Digital Tools for Assessing Disease Severity in Dermatology

Abstract
Innumerable scoring systems have been introduced to measure the disease severity of various dermatological conditions. The development of such scores has proved to be beneficial to assess disease progression and treatment effectiveness in the context of dermatological research. However, these scoring systems tend to be time consuming, monotonous, and hence often difficult to use during overburdened routine clinical consultations, especially when it is in the form of a paper-based system. Many of the scoring systems are now available in the digital form, such as smartphone apps. This aids to calculate effortlessly and reduces human errors associated with paper-based formats. Various calculators like Psoriasis Area Severity Index calculators, Severity Scoring Of Atopic Dermatitis, and Melasma Area Severity Index have been introduced in the digital format for a quicker, efficient quality of work and uncomplicated data storage. This review highlights and discusses some of the digital tools available at present for severity scoring in dermatology.

Keywords: Digital calculators, digitalization, disease severity, scoring systems

Introduction
Dermatology is a field with a growing interplay of digitalization, telehealth, and informatics.[1] The smartphone has become an integral part of our practice—whether it be as an image capture (and storage tool)—both clinical and dermoscopy, teledermatology, or for general applications like drug formularies. This is more so after the beginning of the pandemic. Scoring systems and checklists for diagnostic criteria are an integral part of dermatology practice. Many of these scoring systems and criteria are now available online and as apps.

Scope
Apps for assessing disease severity are useful in routine clinical consultations; come with the advantage of being user friendly, quicker (as compared with the conventional paper-based calculators), and easier for documentation/archiving and linking to patient’s electronic health records. These apps range from simple calculators to apps embedded with machine learning (MI)/artificial intelligence (AI), which can have a more advanced role in disease evaluation.

The paper-based scoring systems have significant inter-observer and intra-observer errors, are time consuming, and record maintenance is cumbersome. Digitalizing these scoring systems provide advantages like increased productivity and quality, reduced manual errors, easy data storage, and is a win-win situation for both the doctor and the patient as the patients do not have to wait for long durations. Such tools have been a boon to clinical practitioners, academic researchers, post-graduate students, and in remote areas in the context of teledermatology. However, practical usage of the apps needs it to be as intuitive and user friendly as possible. Involving dermatologist in the development and testing processes more effectively is key for this.

Convolutional Neural Network
The utility of such apps can be further enhanced by incorporating AI and ML into them. The concept of convolutional neural network (CNN), a type of deep AI neural network, involves comparison between the similarities and biases of two images and classifies it with its highest accuracy. The work that a CNN does to produce a diagnostic result from an image is similar to how a dermatologist uses their training
and knowledge. Diagnosing lesions by a dermatologist generally involves an input image (of a cutaneous lesion) being fed through a processing network (the skills and knowledge of the dermatologist who analyzes it and synthesizes available information) to output a “class” (or diagnosis) or a “probability of classes” (differential diagnosis).[2]

One of the early examples of AI applied to scoring systems in dermatology was that of “Eczema area and severity index (EASI) dig” by Tremp et al.,[3] in which the EASI score was established using digital images. This proved to be a time saving tool and also reduced significant inter-observer error. This paved the way for the development of digital apps related to other scoring systems.

At present, digital scoring/criteria tools are available for many common conditions, such as psoriasis, eczema (including atopic dermatitis), melasma, hidradenitis suppurativa, Behcet’s disease, systemic lupus erythematosus (SLE), burns, pressure ulcers, and for the dermatology life quality index (DLQI) (summary of common apps and websites is given in Table 1).

### Various Apps and Websites for Scoring Systems in Dermatology

#### Psoriasis

Psoriasis area severity index (PASI)[4,5] is currently the gold standard score for the assessment of severity of psoriasis but has the limitation of significant inter-observer variation. There are many PASI calculators available, both online (www.pasitraining.com/calculator; http://pasi.corti.li/) and as mobile app (https://play.google.com/store/apps/details?id=com.thunkable.android.sivasubramaniamdeveloper.PASI_Calculator).

The PASI calculator is developed in a simple web page which just takes the input of the numerical data provided and holds the superiority of producing the PASI score within no fractions of seconds against the traditional way of PASI calculation. This free online application helps physicians and patients in the computation of the PASI [Figures 1 and 2].

#### Atopic dermatitis

SCORAD (Severity Scoring Of Atopic Dermatitis)[6] developed by the European Task Force on atopic dermatitis in 1993 is the most commonly used scoring system for measuring the severity of atopic dermatitis. The SCORAD calculator by MD app[7] (https://www.mdapp.co/scoring-atopic-dermatitis-scorad-calculator-396) provides a free standardized model for assessing the severity of atopic dermatitis lesions. It uses the same formula as used in a traditional way but minimizing the effort and reducing mathematical errors. Dermcalculator (http://www.dermcalculator.com/easi-professional/) is a webpage which allows easy calculation of EASI in less than 1 min [Figure 3]. EASI score (https://easiscore.com/) helps to calculate EASI in an easier method by displaying pictures of the condition; the patient or the physician needs to tap or select the appropriate current stage and the calculation...
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is done. The data storage with unique identification of each patient is possible as it allows us to enter the patient name or ID along with the age [Figures 4 and 5].

### Table 1: Summary of common tools available for assessment of disease severity/activity

| Disease                          | Scores calculated | Name of app/website | Available platforms | Free/ paid | Other remarks               |
|----------------------------------|-------------------|----------------------|---------------------|-----------|-----------------------------|
| Eczema                           | SCORAD            | MDApp                | Online              | Free      | Output as pdf               |
| Atopic Dermatitis                | EASI              | Dermcalculator       | Online              | Free      | -                           |
| Eczema                           | EASI              | EASIscore.com        | Online              | Free      | -                           |
| Psoriasis                        | PASI              | Pasit raining.com    | Android             | Free      | -                           |
| Melasma                          | MASI              | Melasma Score        | Android             | Free      | Output as pdf               |
| Melasma                          | MSI               | MASI Score           | Android             | Free      | -                           |
| Melasma                          | MA SI             | MSI                  | Android             | Free      | Output as pdf               |
| Hidradenitis                     | HS-PGA            | DK-HS/AI             | iOS                 | Free      | -                           |
| Suppurativa                      | iHS4              | Mod sartorius score  | Hurley S            |           |                             |
| Psoriasis                        | PASI              | Dermascore           | Android             | Free      | Output as pdf               |
| Eczema                           | SCORAD            | RODNAN               |                     |           |                             |
| Scleroderma                      | RODNAN            | DLQI                 | Android             | Free      | Output as pdf               |
| Quality of Life of various conditions | DLQI             | DLQI: the official app | Android            | Free      | Output as pdf               |
| Psoriasis                        | PASI              | Dermatools           | Android             | Free      | Output as pdf               |
| Eczema                           | EASI and SCORAD   | iOS                  |                     |           |                             |
| Nail assessment in psoriasis and psoriatic arthritis | NAPPA             |                      |                     |           |                             |
| Quality of life                  | DLQI              |                      |                     |           |                             |
| Psoriatic arthritis             | DAPSA             | MDApp                | Online              | Free      | Output as pdf               |
| Psoriatic arthritis             | CASPAR criteria   | MDApp                | Online              | Free      | Output as pdf               |
| TEN/SJS                          | SCORTEN           | MDApp                | Online              | Free      | Output as pdf               |
| Pressure ulcer                   | Braden scale      | MDApp                | Online              | Free      | Output as pdf               |
| Burns                            | Parkland formula calculator | MDApp            | Online              | Free      | Output as pdf               |
| Urticaria                        | UAS               | MDcalc               | Online              | Free      | -                           |
| Psoriasis                        | PASI              |                      |                     |           |                             |
| Psoriatic arthritis             | CASPAR            |                      |                     |           |                             |
| Cellulitis                       | ALT70             |                      |                     |           |                             |
| Systemic Lupus erythematosus     | SLICC criteria    |                      |                     |           |                             |
| Behcet                           | Checklist for Behcet disease | Calculate by    | Android             | Free      | -                           |
| Systemic Lupus erythematosus     | SLEDAI            | QxMD                 | iOS                 |           |                             |

**Melasma**

Melasma area severity index (MASI) is developed by Kimbrough-Green et al.[5] for the assessment of melasma, in which the Total MASI score is calculated by the following formula:

\[
\text{Forehead} \times 0.3 (D+H) + \text{right malar} \times 0.3 (D+H) + \text{left malar} \times 0.3 (D+H) + \text{chin} \times 0.1 (D+H)
\]

Where, \( D \) = darkness of melasma, \( H \) = homogeneity of hyperpigmentation, \( A \) = areas involved.

Since the Melasma score calculator is available (https://play.google.com/store/apps/details?id=com.thunkable.android.sivasubramaniandev...Melasma&hl=en_IN&gl=US) freely in android play store, calculating MASI,
mMASI (mean MASI), and MSI (Melasma Severity Index) at one click is easy and cumbersome. Another application named MASI Score (https://play.google.com/store/apps/details?id=com.radiant.masiscore&hl=en_US&gl=US) by Radiant Nutraceuticals Limited is accessible on android platform which allows us to calculate only MASI score; the only drawback is that the score output has to be saved as screenshot in the form of pdf because print option is not available [Figures 6–8].

**Hidradenitis suppurativa**

Acne inversa severity index (AISI) is considered to be a new disease severity assessment tool for Hidradenitis Suppurativa[9] and the DK-HS/AI app by Dermavalue is available free on iOS [Figures 9–11]. There is also another app for HS based on the Hurley scale (https://play.google.com/store/apps/details?id=com.everywhereim.HSAppEN&hl=en&gl=US). Using this app, it is possible for the dermatologist to easily categorize individual lesions in the form of abscess, inflammatory/non-inflammatory nodules, papules, pustules, and folliculitis at the respective anatomical sites, and at the end, the app directly displays the calculated HS-PGA (Hidradenitis suppurativa-Physician Global Assessment), iHS4 (International Hidradenitis Suppurativa Severity Score System), Mod sartorius score, and the Hurley Stage which are sent in email. When the data are entered in subsequent visits, it compares with the previous data and highlights the improvement or deterioration of the condition. These data can be directly emailed to the respective physician for record maintenance.

**Quality of Life Indices**

The DLQI is a dermatology-specific QOL measure that has been well validated, used in many diseases, and translated into many languages.[10] The dermatological conditions are linked with social relations, daily activities, and the psychological status. This impact is more easily determined by the patient rather than by the physician. It is useful from a physician point of view in considering the effectiveness of the treatment which can be assessed by using QOL scores in addition to physical assessment. There is a specific set of questionnaire usually in the form of hard copy available with the dermatologists but now, when we are in the transition phase from nonelectronic to digitalization, the Cardiff university has launched DLQI: the official app, wherein 10 questions concerning patient’s perception of the impact of skin diseases on different aspects of their health-related quality of life over the last week is assessed. It can be used by patients to analyze the burden of the condition and by clinicians for evaluation, monitoring treatment efficacy, and psychological burden. It is available free of cost in android platform (https://play.google.com/store/apps/details?id=uk.ac.cardiff.dlqi&hl=en_IN&gl=US) as well as iOS (https://apps.apple.com/in/app/dlqi-the-official-app/id1576503015). It also lets you compare your previous score and is really like managing your quality of life at your fingertips in the time of less than 2 min [Figure 12].
**Multiple disease scoring applications**

Dermascore is an application which is available on android platforms (https://play.google.com/store/apps/details?id=app.dermascore.android), yet to be launched on iOS. Dermascore lets a clinician calculate PASI, SCORAD, and Rodnan score in 1 application itself. PASI calculation is similar to the PASI calculator, while SCORAD is simplified in this version. The modified Rodnan skin score is a measure of skin thickness and is used as a primary or secondary outcome measure in clinical trials of systemic sclerosis (scleroderma),[11] and the assessment is performed by taking into account 17 sites. This app can be managed by trained dermatologists but will be difficult for nontrained professionals and next to impossible for the patients to use it [Figures 13 and 14].

The application “Dermavalue” is a one stop check for all the scoring systems like PASI, EASI, SCORAD, and NAPPA (Nail assessment in psoriasis and psoriatic arthritis). NAPPA is a modular instrument for the assessment of clinical and patient-reported outcomes in nail psoriasis; it has three components: a questionnaire assessing quality of life (NAPPA-QoL), a two-part questionnaire assessing patient-relevant treatment benefits (the Patient Benefit Index, NAPPA-PBI), and a psoriasis Clinical Assessment of Severity (NAPPA-CLIN).[12] DLQI application happens to be very user friendly and time saving for both patients and clinicians. Each score is handled as sore for ePASI* and eSCORAD with the facility of the calculated score to be emailed and saved. There are other parameters like treatment goals and benefits i.e ePBI* or ePAIN questionnaire for the patient’s self assessment [Figures 15–17].

MD app has a tool for measuring severity of psoriatic arthritis based on Disease Activity index for psoriatic Arthritis[13]—https://www.mdapp.co/disease-activity-
This app is a simple 5-point digital scale for easier calculation. Classification criteria for psoriatic arthritis (CASPAR) has been developed by the same platform (https://www.mdapp.co/caspar-criteria-for-psoriatic-arthritis-calculator-422/). SCORTEN for toxic epidermal necrolysis/Stevens-Johnson syndrome is another area where a quick digital scoring tool helps; MD app has a very simple tool for this purpose too (https://www.mdapp.co/scorten-scale-calculator-420/). Further, MD app has tools for severity scoring of pressure ulcers (Braden scale)—https://www.mdapp.co/braden-scale-for-pressure-ulcers-calculator-387/ and the Parkland calculator for burns—https://www.mdapp.co/parkland-formula-calculator-for-burns-104/ MDcalc (www.mdcalc.com) is another utilitarian website which has a number of user friendly scoring systems. This has unrestricted access on both android and iOS platforms.

Dermatology-related scoring systems available on MDcalc include Urticaria Activity Score, PASI, Braden score, CASPAR for psoriatic arthritis (PsA), and ALT-70 score for lower extremity cellulitis. It has a useful systemic steroid dose conversion tool. For systemic lupus, it has both the severity scoring tool, SLEDAI-2K, and the criteria Systemic lupus collaborating clinics (SLICC criteria 2012).

“Calculate by QxMD” (https://qxmd.com/calculate/) is available online as well on both android and iOS free of cost. It includes a criteria checklist for Behcet’s disease and like MDcalc has the SLEDAI-2k and the SLICC for SLE.
Storage of data, related ethical, and medicolegal aspects

The completed scores can be easily saved and shared as pdf or image files. As of now, the available calculators generally do not include an option to add patient details, so there are no ethical issues involved. However, as and when calculators come, in which the name or patient identification number can be tagged and saved or linked to electronic health records, ethical concerns will have to be addressed. These concerns will be similar to the concerns of using electronic health records on third party platforms. In this situation, healthcare workers will need to
use the same stringent security measures, as for any other patient-related data.

The dermatologist can also manually store the scores as pdf or images into folders along with the rest of the patient data like photographs and lab reports. The general principles of storing photographs can be applied here too (tag with patient name, ID number, and date), make backups on at least one hard disc and one cloud storage system. Ensure that access to data is restricted and has appropriate security controls. This would be especially important when the data are part of a research study.

**Conclusion**

The development of digital severity assessment tools in the form of applications and webpages have proved to not only be time saving (the data entry to score calculation takes about only a minute) and cost-effective but also a user friendly approach for the practicing dermatologist, not just in research contexts but also for routine clinical practice. These apps need more studies for validation, across different populations. The future challenges would be to make these apps cheaper, more accessible, enhance integration of AI/MI into the apps to reduce to a minimum the need for manual entry and also to improve aspects like storage/archiving and security.

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Conflicts of interest

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