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ORIGINAL RESEARCH

Update on the Management of Pediatric Psoriasis: An Italian Consensus

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ABSTRACT

Introduction: Psoriasis affects children with a considerable burden in early life. Treating pediatric psoriasis is challenging also because of the lack of updated specific guidelines. With the recent approval of several biologics for pediatric psoriasis and the ongoing COVID-19 pandemic, the management of young psoriatic patients is facing major changes. A revision of treatment recommendations is therefore needed.

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Methods: In September 2021, a board of six Italian dermatologists convened to update treatment recommendations. The board issued evidence- and consensus-based statements covering relevant areas of pediatric psoriasis, namely: assessment of psoriasis severity, management of children with psoriasis, and treatment of pediatric psoriasis. To reach consensus, the statements were submitted to a panel of 24 experts in a Delphi process performed entirely via videoconference. A treatment algorithm was produced.

Results: There was full consensus that psoriasis severity is determined by the extension/severity of skin lesions, site of lesions, and impact on patient quality of life. Agreement was reached on the need for a multidisciplinary approach to pediatric psoriasis and the importance of patient/parents education. The relevance of vaccinations, including COVID-19 vaccination, for psoriatic children was acknowledged by all participants. Management issues that initially failed to reach consensus included the screening for psoriasis comorbidities and early treatment with biologics to prevent them and the use of telemedicine to facilitate patient follow-up. There was full consensus that topical corticosteroids are the first choice for the treatment of mild pediatric psoriasis, while phototherapy and systemic therapy are used in children with moderate-severe psoriasis. According to the proposed treatment algorithm, biologics are the first line of systemic therapy.

Conclusions: Targeted systemic therapies are changing the treatment of moderate-severe pediatric psoriasis, while topical corticosteroids continue to be the first choice for mild disease. Children-centered research is needed to further improve the treatment of pediatric psoriasis.

Keywords: Adolescents; Biologics; Children; Corticosteroid-sparing; Health-related quality of life; Pediatric psoriasis; Plaque psoriasis; Systemic therapy; Topical corticosteroids

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Key Summary Points

Why carry out this study?

Pediatric psoriasis poses a considerable burden on patients and their families

The management and treatment of pediatric psoriasis are complex. The availability of new treatment options, as well as the ongoing COVID-19 pandemic, are changing the management of children with psoriasis

Updated specific guidelines for the management of pediatric psoriasis are needed

What was learned from this study?

A panel of Italian dermatologists produced a set of statements covering relevant areas of pediatric psoriasis management based on the literature, their clinical experience, and consensus

The consensus statements are presented in this article, along with a treatment algorithm. They update current recommendations for the management of children with psoriasis and offer comprehensive practical guidance to dermatologists and pediatricians

As the field of psoriasis management is rapidly evolving, treatment recommendations and the algorithm will need regular revision

INTRODUCTION

Psoriasis is a chronic, immune-mediated, inflammatory disease that affects the skin, nails, and joints and may often develop in early life [1, 2]. Indeed, it is estimated that approximately one-third of the adults with psoriasis had their disease onset during childhood [3]. The preva-

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lence of pediatric psoriasis is uncertain since epidemiologic studies in pediatric populations are lacking. Prevalence rates reported in Europe range between 0.17 and 1.5% [4–7]. Notably, the prevalence appears to increase almost linearly from the age of 1 year to the age of 18 years [6]. Pediatric psoriasis clinically presents with erythematous scaly plaques that are usually smaller, less infiltrating, and less desquamated than those observed in adults [3, 8]. In infants (i.e., children aged < 1 year), psoriasis usually affects diaper areas and inguinal folds (psoriatic diaper rash) [9]. In older children, plaque psoriasis is the most common type, with scalp, face, elbows, and knees being the most frequently involved areas [3, 9]. Like adult psoriasis, pediatric psoriasis may be associated with comorbidities including obesity, hyperlipidemia, hypertension, diabetes mellitus, Crohn's disease, and psoriatic arthritis [6, 10]. Psychiatric comorbidities, including depression and anxiety, have also been reported in children and adolescents with psoriasis [11, 12]. A recent retrospective analysis including 4754 pediatric patients with psoriasis identified anxiety as the most prevalent comorbidity (6.6%), followed by depression (4.1%) and obesity (3.9%) [13].

The burden of disease in children with psoriasis and their families is substantial [14, 15]. Children and adolescents with psoriasis may feel ashamed of their visible skin lesions, have a very negative body image, and experience stigmatization, loss of self-confidence, anxiety, and social isolation [14, 15]. In addition, psoriasis-associated symptoms like pruritus can be extremely bothersome to children [14, 15]. Studies addressing the quality of life of pediatric patients with psoriasis are limited. According to the available evidence, children with psoriasis have a significantly greater impairment of physical, emotional, social, and school functioning compared with healthy children [16]. This impairment is similar to that seen in patients affected by other severe chronic conditions like arthritis, psychiatric disorders, asthma, and diabetes [16]. The parents of children with psoriasis also experience a significant decrease in their quality of life [15, 17].

The management of children with psoriasis is challenging for pediatricians and dermatologists and is further complicated by the lack of specific international guidelines. With a few exceptions, children and adolescents with psoriasis are managed from diagnosis to treatment and follow-up based on what has been learned from studies in adult patients [8, 18–21]. Furthermore, most psoriasis medications are not approved for use in children because of the lack of clinical trials in this age group. In recent years, five targeted therapies with biologics have been granted approval by the European Medicines Agency (EMA) for the treatment of pediatric patients with severe psoriasis. These new options are changing the treatment of pediatric psoriasis. In addition, the coronavirus disease 2019 (COVID-19) pandemic has had a relevant impact on the management of chronic conditions, including psoriasis, forcing healthcare systems to develop new modalities, for example, of patient follow-up. For all these reasons, there is an urgent need to update current treatment strategies for pediatric psoriasis.

In 2017, recommendations for the treatment of severe psoriasis in children were published by a group of Italian dermatologists with experience in pediatric psoriasis [19]. In September 2021, a group of six Italian dermatologists, including some of the authors of the 2017 recommendations, convened to address current issues of pediatric psoriasis treatment. Their primary objective was to update treatment recommendations based on evidence, existing guidelines, and consensus. To this end the group produced a set of statements covering relevant areas of pediatric psoriasis management. The statements were then submitted to a Delphi process to reach consensus. This article presents the results of the Delphi study and discusses the consensus statements. In addition, an updated treatment algorithm is proposed.

METHODS

Study Design

On September 13, 2021, six dermatologists (scientific board; K.P., A.B.F., L.B., G.F., P.G., and

V.D.L.) with expertise in the treatment of psoriasis in Italy convened virtually in a web meeting (kick-off meeting) to update current recommendations for the treatment of pediatric psoriasis. To this purpose, the scientific board had previously drafted a series of statements about current practical issues of pediatric psoriasis across three major areas identified as relevant, based on published evidence, current guidelines, and clinical experience: (1) assessment of psoriasis severity in children; (2) management of children with psoriasis; (3) treatment of pediatric psoriasis. To reach consensus, especially on statements not supported by published evidence, a Delphi study was performed. The Delphi survey technique is an iterative process used in a variety of research areas to create consensus, in the absence of evidence, from different opinions on unresolved questions [22]. Statements covering the topic of interest are submitted to a panel of experts who are asked to express their agreement or disagreement on each statement. Statements on which no consensus has been reached are modified and resubmitted to the review procedure by the expert panel until a predefined level of consensus is reached. The article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

Development of Consensus Statements

Figure 1 shows the steps of the Delphi study, which was performed between September 2021 and December 2021. To ensure physical distancing due to the ongoing COVID-19 pandemic, all the meetings took place via video conferencing, using the Microsoft Teams platform. During the kick-off meeting, the scientific board agreed on a first version of the statements that had been drafted in English prior to the meeting, selected a panel of 24 experts in the treatment of psoriasis who would participate in the Delphi survey, and planned the next steps of the process. The experts, selected on the basis of their documented expertise in the field of psoriasis (i.e., publication record, membership to relevant scientific societies, previous participation in similar studies), were representative of most Italian regions. On November 4, 2021, the scientific board and the expert panel met virtually at the first plenary meeting to discuss and further refine the statements to be voted in the Delphi survey (19 statements over three areas of interest: Assessment of disease severity (statements S1–S3), Management (statements S4–S12), and Treatment (statements S13–S19). The first round of the Delphi voting took place between the first and the second plenary meeting. Evaluation of the statements by the panelists was performed online on a dedicated web platform. The 24 members of the expert panel were asked to express their agreement or disagreement on each statement using a 3-point scale (1 = full agreement, 2 = partial agreement, 3 = full disagreement); consensus was defined by a $\geq$ 80% agreement on a statement (i.e., $\geq$ 80% of scores 1 and 2). During the second virtual plenary meeting held on December 16, 2021, the results of the Delphi survey were discussed and the statements with no consensus were revised and submitted to a second round of voting. A treatment algorithm, previously drafted by the scientific board, was discussed and finalized during the second plenary meeting.

RESULTS

The statements and the results of the Delphi process (second round of voting) are shown in Tables 1, 2, and 3. The participation rate at the first voting round was 100%. Seventeen of the 19 statements achieved consensus. Statements S8 and S12, with an agreement level of 66.7% and 70.4%, respectively, failed to reach consensus. The two statements underwent review during the second plenary meeting and were evaluated by the expert panel in a second round of voting; consensus was reached (participation rate 23/24, 96%; level of agreement 100% for both statements).

Regarding the Delphi process, all the meetings, including the plenary meetings, took place virtually via a video conferencing web platform. Despite the large number of participants, the discussion and revision of the statements during the plenary meetings could be performed

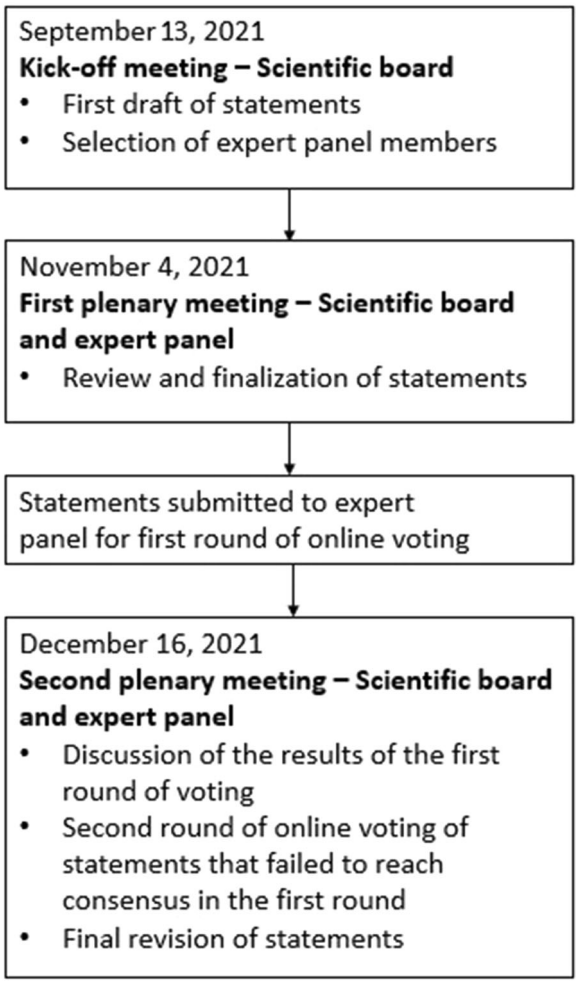

Fig. 1 Flowchart of the Delphi study

successfully with the active involvement of most participants. The two plenary meetings lasted between 2 and 3 h each.

In the following sections, the statements will be discussed in detail, along with the relevant published evidence available.

Assessment of Disease Severity

Statements S1–S3 (Table 1), on which consensus was reached at the first round of voting, point out the three components—extent and severity of skin lesions, affected sites, and quality of life—that should be considered when assessing psoriasis severity. The extent and severity of skin lesions in children are usually measured with the Psoriasis Area and Severity Index (PASI) and the Body Surface Area (BSA). The site of skin lesions is very important, as lesions on certain areas, such as the face and scalp, strongly affect patient quality of life and contribute significantly to disease severity. Quality of life measurements are essential as they provide the patient perspective and help quantify the burden of the disease.

The BSA and PASI assessment tools are widely used in clinical practice. They can be used in children although they have not been formally validated in this population. The BSA determines the total body surface area affected by psoriasis (expressed as % of affected areas). The PASI score is more comprehensive and

combines the measurement of disease extension and the intensity of erythema, plaque thickness, and desquamation. PASI measurement in children requires expertise in pediatric psoriasis. Both BSA and PASI measurements should consider that body proportions of infants and children differ significantly from those of adults. In this regard, the Physician's Global Assessment (PGA), widely used in clinical trials and in adults, may be a valid alternative in children as it does not rely on the affected body surface area [8].

Pediatric patients, especially school children and adolescents, may experience profound distress due to lesions on visible areas of the body and may be more vulnerable than adult patients when they are confronted with stigmatization, avoidance by others, and social isolation. The perception of stigma has detrimental effects on the quality of life [16, 23]. A recent study assessing health-related quality of life (HRQoL) in 110 children with psoriasis found significant correlations between the Children's Dermatology Life Quality Index (CDLQI) and the presence of visible affected areas irrespective of lesion severity [24].

The CDLQI is a validated 10-item questionnaire for the assessment of HRQoL in patients aged from 4 to 16 years with psoriasis and other skin disorders [25–29]. For the assessment of HRQoL in adolescents aged 16–18 years, the DLQI questionnaire for adults can be used although some of its items may not reflect the life of teenagers.

In a European consensus study, Mrowietz et al. defined severity of plaque psoriasis in adult patients as mild when BSA is $\leq$ 10%, PASI is $\leq$ 10, and DLQI is $\leq$ 10; according to the same authors, moderate to severe psoriasis is defined by (BSA $>$ 10% or PASI $>$ 10) and DLQI $>$ 10 [30]. These definitions can be used also in children, as a severity classification specific for pediatric psoriasis is currently not available [8].

Management

This area (statements S4–S12) addresses a number of issues relevant for the management of pediatric patients with psoriasis as well as issues related to the COVID-19 pandemic (Table 2). With the exception of statements S8 and S12, all statements achieved consensus at the first round of voting.

Screening of Comorbidities and Early Treatment

Statements S4 and S8 deal with the course of psoriasis and the development of comorbidities, in particular psoriatic arthritis, and with strategies to delay disease progression and the appearance of comorbidities. Comorbidities are

Table 1 Assessment of disease severity—statements and agreement level

Assessment of disease severity		
Statement #	**Statement**	**Level of agreement (%)**
S1	The Psoriasis Area and Severity Index (PASI) and Body Surface Area (BSA) measurement of involved skin area are the currently available tools for the assessment of pediatric psoriasis severity	92.6
S2	Disease involvement of sensitive and visible skin areas affects pediatric psoriasis severity, daily activities, and the quality of life	100
S3	The Children's Dermatology Life Quality Index (CDLQI) is a validated tool for measuring the impact of psoriasis in children and adolescents up to 16 years	85.2

The level of agreement after the second and final round of Delphi voting is shown

a relevant aspect of the management of both adult and pediatric patients with psoriasis and their early detection and treatment should be a priority [6]. Guidelines for the screening of comorbidities in pediatric psoriasis are available [10].

With an estimated prevalence of 11.2 per 1000 patients, psoriatic arthritis is not uncommon in children with psoriasis [12]. Pediatric psoriatic arthritis shows two peaks of onset, the first at 2–3 years of age and the second at 10–-12 years [10]. In most children with psoriatic arthritis, arthritis precedes skin manifestations by 2–3 years [10]. Psoriatic arthritis can be highly debilitating. Therefore, early detection and treatment are crucial to prevent irreversible damage to the joints. Screening for psoriatic arthritis should rely on relevant symptoms such as morning stiffness and limp, while pain is not sufficient for the detection of arthritis in children [10]. Screening should be performed when skin psoriasis is diagnosed and should be repeated periodically, but the optimal interval between screening visits has not been established yet [10].

The recognition that psoriasis is a systemic inflammatory disease and the evidence of the benefits of early treatment in other immune-mediated inflammatory diseases (e.g., rheumatoid arthritis and Crohn's disease) have led to the hypothesis that early treatment of psoriasis with biologics targeting inflammatory pathways may not only improve skin lesions but may also reduce chronic inflammation and therefore the progression of comorbidities [31, 32]. In patients with moderate to severe psoriasis, decreased levels of inflammation markers (erythrocyte sedimentation rate and C-reactive protein) were reported with several systemic therapies, including methotrexate and biologics [32]. Secukinumab, an IL-17A inhibitor, was reported to reduce the erythrocyte sedimentation rate in patients with psoriatic arthritis [33]. Recent studies showed that the treatment with secukinumab or usetekinumab (an IL-12/23 inhibitor) in patients with moderate to severe psoriasis without clinically clear-cut psoriatic arthritis, but with subclinical synovitis/enthesitis, was able to improve skin lesions and inflammation scores and to prevent the progression of joint disease [34, 35]. However, further research is required to demonstrate the benefits of early targeted treatment in terms of improved patient outcomes and long-term safety. The current lack of robust evidence demonstrating better outcomes for psoriasis patients receiving early biologic treatment may explain why statement S8, which in its first version was more assertive, did not achieve consensus at the first voting round.

Education of Pediatric Patients and Their Parents

Statements S5, S6, and S7 point out the importance of educational efforts directed to young patients and their parents for improving their ability to cope with a chronic relapsing disease and comply with the recommended interventions. Consensus was reached on all three statements at the first round of voting. Educational efforts should encompass information about the disease, its chronic and relapsing course and its comorbidities, information about current topical and systemic therapies, and children-oriented strategies to promote patient involvement and improve compliance [36]. Information about vaccination of children with psoriasis should also be included in the educational programs. The ultimate objective of educational programs is to improve the quality of life of pediatric patients with psoriasis and their parents. Educational support may be particularly indicated for patients who have experienced treatment failure. Education can be provided via face-to-face discussions, leaflets, and videos, or by indicating reliable internet sources (e.g., websites developed and/or endorsed by scientific societies).

Patient educational programs, usually provided by multidisciplinary teams, have been successfully implemented in the management of several chronic diseases, including atopic dermatitis [37–40]. The literature describing educational programs for pediatric psoriasis is limited to small pilot studies, which reported high satisfaction from patients and their parents and promising results in terms of patient outcomes [36, 41].

Multidisciplinary Management

Given the complexity of pediatric psoriasis, the presence of comorbidities, and the impact of psoriasis on HRQoL, the optimal management of psoriatic children and adolescents may require a multidisciplinary team (statements S9 and S10). Consensus was reached on both S9 and S10 statements at the first round. Pediatric psoriasis is managed primarily by the dermatologist who should communicate and collaborate with the patient's pediatrician and with other specialists, for example, nutritionists and psychologists, depending on the disease course and comorbidities. Psychologic support, an important component of pediatric psoriasis treatment, is frequently needed to help young patients and their families cope with the distress caused by the disease. Finally, a multidisciplinary approach leading to timely and comprehensive management of psoriasis might reduce the use of resources related to unnecessary visits, treatment failure, and disease relapse, with a positive impact on costs in the long-term.

Vaccinations

Children and adolescents with psoriasis and psoriatic arthritis, including those on immunosuppressive therapy, can be safely vaccinated with inactivated vaccines and should receive all recommended vaccines according to their immunization plan [20]. The family members of psoriatic patients on immunosuppressive therapy should also receive recommended vaccinations [20]. According to current guidelines, vaccinations should be administered before initiating immunosuppressive therapy; immunosuppressive therapy should start at least 4 weeks after immunization with a live vaccine [20]. Vaccinations should be avoided during an acute flare of psoriasis [20].

Regarding the vaccination against the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (statement S11), in May 2021 the EMA extended the approval of the BNT162b2 vaccine (BioNTech/Pfizer) to adolescents aged 12–15 years. In November 2021, the approval was further extended to children aged 5–-11 years. The formulation indicated for this age group contains one-third of the vaccine dose approved for people aged $\geq$ 12 years. The COVID-19 vaccine Spikevax (previously COVID-19 vaccine Moderna) was approved by the EMA for use in adolescents aged 12–17 years in July 2021; the extension of the indication to children aged 6–11 years was recommended by the EMA in February 2022. As with the BNT162b2 vaccine, the recommended dose of COVID-19 vaccine Spikevax is lower than that used in people aged $\geq$ 12 years. The general recommendations on vaccination mentioned above are valid also for the anti-SARS-CoV-2 vaccination. The fact that two injections of one of the two approved mRNA COVID-19 vaccines are administered, with a 3-week interval, may require careful planning of immunosuppressive treatment initiation, or temporary interruption of the ongoing treatment. Evidence from studies in adults with immune-mediated inflammatory disease suggests that treatment with biologics does not contraindicate anti-SARS-CoV-2 vaccination [42]. It is however unclear to what extent immunosuppressive treatment may reduce the immune response.

Telemedicine

Telemedicine is defined as the remote delivery of medical care using communication technologies. In a few countries, like the US, the application of telemedicine to dermatology, or teledermatology, has evolved very rapidly [43], while in other countries this modality is still in development. The healthcare crisis caused by the COVID-19 pandemic has shown globally that telemedicine may be a convenient alternative to face-to-face follow-up visits, especially in the setting of chronic diseases that require regular monitoring by a specialist [44]. Notably, the inability to receive regular care by a specialist has been reported as one of the main reasons of poor outcomes in patient with chronic skin diseases [45].

In Italy, national guidelines for the use of telemedicine were issued in 2014 and updated in October 2020 [44]. Telemedicine is now a service fully recognized by the Italian healthcare system [44] and a national program of implementation and standardization is ongoing. However, great differences among Italian regions still exist in the adoption of

Table 2 Management—statements and agreement level

Management		
Statement #	**Statement**	**Level of agreement (%)**
S4	Pediatric patients with psoriasis should be screened for psoriatic arthritis through personal and family history, physical signs, and referred symptoms	92.6
S5	Pediatric patients with psoriasis and their parents should be educated about the possible different clinical manifestations, the disease course, the risk of psoriatic arthritis and other comorbidities	93.3
S6	Pediatric patients with psoriasis and their parents should be educated about topical and systemic therapies, the risk of adverse events, and vaccination plans	100
S7	Educational tools (video, leaflets, education programs, etc.) dedicated to children with psoriasis may improve the adherence to topical and systemic treatments, including injectable therapies	92.6
S8	Early treatment with biologics in pediatric patients with moderate to severe psoriasis might positively modify the disease course	100
S9	A multidisciplinary approach, if needed, can provide a more appropriate management of pediatric psoriasis and reduce healthcare costs	92.6
S10	Psychologic support to patients and their parents can reduce the impact of a chronic disease that occurs during childhood	81.5
S11	In light of the available literature on SARS-CoV-2 infection and vaccination and its administration to the pediatric population, it is essential to clarify how to manage possible discontinuation of immunomodulatory therapy in young psoriasis patients	88.9
S12	Clinicians could use telemedicine as a useful option for the follow-up of pediatric patients with psoriasis, allowing continuity of care and providing appropriate medical support to patients and families in case of difficulties in reaching referral centers	100

The level of agreement after the second and final round of Delphi voting is shown

telemedicine, and this service is currently not available throughout the national territory. Statement S12 on the usefulness of telemedicine for the follow-up failed to reach consensus at the first Delphi round. This could be explained by the concern that telemedicine may have a negative impact on the relationship patient-physician, replace face-to-face visits, and result in an increased loss of patients to follow-up.

Evidence about the use of telemedicine for the management of children with psoriasis is limited, while the feasibility of this approach in adults is supported by extensive literature [43–48]. A recent survey among pediatric psoriasis patients in France found that during the COVID-19 lockdown, > 70% of the patients who were visited because of psoriasis did so via telemedicine [49]. The authors of the survey pointed out the lack of standardization in the assessment of disease severity in a telemedicine visit and the need to develop specific tools. Clearly, many practical issues concerning the use of telemedicine for the management of pediatric psoriasis in clinical practice still need to be optimized.

Table 3 Treatment—statements and agreement level

Treatment		
Statement #	**Statement**	**Level of agreement (%)**
S13	Corticosteroids are the first-line topical therapy in pediatric patients with psoriasis	81.5
S14	Although off-label, the combination calcipotriol-betamethasone dipropionate as ointment, foam, or gel applied once daily for up to 4 weeks is a safe and effective treatment for children with mild to moderate plaque psoriasis, aged ≥ 12 years	88.9
S15	Skin care including the use of appropriate moisturizers/emollients, detergents and shampoos should be considered in pediatric patients with psoriasis along with pharmacologic topical therapy	100
S16	Rotational therapy with topical vitamin D analogues, topical calcineurin inhibitors, and emollients should be considered in pediatric patients with psoriasis as a corticosteroid-sparing strategy that may reduce the potential adverse effects of corticosteroids	96.3
S17	Although off-label, the use of topical calcineurin inhibitors should be considered as a corticosteroid-sparing therapy for the treatment of sensitive areas such as face and genitals	92.6
S18	Narrow band-UVB is a treatment option for moderate to severe plaque and guttate psoriasis in children aged > 12 years	92.6
S19	The decision to treat pediatric psoriasis with systemic therapy is based on patient characteristics including age, disease severity, the presence of comorbidities, the lack of response to topical agents and/or phototherapy, reduced physical or psychologic functioning, and impaired quality of life	100

The level of agreement after the second and final round of Delphi voting is shown

Treatment

Topical Treatment

All statements related to topical treatment (statements S13–S17) reached consensus at the first round of voting (Table 3). Topical treatment of pediatric psoriasis relies predominantly on corticosteroids, which are approved by the EMA for pediatric use, represent the first-line treatment for patients with mild psoriasis, and can be used in all phases of the disease (Statement S13). Indeed, topical corticosteroids are widely used in clinical practice, are effective in the majority of pediatric patients, and are used in a variety of regimens [8, 21, 50, 51]. The choice of a particular regimen should consider patient age as well as site, size, and thickness of the skin lesion [21]. According to the general consensus in pediatric dermatology, moderate to potent corticosteroids (class II and III) can be used in children, while very potent corticosteroids (class IV) should be avoided especially in sensitive areas (face, body folds, and genitals) or used for very short periods [8, 21]. Corticosteroids are commonly applied once daily for 1–2 weeks, followed by a period of gradual tapering off [8]. Prolonged treatment with topical corticosteroid should be avoided because of the potential adverse events of these agents, including skin atrophy, striae, and hypothalamic-pituitary-adrenal axis suppression due to systemic absorption [8, 21, 52, 53].

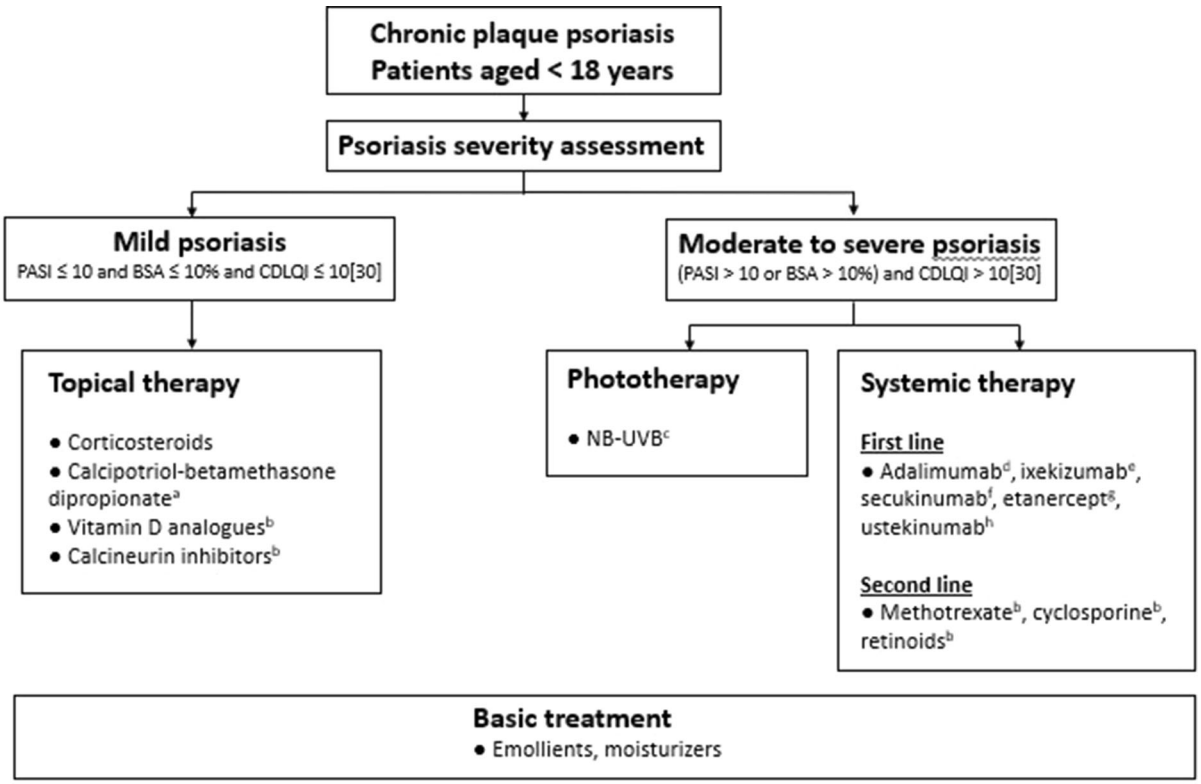

Fig. 2 Treatment algorithm. *BSA* body surface area, *CDLQI* Children's Dermatology Life Quality Index, *NB-UVB* narrow-band ultraviolet light B, *PASI* Psoriasis Area and Severity Index. [a]Not approved by EMA for use in pediatric patients with psoriasis; approved by FDA for patients aged ≥ 12 years. [b]Not approved by EMA for use in pediatric patients with psoriasis. [c]NB-UVB phototherapy is suitable for children aged > 12 years. [d]Adalimumab is approved by EMA for severe chronic psoriasis in children ≥ 4 years old who have had an inadequate response to, or are ineligible for, topical therapies and phototherapy. [e]Ixekizumab is approved by EMA for moderate to severe psoriasis in children ≥ 6 years old, of at least 25 kg of weight, who are candidates for systemic therapy. The reimbursement of ixekizumab for use in children is currently under review by the Italian healthcare system. [f]Secukinumab is approved by EMA for moderate to severe psoriasis in children ≥ 6 years old who are candidates for systemic therapy. The reimbursement of secukinumab for use in children is currently under review by the Italian healthcare system. [g]Etanercept is approved by EMA for severe chronic psoriasis in children ≥ 6 years old who are inadequately controlled by, or are intolerant to, other systemic therapies or phototherapy. [h]Ustekinumab is approved by EMA for moderate to severe psoriasis in children ≥ 6 years old who are inadequately controlled by, or are intolerant to, other systemic therapies or phototherapy. Ustekinumab is however not reimbursed by the Italian healthcare system for use in children

Topical corticosteroids can be combined with other topical therapies, with phototherapy, and with systemic therapies including biologics. A convenient and effective fixed combination of the corticosteroid betamethasone dipropionate with the vitamin D analogue calcipotriol is available (statement S14). The efficacy and safety of this combination for the treatment of pediatric psoriasis are supported by evidence from small trials and clinical practice [54, 55]. In a phase II trial including 31 adolescents (12–17 years) with extensive scalp psoriasis, the combination calcipotriol-betamethasone dipropionate applied once daily for 8 weeks resulted in a clear or almost clear/mild disease in almost 60% of patients [55]. Furthermore, pruritus also improved from baseline to 8 weeks. Adverse events, mostly of

Table 4 Practical recommendations for topical therapy

Topical therapy [8, 21, 72]	
Corticosteroids	Class II and Class III
	Apply once daily and avoid prolonged or repeated treatment
	In sensitive areas, 1–2 week-treatment duration
	Class IV only for certain areas (scalp) and very short periods
	Discontinue treatment gradually
Calcipotriol-betamethasone dipropionate (off-label)	Fixed-dose combination of 50 mcg/g calcipotriene and 0.643 mg/g betamethasone dipropionate (foam, gel, ointment)
	Apply once daily for up to 4 weeks
	Approved by FDA in patients aged $\geq$ 12 years
Vitamin D analogues (off-label)	Calcipotriene, tacalcitol
	Apply once daily
	Do not apply to large skin areas ($<$ 30% BSA for calcipotriene; $<$ 15% BSA for tacalcitol)
	Treatment duration $\geq$ 2 weeks for full efficacy
Calcineurin inhibitors (off-label)	Tacrolimus 0.1%, pimecrolimus
	Use preferentially for sensitive areas (face, body folds, genitals)
	Recommended twice day for a short term use and intermittent use in long term

Table 5 Practical recommendations for phototherapy

Phototherapy [20, 21, 58–60]	
NB-UVB	Minimum age limit is 8 years
	Initial dose: 0.2–0.6 J/cm^2, depending on skin type
	Increase dose subsequently by $\leq$ 25%
	20–30 sessions usually required per treatment cycle, with a frequency of 3–5 sessions per week

mild severity, were reported by 52% of patients, while no severe events occurred. The combination calcipotriol-betamethasone dipropionate is approved by the US Food and Drug Administration (FDA) for children aged $\geq$ 12 years, but not by the EMA, and its use is therefore off-label in Europe. The decision to prescribe an off-label medication should be shared with the patients and their parents.

Vitamin D analogues can be used in psoriatic children of all ages, with good efficacy and relatively favorable safety profile and tolerability [54, 55]. They can cause local skin irritation that can be managed with the concomitant

Table 6 Indications and schedules for systemic therapy with biologics

Systemic therapy—biologics [73–77]	
Adalimumab	Children aged 4–17 years
	Patient weight ≥ 15 kg and < 30 kg: initial dose of 20 mg SC, followed by 20 mg SC every other week
	Patient weight ≥ 30 kg: initial dose of 40 mg SC, followed by 40 mg SC every other week
	In non-responders, treatment beyond 16 weeks should be carefully considered
Ixekizumab	Children aged ≥ 6 years, with body weight ≥ 25 kg and for adolescents
	Patient weight 25–50 kg: start with 80 mg SC, followed by 40 mg SC every 4 weeks
	Patient weight > 50 kg: start with 160 mg SC (two 80 mg-injections), followed by 80 mg SC every 4 weeks
Secukinumab	Children aged ≥ 6 years
	Weekly dosing for 5 weeks, followed by monthly dosing for maintenance
	Body weight < 25 kg: 75 mg SC
	Body weight ≥ 25 kg and < 50 kg: 75 mg SC
	Body weight ≥ 50 kg: 150 mg SC (may be increased to 300 mg SC)
Etanercept	Children aged ≥ 6 years
	25 mg twice weekly or 50 mg SC once weekly
	Alternatively: 50 mg SC twice weekly for up to 12 weeks, followed by 25 mg SC twice weekly, or 50 mg SC once weekly, if needed
	Treatment should be continued until remission, for up to 24 weeks
	Discontinue treatment if no response after 12 weeks
Ustekinumab	Children aged ≥ 6 years
	Administer at week 0 and 4, and then every 12 weeks
	Body weight < 60 kg: 0.75 mg/kg SC (table with injection volumes available in EMA label)
	Body weight ≥ 60 kg SC and ≤ 100 kg: 45 mg SC
	Body weight > 100 kg: 90 mg SC
	Discontinue treatment if no response after up to 28 weeks of treatment

SC subcutaneously

application of emollients. According to the results of a systematic review of the literature concerning treatment efficacy and safety in pediatric psoriasis, calcipotriene with or without topical corticosteroid emerged as the first-choice treatment of pediatric psoriasis [54]. Vitamin D analogues are useful also as corticosteroid-sparing agents and can be used in rotational strategies to avoid corticosteroid-related adverse effects (statement S16). However, they are not approved for pediatric use by the EMA, and their use is therefore off-label.

Topical calcineurin inhibitors can also be used as corticosteroid-sparing agents. These agents may be particularly useful for the treatment of lesions affecting sensitive body surface areas. Burning and stinging at the site of application are the most commonly reported adverse events. Like vitamin D analogues, they are not licensed by the EMA for the treatment of

Table 7 Practical recommendations for systemic therapy with non-biologic options

Systemic therapy—non-biologic options [19–21]	
Methotrexate (off-label)	Oral or subcutaneous/intramuscular administration
	Usual dose: 0.2–0.7 mg/kg once weekly, up to 15 mg per week
	As soon as disease control is achieved (12–16 weeks), reduce gradually dose to lower maintenance regimen
	Daily folic acid (1–5 mg) recommended (except on day of methotrexate administration) to reduce side effects
Cyclosporine A (off-label)	Oral administration
	Initial dose: 2.5–5.0 mg/kg per day
	Optimal response expected after 8–16 weeks
	When disease is stable, slowly reduce to lowest effective dose
	Intermittent treatment courses are recommended
Retinoids (off-label)	Oral administration
	Initial acitretin dose: 0.3–0.5 mg/kg per day
	Maintenance dose: up to 1 mg/kg per day
	Improvement of skin lesions usually seen after 2–3 months of treatment
	Contraception recommended in female adolescents for up to 3 years from treatment discontinuation

pediatric psoriasis. Small studies, case series, and retrospective chart analyses have shown that patients treated with topical calcineurin inhibitors for plaque psoriasis and inverse psoriasis achieved skin clearance within 30 days of treatment [56, 57].

Poor adherence to treatment, especially to topical treatment, is a major issue in psoriasis. In addition, the incorrect application of topical medications in children may contribute to treatment failure. Parents and children should be taught how to apply topical medications to skin lesions. During treatment, appropriate skin care may help alleviate local treatment-related adverse events. Accurate skin care is recommended to all pediatric psoriasis patients, regardless of disease severity (statement S15).

Phototherapy

Phototherapy using narrow-band (NB)-UVB (wavelength of 311–313 nm) is feasible and effective in children and is a valid option for the treatment of moderate to severe plaque psoriasis and guttate psoriasis (statement S18). Concerns have been raised about early and prolonged treatment because of the potential risk of premature skin aging and skin cancer development associated with UV exposure [20]. However, no reports of an increased risk of skin cancer associated with NB-UVB treatment have been published so far.

The effectiveness of phototherapy in psoriasis has long been established [21]. Retrospective studies in psoriatic children aged 5–17 years reported > 50% skin clearance rates with very few, mild adverse events [58–60]. Pretreatment of psoriasis lesions with an emollient was associated with greater efficacy of the NB-UVB treatment, as shown by a reduction in lesion extension, scaling, and induration, and with a lower UV dosage required to achieve skin clearance, compared with no pretreatment [61].

Home NB-UVB phototerapy may be an additional option. A high adherence with instructions and follow-up examinations is mandatory to consider such treatment appropriate for children; however, clinical experiences in childhood psoriasis are lacking.

Systemic Therapy

Systemic therapy is indicated for moderate to severe psoriasis (statement S19). Treatment of severe psoriasis in children is challenging, and the decision to initiate systemic therapy, as well as the choice of the medication, requires the accurate evaluation of disease severity, its impact on physical and psychologic functioning and HRQoL, patient characteristics, comorbidity profile, and the response to previous treatments. Moderate to severe psoriasis is defined as (BSA > 10% or PASI > 10) and DLQI > 10 [30]. Other criteria that define the eligibility to systemic treatment include inadequate response to topical therapy and/or psoriasis in difficult-to-treat areas and guttate, erythrodermic, or pustular psoriasis [19].

According to current guidelines, options for systemic treatment include conventional oral psoriasis medications (methotrexate, cyclosporine, retinoids) and biologics, which target inflammatory pathways involved in the pathogenesis of psoriasis [tumor necrosis factor (TNF)-α, interleukin (IL)-12/23, and IL-17A] [19–21]. Conventional systemic therapies are widely used in adults, but are not licensed in children, while a number of biologics have been evaluated in clinical trials in children and are licensed by the EMA for the treatment of moderate to severe pediatric psoriasis. These include: etanercept, adalimumab, ustekinumab, secukinumab, and ixekizumab [62–68].

Among conventional systemic therapies, methotrexate has been used for psoriasis in adults and children for several decades, and its long-term efficacy and safety are therefore well established [20]. It can be administered orally or subcutaneously and has a slow onset of action [21]. Several studies have demonstrated the efficacy, safety, and positive effect on HRQoL of methotrexate in pediatric patients [19, 21]. To date, there is no consensus about the best methotrexate dosing regimen or treatment duration for pediatric psoriasis, the dose usually given varies from 0.2 to 0.7 mg kg^{-1} $week^{-1}$ [19] with a maximum weekly dose of no more than 20–25 mg [20]. After a sufficient treatment response, which is expected in about 12–-16 weeks, the absolute weekly dose may be slowly tapered [20].

Cyclosporine is administered orally, has a rapid onset of action, and can be used off-label as induction therapy of severe and recalcitrant plaque, pustular, and erythrodermic psoriasis in children. Small studies evaluating the efficacy and safety of cyclosporine in pediatric patients with psoriasis have reported conflicting results [19–21, 69]. As in adults, the initial dose in children is between 2.5 and 5 mg/kg/day [19], divided into a morning and an evening dose. Children may necessitate higher doses than those recommended in adults, because of variances in pharmacokinetics and the greater body surface area-to-weight ratio [3, 36]. The treatment response can be expected early (within 8 weeks) [20]. Similarly, the evidence supporting the use of systemic retinoids in pediatric patients with psoriasis is very limited [70]. Systemic retinoids have proven effective for widespread guttate psoriasis, pustular psoriasis, and palmoplantar psoriasis in children [21]. Due to the elevated risk of teratogenicity and the slow clearance of acitretin (the currently available systemic retinoid), the use of this medication in adolescent girls should be carefully considered [19].

The availability of biologics, which ensure rapid and sustained disease clearance with an acceptable safety profile, is changing considerably the management of patients with moderate to severe psoriasis. Etanercept, adalimumab, ustekinumab, secukinumab, and ixekizumab were evaluated in phase III, randomized controlled trials in populations of > 100 children and adolescents (< 18 years) with moderate to severe psoriasis [62–68]. Children were aged ≥ 4 years in the trials evaluating etanercept and adalimumab [62, 64] and ≥ 6 years in those evaluating secukinumab, ixekizumab [67, 68], and ustekinumab [65]. All biologics consistently showed significantly higher rates of PASI75 response (> 75% improvement of PASI score from baseline) compared to placebo or

other treatments (methotrexate for adalimumab and etanercept for secukinumab). Clinical responses were sustained and reported for up to 5 years with etanercept [63]. With all biologics, clinically meaningful improvements in PASI and other efficacy measures were observed within the first 4 weeks of treatment, highlighting the rapid onset of action of these agents [62–68]. The PASI90 response was among the secondary endpoints in all trials; at 12 weeks, the majority of pediatric patients treated with ustekinumab, secukinumab, or ixekizumab achieved this outcome (54.1%–61.1% with ustekinumab, 67.5–72.5% with secukinumab, and 78% with ixekizumab) [65, 67, 68]. Quality of life improved significantly in most trials as measured using the CLDQI [62, 65, 67, 68]. Efficacy and safety profiles observed in these trials were comparable to those reported in the trials in adult patients with psoriasis.

Treatment Algorithm

Figure 2 shows a treatment flowchart that was developed based on the above statements, the available evidence, and the clinical experience of the authors in the management of pediatric patients with psoriasis. Psoriasis severity is evaluated according to the PASI, BSA, and CDLQI scores. Mild and moderate to severe psoriasis are defined according to Mrowietz et al. [30] [mild psoriasis: BSA $\leq$ 10% and PASI $\leq$ 10 and DLQI $\leq$ 10; moderate to severe psoriasis: (BSA $>$ 10% or PASI $>$ 10) and DLQI $>$ 10]. Mild psoriasis can be effectively treated with topical corticosteroids (Table 4). Other topical medications, which can be used also as corticosteroid-sparing agents, include the fixed combination calcipotriol-betamethasone dipropionate (off-label), vitamin D analogues (off-label), and calcineurin-inhibitors (off-label). NB-UVB phototherapy is a feasible option in children with moderate to severe psoriasis, aged $\geq$ 12 years, although in our experience it may be used also in younger children ($>$ 8 years) (Table 5). The choice of phototherapy must include a comprehensive and careful evaluation of the patient's features, such as phototype, history of skin cancer in first-degree relatives, and compliance as well. Children with moderate to severe psoriasis are eligible for systemic treatment with biologics (age limits: $\geq$ 4 years for adalimumab; $\geq$ 6 years for the other four biologics) (Table 6). All five EMA-approved biologics are recommended as first-line therapy because their efficacy and safety are supported by evidence from clinical trials in children and adolescents [62–68]. Of note, according to the current EMA-label, etanercept and ustekinumab are approved as second-line treatment. Conventional systemic therapies including methotrexate (off-label), cyclosporine (off-label), and retinoids (off-label) can be used as second-line options (Table 7). Basic skin care with emollients and moisturizers is generally recommended and should be combined with all pharmacologic therapies.

DISCUSSION

This study was primarily prompted by the need to update current guidelines for the treatment of pediatric psoriasis so as to include recently approved biologics for patients with moderate to severe psoriasis. Healthcare changes caused by the COVID-19 pandemic, like the adjustment of the recommended vaccination plan for children to include the anti-SARS-CoV-2 vaccination, and the use of telemedicine for the remote follow-up of patients were also addressed. The statements were comprehensively discussed and reviewed during the two online plenary sessions by a large group of dermatologists with a long experience in the management of children with psoriasis across Italy. We believe that the involvement of the expert panel throughout the entire Delphi process allowed capturing many different opinions from a variety of clinical experiences and settings of psoriasis care, making the statements close to real clinical practice. The entire Delphi study was successfully performed online, which demonstrates the effectiveness of video-conferencing techniques in promoting exchanges among large groups of authors like our group.

Most statements achieved consensus at the first round of voting, with the exception of

statements S8 on the early treatment with biologics and its impact on comorbidities, and S12 on the use of telemedicine. Although the efficacy and safety of biologics have been clearly demonstrated in clinical trials involving pediatric populations with psoriasis [62–68], many aspects of these medications still need to be clarified. This uncertainty may complicate the decision to start biologic therapy in a child. It is currently unknown how biologics compare to each other in pediatric psoriasis as head-to-head comparisons are lacking (the comparison of secukinumab with etanercept in the trial leading to the approval of secukinumab for pediatric psoriasis was an exploratory objective) [68]. It is therefore difficult to decide which biologic should be used first. Patient characteristics, in particular comorbidities [71], disease severity, and costs are factors to be considered when making this decision. It is also unknown how long pediatric patients should be treated with biologics and if treatment discontinuation may be considered when stable disease remission is achieved. Long-term efficacy and safety outcomes need to be further investigated as well as the impact of biologics on patient reported outcomes. The transition between treatments and the combination of biologics with other treatments are also unexplored.

As for telemedicine applied to the management of pediatric psoriasis, it must be stressed that remote visits are not meant to replace in-person visits. This modality may however simplify the follow-up schedule required for a chronic disease like psoriasis and possibly have a favorable impact on the quality of life of pediatric patients and their parents. In this field as well, many aspects need to be further defined. Standardization and regulation of telemedicine visits are urgently required.

The proposed algorithm aims to provide practical guidance in selecting the most appropriate treatment among the various options now available especially for moderate to severe psoriasis. Effective topical treatment remains a major issue in pediatric psoriasis, as highlighted by the fact that topical corticosteroids, despite being the only approved topical medication for pediatric patients, have relevant limitations in this age group and should not be used for more than 2 weeks and for body areas typically affected in children, like face and genitals. The algorithm is limited by the fact that many issues remain open; however, it is based on the latest available evidence and the clinical experience of the authors. Despite these limitations, we believe that it provides a much-needed update in the recommendations for the treatment of pediatric psoriasis.

CONCLUSIONS

The statements presented in this paper, along with the treatment algorithm, update current recommendations for the management of pediatric patients with psoriasis and offer practical guidance to dermatologists and pediatricians. As the field of psoriasis treatment is rapidly evolving, regular adjustments of treatment recommendations will be needed.

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