.19”, “H65.191”, “H65.192”, “H65.193”, “H65.194”, “H65.195”, “H65.196”, “H65.197”, “H65.199”, “J03”, “J03.0”, “J03.00”, “J03.01”, “J03.8”, “J03.80”, “J03.81”, “J03.9”, “J03.90”, “J03.91”, “J35.0”, “J35.01”, “J35.03”, “J06”, “J06.9”, “J22”, “J44.0”, “J47.0” }</p>
Allergies	<p>The occurrence of Medical Services with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “477”, “477.0”, “477.1”, “477.2”, “477.8”, “477.9”, “518.6”, “525.66”, “558.3”, “708.0”, “716.2”, “716.20”, “716.21”, “716.22”, “716.23”, “716.24”, “716.25”, “716.26”, “716.27”, “716.28”, “716.29”, “995.3”, “372.14”, “373.32”, “381.04”, “381.05”, “381.06”, “495”, “495.8”, “495.9”, “995.27” } OR</p>

	<p>Diagnosis Code (Any Position), ICD-10-CM is any of: { "B44.81", "D69.0", "H01.11", "H01.111", "H01.112", "H01.113", "H01.114", "H01.115", "H01.116", "H01.119", "J30.1", "J30.5", "J30.81", "J30.9", "K52.2", "L23", "L23.0", "L23.1", "L23.2", "L23.3", "L23.4", "L23.5", "L23.6", "L23.7", "L23.8", "L23.81", "L23.89", "L23.9", "L50.0", "T78.40", "T78.40XA", "T78.40XD", "T78.40XS", "Z91.010", "Z91.011", "Z91.012", "Z91.013", "Z91.018", "H10.45", "H65.11", "H65.111", "H65.112", "H65.113", "H65.114", "H65.115", "H65.116", "H65.117", "H65.119", "H65.41", "H65.411", "H65.412", "H65.413", "H65.419", "J30", "J30.2", "J30.8", "J30.89", "L20.84", "T78.4", "T78.49", "T78.49XA", "T78.49XD", "T78.49XS" }</p>
Depression	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:  Diagnosis Code (Any Position), ICD-9-CM is any of: { "296.2", "296.20", "296.21", "296.22", "296.23", "296.24", "296.25", "296.26", "296.3", "296.30", "296.31", "296.32", "296.33", "296.34", "296.35", "296.36", "298.0", "300.4", "309.0", "309.1", "309.28", "311" }  Diagnosis Code (Any Position), ICD-10-CM is any of: { "F32.0", "F32.1", "F32.2", "F32.3", "F32.4", "F32.5", "F33.0", "F33.1", "F33.2", "F33.3", "F33.40", "F33.41", "F33.42", "F33.9", "F34.1", "F43.21", "F43.23", "F32" }</p>
Anxiety	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:  Diagnosis Code (Any Position), ICD-9-CM is any of: { "293.84", "300.00", "300.02", "300.09", "309.21", "309.24", "309.28", "313.0" }</p>

	Diagnosis Code (Any Position), ICD-10-CM is any of: { "F06.4", "F41.1", "F41.3", "F41.8", "F41.9", "F43.22", "F43.23", "F93.0", "F93.8" }
Fatigue	The occurrence of Medical Services or EHR Diagnosis tables with the following attributes: Diagnosis Code (Any Position), ICD-9-CM is any of: { "780.7", "780.71", "780.79" } Diagnosis Code (Any Position), ICD-10-CM is any of: { "R53.81", "R53.82", "R53.83" }
Cardiovascular disease	The occurrence of Medical Services or EHR Diagnosis tables with the following attributes: Diagnosis Code (Any Position), ICD-9-CM is any of: { "413.9", "410.11", "410.91", "414.01", "414.00", "412", "414.4", "414.9", "410.00", "410.10", "427.31", "428", "433.10", "433.11", "434.91", "433.9", "433.90", "433.91", "402.01", "402.11", "402.91", "429.20", "437.00", "437.10" } The occurrence of Medical Services with the following attributes: Diagnosis Code (Any Position), ICD-10-CM is any of: { "I20.9", "I21.09", "I21.3", "I25.10", "I25.2", "I25.84", "I25.9", "I11.0", "I48.91", "I50.9", "I65.29", "I63.9", "I67.2", "I67.9", "I73.9", "I65.23", "I63.239" }
Hyperlipidemia	The occurrence of Medical Services or EHR with the following attributes:  Diagnosis Code (Any Position), ICD-9-CM is any of: { "272.2", "272.4" }  The occurrence of Medical Services or EHR with the following attributes:

	Diagnosis Code (Any Position), ICD-10-CM is any of: { “E78.5”, “E78.2”, “E78.4” }
Diabetes (Type 1 or 2)	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “250”, “250.0”, “250.00”, “250.01”, “250.02”, “250.03”, “250.1”, “250.10”, “250.11”, “250.12”, “250.13”, “250.2”, “250.20”, “250.21”, “250.22”, “250.23”, “250.3”, “250.30”, “250.31”, “250.32”, “250.33”, “250.4”, “250.40”, “250.41”, “250.42”, “250.43”, “250.5”, “250.50”, “250.51”, “250.52”, “250.53”, “250.6”, “250.60”, “250.61”, “250.62”, “250.63”, “250.7”, “250.70”, “250.71”, “250.72”, “250.73”, “250.8”, “250.80”, “250.81”, “250.82”, “250.83”, “250.9”, “250.90”, “250.91”, “250.92”, “250.93” }</p> <p>The occurrence of Medical Services with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: { “E11”, “E10”, “E10.1”, “E10.10”, “E10.11”, “E10.2”, “E10.21”, “E10.22”, “E10.29”, “E10.3”, “E10.31”, “E10.311”, “E10.319”, “E10.32”, “E10.321”, “E10.329”, “E10.33”, “E10.331”, “E10.339”, “E10.34”, “E10.341”, “E10.349”, “E10.35”, “E10.351”, “E10.359”, “E10.36”, “E10.39”, “E10.4”, “E10.40”, “E10.41”, “E10.42”, “E10.43”, “E10.44”, “E10.49”, “E10.5”, “E10.51”, “E10.52”, “E10.59”, “E10.6”, “E10.61”, “E10.610”, “E10.618”, “E10.62”, “E10.620”, “E10.621”, “E10.622”, “E10.628”, “E10.63”, “E10.630”, “E10.638”, “E10.64”, “E10.641”, “E10.649”, “E10.65”,</p>

	<p>“E10.69”, “E10.8”, “E10.9”, “E11.0”, “E11.00”, “E11.01”, “E11.2”, “E11.21”, “E11.22”, “E11.29”, “E11.3”, “E11.31”, “E11.311”, “E11.319”, “E11.32”, “E11.321”, “E11.329”, “E11.33”, “E11.331”, “E11.339”, “E11.34”, “E11.341”, “E11.349”, “E11.35”, “E11.351”, “E11.359”, “E11.36”, “E11.39”, “E11.4”, “E11.40”, “E11.41”, “E11.42”, “E11.43”, “E11.44”, “E11.49”, “E11.5”, “E11.51”, “E11.52”, “E11.59”, “E11.6”, “E11.61”, “E11.610”, “E11.618”, “E11.62”, “E11.620”, “E11.621”, “E11.622”, “E11.628”, “E11.63”, “E11.630”, “E11.638”, “E11.64”, “E11.641”, “E11.649”, “E11.65”, “E11.69”, “E11.8”, “E11.9”, “E13”, “E13.0”, “E13.00”, “E13.01”, “E13.1”, “E13.10”, “E13.11”, “E13.2”, “E13.21”, “E13.22”, “E13.29”, “E13.3”, “E13.31”, “E13.311”, “E13.319”, “E13.32”, “E13.321”, “E13.329”, “E13.33”, “E13.331”, “E13.339”, “E13.34”, “E13.341”, “E13.349”, “E13.35”, “E13.351”, “E13.359”, “E13.36”, “E13.39”, “E13.4”, “E13.40”, “E13.41”, “E13.42”, “E13.43”, “E13.44”, “E13.49”, “E13.5”, “E13.51”, “E13.52”, “E13.59”, “E13.6”, “E13.61”, “E13.610”, “E13.618”, “E13.62”, “E13.620”, “E13.621”, “E13.622”, “E13.628”, “E13.63”, “E13.630”, “E13.638”, “E13.64”, “E13.641”, “E13.649”, “E13.65”, “E13.69”, “E13.8”, “E13.9”}</p>
Hypertension	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { "401", "401.0", "401.1", "401.9", "402", "402.0", "402.00", "402.1", "402.10", "402.9", "402.90", "403", "403.0", "403.00", "403.01", "403.1", "403.10", "403.11", "403.9", "403.90", "403.91", "404", "404.0", "404.00", "404.01", "404.02", "404.03", "404.1", "404.10", "404.11", "404.12", "404.13", "404.9", "404.90",</p>

	<p>"404.91", "404.92", "404.93", "405", "405.0", "405.01", "405.09", "405.1", "405.11", "405.19", "405.9", "405.91", "405.99" }</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: { "I10", "I11", "I11.0", "I11.9", "I12", "I12.0", "I12.9", "I13", "I13.0", "I13.1", "I13.10", "I13.11", "I13.2", "I15", "I15.0", "I15.1", "I15.2", "I15.8", "I15.9" }</p>
Myocardial infarction	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes: Diagnosis Code (Any Position), ICD-9-CM is any of: { "410.0", "410", "410.00", "410.01", "410.1", "410.10", "410.11", "410.2", "410.20", "410.21", "410.3", "410.30", "410.31", "410.4", "410.40", "410.41", "410.5", "410.50", "410.51", "410.6", "410.60", "410.61", "410.7", "410.70", "410.71", "410.8", "410.80", "410.81", "410.9", "410.90", "410.91" }</p> <p>The occurrence of Medical Services with the following attributes: Diagnosis Code (Any Position), ICD-10-CM is any of: { "I21", "I21.0", "I21.01", "I21.02", "I21.09", "I21.1", "I21.11", "I21.19", "I21.2", "I21.21", "I21.29", "I21.3", "I21.4", "I22", "I22.0", "I22.1", "I22.2", "I22.8", "I22.9" }</p>
Cerebrovascular disease	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes: Diagnosis Code (Any Position), ICD-9-CM is any of: { "436", "437", "437.1", "437.8", "437.9", "438", "438.8", "438.81", "438.82", "438.89", "438.9" }</p> <p>The occurrence of Medical Services with the following attributes: Diagnosis Code (Any Position), ICD-10-CM is any of: { "I67.9", "I67", "I67.8", "I67.89" }</p>

Chronic pulmonary disease	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “490”, “491”, “491.0”, “491.1”, “491.2”, “491.20”, “491.21”, “491.22”, “491.8”, “491.9”, “492”, “492.0”, “492.8”, “493”, “493.0”, “493.00”, “493.01”, “493.02”, “493.1”, “493.10”, “493.11”, “493.12”, “493.2”, “493.20”, “493.21”, “493.22”, “493.8”, “493.81”, “493.82”, “493.9”, “493.90”, “493.91”, “493.92”, “494”, “494.0”, “494.1”, “495”, “495.0”, “495.1”, “495.2”, “495.3”, “495.4”, “495.5”, “495.6”, “495.7”, “495.8”, “495.9”, “496”, “500”, “501”, “502”, “503”, “504”, “505”, “506.4”“416”}</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: { “J40”, “J41”, “J42”, “J43”, “J44”, “J45”, “J47”, “J60”, “J61”, “J62”, “J63”, “J64”, “J65”, “J66”, “J67” }</p>
Crohn’s disease	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “555”, “555.0”, “555.1”, “555.2”, “555.9”}</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: {“K50”, “K50.0”, “K50.00”, “K50.01”, “K50.011”, “K50.012”, “K50.013”, “K50.014”, “K50.018”, “K50.019”, “K50.1”, “K50.10”, “K50.11”, “K50.111”, “K50.112”, “K50.113”, “K50.114”, “K50.118”, “K50.119”, “K50.8”, “K50.80”, “K50.81”, “K50.811”, “K50.812”, “K50.813”, “K50.814”, “K50.818”, “K50.819”, “K50.9”, “K50.90”, “K50.91”, “K50.911”, “K50.912”, “K50.913”, “K50.914”, “K50.918”, “K50.919”}</p>

Ulcerative colitis	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “556”, “556.0”, “556.1”, “556.2”, “556.3”, “556.4”, “556.5”, “556.6”, “556.8”, “556.9” }</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: { “K51”, “K51.0”, “K51.00”, “K51.01”, “K51.011”, “K51.012”, “K51.013”, “K51.014”, “K51.018”, “K51.019”, “K51.2”, “K51.20”, “K51.21”, “K51.211”, “K51.212”, “K51.213”, “K51.214”, “K51.218”, “K51.219”, “K51.30”, “K51.31”, “K51.311”, “K51.312”, “K51.313”, “K51.314”, “K51.318”, “K51.319”, “K51.40”, “K51.41”, “K51.411”, “K51.412”, “K51.413”, “K51.414”, “K51.418”, “K51.419”, “K51.5”, “K51.50”, “K51.51”, “K51.511”, “K51.512”, “K51.513”, “K51.514”, “K51.518”, “K51.519”, “K51.8”, “K51.80”, “K51.81”, “K51.811”, “K51.812”, “K51.813”, “K51.814”, “K51.818”, “K51.819”, “K51.9”, “K51.90”, “K51.91”, “K51.911”, “K51.912”, “K51.913”, “K51.914”, “K51.918”, “K51.919” }</p>
Osteoarthritis	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “715.00”, “715.04”, “715.09”, “715.10”, “715.11”, “715.12”, “715.13”, “715.14”, “715.15”, “715.16”, “715.17”, “715.18”, “715.20”, “715.21”, “715.22”, “715.23”, “715.24”, “715.25”, “715.26”, “715.27”, “715.28”, “715.30”, “715.31”, “715.32”, “715.33”, “715.34”, “715.35”, “715.36”, “715.37”, “715.38”, “715.80”,</p>

	<p>“715.89”, “715.90”, “715.91”, “715.92”, “715.93”, “715.94”, “715.95”, “715.96”, “715.97”, “715.98”, “V13.4” }</p> <p>Diagnosis Code (Any Position), ICD-10-CM is any of: { “M15.0”, “M15.1”, “M15.2”, “M15.3”, “M15.4”, “M15.8”, “M15.9”, “M16.0”, “M16.10”, “M16.11”, “M16.12”, “M16.2”, “M16.30”, “M16.31”, “M16.32”, “M16.4”, “M16.50”, “M16.51”, “M16.52”, “M16.6”, “M16.7”, “M16.9”, “M17.0”, “M17.10”, “M17.11”, “M17.12”, “M17.2”, “M17.30”, “M17.31”, “M17.32”, “M17.4”, “M17.5”, “M17.9”, “M18.0”, “M18.10”, “M18.11”, “M18.12”, “M18.2”, “M18.30”, “M18.31”, “M18.32”, “M18.4”, “M18.50”, “M18.51”, “M18.52”, “M18.9”, “M19.011”, “M19.012”, “M19.019”, “M19.021”, “M19.022”, “M19.029”, “M19.031”, “M19.032”, “M19.039”, “M19.041”, “M19.042”, “M19.049”, “M19.071”, “M19.072”, “M19.079”, “M19.111”, “M19.112”, “M19.119”, “M19.121”, “M19.122”, “M19.129”, “M19.131”, “M19.132”, “M19.139”, “M19.141”, “M19.142”, “M19.149”, “M19.171”, “M19.172”, “M19.179”, “M19.211”, “M19.212”, “M19.219”, “M19.221”, “M19.222”, “M19.229”, “M19.231”, “M19.232”, “M19.239”, “M19.241”, “M19.242”, “M19.249”, “M19.271”, “M19.272”, “M19.279”, “M19.90”, “M19.91”, “M19.92”, “M19.93” }</p>
Ankylosing spondylitis	<p>The occurrence of Medical Services or EHR Diagnosis tables with the following attributes:</p> <p>Diagnosis Code (Any Position), ICD-9-CM is any of: { “720.0” }</p>

	Diagnosis Code (Any Position), ICD-10-CM is any of: { “M45”, “M45.0”, “M45.1”, “M45.2”, “M45.3”, “M45.4”, “M45.5”, “M45.6”, “M45.7”, “M45.8”, “M45.9”, “M48.1”, “M48.10”, “M48.11”, “M48.12”, “M48.13”, “M48.14”, “M48.15”, “M48.16”, “M48.17”, “M48.18”, “M48.19” }
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**eAppendix Table 2. Treatments for PSO and/or PsA in Definition of Disease-Related HCRU and Healthcare Costs**

<b>Biologics</b>	<b>Non-biologic treatments</b>
Certolizumab pegol	Cyclosporine
Etanercept	Methotrexate
Adalimumab	Apremilast
Infliximab	Acitretin
Golimumab	Phototherapy (UVA, PUVA)
Secukinumab	Other DMARDS (antimalarials, repository corticotropin injection, azathioprine, leflunomide, sulfasalazine)
Ixekizumab	Oral corticosteroids
Ustekinumab	Tofacitinib
Abatacept	
Brodalumab	
Guselkumab	
Rituximab	

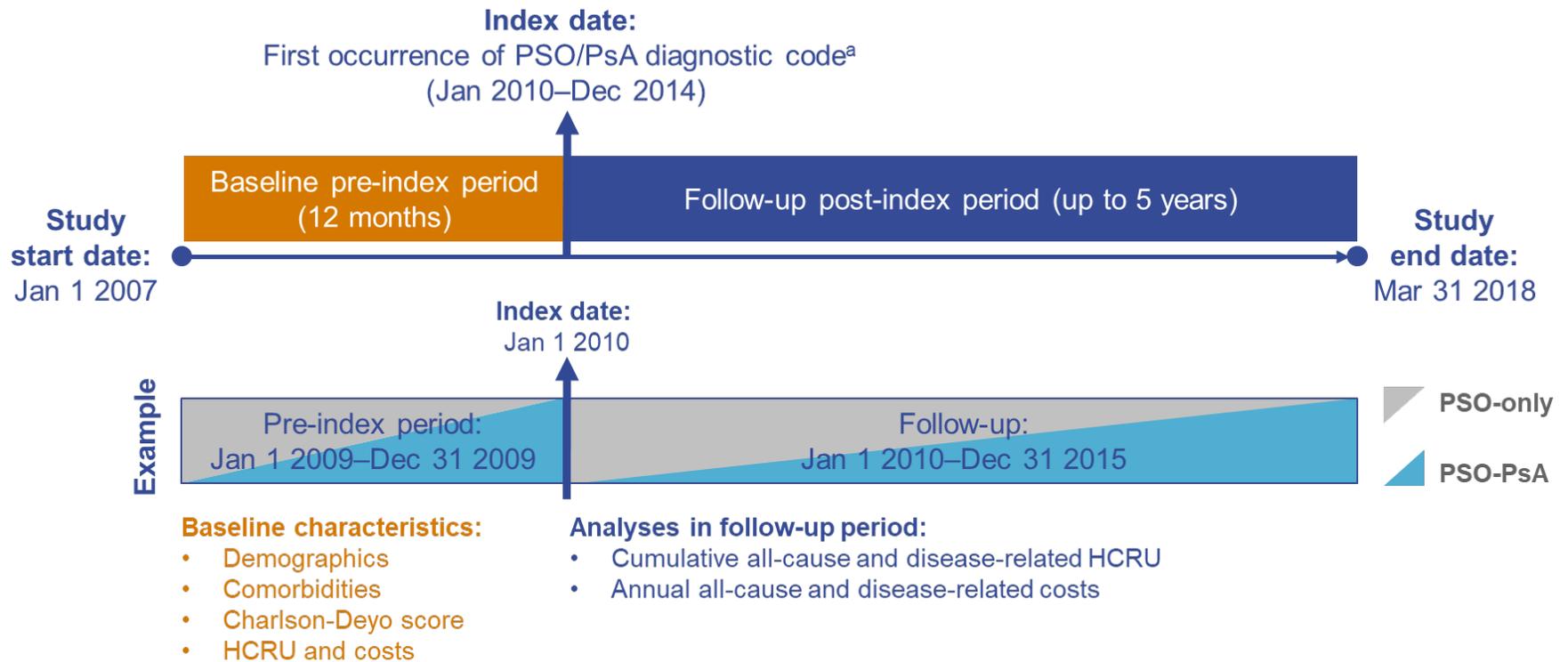
DMARDs: disease-modifying antirheumatic drugs; HCRU: healthcare resource utilization; PsA: psoriatic arthritis; PSO: psoriasis; PUVA: psoralen and ultraviolet A; UVA: ultraviolet A.

**eAppendix Table 3. Pre-Match Patient Comorbidities in <5% of Patients**

<b>12-month baseline period</b>			
<b>Comorbidities, n (%)</b>	<b>PSO-only subgroup (n=18,515)</b>	<b>PSO-PsA subgroup (n=4,430)</b>	<b>p value<sup>a</sup></b>
Obesity	297 (1.6)	116 (2.6)	<b>&lt;0.05</b>
AIDS/HIV	74 (0.4)	9 (0.2)	0.07
Hepatitis	142 (0.8)	52 (1.2)	<b>&lt;0.05</b>
Tuberculosis	23 (0.1)	10 (0.2)	0.17
Cancer	719 (3.9)	161 (3.6)	0.46
Diabetes, severe <sup>b</sup>	292 (1.6)	86 (1.9)	<b>&lt;0.05</b>
Cerebrovascular disease	76 (0.4)	30 (0.7)	<b>&lt;0.05</b>
Myocardial infarction	53 (0.3)	15 (0.3)	0.67
Renal disease	194 (1.0)	67 (1.5)	<b>&lt;0.05</b>

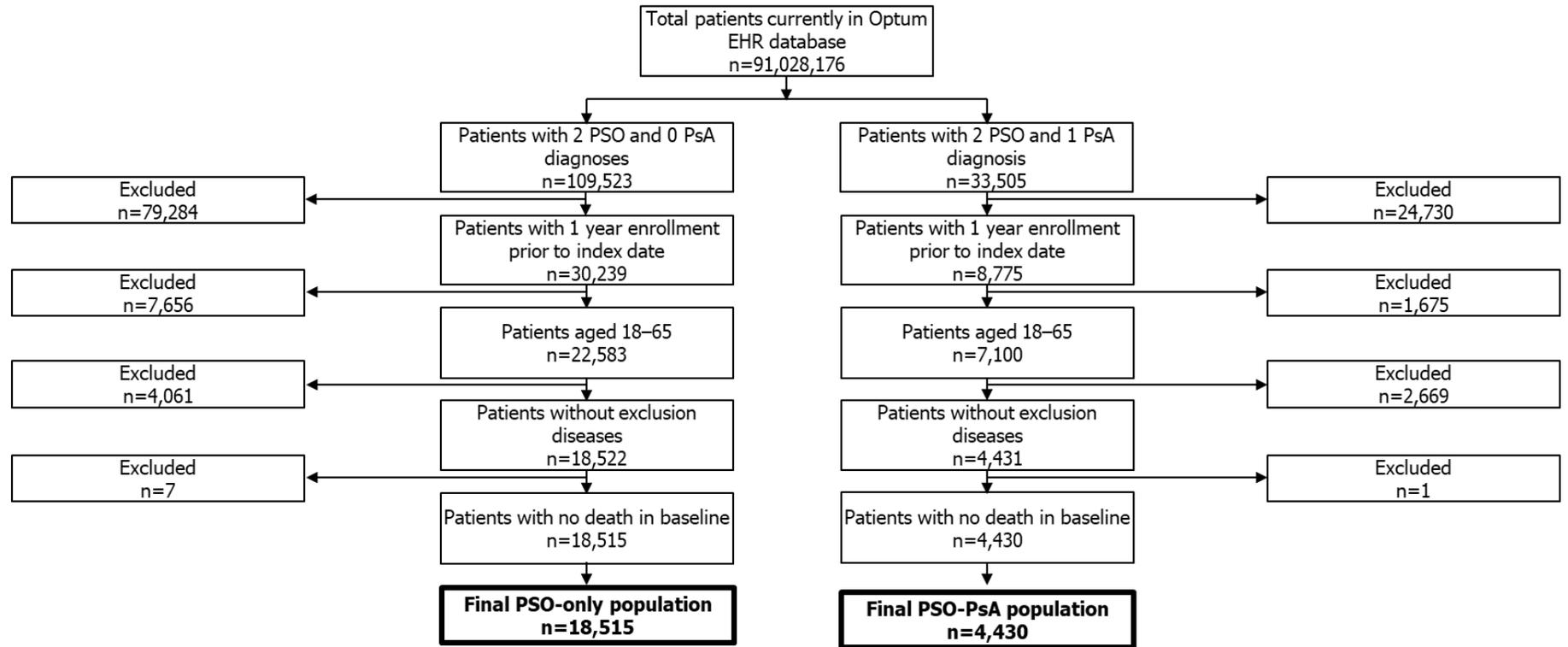
<sup>a</sup>Significance testing for continuous variables was calculated using two-sample t-tests allowing for unequal variances and two-sample comparison of independent proportions using the normal distribution and a continuity correction for categorical variables. p values show the comparisons between the PSO-only vs PSO-PsA subgroups. <sup>b</sup>Defined as diabetes with chronic complications. PsA: psoriatic arthritis; PSO: psoriasis.

**eAppendix Figure 1. Study Design**



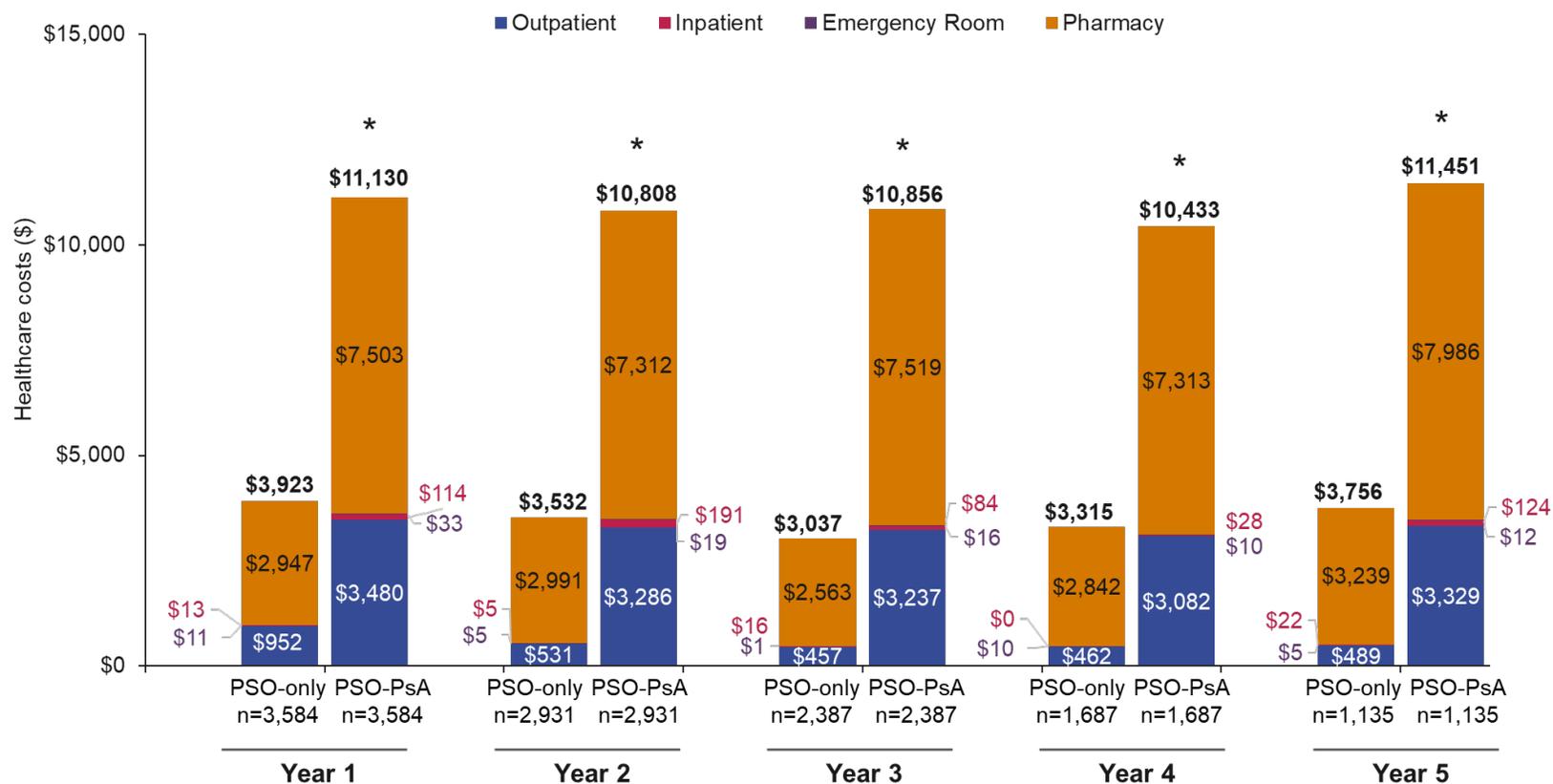
<sup>a</sup>The index date was the first record of a diagnostic code for PSO (PSO-only group) or PsA (PSO-PsA group) during the identification period (January 1, 2010–December 31, 2014). HCRU: healthcare resource utilization; PsA: psoriatic arthritis; PSO: psoriasis.

**eAppendix Figure 2. Patient Disposition Flow Chart**



EHR: electronic health record; PsA: psoriatic arthritis; PSO: psoriasis.

**eAppendix Figure 3. Disease-Related Healthcare Costs during Follow-up (PS-Matched Cohorts)**



Mean annual healthcare costs related to PSO or PsA per patient were calculated over the time period indicated and are reported in 2018 US dollars. Data are shown for propensity score-matched patients. Values above the bars indicate total disease-related annual healthcare costs per patient. Cohorts were re-matched each year. \*  $p < 0.05$  (total disease-related costs per patient, PSO-only vs PSO-PsA). PS: propensity score; PsA: psoriatic arthritis; PSO: psoriasis.