Psoriasis is an inflammatory noncommunicable skin disease that affects both adults and children. At present, the epidemiology and natural history of psoriasis are not widely understood. This scoping review aimed to map the existing literature on the epidemiology of childhood psoriasis, identify research gaps for future studies and provide a comprehensive, clinically useful review. Search strategies were developed for Ovid Medline, Ovid Embase, Google Scholar and hand searching. In total, 131 articles met the inclusion criteria and were mapped; 107 articles were included for data extraction. Over the last 25 years there has been a dramatic increase in the volume of published observational epidemiological studies on childhood psoriasis. The majority were case series or cross-sectional studies, concentrated in Europe, Asia and North America. The prevalence of childhood psoriasis was found to be higher in European countries, older children and girls. Up to 48-8% of children had a family history of psoriasis in a first-degree relative. The most frequent subtype was plaque psoriasis and the most common initial sites of presentation were the scalp, limbs and trunk. Specific genetic differences have been found between child-onset and adult-onset populations. Case–control and cohort studies investigating risk factors for psoriasis onset, comorbidities and long-term health outcomes were extremely limited. The choice of study design and heterogeneity in methodology limit the validity and generalizability of the information, consistency of the results, and comparability of the studies. Well-designed epidemiological studies are needed to provide precise and consistent information about the frequency and clinical presentation, risk factors, associated diseases and long-term outcomes in childhood psoriasis.

What’s already known about this topic?

- The prevalence of psoriasis in children is lower than in adults, but the significant number of adults who first developed skin disease in childhood supports the frequent persistence of psoriasis into adulthood.
- Genetic and environmental factors both play an important role in the onset of psoriasis.
- Disease associations, such as obesity, are an important area of current research activity.

What does this study add?

- Mapping has shown a dramatic increase in the number of published studies over the past 25 years.
- Studies have been concentrated in Europe, Asia and North America. These studies have largely been case series or cross-sectional studies.
Psoriasis is an inflammatory noncommunicable skin disease that affects both adults and children. Early-onset disease may persist into adulthood. Lombholt examined a little over one-third of the population of the Faroe Islands and found that more than 70% of those diagnosed with psoriasis had an age of onset younger than 20 years. In Sweden, 50% of the 5197 families surveyed by Swanbeck et al. developed psoriasis before the age of 25 years. In view of the likely common occurrence and chronic nature of child-onset psoriasis, it is important that best-practice management is initiated early and information is readily available for children and their families.

At present, the epidemiology and natural history of psoriasis are not widely understood. Instead, recent scientific activity in the field of psoriasis has focused on disease pathophysiology, driven by the development of targeted biological therapies and the role that systemic inflammation may play in psoriasis morbidity and mortality. Epidemiological studies not only contribute to understanding the distribution and determinants of disease, but also inform primary and secondary prevention measures, including therapeutic interventions. Additionally, they can help answer questions that are important to patients and healthcare providers about how common the disease is, possible causes and long-term outcomes of the condition.

Scoping reviews aim to map the existing literature in a field of interest in terms of the volume, nature and characteristics of the primary research. A scoping review can thereby identify research gaps for future studies. This review also aimed to provide a comprehensive, clinically useful summary of the epidemiology of childhood psoriasis. The four core questions this review aimed to address were:

1. What is the prevalence, incidence and clinical presentation of childhood psoriasis?
2. What are the genetic and environmental factors associated with the onset of psoriasis in childhood?
3. What other conditions are associated with psoriasis in children?
4. What are the long-term outcomes for patients with childhood psoriasis?

Materials and methods

The search strategy was designed with an information specialist (D.G.) (Appendix 1). Ovid Medline In-Process & Non-Indexed Citations and Ovid Medline 1948 to present and Ovid Embase were searched on 27 May 2015. The reference lists of 10% of studies included in the review and nonsystematic review articles were hand searched until saturation in the identification of additional studies was reached. Google Scholar was searched using the terms ‘epidemiology of psoriasis in children’ and ‘epidemiology of paediatric psoriasis’ and the first 100 citations were reviewed on 15 September 2015.

Articles were included if they were observational studies of childhood psoriasis, or studies with separated data for this group, that provided primary epidemiological data on one of the four core questions. Childhood psoriasis was defined as disease onset under the age of 18 years, although flexibility was shown for studies with grouped data in decades which included patients up to the age of 20 years. Systematic reviews of observational studies were included. Therapeutic intervention studies and single case reports were excluded. Studies not reported in English (n = 8) and conference abstracts (n = 16) were included as part of mapping the extent of the evidence, but results data were not extracted.

Titles, abstracts and full-text articles (where available) were screened according to the inclusion criteria by two authors (E.B.-T. and E.A.). The full texts of studies identified through screening were independently assessed for eligibility by two authors (E.B.-T. and R.M.). Data extraction was undertaken by one author (E.B.-T.) using a structured form. The accuracy of data extracted from 10% of the included studies was checked by a second author (R.M.). Studies were classified for mapping according to definitions and description of methods provided in the publication. Where there was uncertainty the classification was discussed between two authors (E.B.-T. and S.R.).

The breadth of the review questions and heterogeneity of the studies necessitated a narrative synthesis of the data. Critical appraisal of individual studies and meta-analysis were not performed within this scoping review.

Results

The search strategy yielded 2490 potential citations. After the removal of duplicates, initial screening and review for eligibility, 112 articles remained. A further 19 articles were identified through hand searching and Google Scholar. In total, 131 articles were mapped. After the removal of non-English studies and conference abstracts, 107 articles were included in the results summary (Appendix 2).

Mapping of studies

The characteristics of the included studies are presented in Table 1. There has been a linear increase in the number of observational studies on childhood psoriasis over the past 20 years (1996–2000, n = 8; 2011–2015, n = 50). Most studies were based in Europe (65 of 131), in particular the U.K. (10 of 131), Sweden (nine of 131), Germany (seven of 131) and Turkey (six of 131).
Cross-sectional studies (75 of 131) and case series (30 of 131) were most common. Observational studies to date have concentrated on incidence or prevalence (47 of 131), age of onset, sex or family history (69 of 131) and clinical presentation of psoriasis (63 of 131).

**What is the prevalence, incidence and clinical presentation of childhood psoriasis?**

**Incidence and prevalence**

Overall, there were two incidence studies, 37 prevalence studies and one systematic review.\(^{10}\) Seventeen prevalence studies were population-based.\(^{11-27}\) Twenty studies were secondary/hospital care prevalence studies.\(^{28-47}\)

The prevalence of childhood psoriasis varied depending on the study population. Estimates reported from population-based studies ranged from 0% to 2.1%. The highest values were from European studies, namely Italy (2-1%), Germany (1.3%)\(^ {13}\) and the U.K. (1.3% for 10–19 year olds)\(^ {17}\) compared with low prevalence in Taiwan (0%)\(^ {5,27}\) and Egypt (0.05%).\(^ {26}\) Studies that stratified prevalence according to age reported psoriasis to be more common after puberty (0.6–1.3%) than before puberty (0.1–0.5%). Psoriasis was a fairly common presentation in paediatric dermatology clinics with a reported prevalence of 0.7–6.2%.

With regard to incidence studies, a health survey of Norwegian twins showed that the incidence of psoriasis increased with age throughout childhood (0–3 years to 16–19 years) from an incidence rate of 0.5 to 2.9 and 0.3 to 2.0 per 1000 person-years in girls and boys, respectively.\(^ {48}\) Tollefson et al. showed that the number of children diagnosed with psoriasis had increased over a 30-year period in the U.S.A. from 29.6 to 62.7 per 100 000 patient-years. Proposed reasons for this increase included changes in risk factors such as psychosocial stress, infection and obesity.\(^ {49}\)

Studies varied in how cases of psoriasis were ascertained (self-reported, diagnostic codes in health records, physician examination) and there was also potential variation in how psoriasis was defined; most studies required a ‘clinical diagnosis’ of psoriasis with no predefined criteria.

**Sex and age of onset**

Overall, 42 studies provided data on the sex distribution. Thirty-three studies provided data on the percentage of the study population who were male.\(^ {25,28,30,32,34,49,52,59,60,70,72,75,78-84}\) Twenty-five of these 33 studies found that less than 50% of children with psoriasis were boys (range 35.9–49%). The male to female ratio was provided in 16 studies and varied from 1:14 :1 to 1 : 2.33.\(^ {30,32,34,49,52,59,60,70,72,75,78-84}\) Matusiewicz et al. reported that the prevalence of psoriasis in children was lower in boys than in girls (0.35% compared with 0.44%).\(^ {10}\) A survey of 5600 patients with psoriasis by Farber and Nall found that childhood onset in boys was less common than in girls, especially among those with psoriasis onset under the age of 10 years.\(^ {73}\) This female predominance seen in the prevalence of childhood psoriasis is the opposite of that commonly observed in adults.\(^ {85}\)

Age of onset of psoriasis was reported in 30 studies. The range of age of onset was reported in 17 studies and included from birth to 18 years.\(^ {30,32,52,53,55,57-59,63,67,72,74,79,83,86-88}\) The average age of onset was reported in 22 studies and varied from 2.1 months to 10.6 years.\(^ {28,32,34,49-53,55,58,60,65,69,71,72,74,77,79,80,82,83,89}\)

Age of onset may vary with psoriasis subtype. An earlier age of onset was reported for pustular psoriasis.\(^ {33,81}\) Popadic and Nikolic described the 20-year experience of childhood pustular psoriasis at their centre and found that 50% of...
children presented before their first birthday.\(^{83}\) The average age of onset in plaque psoriasis is less clear. This variation may reflect differences in subtype definition, for example, inclusion of scalp, flexural or napkin psoriasis in the term ‘plaque psoriasis’. Leow and Giam reported a case series of 122 children; 91.9\% had plaque psoriasis and 37.5\% developed psoriasis before age 1 year.\(^{34}\) However, four studies with predominantly plaque psoriasis reported an average age of onset around 10 years.\(^{81,58,60,80}\) Only one study contained a predominance of children with guttate psoriasis and found a clear peak in age of onset for girls at 8 years, but possibly three peaks for boys at 5, 10 and 13 years.\(^{72}\)

Reliance on medical documentation and patient/parent recall, in addition to inconsistencies in subtype definition, all contribute to difficulties in accurately understanding age of onset in childhood psoriasis.

**Family history**

Thirty-eight studies provided data on family history.\(^{28,30,32,34,50–65,67,69,70,72,76–84,86,87,89–91}\) The percentages of children with a positive history of psoriasis in a first-degree relative varied from 6–2\% to 54–7\% and a positive family history in any family member from 4–5\% to 88\%. Farber et al. found that adolescents with psoriasis (10–19 years) were most likely to have a family member with psoriasis, compared with other age groups of children.\(^{66}\) The large variation reported in family history of psoriasis may, in part, be due to genetic differences between ethnic populations. For example, a study comparing Asian and European children found that only 13–6\% of Singaporean children had a first- or second-degree relative affected by psoriasis compared with 73–3\% of Dutch children.\(^{79}\) This supports child-onset psoriasis as a genetically heterogeneous condition and further research is needed into gene–environment interactions in different populations.

**Clinical presentation**

Eleven studies reported the initial body site of presentation in child-onset psoriasis.\(^{30,34,55,58,59,69,72,76,80,82,84}\) Collectively, these studies included nearly 3000 children. The scalp, limbs and trunk were the most common body sites affected (17–9–64–8\%, 9–5–90\% and 7–8–93–3\%, respectively). The face was a common site of presentation (3–5–56–7\%), but facial skin changes may still be seen more frequently in children with eczema compared to children with psoriasis.\(^{28}\) Napkin skin changes were present in most infants with psoriasis and therefore this feature needs to be considered an important presenting sign in this age group.\(^{66}\)

Twenty-three studies presented data on the frequency of different subtypes in childhood psoriasis.\(^{28,30,32,34,49,51,52,55,56,58–64,70,72,79,80,84,90,91}\) Similar to the adult population, the most common subtype was chronic plaque psoriasis. The range of frequencies of different subtypes were as follows: plaque psoriasis (9–91–9\%), guttate psoriasis (1–6–48–2\%), pustular (0–13–1\%), erythrodermic (0–1–5–8\%) and palmoplantar (0–9–12–8\%). Nail psoriasis was also a common subtype or current site of involvement (between 2\% and 39–3\%) and one study found it to be the sole presenting feature in 2–3\% of children.\(^{59}\)

A few studies have compared the clinical presentation of childhood psoriasis according to ethnicity, sex and age. No clear conclusions can be drawn about the effect of ethnicity.\(^{55,70}\) The presentation may vary according to sex. A multicentre cross-sectional study from the U.S.A. found that nail psoriasis was more frequent [odds ratio (OR) 3–01, confidence interval (CI) 1–62–5–6\)] and scalp psoriasis was less frequent (OR 0–40, CI 0–19–0–84) in boys compared with girls.\(^{81}\) The authors suggested that this may be a result of the Koebner phenomenon.

Age appears to be an important factor influencing presentation. Kwon et al. reported that guttate, plaque and generalized pustular psoriasis were significantly more common in children under the age of 12 years.\(^{60}\) Flexural involvement was found to be more common in prepubertal children (OR 2–8, P < 0–05), especially boys (OR 2–5, P < 0–05).\(^{61}\) Kim et al. found involvement of the face to be a more common presenting sign in children compared with adults.\(^{84}\)

Percentages for the frequency of initial site of presentation and subtype of psoriasis varied widely. Possible explanations include differences in the clinic populations studied, as well as differences in the definition, assessment and documentation of subtypes and sites of presentation.

**What are the genetic and environmental factors associated with the onset of psoriasis in childhood?**

**Genetic factors**

Eight studies reported genetic findings regarding child-onset psoriasis (Table 2).\(^{61,65,71,72,92–95}\) The studies suggest a difference in the genetics of pre- and postpubertal onset psoriasis. In 2013, Lysell et al. found endoplasmic reticulum aminopeptidase type 1 was only associated with onset of psoriasis between the ages of 10 and 20 years.\(^{94}\) In 2015, Lysell et al. found that the proportion of HLA-C*06-positive patients was higher among those with postpubertal onset.\(^{61}\) Conversely, IL22 promoter and IL12B were only associated with the onset of psoriasis under the age of 10 years.\(^{65,95}\)

Nanda et al. found no association between psoriasis and HLA-C*06 in Kuwaiti children, unlike similar studies in mostly white children.\(^{72}\) This study highlights the need for genetic studies in more diverse populations.

Two studies specifically looked at the genotype–phenotype correlation. HLA-C*06 was associated with guttate psoriasis (OR 3–4, P < 0–5) and facial lesions (OR 3–8, P < 0–01), after controlling for demographic variables,\(^{61}\) but HLA-C*06 negative patients were found to have greater nail involvement (OR 0–32, CI 0–14–0–76).\(^{55}\) While there is some data, it is evident that further studies investigating genotype–phenotype correlations are needed.
Table 2: Studies reporting genetic findings specific to the paediatric psoriasis population

| Author, year | Country        | Study design | Type of psoriasis | Sample size with an age of onset in childhood | Main genetic findings |
|--------------|----------------|--------------|-------------------|----------------------------------------------|-----------------------|
| Bergboer et al., 2012 | the Netherlands | Case–control. 217 patients stratified by age of onset and 450 healthy controls | Psoriasis vulgaris excluding solitary scalp or napkin psoriasis | 80 | IL23R, ERAP1, HLA-C*06, LCE3C_LCE3B deletion and HLA-C*06 significantly associated with child-onset psoriasis |
| Brenner et al., 1978 | Austria | Cross-sectional. 77 patients stratified by age of onset | Psoriasis vulgaris excluding pustular psoriasis and psoriatic arthritis | 57 | Higher prevalence of HLA-Cw6 in patients with an age of onset between 10–20 years compared with 35–45 years |
| Lysell et al., 2013 | Sweden | Case–control. 954 patients stratified by age of onset and 1748 controls | Plaque or guttate psoriasis excluding solitary scalp or napkin psoriasis | 322 (119 prepubertal) | Strongest association for HLA-C*06:02 and a significant association with ERAP1 in patients with an age of onset between 10 and 20 years. ERAP1 was not associated with onset of psoriasis under the age of 10 years |
| Lysell et al., 2015 | Sweden | Cross-sectional. 109 patients recruited stratified by prepubertal and postpubertal onset | All psoriasis types except solitary scalp of napkin psoriasis | 109 (63 prepubertal) | HLA-C*06 associated with age of onset, controlling for family history and guttate phenotype, and facial lesions controlling for demographic variables. Higher proportion of HLA-C*06-positive patients in post pubertal children |
| Nanda et al., 2000 | Kuwait | Cross-sectional. 50 patients recruited under the age of 12 years and 120 controls | Not specified | 50 | HLA-A3, Cw1 and DR7 significantly associated with child-onset psoriasis (<12 years). No association found with HLA-Cw6 |
| Nikamo et al., 2014 | Sweden | Case–control. 1069 patients recruited stratified by age of onset and 1529 controls | Not specified Solitary scalp or napkin psoriasis excluded | 603 (207 prepubertal) | IL22 promoter association confined to onset before the age of 10 years |
| Oostveen et al., 2014 | the Netherlands | Case–control. 151 patients recruited stratified by age of onset before or after the age of 10 years, and 450 controls | Plaque-type psoriasis | 151 (86 prepubertal) | IL23R, ERAP1, HLA-C*06, LCE3C_LCE3B deletion and HLA-C*06 significantly associated with child-onset psoriasis. IL12B significantly associated with age of onset < 10 years |
| Winge et al., 2013 | Sweden | Case–control. 241 patients recruited under the age of 15 years and 314 controls | Not specified | 241 | No association with prevalent or novel FLG mutations in child-onset psoriasis |
| Author, year, country | Participants | Type of psoriasis | Sample size | Infection | Stress | Trauma | Other |
|-----------------------|--------------|-------------------|-------------|-----------|--------|--------|-------|
| Becker et al., 2014, U.S.A. | 51 5–17 years, BMI > 85th percentile at diagnosis | Not specified | 27 | | | | Overweight or obesity (BMI > 85th or > 95th percentile, respectively) preceded psoriasis in 93% |
| Oostveen et al., 2014, the Netherlands | < 18 years at onset | Plaque | 151 (450 controls) | Koebner positive: | 30-9% | Tobacco smoke at home (OR 2.9, CI 2.27–3.78) |
| Ozden et al., 2011, Turkey | < 18 years at onset | All types of psoriasis | 537 (511 controls) | Stressful life event (OR 2.94, CI 2.28–3.79) | | BMI > 26 kg m⁻² (OR 2.52, CI 1.42–4.49) |
| Boccardi et al., 2009, Italy | < 15 years | Not specified | 96 | | | | BMI > 110% (OR 2.55, CI 1.31–4.96) |
| Chiam et al., 2011, the Netherlands and Singapore | < 18 years | All types of psoriasis | 207 | Stress the Netherlands: 20% | | | |
| Fabrizi et al., 2001, Italy | 5–19 years | Not specified | 20 | Stress Singapore: 25% | | | |
| Kim et al., 2010, Korea | < 15 years | All types of psoriasis | 30 | Upper respiratory tract infection: 43-4% | Psychological stress: 3-3% | | Atopic dermatitis 6-7% |
| Koebnick et al., 2011, U.S.A. | 2–19 years | Not specified | 1350 | | | | Other 23-3% |
| Mercy et al., 2013, U.S.A. | 5–17 years | Plaque | 181 | Streptococcal infection: 22-1% | | | Obese (BMI ≥ 30 kg m⁻²) (OR 1.39, CI 1.19–1.63) |
| Nanda et al., 2000, Kuwait | < 12 years | Not specified | 305 | Upper respiratory tract infection: 3% | Stress: 1% | Trauma: 1% | Extremely obese (BMI ≥ 35 kg m⁻²) (OR 1.78, CI 1.49–2.14) |
| Raychaudhuri and Gross, 2000, U.S.A. | Questionnaires completed by adult patients with psoriasis, data stratified by age of onset before and after 16 years | Not specified | 223 | Sore throat: 11-6% | | | Winter season: 14% |

(continued)
### Table 3 (continued)

| Author, year, country | Participants | Type of psoriasis | Sample size | Infection | Stress | Trauma | Other |
|-----------------------|--------------|-------------------|-------------|-----------|--------|--------|-------|
| Al-Hamdi et al., 2008, Iraq | Infancy to 11 years | All types of psoriasis | 104 | Infections and fever: 27.9% | Emotional stress: 15.2% | | Environmental factors: 4.8% |
| de Oliveira et al., 2010, Brazil | ≤ 12 years | Pustular | 7 | Tonsillitis: 14.2% | Emotional stress: 14.2% | | Winter: 14.2% |
| Kumar et al., 2004, India | < 14 years | All types of psoriasis | 419 | Throat infection: 2.3% | Emotional factors: 0.7% | Trauma: 3.3% | Koebnerization: 27.9% |
| Leow and Giam, 1994, Singapore | < 12 years | All types of psoriasis | 112 | Upper respiratory tract infection: 7.1% | Emotional factors: 1.8% | Injury: 3.6% | Koebnerization: 30.3% |
| Nanda et al., 1990, India | < 14 years | All types of psoriasis | 112 | Throat infection 15.2% | Emotional factors: 1.8% | Koebnerization: 30.3% | |
| Nyfors and Lemholt, 1975, Denmark | Children | All types of psoriasis | 245 | Infection, particularly sore throats: 16.7% | Psychological stress: 5.4% | | |
| Seyhan et al., 2006, Turkey | < 18 years | All types of psoriasis | 61 | Upper respiratory tract infections: 14.8% | Psychological stress: 5.1% | | Atopic dermatitis: 3.3% |
| Wu et al., 2010, China | < 14 years | All types of psoriasis | 137 | Upper respiratory tract infection: 28.5% | Psychological stress: 3.1% | Trauma: 2.9% | Koebnerization: 20.4% |
| Zelickson and Muller, 1991, U.S.A. | < 18 years | Pustular | 13 | Infections (otitis, streptococcal, staphylococcal, urinary tract infection): 38% | Stress: 15% | | Sun: 38% |

The main findings from each study are presented. BMI, body mass index; CI, confidence interval; OR, odds ratio. Percentages calculated if not given in the paper. *Cross-sectional study providing data on risk factors with nested case–control genetics study.*

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Environmental factors: infection, emotional stress, trauma and obesity

Trigger factors for the onset of psoriasis are reported in a large number of studies, but often the study design employed did not allow the time relationship between exposure and the onset of psoriasis to be assessed. The data from these 20 studies are presented in Table 3.18,30,34,51,52,54,57,59,65,67,70,72,76,77,79–82,84,96 Only one paper, Ozden et al., specifically investigated environmental risk factors for the onset of childhood psoriasis in a case–control study.82

Infection was identified as a potential trigger factor in up to 43-4% of children. The most commonly described infection was an upper respiratory tract infection. Two studies specifically reported streptococcal infection, occurring in 21.3–22.1% of children.50,81 and Nyfors and Lemholt found elevated antistreptococcal titres in 60% of children with psoriasis.77 Other types of infection identified as triggers were urinary tract infections, chicken pox and otitis media.

Stress was identified as a potential trigger factor in 1–66.7% of children. This was most commonly defined as emotional or psychological stress. Ozden et al. found that a stressful life event was a risk factor for the onset of psoriasis (OR 2.94, CI 2.28–3.79).83

A history of trauma was identified as a potential trigger factor in 1–11.5% of children. Koehnerization was reported in 20.4–49.6% of children but further details about the timing in relation to disease onset were not always reported.

Obesity may be an important risk factor for the onset of psoriasis. Ozden et al. found that a body mass index > 26 kg m

² was a risk factor for psoriasis in children (OR 2.52, CI 1.42–4.49). A small retrospective cohort study found a diagnosis of obesity or being overweight preceded psoriasis in 93% of children.51 Boccardi et al. reported that the OR of being obese at first diagnosis of psoriasis was 2.55 (CI 1.31–4.96).54

There is a need for studies to differentiate between risk factors for disease onset and aggravating factors for a disease flare. Details about identification and measurement of potential risk factors are often minimal, making evaluation of their clinical relevance difficult.

What other conditions are associated with psoriasis in children?

Studies investigating diseases associated with psoriasis varied in methodology and only three used a study design that allowed a causal relationship to be assessed. Eighteen studies reported data on associated diseases (Table 4).11,13,20,24,61,69,80,91–106 Nineteen studies reported data on juvenile psoriatic arthritis and these papers are summarized below.

Eleven studies have provided data on cardiovascular disease and hypertension. Childhood psoriasis may increase the risk of hypertension. In two retrospective cohort studies hypertension was found in 1% (P = 0.001)107 and up to 0.5% of children following a diagnosis of psoriasis.108 A significant association with cardiovascular disease has not been shown.

Obesity data were presented in 11 studies, many of which support a significant association between psoriasis and obesity. Kimball et al. reported the prevalence of obesity following a diagnosis of psoriasis to be 1-8% (P = 0.001),109 much lower than large cross-sectional studies such as Mahe et al. 2015, Lysell et al. and Paller et al., 10% (P = 0.001), 15% and 20-2% (P < 0.001), respectively.61,91,102 This may imply that obesity was coexistent at the onset of psoriasis, as reported by Becker et al.51

Twelve studies have presented data on metabolic disease. A retrospective cohort study found that children were at higher risk of diabetes and hyperlipidaemia following a diagnosis of psoriasis.101

Four studies reported findings on psychological disorders and childhood psoriasis. Kimball et al. investigated the onset of a psychological disorder following a diagnosis of psoriasis. The hazard ratio (HR) was significantly raised for any psychiatric disorder (HR 1.25, CI 1.11–1.4).101

Juvenile psoriatic arthritis

Nineteen studies reported data on juvenile psoriatic arthritis in a paediatric psoriasis population.13,32,51,52,56–59,61,64,79–82,90,91,99,101,103 In a predominantly plaque or guttate psoriasis population, the prevalence of psoriatic arthritis was reported to be between 0.7% and 10.5%. In a case series of seven children with pustular psoriasis, two children were found to have psoriatic arthritis.57 The highest proportion of children with juvenile psoriatic arthritis (10.5%) was reported by Mercy et al., a secondary/hospital multicentre study of children with plaque psoriasis aged 5–17 years.81

What are the long-term outcomes for patients with childhood-onset psoriasis?

Twenty-two studies provided data on the natural history and long-term outcomes of child-onset psoriasis.2,3,34,50,52,56,68,69,73,76,77,83,86–89,107–112 Ten studies reported the percentage of adult patients with psoriasis with child-onset disease. This was found to be between 12% and 37-1% and was much lower in a study solely reporting on genital psoriasis (5%).110 Four studies, either prospectively or retrospectively, followed up infants with psoriasisform napkin disease. In a small cohort of nine infants seven had recurrent psoriasis,86 whereas the proportion with recurrent psoriasis in larger studies was much lower. Neville and Finn found that 17% of 71 infants with psoriasisform changes developed psoriasis in childhood,89 but Andersen and Thomsen found that this occurred in only 3% of infants.50 Continuous disease throughout childhood occurred in 54–56%,52,77,83

In terms of the long-term severity, Lomholt reported that 35% of patients with childhood-onset psoriasis had significant disease and flares compared with 18% of those with onset of psoriasis over the age of 20 years.7 Two studies investigated quality of life in childhood-onset psoriasis. De Jager et al. found that intrapatient rating of quality of life was lower in childhood compared with adulthood in those with persistent
| Author, year, country | Data source | Sample size | Type of psoriasis | Cardiovascular disease and hypertension | Obesity | Metabolic disease | Psychological | Other |
|-----------------------|-------------|-------------|-------------------|----------------------------------------|---------|-----------------|--------------|-------|
| Retrospective cohort studies |
| Kaye et al., 2008, U.K.100 | General practice database | 6945 | Not specified | Hypertension: $<10$ years: 0% | BMI $>30$ kg m$^{-2}$: $<10$ years old: 0.3% | Diabetes: $<10$ years: 0.6% | Hypertension: $<10$ years: 0.6% | Other: $<10$ years: 0.1% |
| Kimball et al., 2012, U.S.A.101 | Insurance database | 7404 | Not specified | Cardiovascular disease: 0% | Obesity NOS: 1.8% | Diabetes: 1% ($P=0.0037$) | Hyperlipidaemia: 2% ($P<0.0001$) | Any psychiatric disorder: HR$^a$ 1.25 (CI 1.11–1.40) |
| Mallbris et al., 2004, Sweden102 | National inpatient registry and the Swedish Psoriasis Association | Unclear | Not specified | Cardiovascular death: 0 (for patients treated for psoriasis as an inpatient or outpatient) | | | | Peripheral vascular disease: 0.2% ($P=0.0094$) |
| Case–control |
| Jensen et al., 2014, Denmark99 | Secondary/hospital care | 30 | Plaque | Systolic blood pressure: 105 mmHg ($P=0.023$) | BMI $>20$ kg m$^{-2}$ ($P=0.016$) | Glucose: 5.3 mmol L$^{-1}$ ($P=0.043$) | | |
| Mahé et al, 2015, France10 | Secondary/hospital care | 261 | Plaque | Hypertension: 0.8% ($P=0.015$) | Overweight (BMI $>97$th percentile) with abdominal obesity: 8.4% ($P=0.009$) | Obese (BMI $>30$): 10% ($P=0.001$) | Dyslipidaemia: 3% ($P=0.08$) | | |
| Cross-sectional studies |
| Augustin et al., 2010, Germany11 | Insurance database | 2549 | Not specified | Ischaemic heart disease: PR 1.52 | Obesity NOS: PR 1.70 | Hyperlipidaemia: PR 2.15 | | |
| | | | | Arterial hypertension: PR 1.89 | | Diabetes: PR 2.01 | | |

(continued)
| Author, year, country | Data source | Sample size | Type of psoriasis | Cardiovascular disease and hypertension | Obesity | Metabolic disease | Psychological | Other |
|-----------------------|-------------|-------------|-------------------|----------------------------------------|---------|-----------------|--------------|-------|
| Augustin et al., 2015, Germany | Insurance database | 1313 | Not specified | Arterial hypertension: PR 2.09 (P < 0.05) | Obesity NOS: PR 1.89 (P < 0.05) | Hyperlipidaemia: PR 1.79 (P < 0.05) | Depression: PR 1.69 (P < 0.05) | Indocyanine: PR 9.53<sup>b</sup> | Alopecia areata: PR 2.8<sup>b</sup> |
| Cohen et al., 2008, Israel | Health provider database | 585 | Not specified | Ischaemic heart disease: PR 1.27 (P > 0.05) | Diabetes: OR 2.10 (P > 0.05) | Metabolic syndrome: 30% (P < 0.04) | Fasting blood glucose: 91.1 g dl<sup>-1</sup> (P = 0.01) | Viral warts: PR 1.5<sup>b</sup> | Allergic rhinitis: PR 1.67<sup>b</sup> |
| Goldminz et al., 2013, U.S.A. | Secondary/hospital care | 20 | Not specified | Systolic blood pressure: 111.7 mmHg (P = 0.64) | Diastolic blood pressure: 70.9 mmHg (P = 0.65) | BMI: 22.7 kg m<sup>-2</sup> (P = 0.89) | Waist circumference: 81.1cm (P = 0.42) | Bronchial asthma: PR 1.34<sup>b</sup> | Crohn disease: PR 0.7<sup>b</sup> |
| Lyssel et al., 2015, Sweden | Secondary/hospital care | 109 | All types of psoriasis | Hypertension: 12.5%<sup>d</sup> | BMI 28.5 kg m<sup>-2</sup> | Diabetes: 4.6%<sup>d</sup> | Dyslipidaemia: 16.4%<sup>d</sup> | Metabolic syndrome: 7.6%<sup>d</sup> | | |
| Mahé et al., 2013, France | Secondary/hospital care | 545 (adults with childhood psoriasis) | Majority plaque | Major adverse cardiovascular event: 2.6%<sup>d</sup> | | | | | | |
| Matusiewicz et al., 2014, Poland | Insurance database | 4499 | Not specified | Heart valve and rheumatic heart disease: 0.6% | | Serious endocrine and metabolic disease: 0.4% | | Rheumatoid arthritis and inflammation: 2.1% | |
| Paller et al., 2013, U.S.A./Italy/the Netherlands | Secondary/hospital care | 614 | Plaque | Excess adiposity (BMI > 85th percentile): 57.8% (OR 2.65, CI 1.74–4.15; P < 0.001) | Obese (BMI > 95th percentile): 20.2% (OR 4.29, CI 1.96–9.39; P < 0.001) | | | | |
| Pietrzak et al., 2002, Poland | Secondary/hospital care | 70 | Psoriasis vulgaris | | | | | | No difference in liver measurements and parenchymal echogenicity between psoriatic and healthy children |
Table 4 (continued)

| Author, year, country | Data source | Sample size | Type of psoriasis | Cardiovascular disease and hypertension | Obesity | Psychosocial | Metabolic disease |
|-----------------------|-------------|-------------|-------------------|------------------------------------------|--------|--------------|------------------|
| Remrod et al., 2013, Sweden | 106 | Secondary/hospital care | 48 (adults with child-onset psoriasis) | Plaque | Higher anxiety score ($P = 0.006$) | Higher depression score ($P = 0.028$) | Higher scores of four personality traits: embitterment, irritability, mistrust, verbal |
| Shapiro et al., 2006, Israel | Not specified | Insurance database | 4658 | Plaque | | | Diabetes: 0–5 years: OR 12.45 ($P < 0.005$) 5–15 years: OR 1.98 ($P > 0.05$) Dyslipidaemia: 15% ($P = 0.48$) Metabolic syndrome: 25% ($P = 0.07$) |
| Torres et al., 2014, Portugal | 105 | Secondary/hospital care | 20 | Plaque | Systolic/diastolic blood pressures > 90th percentile: 30% ($P = 0.032$) BMI > 90th percentile: 25% ($P = 0.03$) Waist circumference > 75th percentile: 75% ($P = 0.002$) | | | Waist circumference > 75th percentile: 75% ($P = 0.002$) |
| Wu et al., 2010, China | Case series | Secondary/hospital care | 137 | All types of psoriasis | | | Allergic contact dermatitis: 22.6% Eczema: 4.2% Vitiligo: 3.6% Alopecia areata: 2.2% Systemic lupus erythematosus: 0.7% Aesopha gca: 0.7% |

The main findings from each study are presented. All figures presented represent an increased risk of a disease association or comorbidity unless stated otherwise. PR, prevalence ratio; OR, odds ratio; HR, hazard ratio; NOS, not otherwise specified; BMI, body mass index. Adjusted for confounders. *Adjusted for confounders ($P < 0.005$). **Reduced compared with adult-onset ($P < 0.0001$).
disease. Kim et al. found that lifetime quality-of-life scores were lower for those with childhood-onset compared with adult-onset disease. This supports the theory of a cumulative life-course impairment described by Warren et al.

Cohort studies on the natural history of child-onset psoriasis have to date focused on napkin psoriasis and evidence on outcomes even within child is extremely limited. Data on childhood psoriasis is often obtained from adults with persistent disease, which introduces the risk of recall bias and excludes those whose psoriasis has resolved.

Discussion

Summary of findings

Over the past 25 years there has been a dramatic increase in the volume of published studies in the field of childhood psoriasis epidemiology, the majority of which have been case series and cross-sectional studies concentrated in Europe, Asia and North America.

The prevalence of childhood psoriasis was found to be higher in European countries, older children and girls. Up to 48.8% of children had a positive family history of psoriasis in a first-degree relative. The most frequent subtype was plaque psoriasis and the most common initial sites of presentation were the scalp, limbs and trunk. Specific genetic differences have been found between child-onset and adult-onset populations. Case–control studies and cohort studies investigating the risk factors for psoriasis onset, comorbidities and long-term health outcomes were extremely limited.

Strengths and limitations

This scoping review is the first paper to map and summarize epidemiological data on childhood-onset psoriasis. The search strategy was designed to be extensive and the protocol designed to minimize bias. Reference lists were hand searched until saturation of additional studies was reached. The accuracy of extracted data was cross-checked for 10% of studies; minimal discrepancies were found in this sample and any errors were likely to have an unpredictable effect on the results.

A narrative synthesis within a scoping review summarizes the available literature in a broad topic, providing an extensive overview that is not possible with more traditional systematic reviews. Through exploring the scope of the literature, the feasibility and design considerations of future focused systematic reviews can be understood. We recognize that a limitation of this review is the absence of structured critical appraisal of individual studies; however a scoping review is a starting point for such work.

Research gaps

This scoping review has identified gaps in our evidence base about childhood psoriasis relating to all four core questions this review aimed to address. Although over 100 studies contained epidemiological data, the choice of study design and heterogeneity in methodology limit the validity and generalizability of the information, consistency of the results and comparability of the studies.

A clear definition of psoriasis and psoriasis subtypes would ensure that inclusion criteria are standardized and that subtype frequencies could be accurately recorded. A clear definition of the potential risk factors, associated diseases and uniformity of parameters measured would help the clinical applicability of the findings and allow a meta-analysis of results. Work towards the standardization of disease definition, exposure and outcomes should follow the methodology of ongoing projects to develop core outcome sets.

Population-based prevalence and incidence studies in particular are needed to understand the burden of disease globally. These studies should explore the impact of variables such as geographic location, socioeconomic class and ethnicity. Studies using routinely collected healthcare data, existing birth cohort studies and newly initiated community-based research projects should all be considered. Prospective multicentre cohort studies in secondary care would provide the opportunity to obtain accurate data on the clinical presentation of childhood psoriasis (e.g. subtypes, sites of involvement, severity) and explore the impact of variables such as puberty and ethnicity on the genotype–phenotype presentation. Prospective cohort studies will also enable long-term health outcomes to be investigated in this hospital population. Individual centre case series and cross-sectional studies are not as valuable as a coordinated effort of prospectively collected data.

This scoping review identified very few specifically designed case–control and cohort studies that have investigated the risk factors for disease onset and associated diseases. Meta-analysis of all available data in these areas will be challenging owing to the heterogeneity. There is an indication that infection, trauma, stress and obesity are important triggers for psoriasis onset, but these factors have not been quantified. There is also an indication that psoriasis is associated with several comorbidities, but confirmation and level of risk is unknown. Multicentre case–control and cohort studies using population-based data and children recruited from both the community and secondary care would help to answer these questions. To date, there is minimal information on long-term outcomes, which would be best answered through cohort studies both at secondary care (prospective multicentre) and population level (routinely collected health data and birth cohort studies).

Conclusion

This is the first review to map and summarize the epidemiological data for psoriasis in children. The knowledge gaps identified in this review should be used to initiate new well-designed epidemiological studies. These studies need to report clear and unified definitions of disease, exposures and outcomes to allow effective comparison and meta-analysis of data, thereby reducing research wastage. Such work should
follow the many examples of international research efforts to develop core outcome sets within dermatology and other specialties. Studies utilizing multicentre prospective hospital cohorts, population-based data and birth cohorts will, in combination, help to address these knowledge gaps. In particular, factors affecting prevalence, risk factors for disease onset and long-term health outcomes should be established for all children affected by psoriasis, not only those under hospital review. Studies addressing these knowledge gaps will be important to inform primary and secondary prevention strategies to improve the health of children.

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Appendix 1

Search strategy

Ovid Embase

exp Infant/ or infant.$mp. or infancy.mp. or newborn.$mp. or baby.$mp. or babies.mp. or neonat.$mp. or exp Child/ or child.$mp. or kid.mp. or kids.mp. or toddler.$mp. or exp Adolescent/ or adole.$mp. or teen.$mp. or boy.$mp. or girl $mp. or exp Pediatrics/ or pediatric$mp. or paediatric$.mp. or paediatric$mp. or young people.mp.

AND

psoriasis.mp. or exp Psoriasis/

AND

Epidemiology/ or epidemiolo$mp. or exp case control study/ or exp cohort analysis/ or case control.mp. or (cohort adj (study or studies)).mp. or cohort analy$.$mp. or (follow up adj (study or studies)).mp. or (observational adj (study or studies)).mp. or longitudinal.mp. or retrospective.mp. or cross sectional.mp. or cross-sectional study/

Ovid Medline

exp Infant/ or infant.$mp. or infancy.mp. or newborn.$mp. or baby.$mp. or babies.mp. or neonat.$mp. or exp Child/ or child.$mp. or kid.mp. or kids.mp. or toddler.$mp. or exp Adolescent/ or adole.$mp. or teen.$mp. or boy.$mp. or girl $mp. or exp Pediatrics/ or pediatric$mp. or paediatric$.mp. or paediatric$mp. or young people.mp.

AND

psoriasis.mp. or exp Psoriasis/

AND

Epidemiologic studies/ or epidemiolo$mp. or exp case control studies/ or exp cohort studies/ or case control.mp. or (cohort adj (study or studies)).mp. or cohort analy$.$mp. or (follow up adj (study or studies)).mp. or (observational adj (study or studies)).mp. or longitudinal.mp. or retrospective.mp. or cross sectional.mp. or cross-sectional study/

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Appendix 2

Flowchart showing the flow of studies from study identification to data extraction

**IDENTIFICATION**
- 1416 records identified through Ovid Medline and 1074 identified through Embase

**SCREENING**
- 2053 unique records screened for inclusion
- 1817 records excluded:
  - 204 Duplicates
  - 830 Not psoriasis
  - 493 Not children
  - 274 Not observational/nontreatment
  - 12 Other

**ELIGIBILITY**
- 236 full-text articles were assessed for eligibility
- 105 records excluded

**INCLUDED IN MAPPING**
- 131 articles included in the systematic scoping review

**DATA EXTRACTION**
- 107 articles included in data extraction