



Patient Characteristics and Treatment Patterns in European Pediatric Patients with Psoriasis: A Real-World, Cross-Sectional Study

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ABSTRACT

Introduction: This study evaluated patient characteristics and treatment patterns according to weight in pediatric patients with psoriasis in a real-world setting.

Methods: Primary care and specialist physicians treating pediatric patients with psoriasis aged 6–17 years in five European countries were surveyed in the 2019–2020 Adelphi Real World

Pediatric Psoriasis Disease Specific Programme. At least two patients with current or previous biologic use were included per physician. Patient characteristics and treatment patterns were analyzed overall and for patients weighing 25–50 kg or more than 50 kg.

Results: Data from 772 patients weighing 25–50 kg and 1147 weighing more than 50 kg were analyzed. Median age at diagnosis was significantly less in lighter than heavier patients (10.0 vs. 14.0 years; $p < 0.001$), as was median disease duration (2.2 vs. 3.0 years; $p < 0.001$). Topical treatments were prescribed in 59.0% of patients overall (70.3% of lighter and 51.4% of heavier patients; $p < 0.001$), and were used to

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treat mild rather than moderate-to-severe psoriasis. Conventional systemic use was low (10.8% of patients overall) and predominantly for moderate-to-severe psoriasis. In this biologic-enriched sample, most biologics (78.2%) were prescribed in older (> 13 years) patients. Biologic use increased with line of therapy (6.6% of first-line, 18.0% of second-line, 33.7% of third-line, 44.7% of fourth-line treatments).

Conclusion: Biologics are predominantly prescribed in older (> 13 years) and heavier (> 50 kg) patients, with little first- or second-line use. The low use of biologics in European pediatric patients with psoriasis may represent an unmet treatment need, as topical or conventional systemic agents remain the main treatment option for moderate or severe psoriasis in these patients through the treatment pathway.

PLAIN LANGUAGE SUMMARY

This study looked into types of treatments according to body weight in children with psoriasis, since approved dosing regimens for some treatments are based on body weight. Primary care and specialist physicians treating children with psoriasis aged 6–17 years in five European countries completed a survey. Patient information for those receiving specific types of psoriasis treatments were collected. Of the children included, 772 weighed 25–50 kg and 1147 weighed more than 50 kg. Most children received treatments applied to the skin, such as creams and ointments; this occurred in 70% of lighter patients and in 51%

of heavier patients. Conventional treatments taken via the mouth were prescribed in a few patients (11% [overall]), while newer biologic drugs were taken to a greater extent in heavier (30%) than lighter (16%) patients. Most biologics (78%) were prescribed in older (> 13 years) patients. Biologic use increased with the number of failed previous treatments, comprising 7%, 18%, 34%, and 45% of first, second, third, and fourth treatments, respectively. We conclude that children with psoriasis who are treated with biologic drugs are predominantly older and heavier, and have more severe psoriasis. Prescriptions for biologics are given after many other treatments have been tried.

Keywords: Biologic treatment; Body weight; Observational study; Pediatrics; Population characteristics; Psoriasis; Treatment patterns

Key Summary Points

Why carry out this study?

Dosing for recently approved psoriasis treatments in children is primarily based on body weight, but there are limited published real-world data on patient characteristics and treatment patterns according to weight in pediatric patients with psoriasis.

This study evaluated patient characteristics and treatment patterns by weight in pediatric patients with psoriasis in a real-world setting.

What was learned from this study?

Biologic treatments for pediatric patients with psoriasis in Europe are predominantly prescribed in older, heavier patients.

Low use of biologics may represent an unmet treatment need, as topical or conventional systemic agents remain the main treatment option for moderate or severe psoriasis in pediatric patients through the treatment pathway.

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INTRODUCTION

Psoriasis is a chronic, inflammatory, immune-mediated skin disease characterized by scaly plaques on the skin and often requires lifelong treatment [1]. Psoriasis affects 2–3% of the global population [2, 3] and its prevalence gradually increases with age [4]. For one-third of those affected, psoriasis starts before the age of 18 years [5, 6], with an estimated prevalence of approximately 1% in children under 18 years of age [7, 8]. Psoriasis in children can severely impact quality of life, affecting self-esteem, family and social relationships, and school life [4–6]. Early diagnosis and treatment may reduce the impact of psoriasis on these parameters [6, 9–13].

The management of pediatric psoriasis is challenging and may require a multidisciplinary approach involving dermatologists, pediatricians, and potentially rheumatologists [14]. Guidelines for the management of pediatric psoriasis have recently been published [8, 15–17]; these provide an advance on previous approaches to treatment, which were based on recommendations for adults, expert opinion [18–21], or physician personal experience. In addition, physicians often used off-label treatments [22, 23]. It is therefore important to obtain an updated overview of treatment patterns for pediatric psoriasis in Europe.

Although pediatric patients with psoriasis typically respond well to treatment with topical products or phototherapy, a substantial proportion (around one-quarter) experience inadequate disease control with such treatment, requiring systemic treatment with immunosuppressants, such as methotrexate and cyclosporine [24]. These are off-label treatments for pediatric psoriasis [23], but may be considered for the treatment of moderate-to-severe or recalcitrant disease [17, 20, 25–28]. A number of biologic agents, including the newer biologics ixekizumab and secukinumab, are now approved in Europe for moderate-to-severe pediatric psoriasis (Table 1) [8, 16, 17, 20, 29–35], and other agents are being investigated, including brodalumab [36], guselkumab [37], and risankizumab [38].

Dosing in children for recently approved psoriasis treatments is primarily based on body weight [30, 31]. However, there are limited published data on patient characteristics and treatment patterns according to age and weight in pediatric patients receiving treatment for psoriasis in a real-world setting. The aim of this study was to describe patient demographics, disease, and treatment characteristics, with a focus on biologic drug use, in two weight groups of pediatric patients (25–50 kg and > 50 kg) with psoriasis from five European countries. The two weight groups were chosen to reflect approved dosage regimens for biologics in psoriasis [30, 31].

METHODS

Study Design, Data Source, and Population

This study used physician survey data from the Adelphi Real World Pediatric Psoriasis Disease Specific Programme (DSPTM). Adelphi DSPs are large, multinational, point-in-time surveys that collect cross-sectional real-world data through patient and physician surveys [39]. For the current study, primary care or specialist physicians treating pediatric patients with psoriasis in France, Germany, Italy, Spain, and the UK were surveyed between December 2019 and June 2020. Third-party fieldwork agencies identified, contacted, and recruited physicians on the basis of public lists of healthcare professionals. Thirty dermatologists, 15 pediatricians, and 10 primary care physicians (PCPs) were recruited per country. In the UK, the fieldwork agency advised that pediatricians would be difficult to recruit, which proved to be the case; consequently, pediatricians were replaced with dermatologists. In all countries, physicians were compensated for their participation according to fair market research rates consistent with the time involved. Care was taken to ensure that the sample of surveyed physicians was geographically representative of each country.

Each physician was required to be actively managing pediatric patients with psoriasis of

Table 1 Biologics approved for the treatment of plaque psoriasis in pediatric/adolescent patients [30, 31, 33–35]

Biologic	Year of EMA approval for use in children	Indication	Recommended dose
Etanercept	2009	Children aged ≥ 6 years with long-term severe disease inadequately controlled by other systemic therapies	0.8 mg/kg up to a maximum of 50 mg/dose once weekly for up to 24 weeks
Adalimumab	2015	Children aged ≥ 4 years with long-term severe disease	Initial dose then Q2W starting 1 week after the initial dose: 15 to < 30 kg: 20 mg ≥ 30 kg: 40 mg
Ustekinumab	2015	Children aged ≥ 6 years with moderate-to-severe disease	Initial dose, dosing after 4 weeks, then Q12W: < 60 kg: 0.75 mg/kg 60–100 kg: 45 mg > 100 kg: 90 mg
Ixekizumab	2020	Children aged ≥ 6 years weighing ≥ 25 kg with moderate-to-severe disease	25–50 kg: initial dose 80 mg, then 40 mg Q4W > 50 kg: initial dose 160 mg, then 80 mg Q4W
Secukinumab	2020	Children aged ≥ 6 years with moderate-to-severe disease	Once weekly for 4 weeks, then Q4W: < 25 kg: 75 mg 25 to < 50 kg: 75 mg ≥ 50 kg: 150 mg (may be increased to 300 mg)

QXW every X weeks, *EMA* European Medicines Agency

any severity and to see at least five such patients in a typical month (three or more in the UK). They were asked to recruit their next 10 consulting pediatric patients with psoriasis into the study. Dermatologists were requested to include two patients who were currently receiving or had received a biologic in the last 12 months. Patients had to be at least 6 but less than 18 years of age, and to be receiving treatment for any-severity plaque psoriasis (including nail, scalp, inverse/flexural, and palmoplantar).

Physicians completed a patient record form (PRF) for each patient online, covering demographics, disease severity, symptoms, treatment history, patient management, and physician satisfaction with disease control. Information was collected from the time of diagnosis until the time of data collection. Disease severity was captured at diagnosis, immediately prior to initiation of the current treatment and at the time of data collection, and was rated as mild, moderate, or severe on the basis of the physicians' own judgment. Psoriasis Area and

Severity Index (PASI) scores within a range of 0–72 were also provided if known. Physicians were asked to provide a treatment history for each patient, working backwards from current to first regimen. A change in the line of treatment was defined as the initiation of new treatment, switch, or discontinuation of treatment. Treatment discontinuation was defined as discontinuation of a particular product (excluding topical treatment, for which data were only collected at the class level). Treatment breaks and treatment duration were not captured. First-line treatment was defined as the first treatment regimen the patient received, second-line treatment as the second treatment regimen, and so on. For each treatment line, patients could receive more than one type of drug category. Data were captured on up to 10 previous treatment lines. In addition, physicians completed a workload form and questions about the type and number of patients treated, and what drove the treatment choice.

Statistical Analysis

Patient and treatment characteristics were compared between those weighing 25–50 kg and those weighing more than 50 kg. Continuous variables were compared using Student's *t* test; ordinal and categorical variables were compared using chi-squared or Fisher's exact test. All other data were analyzed descriptively (no adjustments) overall and by country. Data on treatment characteristics were also analyzed by type of prescriber, as this is likely to be of clinical interest given that pediatric patients consult different medical specialties at different stages of their disease and depending on disease severity. Data were analyzed using the software package SPSS® Version 15 (SPSS Inc., Chicago, IL, USA). Continuous variables were summarized as mean ± standard deviation and median with interquartile range, while categorical variables were summarized as the number and percentage of patients. No allowance was made for missing data (e.g., by multiple imputation); where data were missing for specific variables (e.g., sometimes patients did not answer all

questions), patients were excluded from the analyses for that variable.

Ethical Considerations

The study was approved by the WCG IRB (tracking number 20193181). All participants provided consent to participate in the survey. Physician responses were anonymized and pseudonymized, and data collection and handling complied with applicable laws, regulations, and guidance regarding patient protection, including patient privacy. The study was conducted in accordance with the 1964 Declaration of Helsinki and its later amendments, Good Pharmacoepidemiology Practices, and applicable laws and regulations of the participating countries.

RESULTS

A total of 239 physicians participated in the survey, including 138 dermatologists, 45 pediatricians, and 56 PCPs (Supplementary Material, Fig. S1). PRFs were completed for 1919 patients, of whom 772 (40.2%) weighed 25–50 kg and 1147 (59.8%) weighed more than 50 kg. The proportion of patients weighing 25–50 kg was lower in Germany, Spain, and the UK (29.3–36.8%) than in France and Italy (47.3%) (Supplementary Material, Table S1).

Patient Characteristics at Diagnosis and at the Time of Data Collection

Patient characteristics at diagnosis and time of data collection, overall and by weight category, are shown in Table 2. Some characteristics were significantly different between the two weight groups, including age, the proportion of male patients, body mass index (BMI), age at diagnosis, time since diagnosis, and disease severity at diagnosis. Median patient age at diagnosis was 12.0 years overall, 10.0 years in patients weighing 25–50 kg, and 14.0 years in those weighing more than 50 kg ($p < 0.001$). Overall, 56.9% of patients were male. Median current BMI was 21.0 overall, 19.0 in patients weighing

Table 2 Patient characteristics and history of psoriasis at the time of data collection, overall and by weight category

Parameter ^a	Overall	Weighing 25–50 kg	Weighing > 50 kg	<i>p</i> value ^b
Number and percentage of patients	1919 (100.0%)	772 (40.2%)	1147 (59.8%)	
Current age (years)				
Mean ± SD	13.9 ± 2.9	11.5 ± 2.8	15.5 ± 1.6	< 0.001
Median [IQR]	15.0 [12.0, 16.0]	11.0 [9.0, 14.0]	16.0 [15.0, 17.0]	
Male	1091 (56.9%)	352 (45.6%)	739 (64.4%)	< 0.001
Current body mass index				
Mean ± SD	21.9 ± 7.3	19.8 ± 6.8	23.3 ± 7.2	< 0.001
Median [IQR]	21.0 [19.0, 23.0]	19.0 [18.0, 20.0]	22.4 [21.0, 24.0]	
Type of psoriasis				
Plaque	1734 (90.4%)	694 (89.9%)	1040 (90.7%)	0.294
Other	185 (9.6%)	78 (10.1%)	107 (9.3%)	
Age at diagnosis (years)				
Mean ± SD	11.4 ± 3.5	9.5 ± 2.9	12.8 ± 3.1	< 0.001
Median [IQR]	12.0 [9.0, 14.0]	10.0 [8.0, 11.0]	14.0 [11.0, 15.0]	
Time since diagnosis (years)				
Mean ± SD	2.7 ± 2.7	2.2 ± 2.4	3.0 ± 2.9	< 0.001
Median [IQR]	1.8 [0.8, 3.6]	1.4 [0.5, 3.1]	2.0 [1.1, 4.1]	
Severity of psoriasis at diagnosis ^c				
Mild	641 (33.4%)	295 (38.2%)	346 (30.2%)	< 0.001
Moderate/severe	1278 (66.6%)	477 (61.8%)	801 (69.8%)	
BSA affected at diagnosis (%)				
Mean ± SD	15.2 ± 14.9	15.0 ± 15.9	15.4 ± 14.1	0.655
Median [IQR]	10.0 [6.0, 20.0]	10.0 [5.0, 18.0]	10.0 [6.0, 20.0]	
Family history of psoriasis	899 (46.8%)	353 (45.7%)	546 (47.6%)	0.249
Diagnosis of psoriatic arthritis	82 (4.3%)	28 (3.6%)	54 (4.7%)	0.300
Diagnosed using CASPAR criteria	42 (51.2%) ^d	11 (39.3%) ^d	31 (57.4%) ^d	0.143

Values are shown as mean ± standard deviation and median [IQR] or *n* (%) unless otherwise indicated
BSA body surface area, *CASPAR* Classification Criteria for Psoriatic Arthritis, *IQR* interquartile range, *SD* standard deviation

^aNumber of patients was lower for some parameters

^bFor the comparison between the two patient weight groups. Continuous variables were compared using Student's *t* test; ordinal and categorical variables were compared using chi-squared or Fisher's exact test

^cDisease severity was based upon the physicians' own judgment

^dOf those with a diagnosis of psoriatic arthritis

25–50 kg, and 22.4 in those weighing more than 50 kg ($p < 0.001$). Similar patterns were seen across countries for age, sex, and BMI (Supplementary Material, Table S2). The majority of patients (90.4%) had plaque psoriasis. Overall, 4.3% of patients had psoriatic arthritis (PsA).

Disease Severity and Symptoms

Overall, 66.6% of patients had moderate or severe psoriasis at diagnosis, and this was similar for the two weight categories (Table 2). Immediately before starting the current/most recent treatment regimen (topical and/or systemic), most patients (71.8%) had moderate or severe psoriasis (Table 3). While receiving current treatment, most patients (80.0%) had mild psoriasis. Dermatologists treated more patients with moderate or severe psoriasis (as defined immediately prior to the current/most recent treatment regimen) than pediatricians and PCPs. The three types of prescribers were uniform in rating current disease severity (Supplementary Material, Table S3).

Mean PASI prior to the initiation of current treatment was 7.0 ± 8.4 for patients with mild psoriasis, 12.8 ± 9.9 for those with moderate disease, and 22.5 ± 14.7 for those with severe disease. For patients weighing 25–50 kg, mean PASI prior to the initiation of current treatment was 21.5 ± 14.7 for biologic-treated patients and 10.2 ± 11.3 for patients treated with non-biologics. Corresponding values for patients weighing more than 50 kg were 20.7 ± 12.6 and 11.4 ± 10.8 , respectively.

The most common current symptoms overall were scaling/flaking (55.5% of patients), red inflamed skin (49.6%), itching (48.0%), redness/discoloration (28.6%), cracked skin (26.0%), and burning (18.4%). A similar pattern was seen across the weight categories and countries.

Overall Treatment

Most patients ($N = 1919$) across both weight categories were prescribed topical treatments (Table 3). These were more likely to be used to treat mild rather than moderate-to-severe psoriasis, while conventional systemics and

biologics were more likely to be used for moderate-to-severe rather than mild psoriasis (Fig. 1). A similar pattern was seen across countries (Supplementary Material, Fig. S2). A complete treatment history was available for 1721 patients, all of whom had received a first-line regimen, 809 a second-line regimen, 350 a third-line regimen, and 123 a fourth-line regimen (Fig. 2).

Topical and Conventional Systemic Treatments

Topical therapy alone was the most prescribed current treatment (59.0% of patients overall), with significantly greater use in patients weighing 25–50 kg (70.3%) than in those weighing more than 50 kg (51.4%; $p < 0.001$) (Table 3). Topical therapy was more likely to be prescribed by pediatricians (75.4%) or PCPs (87.7%) than dermatologists (43.4%) (Supplementary Material, Table S3). The use of topical therapy alone decreased with regimen line, but was consistently higher in patients in the lower-weight category. The exception was for first-line regimens, where usage was similar between the two weight categories (Fig. 2).

Conventional systemics, including methotrexate, cyclosporine, acitretin, and fumarate, were prescribed in 10.8% of patients overall. The use of these agents was higher in patients weighing more than 50 kg than in those weighing 25–50 kg ($p = 0.002$; Table 3). A similar pattern was seen across countries, apart from Spain, where their use was similar between the two weight categories (Supplementary Material, Table S4). Conventional systemics were more likely to be prescribed by dermatologists (14.5%) than pediatricians (7.0%) or PCPs (4.1%) (Supplementary Material, Table S3). The use of conventional systemics was low for first-line regimens (7.6% overall), but increased for later regimen lines (Fig. 2).

Methotrexate was the most prescribed conventional agent overall (6.8% of patients with a treatment history, 19.3% of patients prescribed systemic treatments [conventional systemics and biologics], and 62.5% of patients prescribed conventional systemics) (Table 3) and across all

Table 3 Current treatment characteristics overall and by weight category

Treatment ^a	Overall (<i>N</i> = 1919)	Weighing 25–50 kg (<i>N</i> = 772)	Weighing > 50 kg (<i>N</i> = 1147)	<i>p</i> value ^b
Severity of psoriasis immediately prior to current/most recent treatment regimen				< 0.001
Mild	541 (28.2%)	261 (33.8%)	280 (24.4%)	
Moderate/severe	1378 (71.8%)	511 (66.2%)	867 (75.6%)	
Current severity of psoriasis				1.000
Mild	1536 (80.0%)	618 (80.1%)	918 (80.0%)	
Moderate/severe	383 (20.0%)	154 (19.9%)	229 (20.0%)	
Topical only	1133 (59.0%)	543 (70.3%)	590 (51.4%)	< 0.001
Topical corticosteroid ^c	648 (33.8%)	300 (38.9%)	348 (30.3%)	< 0.001
Topical non-corticosteroid ^c	569 (29.7%)	266 (34.5%)	303 (26.4%)	< 0.001
Topical combination product ^{c,d}	498 (26.0%)	194 (25.1%)	304 (26.5%)	0.490
Phototherapy (PUVA, UVB) ^c	139 (7.2%)	57 (7.4%)	82 (7.1%)	0.858
Conventional systemics	208 (10.8%)	63 (8.2%)	145 (12.6%)	0.002
Methotrexate ^c	30 (6.8%)	43 (5.6%)	87 (7.6%)	0.095
Cyclosporine ^c	50 (2.6%)	15 (1.9%)	35 (3.1%)	0.146
Acitretin ^c	25 (1.3%)	6 (0.8%)	19 (1.7%)	0.104
Fumarate ^c	5 (0.3%)	1 (0.1%)	4 (0.3%)	0.654
Biologics ^e	466 (24.3%)	121 (15.7%)	345 (30.1%)	< 0.001
Etanercept ^c	80 (4.2%)	27 (3.5%)	53 (4.6%)	0.245
Etanercept or biosimilar ^c	107 (5.6%)	38 (4.9%)	69 (6.0%)	0.361
Adalimumab ^c	221 (11.5%)	60 (7.8%)	161 (14.0%)	< 0.001
Adalimumab or biosimilar ^c	264 (13.8%)	66 (8.5%)	198 (17.3%)	< 0.001
Ustekinumab ^c	95 (5.0%)	17 (2.2%)	78 (6.8%)	< 0.001
Other ^f	9 (0.5%)	3 (0.4%)	6 (0.5%)	0.747
Ever received a biologic	501 (26.1%)	135 (17.5%)	366 (31.9%)	< 0.001

Values are shown as *n* (%)

PUVA psoralen and ultraviolet A, UVB ultraviolet B

^aNumber of patients was lower for some parameters

^bFor the comparison between the two patient weight groups (Fisher's exact test)

^cPercentages based on the number of patients with a treatment history: 1898 overall, 765 for patients weighing 25–50 kg and 1133 for patients weighing > 50 kg

^dFor example, calcipotriol + betamethasone dipropionate

^eNo data on off-label biologic use were collected

^fIncluded urea, tacrolimus, calcipotriol/betamethasone, and emollients

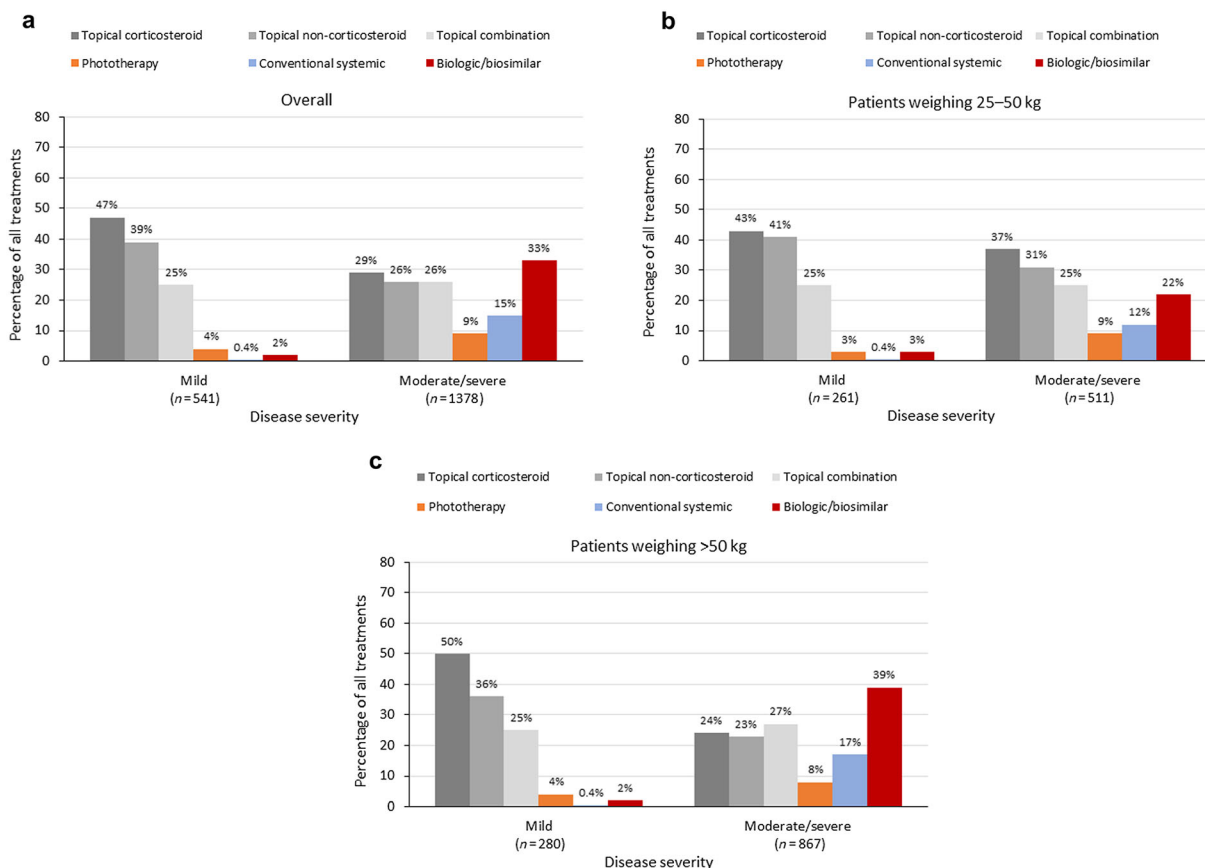


Fig. 1 Treatments received according to disease severity prior to the initiation of current treatment in **a** the overall patient population, **b** patients weighing 25–50 kg, and

c patients weighing more than 50 kg. Patients could receive multiple treatments

countries apart from Italy (Supplementary Material, Table S4). In Italy, cyclosporine was the most prescribed conventional agent (67.5% of patients receiving conventional systemics), followed by methotrexate (37.5% of patients prescribed conventional systemics).

Biologic Treatments

Overall, in our biologic user-enriched population, 466 of 1919 patients (24.3%) were currently receiving biologic therapy, while 501 patients (26.1%) had ever received a biologic (patients who received a biologic at some point in their psoriasis treatment pathway, and including those currently receiving any-line biologic therapy). Biologic therapy was significantly more likely to be prescribed in patients

weighing more than 50 kg (74.0% of patients prescribed a biologic) than in those weighing 25–50 kg (26.0% of patients prescribed a biologic; *p* < 0.001) (Table 3). A similar pattern was seen across countries (Supplementary Material, Table S4). Biologics were also more likely to be prescribed in patients with moderate-to-severe disease (32.9%) than in those with mild disease (2.4%; Fig. 1 and Supplementary Material, Fig. S2), in patients with comorbid PsA (69.5% were prescribed a biologic), and, in line with inclusion criteria, by dermatologists (35.4%) than pediatricians (13.4%) or PCPs (3.4%) (Supplementary Material, Table S3).

For patients currently receiving a biologic, the median age at biologic initiation was 16.0 years overall (Supplementary Material, Fig. S3). Biologic use started to increase at the age of 13.0 years, and most biologics (78.2%)

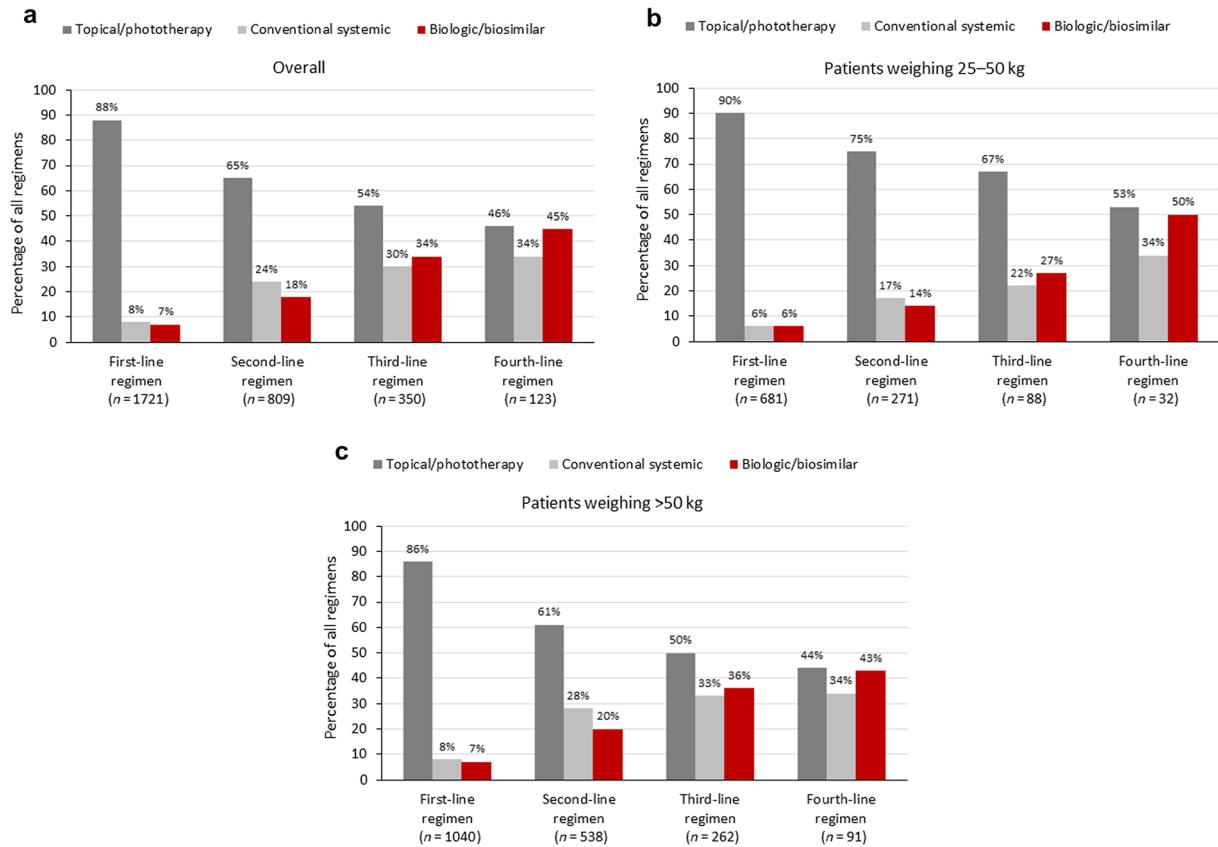


Fig. 2 Treatments by line of therapy for patients with a complete treatment history for **a** the overall patient population, **b** patients weighing 25–50 kg, and **c** patients weighing more than 50 kg. Data were collected at the class

level only. Percentages for each regimen line add up to more than 100% as patients could receive multiple treatments for each regimen line

were prescribed to patients older than this. A similar pattern was seen across countries (Supplementary Material, Fig. S3). The current median weight of patients receiving biologics was 60.0 kg, and most biologics (approx. 75%) were prescribed to patients weighing more than 50 kg and those with a BMI of 20–24, although differences between countries were observed (Supplementary Material, Fig. S4).

As expected, across all patients with complete treatment history data ($n = 1721$), biologic use increased with line of therapy, from 6.6% of all first-line regimens to 18.0% as a second-line regimen, 33.7% as a third-line regimen, and 44.7% as a fourth-line regimen (Fig. 2). A similar pattern was observed across countries, except that the use of biologics was much lower in the

UK for earlier regimen lines (Supplementary Material, Fig. S5).

The most prescribed biologic was adalimumab or a biosimilar (13.8% of all patients, 56.7% of patients prescribed a biologic; Table 3), and use of this agent or a biosimilar was significantly greater among patients weighing more than 50 kg than among those weighing 25–50 kg (17.3% vs. 8.5%; $p < 0.001$). A similar pattern was seen across countries (Supplementary Material, Table S4). The use of etanercept or a biosimilar was relatively consistent across treatment lines, whereas the use of adalimumab or a biosimilar and ustekinumab increased with treatment line, both overall and in the two weight categories.

The mean length of time on biologic treatment for patients currently receiving a biologic

was 32.9 ± 27.9 weeks overall; this was similar for the two weight categories (33.8 ± 26.3 weeks for those weighing 25–50 kg and 32.5 ± 28.4 weeks for those weighing more than 50 kg). A similar pattern was seen in Germany and the UK, while treatment was shorter in patients in the lower-weight category in France, but longer in patients in the lower-weight category in Italy and Spain (Supplementary Material, Table S5).

Of the 466 patients who were prescribed a biologic, approximately one-third (36.5% [$n = 170$]) were taking concomitant treatment: 4.7% ($n = 22$) were also using a topical or phototherapy, and 31.8% ($n = 148$) were also taking a conventional systemic.

Factors Influencing Biologic Prescribing

The main factors physicians considered from a pre-selected list before prescribing a biologic were previous treatments received (68.4% of physicians), the patient's PASI (65.8%), the presence/absence of PsA and/or joint pain (46.0%), the patient's age (> 12 years; 43.9%), and the impact of treatment on patients' normal daily activities (43.5%) and emotional well-being (42.6%). Specific clinical measures (PASI, body surface area [BSA] affected) were more of an influence on dermatologists' decision to prescribe a biologic than for pediatricians and PCPs, whereas pediatricians and PCPs were more concerned about the number and size of plaques than dermatologists.

The main factors influencing physician choice of the current biologic ($n = 466$) were the likelihood of clearing psoriatic lesions through achievement of at least 75% improvement in PASI (50.9%), control of flares (45.1%), long-term efficacy (44.6%), likelihood of clearing psoriatic lesions through achievement of at least 90% improvement in PASI (44.4%), relief of itching (43.1%), improved/maintained patient quality of life (41.8%), and a reduction in the BSA affected (41.6%). Thirty-one percent (31.1%) of physicians considered the biologic's general and long-term safety profile, and 21.0% considered the likelihood of serious adverse

events when choosing a biologic. Findings were generally similar across countries.

Physician Satisfaction with Disease Control

For patients with moderate or severe disease, 41.3% of physicians were satisfied with current control of the disease, 15.1% were not satisfied but believed this was the best control that could realistically be achieved, and 43.6% were not satisfied and believed better control could be achieved. The main reasons for dissatisfaction with current disease control (any treatment) were incomplete skin clearance (35.6%), slow onset of efficacy (27.1%), loss of response over time (22.7%), and dissatisfied patient (20.4%). For patients with mild psoriasis, 89.0% of physicians were satisfied with current disease control, 3.8% were not satisfied but believed this was the best control that could realistically be achieved, and 7.1% were not satisfied and believed better control could be achieved.

DISCUSSION

This study investigated treatment patterns and patient characteristics by weight in a biologic-enriched sample of pediatric patients with psoriasis in a large real-world sample of pediatric patients aged 6 years or older, both overall and by country. Results showed that the use of topical agents was high across all treatment lines. There was little use of biologics as first- or second-line therapy. Biologic use started to increase at the age of 13 years, and most pediatric patients receiving these drugs were older (≥ 16 years) and heavier (> 50 kg). For patients with moderate-to-severe psoriasis, the main reason for physician dissatisfaction with current treatment was incomplete skin clearance.

The finding that pediatric patients with psoriasis were most likely to be prescribed topical treatments was supported by the results of a survey of 92 German pediatricians who were treating patients with psoriasis [40]. In this survey, 53% of German pediatricians would prescribe topical treatment for confirmed psoriasis and 10% would recommend conventional

systemics. Similarly, a survey of 384 French physicians (PCPs, pediatricians, and dermatologists) showed that topical corticosteroids were the most prescribed agents (by 88% of physicians) for children with psoriasis, while the prescribing of systemic treatments was limited [41]. In our study, the use of topical treatments was greater among lower- than higher-weight patients, possibly reflecting physician reluctance to prescribe systemic treatments in lower-weight patients who are also likely to be younger.

Methotrexate was the preferred conventional systemic overall in the current study (62.5% of patients taking these drugs) and in all countries apart from Italy, where cyclosporine was the preferred conventional systemic, prescribed in 67.5% of patients receiving systemic treatment. A similar pattern was observed in a study of systemic treatment patterns in 58 Italian children and adolescents with moderate-to-severe psoriasis [42]. Cyclosporine was the preferred first-line treatment, prescribed in 53% of patients. However, in contrast to our study, acitretin was prescribed in 22% of patients (compared with none in Italy in our study) and methotrexate in 7% of patients (compared with 37.5% in Italy in our study). In line with our study, a retrospective medical record review of 234 pediatric patients with psoriasis treated with methotrexate and/or biologics in Europe and North America found that 70% of patients were treated exclusively with methotrexate [43].

As a result of the biologic-enriched sample included, one-quarter of pediatric patients in our study were prescribed biologics at some point in their treatment pathway; although not necessarily representative of prescribing patterns, this enabled meaningful characterization of these biologic-treated patients and their associated treatment patterns. In the study by Bronckers et al. [43], 20% of patients were treated exclusively with biologics, while 10% received methotrexate and biologics sequentially. The previously mentioned survey of French physicians found that 5.2% had prescribed etanercept to their pediatric patients with psoriasis, similar to the 7.9% in France in our study [41], while the survey of German pediatricians mentioned above found that none

had prescribed a biologic in children with psoriasis, even in those with severe disease [40]. By comparison, 8.7% of patients prescribed a biologic in Germany had received their prescription from a pediatrician in our study.

In the current study, country differences were seen in the distribution of BMI among patients receiving biologics. In France, children with psoriasis are more likely to be obese than those without psoriasis [44, 45]. However, in the current study, the distribution of BMI in France matched that seen overall, with most patients receiving biologics having a BMI of 20–24, and fewer patients with a BMI above 25 receiving these agents. This difference was most likely due to the majority of patients (61.0%) having a BMI of 20–24 and a smaller number (18.1%) having a BMI of greater than 25.

The main factors physicians considered from a pre-selected list before prescribing a biologic were previous treatments received, the patient's PASI, the presence of psoriatic arthritis, and the patient's age. Likewise, in a French retrospective observational study of biologic drug survival in 134 pediatric patients with psoriasis, factors significantly associated with the choice of first-line biologic were age at onset of psoriasis, age at biologic initiation, PASI, and physician global assessment [46]. Conversely, a survey of 384 French physicians treating children with psoriasis showed that severity scores were underused, with only 4% of PCPs and pediatricians and 24% of dermatologists reporting the use of severity measures [41].

Strengths of our study are that Adelphi DSPs contribute data from large international databases providing country-specific real-world information on disease characteristics, management, and outcomes; and the use of standardized data collection tools allowing comparisons to be made between countries. Study limitations are that the sample was not truly random as the next 10 consulting patients who were suitable were included, creating a convenience sample. Consequently, patients who consulted more frequently were more likely to be included in the sample; it is possible that such patients had more active, advanced, or complex disease, which may have accounted for the high proportion of patients with

moderate-to-severe disease in our study. In addition, patients receiving biologics were oversampled in the study, and, as dermatologists were most frequently surveyed, this could explain the high proportion of patients with moderate-to-severe disease. Also, only around half of patients on biologics were taking concomitant therapy, which is lower than expected. Therefore, our sample may not represent the overall population of pediatric patients with psoriasis.

Furthermore, the diagnosis of psoriasis was based primarily on the judgment and diagnostic skills of the physician rather than a formal diagnostic checklist, although patients were managed in accordance with routine diagnostic procedures reflecting those in clinical practice. Nevertheless, it is possible that some patients were misclassified as having mild disease but actually had moderate disease, as 6% of patients with mild disease had BSA involvement of greater than 10%, which objectively may be considered moderate disease [47]. Physician inclusion was likely influenced by willingness to participate, which may introduce selection bias; data quality was dependent on the accurate reporting of information by physicians and may have been subject to recall bias; and finally, as data collection in the DSPs is cross-sectional, longitudinal treatment use cannot be tracked and the data cannot be used to demonstrate cause and effect.

CONCLUSIONS

The use of topical agents is high across all treatment lines in European pediatric patients with psoriasis aged 6–17 years. There is little first- or second-line use of biologic agents and, when prescribed, biologics tend to be used in older patients and those weighing more than 50 kg. Physicians report dissatisfaction with current treatments for moderate-to-severe psoriasis. The low use of biologics may represent an unmet treatment need, as topical or conventional systemic agents remain the main treatment option for moderate or severe psoriasis in pediatric patients through the treatment pathway.

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Compliance with Ethics Guidelines. The study was approved by the WCG IRB (tracking number 20193181). All participants provided consent to participate in the survey. Physician responses were anonymized and pseudonymized, and data collection and handling complied with applicable laws, regulations, and guidance regarding patient protection, including patient privacy. The study was conducted in accordance with the 1964 Declaration of Helsinki and its later amendments, Good Pharmacoepidemiology Practices, and applicable laws and regulations of the participating countries.

Data Availability. All data generated or analyzed during this study are included in this published article and the supplementary information files.

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