Title

A systematic review of diagnostic criteria for psoriasis in adults and children: Evidence from studies with a primary aim to develop or validate diagnostic criteria

Running head: Systematic review of diagnostic criteria for psoriasis

Manuscript word count: 3496
Table count: 1
Figure count: 3

Burden-Teh E [1], Phillips RC [2], Thomas KS [1], Ratib S [1], Grindlay D [1], Murphy R [3]

[1] Centre of Evidence Based Dermatology, University of Nottingham, Nottingham, UK
[2] Department of Paediatric Dermatology, Nottingham University Hospitals NHS Trust, Nottingham UK
[3] Department of Dermatology, Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, UK

Corresponding author:
Dr Esther Burden-Teh
Centre of Evidence Based Dermatology, King's Meadow Campus, University of Nottingham, NG7 2RD
Esther.Burden-Teh@nottingham.ac.uk

No funding sources
No conflicts of interest

What's already known about this topic?

- Diagnostic criteria can aid both clinical diagnosis and support standardisation in clinical trials and observational research.
- In routine dermatology practice, psoriasis is a clinical diagnosis and the gold (reference) standard is a dermatologist's diagnosis, supported where needed by histology.
- Diagnostic criteria are currently not widely used in clinical practice or research on psoriasis.

What does this study add?

- No clinical examination-based diagnostic criteria have been developed or validated for psoriasis in adults or children
- Genetic, molecular, skin imaging, histopathology, questionnaire-based, computer-aided and traditional Chinese medicine diagnostic criteria have been developed for psoriasis, but their utility in clinical practice and research needs further exploration.
- Many of the included diagnostic accuracy studies had unclear or high risk of bias due to weaknesses in study design and study reporting.

Abstract

Background
The diagnosis of psoriasis in adults and children is made clinically, for both patient management and the selection of participants in research. Diagnostic criteria provide a structure for clinical assessment, which in turn helps standardise patient recruitment into clinical trials and case definitions in observational studies.

Objective
The aim of this systematic review was to identify and critically appraise the published studies to date that had a primary research aim to develop or validate diagnostic criteria for psoriasis.

Method
A search of Ovid MEDLINE and Ovid Embase was conducted in October 2016. The primary objective was sensitivity and specificity of diagnostic criteria for psoriasis. Secondary objectives included diagnostic recommendations, applicability to children and study characteristics. Diagnostic accuracy studies were critically appraised for risk of bias using the QUADAS-2 tool.

Results
Twenty-three studies met the inclusion criteria.None detailed clinical examination-based diagnostic criteria. The included criteria varied from genetic and molecular diagnostic models to skin imaging, histopathology, questionnaire-based, computer-aided and traditional Chinese medicine criteria. High sensitivity and specificity (>90%) were reported in many studies. However, the study authors often did not specify how criteria would be used clinically or in research. This review identified studies with varyingrisk of bias and due to each study developing separate criteria meta-analysis was not possible.

Conclusion
Clinical examination-based diagnostic criteria are currently lacking for psoriasis. Future research could follow an international collaborative approach and employ high quality diagnostic accuracy study design. Existing and newly developed criteria require validation.

Introduction

The aim of this systematic review was to identify and critically appraise studies where the primary research aim was to develop or validate diagnostic criteria for psoriasis in adults or children. The review was designed to be broad and inclusive of all ages, types of psoriasis and types of diagnostic criteria. In this way, the review aimed to provide a comprehensive overview of the available evidence.

Psoriasis is an immune-mediated chronic inflammatory disease affecting the skin, joints, or both. It is associated with both a genetic predisposition and environmental triggers[1]. Onset may occur at any age, with an estimated prevalence of 1.0% to 8.5% in adults and up to

2.1% in children[2,3]. Psoriasis is associated with systemicinflammation , although the risk of comorbidity and comorbidity-related mortality remains controversial[4-7].

In routine clinical practice, the diagnosis of psoriasis is made based on pattern recognition of clinical features, including the distribution, configuration and morphology of skin changes[8-10]. The gold or reference standard is conventionally accepted to be a clinical diagnosis made by a qualified dermatologist, which may be supported, when required, by a skin biopsy. Unlike in other conditions such as Behçets disease, where clinical diagnostic criteria exist to aid the clinical assessment, and atopic dermatitis, where criteria are used in clinical research, diagnostic criteria are not widely used in the assessment of psoriasis[11-13].

Clinical diagnostic criteria not only support and provide a structure to clinical diagnosis, but also standardise recruitment into clinical trials and case definitions in observational studies. Studies which develop diagnostic criteria should follow the principles of high quality diagnostic accuracy study design and reporting, and then go on to validate the criteria in the study or clinical population they are intended to be used[14].

Method

The protocol was registered on PROSPERO (http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015032311), and the results have been reported according to the PRISMA checklist[15]. The term 'diagnostic criteria' was interpreted to mean a group of diagnostic features which support a diagnosis of psoriasis.

Studies were included where the primary aim was to develop or validate diagnostic criteria for psoriasis. No restrictions were applied to study type, age of participants, language, type of psoriasis or type of diagnostic criteria developed. Studies were not required to include a comparator group. . Review articles and studies focusing solely on psoriatic arthritis were excluded. Conference abstracts were excluded due to insufficient information; this was an alteration from the protocol.

The primary outcome was sensitivity and specificity of diagnostic criteria for psoriasis. Secondary outcomes were as follows: recommendations on how to diagnose psoriasis, applicability of the diagnostic criteria to a paediatric population, study design and study population. The diagnosis of psoriasis can be more challenging in children, in part due to a different presentation compared to adults, therefore this review assessed the applicability of diagnostic criteria to this specific population.

The search was conducted in October 2016 in Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) 1946 to Present, and Ovid Embase 1974 to 2015. A search strategy was developed with an information specialist (DG) using MeSH headings and free text search terms around the keywords 'diagnosis', 'criteria' and 'psoriasis' (Appendix 1). Reference citations from included studies were searched for additional relevant papers.

Titles and abstracts of identified studies were independently screened by two authors according to the inclusion and exclusion criteria (EBT and either RP, SR or DG). Full text

papers were obtained for studies meeting the inclusion criteria. Two authors (EBT and RP) independently assessed the eligibility of full text papers. Study authors were contacted to clarify missing data from potentially eligible studies. Any disagreements on study eligibility were resolved through discussion or involvement of a third author (KT).

Data were independently extracted by two authors (EBT and RP) using a standardised proforma (Appendix 2). The proforma was piloted on three studies and refined before independent extraction was initiated. Discrepancies between the two sets of data extraction were discussed and checked against the original manuscript. For those studies not reported in English, data was extracted by an associate proficient in that language.

Diagnostic accuracy studies were individually critically appraised for risk of bias using the QUADAS-2[16]. The QUADAS-2 tool was specifically designed to assess the quality of studies included in diagnostic accuracy systematic reviews. The tool assesses risk of bias across four domains; each guided by prompt questions. Patient selection: recruitment of consecutive or a random sample, case-control design avoided, inappropriate exclusions. Index test (diagnostic criteria): results interpreted without knowledge of the reference standard, use of a pre-specified threshold. Reference standard (gold standard): results interpreted without knowledge of the index test, likely to correctly classify psoriasis. Flow of patients in the study: interval between index test and reference standard, complete verification, inclusion of all patients in the analysis. All studies, regardless of overall quality, were included in data synthesis.

Paired forest plots and summary ROC (SROC) curves were planned for studies which were clinically similar and suitable for meta-analysis. A narrative synthesis was planned for secondary outcomes.

Results

Within the 11,702 studies identified from the search strategy no clinical examination based diagnostic criteria for psoriasis in adults or children were found. Only 23 studies[17-39] met the inclusion criteria and presented a broad range of diagnostic criteria including genetic, molecular, dermoscopy, confocal microscopy, histopathology, questionnaire-based, computer aided and traditional Chinese medicine criteria (Table 1). Sixteen [22]studies were of a case-control design, five studies were case-series, one study was cross-sectional and one study was a Delphi consensus study. No studies developed diagnostic criteria specifically for children or validated diagnostic criteria specifically in a paediatric population.

Studies were excluded because they were duplicates (n=4374), did not focus on psoriasis (n=4266), did not mention diagnostic criteria for psoriasis (n=2950), did not develop or validate diagnostic criteria (n=34) or were review articles (n=55). The search strategy was extensive and inclusive of many terms associated with diagnostic criteria and psoriasis. A large number of studies were therefore excluded at the screening stage. A PRISMA flow diagram of included and excluded studies is presented in Figure 1.

The diagnostic criteria have been summarised, including consideration of their utility, and study quality is reported using the QUADAS-2 tool. With regards to the review primary

outcome, sensitivity and specificity of the diagnostic criteria, only 16 of the included studies were diagnostic accuracy studies [17-20,22-24,26-29,31,35-38] and of these studies only thirteen studies provided these data[18,20,22-24,26-29,31,35,36,38]. Figure 2 shows a scatterplot of the available sensitivity and specificity results of these 13 studies.

Meta-analysis was not appropriate due to heterogeneity of the diagnostic criteria in terms of different study populations, experimental and reference tests [40], therefore a narrative review was undertaken.

Genetic and moleculardiagnostic criteria

Six studies reported genetic[18-21,23,24] and three studies reported molecular[17,22] diagnostic criteria (Table 1). These studies aimed to identify a combination of genetic or molecular markers which could best predict psoriasis. Seven studies were of a case-control design and one was a cross-sectional study. Sensitivity and specificity results of the criteria were presented or available on request for five studies; the sensitivity values ranged from 65.6 to 98 and specificity from 58.2 to 100[18,20,22-24]. Diagnostic accuracy results were oftenreported as area under the curve (AUC) and three studies reported a value of 0.7 or greater[17,18,22,24]. Six studies undertook validation testing of their developed criteria[17,19-21,23,24]; in two studies[20,24] this was conducted in a separate cohort but no studies reported validation in their intended population.

Domain 1 (patient selection) was scored high risk of bias in six studies [17-19,22-24], the remaining three domains nearly all scored low or unclear risk of bias in the seven diagnostic accuracy studies (Figure 3). The low scores reflect that the index test was interpreted separately from the reference standard and the flow of patients through each study minimised bias. However, the reference standard was only detailed in one study[24].

Across the eight studies, the study authors proposed that their research may improve the efficiency and/or accuracy of diagnosis including screening individuals at high risk for psoriasis[19,24], improve disease outcomes[17], further understanding of pathogenesis[18,20] and aid the development of personalised medicine[20,24] and new treatment[23]. The authors of two studies proposed that these genetic criteria would, in time, translate into routine clinical practice[20,23].

We conclude that the research and clinical utility of these genetic and molecular criteria for the diagnosis of psoriasis require further exploration, and new validation studies are needed. The cost of the laboratory investigation and skill required to undertake a skin biopsy for current genetic testing are likely to be barriers to adoption. The effect of the anatomical distribution of psoriasis on the predictive ability of these criteria is unknown.

Skin imaging diagnostic criteria

Four studies reported dermoscopic or videodermoscopic diagnostic criteria[27-30], two studies reported reflective confocal microscopy (RCM)[26,31] criteria and one study reported high definition optical confocal tomography (HD-OCT)[25] (Table 1). All seven studies were of a case-control study design and five studies[26-29,31] assessed the diagnostic accuracy of the

proposed criteria in distinguishing psoriasis from other inflammatory skin disease and skin cancer.

The different dermoscopic criteria studies reported variable sensitivity (45% to 98%), but high specificity (88% to 99.5%) for diagnosing psoriasis[27-29]. Koller *et al*[26]reported high sensitivity (89.13%) and specificity (95.41%) for the RCT criteria tested and Munro's microabscesses on RCT achieved both high sensitivity and specificity (90% and 96.4%)[31]. The Videodermoscopy Scalp Psoriasis Severity Index (VSCAPSI) criteria had poor inter-observer reproducibility; only 68% of dermatologists recognised ≥13 images[30]. None of the imaging studies included testing the diagnostic criteria in a validation cohort.

The risk of bias was highly variable across the five diagnostic accuracy studies (Figure 3). These scores not only reflect study quality but also the quality of study reporting; for example the details reported by Liu *et al*[28] and Zhong *et al*[31] were brief and therefore many of the domains were scored as unclear. Lallas *et al* and Koller *et al*[26,27] achieved a low risk of bias score in three out of four domains, demonstrating both a strong study design and detailed reporting.

The authors of the seven skin imaging studies proposed that the developed criteria may assist clinical diagnosis reducing the need for skin biopsy[25,29,31], help identify an optimal site to biopsy [26], enable response to treatment and side effect monitoring[27], and help identify patients requiring screening for psoriatic arthritis[30]. One group of authors highlighted that the feasibility of applying imaging criteria in clinical practice requires further evaluation[27]. The authors of one study suggested that the criteria could be adopted as an outcome tool in clinical trials[30].

We conclude that further discussion about the clinical and research utility of imaging criteria in the diagnosis of psoriasis is needed, including validation of their diagnostic accuracy in the proposed setting and population. The implementation of imaging criteria research is likely to be restricted to the specialist setting due to the availability of equipment and trained professionals. Dermoscopy is already widely practised amongst dermatologists for the assessment of skin cancer and therefore further training could extend existing skills to inflammatory lesions. However, the availability of confocal microscopy is limited to specialist research centres. Further studies are also needed to guide lesion selection, as it is not clear whether the performance of the criteria varies when plaques at different anatomical sites are assessed.

Histopathological diagnostic criteria

Four studies have contributed to the development of histopathological criteria[32-35], focusing on clinical situations where diagnosing psoriasis is recognised as challenging; isolated scalp psoriasis, isolated nail psoriasis, erythroderma (Table 1). Three studies were case-series and one[35] was of a case-control design and provided diagnostic accuracy data. None included a validation cohort. Park *et al*[35] reported poor sensitivity (33%) and good specificity (90%) of >5.75 mitotic features in one high power field for the diagnosis of psoriasis. Minimal study details were provided and therefore the risk of bias was high or unclear across the four

domains evaluated (Figure 3). The study was strengthened by assessment of histological samples by three independent histopathologists, but no intra-observer data was provided.

The authors of the four histopathology studies provided few details on the potential application of the proposed diagnostic criteria, except stating they would assist clinical diagnosis. We conclude that the clinical and research utility of histopathological criteria is poorly explored, especially considering histology was often part of the inclusion criteria for many studies within this review. A skin biopsy is a small but invasive procedure, incurs costs and is not widely available outside the specialist setting. These factors are likely to limit the adoption of histological criteria outside dermatology clinics and within clinical trials. Clinically, histological criteria may be of greatest benefit in those with indeterminate skin changes. The criteria proposed are for specific anatomical sites, and therefore it is unknown if these findings are applicable to other body sites.

Computer-aided diagnostic criteria

Two case-control studies developed computer-aided diagnostic criteria and reported high diagnostic accuracy (sensitivity and specificity 100%, 5.7 errors per 100 cases)[36] (Table 1). Neither included a validation group. The risk of bias across the four domains varied between the two studies, reflecting the specific details reported in West and West on the reference test and index test[36,37] (Figure 3).

Both sets of authors proposed that their criteria would be used in the clinical setting, although differed on whether the computer-aided tool would augment or replace current diagnostics. We propose that further discussion of clinical and research utility is needed, and validation studies. The performance of the criteria when psoriasis affects specific body areas is unknown.

Questionnaire-based diagnostic criteria

Dominguez *et al* developed a self-administered screening questionnaire for the diagnosis of psoriasis[38]. In this case-control study the questionnaire achieved high diagnostic accuracy; sensitivity 98% and specificity 95%[38]. However, the performance of the questionnaire relied heavily on question number three, 'I have been diagnosed with psoriasis by a dermatologist' (sensitivity 93%, specificity 98%), and removal of this question led the sensitivity and specificity to fall to 35% and 50% respectively[38].

The risk of bias assessment was variable across the four domains. In particular, the quality of the study was limited by lack of clarity as to whether the index test (questionnaire) was separated from the reference standard (dermatologist's diagnosis) (Figure 3).

The study authors designed the questionnaire for research purposes and aimed to reliably ascertain psoriasis and psoriasis subtypes in remote populations[38]. We conclude that the diagnostic accuracy of the criteria may be poor in areas with low levels of access to dermatologists, potentially limiting its usefulness in this setting. Future studies are needed to validate the questionnaire in a community setting. A questionnaire is a low-cost diagnostic tool, making it suitable for large and population-based studies. It is not clear what

impact limited psoriasis or psoriasis affecting only certain body sites may have on the questionnaire's diagnostic ability.

Traditional Chinese Medicine diagnostic criteria

A Delphi consensus study, Yang *et al* [39] aimed to develop a checklist for traditional Chinese medicine symptoms and signs of psoriasis. The study did not assess diagnostic accuracy, but within the consensus study there was good intra-observer but poor inter-observer agreement.

The study authors proposed that the criteria may aid the diagnosis and classification of psoriasis in clinical practice and research[39], but no further details were provided. We conclude that further discussion about the criteria's utility is needed and testing of its diagnostic performance. No reference was made to psoriasis affecting specific body areas. It is likely that the usefulness of these criteria will be mostly limited to settings practising traditional Chinese medicine.

Discussion

Summary of key findings

This systematic review identified 23 studies that reported diagnostic criteria for psoriasis, but it is surprising that no clinical examination-based diagnostic criteria have been developed or tested. The questionnaire-based criteria by Dominguez *et al* [38] were the closest in type to clinical diagnostic criteria, but relied on patient confirmation of a dermatologist's diagnosis. Validation was frequently performed within studies developing genetic and molecular criteria, but no studies validated their criteria in the setting and population they were intended to be used. Due to the heterogeneity of diagnostic criteria included in this review it was not possible to compare their diagnostic accuracy. Nevertheless, high sensitivity and specificity (>90%) were reported in many studies.

The majority of included studies were limited by their case-control design, which is likely to over-estimate the diagnostic accuracy of a test or tool[41,42]. There was also significant variation in study reporting, with frequent or high risk of bias in domains where details were limited or missing about the study population, reference standard and flow of patients in the study[16]. Nearly all diagnostic accuracy studies were undertaken on a selected population using a case-control study design and therefore the QUADAS-2 domain 1 (patient selection) was rated high risk of bias in all critically appraised studies.

Overall, studies often poorly described the clinical and research utility of their proposed criteria, or future research required to validate and implement them. Studies focused, where detailed, on plaque psoriasis and the diagnostic performance of the criteria across a variety of body areas is unknown.

Diagnostic criteria in dermatology

The benefits of diagnostic criteria in supporting improved clinical diagnosis, research studies and systematic reviews are widely reported[9,43,44]. However, diagnostic criteria have only been developed for a small number of diseases in dermatology;

In eczema, Brenninkmeijer *et al* [12] summarised and assessed the validity of six examination-based diagnostic criteria, developed mostly for research purposes. These criteria achieved varied diagnostic accuracy and Brenninkmeijer *et al* commented that the methodological quality in both the conduct and reporting of the eczema studies differed substantially; a similar finding to this review on diagnostic criteria for psoriasis. In Behçet's disease, Davatchi *et al* [45] appraised 17 sets of examination-based diagnostic criteria that were developed to aid clinical diagnosis. Two internationally developed sets of diagnostic criteria for Beçhet's disease were found to be the best performing criteria. The review emphasised that further validation studies in different countries were required and the need to accept that the clinical picture of a disease may change over time[45]. These are both concepts which need to be considered when developing diagnostic criteria for psoriasis.

Diagnostic criteria have also been proposed for a small number of other dermatological conditions, primarily those with extra-cutaneous involvement and those requiring multi-professional input. For example, mucous membrane pemphigoid, PHACE (Posterior fossa, Haemangioma, Arterial lesions, Cardiac abnormalities, Eye abnormalities) syndrome and erosive lichen planus[46-48]

Relevance to clinical practice

Diagnostic criteria in dermatology aim to support not replace clinical diagnosis, especially in the specialist setting where the reference standard is a dermatologist's diagnosis. In this review many of the criteria identified were 'test-based'. The utility of skin imaging or histopathological diagnostic criteria alone may be limited, as they are unlikely to be used without a clinical assessment. However, they are likely to be useful adjuvants to clinical diagnosis for example, in cases of clinical diagnostic uncertainty where a dermoscopic followed by a histopathological diagnostic criteria may be applied. At present, it is more difficult to recognise how genetic or molecular diagnostic criteria would be used in routine clinical practice.

Most studies in this review, where stated, included an adult secondary care population, therefore the findings of this review would be difficult to translate to children or a community setting where the diagnostic challenges are different.

The implications for patients of not receiving an accurate psoriasis diagnosis (false negatives) include a delay in initiating effective treatment and monitoring for comorbidities. Incorrectly identifying patients with psoriasis (false positives) may result in inappropriate treatment for their skin condition and the possible anxiety of being labelled with a potentially life-long skin condition.

Research implications

Only the questionnaire-based diagnostic criteria were specifically developed for research purposes[38]. However, the diagnostic accuracy of this tool in the community setting has not yet been assessed in a validation study. Genetic and molecular diagnostic criteria may play an important role in future geno-epidemiological studies, developing biobanks and stratifying patients according to disease. However, further work is needed to improve the diagnostic accuracy of such criteria and validate them.

The diagnostic criteria identified in this review are currently not suitable to standardise psoriasis disease definition in clinical trials and observational studies; confirming an important gap in the available literature.

Strengths and limitations

To the authors' knowledge this review is the first to collate and appraise available studies that have developed and/or validated diagnostic criteria for psoriasis. The search strategy was designed to be comprehensive and was supported by an information specialist. Diagnostic accuracy studies were critically appraised using the validated QUADAS-2 tool. As the literature in this area was anticipated to be limited a broad definition of diagnostic criteria was applied. Therefore, the types of diagnostic criteria included in this review are diverse and meta-analysis was not possible.

Conclusions

At present there are no available clinical examination-based diagnostic criteria for psoriasis to support clinical diagnosis and standardisation of disease definition in research studies. A number of criteria based on different diagnostic methods have been developed but their clinical and research utility is unclear. There is a need for these proposed criteria to be validated in the populations and settings they are intended to be used. To date, studies have focused on the adult population. The work to develop clinical examination-based diagnostic criteria chould be undertaken as an international collaborative approach, consider the type and extent of psoriasis, aim to minimise the risk of bias in the study design and propose to validate the criteria in the target population. Such work should carefully consider the diagnostic challenges of psoriasis affecting particular sites and ages.

Acknowledgements

Dr Lu Ban, Centre of Evidence Based Dermatology, University of Nottingham, Nottingham, UK for assisting with the assessment for eligibility and data extraction of Chinese manuscripts.

References

1 Boehncke WH, Schon MP. Psoriasis. *Lancet* 2015; **386**: 983-94.

2 Parisi R, Symmons DP, Griffiths CE *et al.* Global epidemiology of psoriasis: a systematic review of incidence and prevalence. *The Journal of investigative dermatology* 2013; **133**: 377-85.
3 Burden-Teh E TK, Ratib S, Grindlay D, Adaji E, Murphy R. The Epidemiology of Childhood Psoriasis: A Scoping Review. *British Journal of Dermatology* 2016 **174**: 1242-57.
4 Abuabara K, Azfar RS, Shin DB *et al.* Cause-specific mortality in patients with severe psoriasis: a population-based cohort study in the U.K. *The British journal of dermatology* 2010; **163**: 586-92.
5 Langan SM, Seminara NM, Shin DB *et al.* Prevalence of metabolic syndrome in patients with psoriasis: a population-based study in the United Kingdom. *The Journal of investigative dermatology* 2012; **132**: 556-62.
6 Dowlatshahi EA, Kavousi M, Nijsten T *et al.* Psoriasis is not associated with atherosclerosis and incident cardiovascular events: the Rotterdam Study. *The Journal of investigative dermatology* 2013; **133**: 2347-54.
7 Parisi R, Rutter MK, Lunt M *et al.* Psoriasis and the Risk of Major Cardiovascular Events: Cohort Study Using the Clinical Practice Research Datalink. *The Journal of investigative dermatology* 2015; **135**: 2189-97.
8 Rimoin L, Altieri L, Craft N *et al.* Training pattern recognition of skin lesion morphology, configuration, and distribution. *Journal of the American Academy of Dermatology* 2015; **72**: 489-95.
9 Naldi L, Gambini D. The clinical spectrum of psoriasis. *Clinics in dermatology* 2007; **25**: 510-8.
10 Cox NH CI. Diagnosis of Skin Disease. In: *Rook's Textbook of Dermatology* (DA Burns SB, NH Cox, CEM Griffiths, ed), 8th Edition edn.: Blackwell. 2009.
11 Williams HC, Burney PG, Pembroke AC *et al.* The U.K. Working Party's Diagnostic Criteria for Atopic Dermatitis. III. Independent hospital validation. *The British journal of dermatology* 1994; **131**: 406-16.
12 Brenninkmeijer EE, Schram ME, Leeflang MM *et al.* Diagnostic criteria for atopic dermatitis: a systematic review. *The British journal of dermatology* 2008; **158**: 754-65.
13 Davatchi F. Diagnosis/Classification Criteria for Behcet's Disease. *Pathology research international* 2012; **2012**: 607921.
14 Bossuyt PM, Reitsma JB, Bruns DE *et al.* STARD 2015: an updated list of essential items for reporting diagnostic accuracy studies. *Bmj* 2015; **351**: h5527.
15 Moher D, Liberati A, Tetzlaff J *et al.* Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Bmj* 2009; **339**: b2535.
16 Whiting PF, Rutjes AW, Westwood ME *et al.* QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. *Annals of internal medicine* 2011; **155**: 529-36.
17 Alonso A, Julia A, Vinaixa M *et al.* Urine metabolome profiling of immune-mediated inflammatory diseases. *BMC Medicine* 2016; **14**: 133.
18 Chen H, Poon A, Yeung C *et al.* A genetic risk score combining ten psoriasis risk loci improves disease prediction. *PLoS ONE* 2011; **6**.
19 Guo P, Luo Y, Mai G *et al.* Gene expression profile based classification models of psoriasis. *Genomics* 2014; **103**: 48-55.
20 Inkeles MS, Scumpia PO, Swindell WR *et al.* Comparison of molecular signatures from multiple skin diseases identifies mechanisms of immunopathogenesis. *Journal of Investigative Dermatology* 2015; **135**: 151-9.
21 Kamsteeg M, Jansen PA, van Vlijmen-Willems IM *et al.* Molecular diagnostics of psoriasis, atopic dermatitis, allergic contact dermatitis and irritant contact dermatitis. *British Journal of Dermatology* 2010; **162**: 568-78.
22 Maejima H, Nagashio R, Yanagita K *et al.* Moesin and stress-induced phosphoprotein-1 are possible sero-diagnostic markers of psoriasis. *PLoS ONE* 2014; **9**.
23 Sundarrajan S, Arumugam M. Weighted gene co-expression based biomarker discovery for psoriasis detection. *Gene* 2016; **593**: 225-34.

24 Yin X, Cheng H, Lin Y *et al.* A weighted polygenic risk score using 14 known susceptibility variants to estimate risk and age onset of psoriasis in Han Chinese. *PLoS ONE* 2015; **10**.
25 Boone M, Norrenberg S, Jemec G *et al.* High-definition optical coherence tomography: Adapted algorithmic method for pattern analysis of inflammatory skin diseases: A pilot study. *Archives of Dermatological Research* 2013; **305**: 283-97.
26 Koller S, Gerger A, Ahlgrimm-Siess V *et al.* In vivo reflectance confocal microscopy of erythematosquamous skin diseases. *Experimental Dermatology* 2009; **18**: 536-40.
27 Lallas A, Kyrgidis A, Tzellos TG *et al.* Accuracy of dermoscopic criteria for the diagnosis of psoriasis, dermatitis, lichen planus and pityriasis rosea. *British Journal of Dermatology* 2012; **166**: 1198-205.
28 Liu XJ, Zhang JL, Kong XJ *et al.* Psoriasis vulgaris, chronic eczema and pityriasis rosea: 187 cases of dermoscopic analysis. [Chinese]. *Journal of Clinical Dermatology* 2015; **44**: 484-6.
29 Pan Y, Chamberlain AJ, Bailey M *et al.* Dermatoscopy aids in the diagnosis of the solitary red scaly patch or plaque-features distinguishing superficial basal cell carcinoma, intraepidermal carcinoma, and psoriasis. *Journal of the American Academy of Dermatology* 2008; **59**: 268-74.
30 Rossi A, Mandel VD, Garelli V *et al.* Videodermoscopy Scalp Psoriasis Severity Index (VSCAPSI): A useful tool for evaluation of scalp psoriasis. *European Journal of Dermatology* 2011; **21**: 546-51.
31 Zhong LS, Wei ZP, Liu YQ. Sensitivity and specificity of Munro microabscess detected by reflectance confocal microscopy in the diagnosis of psoriasis vulgaris. *Journal of Dermatology* 2012; **39**: 282-3.
32 Braegelmann J, D'Erme AM, Akmal S *et al.* Interleukin-36gamma (IL-1F9) identifies psoriasis among patients with erythroderma. *Acta Dermato-Venereologica* 2016; **96**: 386-7.
33 Braun-Falcon O, Heilgemeir GP, Lincke-Plewig H. Histological differential diagnosis of psoriasis vulgaris and seborrheic eczema of the scalp. [German] Histologische Differentialdiagnose Von Psoriasis Vulgaris Und Seborrhoischem Ekzem Des Kapillitium. *Hautarzt* 1979; **30**: 478-83.
34 Hanno R, Mathes BM, Krull EA. Longitudinal nail biopsy in evaluation of acquired nail dystrophies. *J Am Acad Dermatol* 1986; **14**: 803-9.
35 Park JH, Park YJ, Kim SK *et al.* Histopathological Differential Diagnosis of Psoriasis and Seborrheic Dermatitis of the Scalp. *Annals of Dermatology* 2016; **28**: 427-32.
36 Shrivastava VK, Londhe ND, Sonawane RS *et al.* Computer-aided diagnosis of psoriasis skin images with HOS, texture and color features: A first comparative study of its kind. *Computer Methods and Programs in Biomedicine* 2016; **126**: 98-109.
37 West D, West V. Improving diagnostic accuracy using a hierarchical neural network to model decision subtasks. *International Journal of Medical Informatics* 2000; **57**: 41-55.
38 Dominguez PL, Assarpour A, Kuo H *et al.* Development and pilot-testing of a psoriasis screening tool. *British Journal of Dermatology* 2009; **161**: 778-84.
39 Yang X, Chongsuvivatwong V, McNeil E *et al.* Developing a diagnostic checklist of traditional Chinese medicine symptoms and signs for psoriasis: A Delphi study. *Chinese Medicine (United Kingdom)* 2013; **8**.
40 Deeks JJ. Systematic reviews in health care: Systematic reviews of evaluations of diagnostic and screening tests. *BMJ* 2001; **323**: 157-62.
41 Lijmer JG, Mol BW, Heisterkamp S *et al.* Empirical evidence of design-related bias in studies of diagnostic tests. *Jama* 1999; **282**: 1061-6.
42 Rutjes AW, Reitsma JB, Vandenbroucke JP *et al.* Case-control and two-gate designs in diagnostic accuracy studies. *Clinical chemistry* 2005; **51**: 1335-41.

43 Chuh A, Zawar V, Law M *et al.* Gianotti-Crosti syndrome, pityriasis rosea, asymmetrical periflexural exanthem, unilateral mediothoracic exanthem, eruptive pseudoangiomatosis, and papular-purpuric gloves and socks syndrome: a brief review and arguments for diagnostic criteria. *Infectious disease reports* 2012; **4**: e12.
44 Flohr C. Atopic dermatitis diagnostic criteria and outcome measures for clinical trials: still a mess. *The Journal of investigative dermatology* 2011; **131**: 557-9.
45 Davatchi F, Sadeghi Abdollahi B, Chams-Davatchi C *et al.* The saga of diagnostic/classification criteria in Behcet's disease. *International journal of rheumatic diseases* 2015; **18**: 594-605.
46 Chan LS, Ahmed AR, Anhalt GJ *et al.* The first international consensus on mucous membrane pemphigoid: definition, diagnostic criteria, pathogenic factors, medical treatment, and prognostic indicators. *Archives of dermatology* 2002; **138**: 370-9.
47 Metry D, Heyer G, Hess C *et al.* Consensus Statement on Diagnostic Criteria for PHACE Syndrome. *Pediatrics* 2009; **124**: 1447-56.
48 Simpson RC, Thomas KS, Leighton P *et al.* Diagnostic criteria for erosive lichen planus affecting the vulva: an international electronic-Delphi consensus exercise. *The British journal of dermatology* 2013; **169**: 337-43.