Received: 19 December 2022 | Revised: 8 May 2023 | Accepted: 1 June 2023

DOI: 10.1111/jocd.15866

JCD Journal of Cosmetic Dermatology WILEY

ORIGINAL ARTICLE

Skin hyperpigmentation index in melasma: A complementary method to classic scoring systems

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Abstract

Background: Due to relapsing nature of melasma with significant impact on quality of life, an objective measurement score is warranted, especially to follow-up the patients with melasma and their therapy response in a quantitative and precise manner.

Aims: To prove concordance of skin hyperpigmentation index (SHI) with well-established scores in melasma and demonstrate its superiority regarding inter-rater reliability. Development of SHI mapping for its integration in common scores.

Methods: Calculation of SHI and common melasma scores by five dermatologists. Inter-rater reliability was assessed by intraclass correlation coefficient (ICC) and concordance by Kendall correlation coefficient.

Results: Strong concordance of SHI with melasma area and severity index (MASI)-Darkness (0.48; 95% CI: 0.32, 0.63), melasma severity index (MSI)-Pigmentation (0.45; 95% CI: 0.26, 0.61), and melasma severity scale (MSS) (0.6; 95% CI: 0.42, 0.74). Using step function for mapping SHI into pigmentation scores showed an improvement of inter-rater reliability with a difference in (ICC of 0.22 for MASI-Darkness and 0.19 for MSI-Pigmentation), leading to an excellent agreement.

Conclusion: Skin hyperpigmentation index could be an important additional cost-and time-conserving assessment method, to follow-up the patients with melasma undergoing brightening therapies in clinical studies, as well as in routine clinical practice. It is in strong concordance with well-established scores but superior regarding inter-rater reliability.

KEYWORDS
melasma, score, skin hyperpigmentation index

Kristine Heidemeyer and Simone Cazzaniga are co-authors.

1 | INTRODUCTION

Melasma is an acquired chronic recurrent pigment disorder affecting mainly the face and predominantly women.[1] It can occur in all skin types but the prevalence is higher in darker skin types (Fitzpatrick III–V)[1,2] and reach in south Asia a prevalence of 40% among women.[2,3] The exact pathomechanism is not yet fully understood, but several factors influencing the development and aggravation of melasma have been described.[4] The melasma has a huge impact on life-quality, inducing emotional distress and lower self-esteem, and is therefore a frequent reason for consultations in dermatology.[2] The very refractory nature and the almost consequent relapse makes treatment challenging and push the development and evaluation of new treatment options.[5] For evaluation of efficacy in clinical trials, melasma area and severity index (MASI) and modified MASI (mMASI) are commonly used. Other scores such as melasma severity scale (MSS) and melasma severity index (MSI), although less popular in clinical studies,[6,7] are more practical and easier to apply in daily clinical practice.

All these scales are limited by the subjective evaluation of several factors. More available precise methods, such as image analysis with colorimetry and spectrophotometry, are usually too expensive and time-consuming for practical applications.

Recently, a simple and fast tool for the objective measurement of skin hyperpigmentation, named skin hyperpigmentation index (SHI), has been introduced.[8,9] For the automatic calculation of SHI of lesional and non-lesional non-sun exposed skin areas, dermoscopic pictures are taken, for example, using a smartphone dermatoscope adapter and an online calculator, freely available at: https://shi.skinimageanalysis.com, can be used.

This index could be an important tool for the evaluation of melasma as it is easy to perform and quantifies pigmentation without the most frequent bias of dependency on rater reliability and on the quality of pictures, including variation of darkness by inconstancy in lightening. The excellent intra-and inter-rater reliability of the SHI in other pigmented lesions has already been demonstrated in previous studies.[9]

This study aimed to evaluate the inter-rater reliability of SHI and well-established scores as MASI in melasma patients, as well as to demonstrate the concordance of the SHI with the well-established MASI, regarding darkness measurement, along with the development of a SHI mapping function for its integration in common scores.

2 | MATERIALS AND METHODS

The study was performed at the outpatient's clinic of Department of Dermatology at the University Hospital of Bern. The study was approved by the ethical committee of the Canton of Bern (KEK-2022-00136) and conducted according to the Declaration of Helsinki principles. The evaluation was based on consecutive melasma patients of whom both clinical pictures of the whole face and dermoscopy images of a representative area of the melasma lesion and non-sun exposed skin of the body have been taken at the same time by five dermatologists. All patients have signed informed consent.

Clinical pictures were rated by the same five dermatologists for the variables of MASI/mMASI (darkness (0–4), area (1–6), homogeneity (0–4) on forehead, right cheek, left cheek, and chin), the MSS (global assessment 0–3) as well as MSI (pigmentation (0–4) and area (1–4) for left and right face and nose, respectively).

2.1 | Calculation of conventional scoring systems

- Melasma area and severity index[7]

$$\text{MASI} = 0.3\text{A}\,(\text{D}+\text{H})\ \text{forehead} + 0.3\text{A}\,(\text{D}+\text{H})\ \text{r. malar} + 0.3\text{A}\,(\text{D}+\text{H})\ \text{l. malar} + 3\text{A}\,(\text{D}+\text{H})\ \text{chin}$$

MASI: melasma area and severity index; A: area of involvement (0 indicates absent; 1, <10%; 2, 10%–29%; 3, 30%–49%; 4, 50%–69%; 5, 70%–89%; 6, 90%–100%); D: darkness (0 indicates absent; 1, slight; 2, mild; 3, marked; 4, severe); H: homogeneity (0 = no pigment, 1 = specks, 2 = <2 cm patches, 3 = >2 cm patches, 4 = homogeneous); r: right; l: left.

- Modified melasma area and severity index[7]

$$\text{mMASI} = 0.3\text{A}\times\text{D}\ \text{forehead} + 0.3\text{A}\times\text{D}\ \text{r. malar} + 0.3\text{A}\times\text{D}\ \text{l. malar} + 3\text{A}\times\text{D}\ \text{chin}$$

mMASI: modified melasma area and severity index; A: area of involvement (0 indicates absent; 1, <10%; 2, 10%–29%; 3, 30%–49%; 4, 50%–69%; 5, 70%–89%; 6, 90%–100%); D: darkness (0 indicates absent; 1, slight; 2, mild; 3, marked; 4, severe); r: right; l: left.

- Melasma severity index[6]

$$\text{MSI} = 0.4\,(\text{a}\times\text{p}^2)\ \text{l. face} + 0.4\,(\text{a}\times\text{p}^2)\ \text{r. face} + 0.2\,(\text{a}\times\text{p}^2)\ \text{nose}$$

MSI, melasma severity index; p: pigmentation (0 indicates no visible pigmentation; 1, barely visible pigmentation; 3, moderate pigmentation; 4, severe pigmentation); a: area (1, ≤10%; 2, 11%–30%; 3, 31%–60%; 4, >60%); r: right; l: left.

- Melasma severity scale[7]

MSS range: 0 = none, 1 = mild, 2 = moderate, and 3 = severe.
MSS, melasma severity scale.

2.2 | Calculation of SHI[8]

The SHI was calculated based on dermoscopy pictures of melasma as well as non-sun exposed reference skin using the online free calculator (Figure 1).

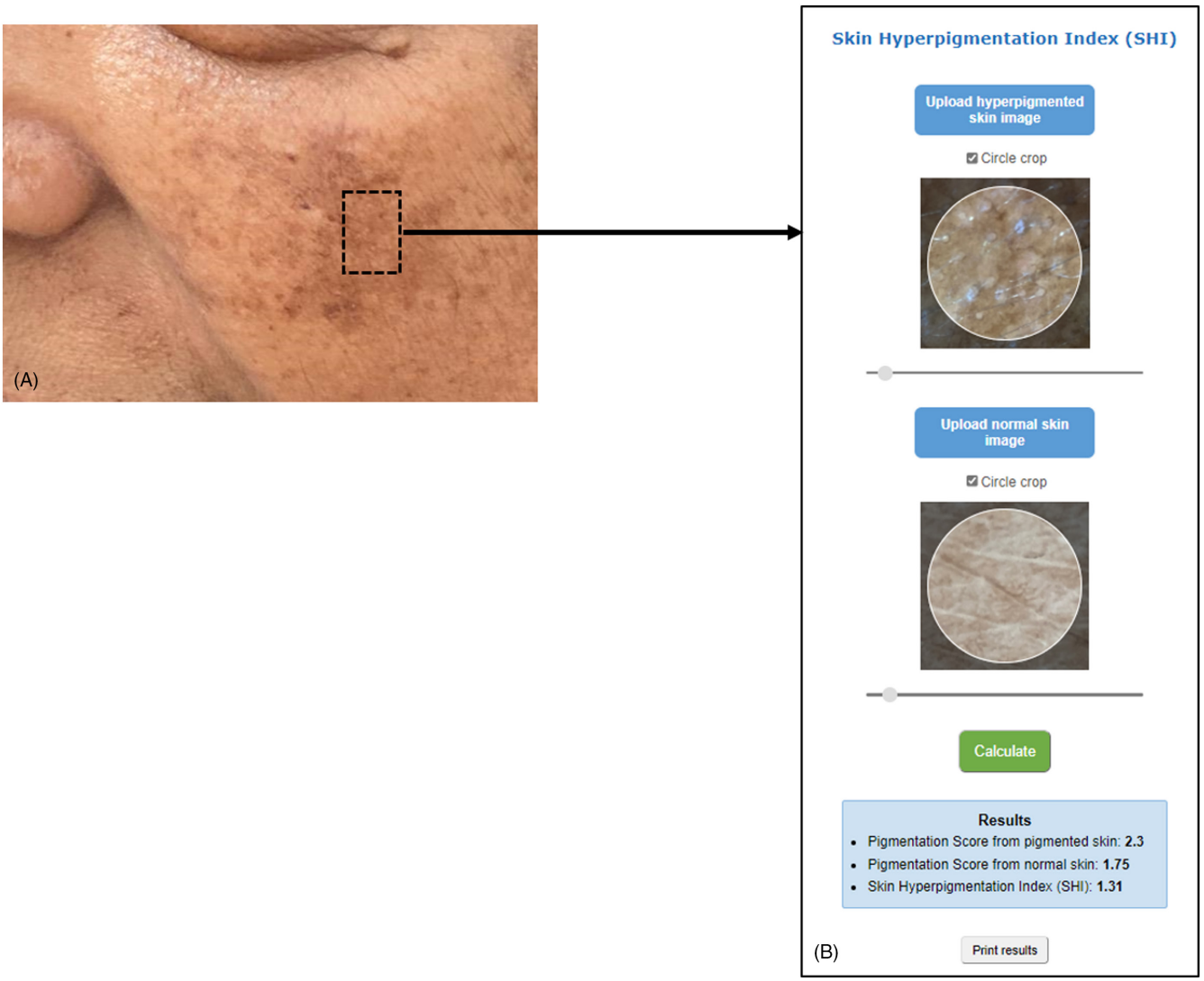

FIGURE 1 (A) Overview of a patient with a localized melasma on the right cheek, (B) calculated SHI of melasma on the right cheek at https://shi.skinimageanalysis.com/ with circle drop and zoom function. Ratio of pigmentation values of hyperpigmented and normal skin. Illustration with uploaded photos.

Briefly, the algorithm employs color deconvolution and image histogram profiling of brown pixel intensities for the automated evaluation of a quantitative skin pigmentation score (PS), calculated as a weighted sum of four intensity areas (7):

$$PS = \frac{\left(\begin{array}{l}\%\text{contribution of very high pigmentation} \times 4 \\ +\%\text{contribution of high pigmentation} \times 3 \\ +\%\text{contribution of normal pigmentation} \times 2 \\ +\%\text{contribution of low pigmentation} \times 1\end{array}\right)}{100}$$

The PS score ranges from 1 (no hyperpigmentation) to 4 (maximum hyperpigmentation).

Then SHI is computed as the ratio of the PS scores in pigmented versus reference normal skin area, as shown in the following equation:

$$SHI = \frac{PS_{\text{area with pigmentation}}}{PS_{\text{reference area}}}$$

The SHI ranges from 1 (no hyperpigmentation) to 4 (maximum hyperpigmentation).

2.3 | Statistical analysis

Continuous data were described as medians with interquartile ranges (IQR), while categorical variables as numbers with percentages. The median scores among all raters were considered for descriptive purposes.

The inter-rater reliability was assessed by single measure, absolute agreement, two-way random effects intraclass correlation coefficient (ICC) for SHI, MASI, mMASI, MSS, and MSI. In the

second step, the inter-rater reliability of pigmentation measures of MASI and MSI as well as MSS using SHI with step function mapping has been calculated. ICC can be interpreted as follows: <0.2: poor, 0.2–0.39: fair, 0.4–0.59: moderate, 0.6–0.79: good, and ≥0.80: excellent.

The concordance between SHI and (m)MASI-Darkness score, MSI Pigmentation score and MSS was calculated based on the Kendall τ-c rank correlation coefficient. Values of τ-c ≥ 0.30 can be considered evidence of strong association. All measures were reported along with their 95% confidence intervals (CI).

For mapping of the SHI to (m)MASI-Darkness, MSI pigmentation and MSS, several models including linear regression, total least squares (TLS) regression, step function fitting, and linear discriminant analysis (LDA) classifier have been evaluated. Measures of classification accuracy and model fit in terms of R^2 were produced as well.

Analyses were performed using SPSS software v.26 (IBM Corp) and MATLAB v.9.1 (The MathWorks Inc.).

Before performing the study, we calculated that at least 12 patients and 5 assessors were needed to detect, for the SHI, ICC ≥0.85 significantly higher than 0.60 ($\alpha = 0.05$, $\beta = 0.20$, two-sided test).

3 | RESULTS

Overall, 12 patients were included in the study, mostly females (91.7%), with a median age of 42.5 years (IQR: 37.5–50.5). The skin-type of patients varied between II and V, while most of the patients (50%) had skin type V. The median SHI was 1.9 (IQR: 1.5–2.2). The medians for general scores were 4.2 (2.4–10.9) for MASI, 2.1 (1.1–6.4) for mMASI, 2.0 (1.0–2.5) for MSS, and 6.4 (0.8–21.8) for MSI. Regarding specific pigmentation measures, the median MASI-Darkness was 2.0 (1.5–3.5) and the median MSI-Pigmentation was 2.0 (2.0–4.0) (Table 1).

The calculation of concordance between SHI and pigmentation measures on the same locations, based on the Kendall correlation

TABLE 1 General characteristics and melasma measures of patients included in the study.

	N = 12	%	Median	IQR
Fitzpatrick skin type			4.5	3.5–5.0
II	1	8.3		
III	2	16.7		
IV	3	25.0		
V	6	50.0		
SHI			1.9	1.5, 2.2
Localization				
Cheek	7	58.3		
Forehead	5	41.7		
MSS			2.0	1.0, 2.5
1: Mild	4	33.3		
2: Moderate	5	41.7		
3: Severe	3	25.0		
MASI			4.2	2.4, 10.9
MASI-Darkness[a]			2.0	1.5, 3.5
1: Slight	3	25.0		
2: Moderate	4	33.3		
3: Marked	2	16.7		
4: Very marked	3	25.0		
mMASI			2.1	1.1, 6.4
MSI			6.4	0.8, 21.8
MSI-Pigmentation[a]			2.0	2.0, 4.0
1: Barely visible	2	22.2		
2: Mild	3	33.3		
3: Moderate	1	11.1		
4: Severe	3	33.3		

Abbreviations: IQR, interquartile range; MASI, melasma area and severity index; mMASI, modified MASI; MSI, melasma severity index; MSS, melasma severity score; SHI, skin hyperpigmentation index.

[a]Calculated on the same site of SHI. Nonmatching sites were excluded.

coefficient, was 0.48 (95% CI: 0.32, 0.63) for MASI-Darkness, 0.45 (95% CI: 0.26, 0.61) for MSI-Pigmentation, and 0.6 (95% CI: 0.42–0.74) for MSS, representing strong concordance (Table 2).

The inter-rater reliability, according to ICC, was 0.86 (95% CI: 0.72, 0.95) for SHI, meaning excellent agreement, 0.42 (95% CI: 0.17, 0.72) for MASI, representing moderate agreement, and 0.5 (95% CI: 0.24, 0.77) and 0.55 (95% CI 0.28, 0.81) for mMASI and MSI, respectively, showing moderate agreement as well. For MASI and MSI-Pigmentation scores the ICC was 0.66 (95% CI:0.42, 0.86) and 0.68 (95% CI: 0.4, 0.90), respectively, representing a good agreement (Table 2).

For mapping SHI to other comparable melasma measures, the step function fitting showed the best accuracy (43.3% for MASI-Darkness and 42.2% for MSI-Pigmentation) compared to other models. The different formulas with related accuracy measures are listed in Table 3.

When using SHI with step function mapping for the calculation of pigmentation measures of MASI and MSI, ICC was 0.87 (95% CI: 0.74, 0.95) for MASI-Darkness and MSI-Pigmentation. This shows an ICC improvement of 0.22 (95% CI: 0.01–0.48) for MASI-Darkness and of 0.19 (95% CI: −0.02, 0.47) for MSI-Pigmentation, leading to an excellent instead of good agreement (Table 4).

4 | DISCUSSION

Melasma is a common acquired recurrent pigment disorder predominantly in women and darker skin types, accompanied with a high impact on quality of life and emotional stress.[2,3,10] Due to its high prevalence (up to 34% and 40% among women in Brazil and South Asia) and its treatment-resistant behavior and relapsing nature, it is one of the most frequent reasons for dermatologic consultations.[2,3] As no punching through treatment has been discovered so far, every year a huge number of studies are conducted to determine the most effective treatment option. Therefore, it is very important to have an objective measurement method for validation of pigmentation. Up to now, the most frequently used scales in clinical studies are MASI and mMASI, while less popular choices are MSI and MSS.[3,6,7] These scales have however some limitations, both for studies and private practice, as naked-eye assessment is dependent on evaluator which has shown to vary according to experience and quality of pictures.[7,11]

Skin hyperpigmentation index can be used for quantification of skin pigmentation independently from the skin type.

Our pilot study proves that SHI has a strong concordance with MASI/mMASI-Darkness and MSI-Pigmentation as well as with MSS. However, the inter-rater reliability was superior in SHI compared to MASI, mMASI, and MSI, as well as for their pigmentation components. The inter-rater reliability of MASI and MASI-Darkness depends on physician training and location, but our results are in line with previous described findings.[7]

For allowing inclusion of SHI in global scores, we calculated a mapping function as presented. Several models had been compared, with step function showing the best accuracy.

Due to its standardized nature, there are several advantages of using SHI. Regarding picture quality, especially if pictures are taken in non-standardized environment, depending on flashes, shades, and lightening, the darkness and the area can be misevaluated. These factors are eliminated in SHI due to standardized dermoscopy pictures with homogenous lightening.

Another disadvantage of the common scores is the division into groups for evaluation, so that they cannot catch little differences of pigmentation, a limitation already described by other authors.[7] Detecting small differences is crucial in clinical trials as well as in private practice, as most of the treatments show a very slow improvement.

A further advantage of the SHI is that, in contrast to other computerized image analysis methods for pigmentation, it allows to

TABLE 2 Inter-rater reliability and concordance of SHI with other melasma measures.

	Inter-rater reliability		
	ICC[a] (95% CI)	SHI vs. other measures, ΔICC[a] (95% CI)	Concordance with SHI[b] (95% CI)
SHI	0.86 (0.72, 0.95)	-	-
MASI-Darkness[c]	0.66 (0.42, 0.86)	0.20 (−0.05, 0.47)	0.48 (0.32, 0.63)
MSI-Pigmentation[c]	0.68 (0.40, 0.90)	0.18 (−0.06, 0.52)	0.45 (0.26, 0.61)
MSS	0.73 (0.51, 0.90)	0.13 (−0.11, 0.39)	0.60 (0.42, 0.74)
MASI	0.42 (0.17, 0.72)	0.44 (0.17, 0.58)	-
mMASI	0.50 (0.24, 0.77)	0.36 (0.13, 0.53)	-
MSI	0.55 (0.28, 0.81)	0.31 (0.13, 0.47)	-

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient; MASI, melasma area and severity index; mMASI, modified MASI; MSI, melasma severity index; MSS, melasma severity score; SHI, skin hyperpigmentation index.

[a]Single measure, absolute agreement, two-way random effects ICC.

[b]Concordance based on Kendall τ-c rank correlation coefficient, calculated only for SHI comparable measures.

[c]Calculated on the same site of SHI. Nonmatching sites were excluded.

TABLE 3 Models for mapping SHI to specific pigmentation measures and general scores.

	Linear regression[a]			TLS regression[a]			Step function			LDA classifier
	Formula	R^2	Accuracy (95% CI)[b]	Formula	R^2	Accuracy (95% CI)[b]	Formula	R^2	Accuracy (95% CI)	Accuracy (95% CI)
MASI-Darkness[c]	1.32*SHI−0.26	0.28	28.3% (17.5, 41.4)	4.21*SHI−5.67	0.35	30.0% (18.8, 43.2)	SHI = 1 → 0 SHI in (1, 1.5) → 1 SHI in [1.5, 2) → 2 SHI in [2, 2.5) → 3 SHI in [2.5, 4] → 4	0.32	43.3% (30.6, 56.8)	35.0% (23.1, 48.4)
MSI-Pigmentation[c]	1.28*SHI−0.14	0.27	31.1% (18.2, 46.6)	4.23*SHI−5.97	0.35	28.9% (16.4, 44.3)	SHI = 1 → 0 SHI in (1, 1.5) → 1 SHI in [1.5, 2) → 2 SHI in [2, 2.5) → 3 SHI in [2.5, 4] → 4	0.37	42.2% (27.7, 57.8)	33.3% (20.0, 49.0)
MSS	1.02*SHI+0.03	0.32	48.3% (35.2, 61.6)	2.54*SHI−2.83	0.39	50.0% (36.8, 63.2)	SHI = 1 → 0 SHI in (1, 1.5) → 1 SHI in [1.5, 2) → 2 SHI in [2, 4] → 3	0.46	63.3% (49.9, 75.4)	60.0% (46.5, 72.4)

Abbreviations: CI, confidence interval; LDA, linear discriminant analysis; MASI, melasma area and severity index; MSI, melasma severity index; MSS, melasma severity score; SHI, skin hyperpigmentation index; TLS, total least squares.

[a]Clipping was applied outside target function limits.

[b]After rounding.

[c]Calculated on the same site of SHI. Nonmatching sites were excluded.

TABLE 4 Inter-rater reliability of pigmentation measures and MSS using SHI with step function mapping.

	ICC[a] (95% CI)	SHI mapping vs. standard assessment, ΔICC[a] (95% CI)
MASI-Darkness	0.87 (0.74, 0.95)	0.22 (0.01, 0.48)
MSI-Pigmentation	0.87 (0.74, 0.95)	0.19 (−0.02, 0.47)
MSS	0.93 (0.85, 0.98)	0.20 (−0.02, 0.42)

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient; MASI, melasma area and severity index; MSS, melasma severity score; SHI, skin hyperpigmentation index.

[a]Single measure, absolute agreement, two-way random effects ICC.

calculate an index based on melasma-affected skin standardized in respect to the same skin without sun exposure.[3,11] In this way it is possible to quantify pigmentation independently from the skin type, which is important for studies including several skin types. The fact that the comparison is made with a non-sun-exposed skin is necessary to avoid bias due to tanning of the face in summertime of non-involved skin, resulting in less severe appearance of melasma.

For clinical use, it is important that a score is quick, simple to perform, and objective. The cost could be a further criterion. Compared to other computerized pigment measurements[3,11–13] or spectrophotometry,[14] SHI is very simple, quick, and cost-effective as only a smartphone and a dermoscopy adapter is needed.

Furthermore, the SHI catches pigmentation of smaller areas, which is important in clinical practice, in case of evaluation of test patches, mainly after laser treatments.[15] Also in clinical trials with split-lesion protocols, this would be superior to global measurement scores.

The main limit of the study is the very small sample size with only few patients included. Furthermore, SHI has only been performed in one area of the face, with patients characterized by fair skin types and mild-to-moderate melasma. To prove the superiority of using SHI mapping function for MASI, mMASI, and MSI, further larger studies with calculation of SHI in different regions and skin types are needed. The fact that evaluators of clinical pictures had only limited training for calculation of MASI, could have led to low interrater reliability estimates. However, previous studies with trained physicians showed similar results.

5 | CONCLUSION

This pilot study shows that SHI could be an important additional cost- and time-saving examination tool for melasma studies as well as in private practice. The main advantages are objective measurement with excellent inter-rater agreement also with not fully trained physicians, independency of lightening influence using dermoscopy pictures, the possibility to evaluate only a small area of lesion, and the possibility to increase inter-rater-reliability by including it in well-established scores as MASI or mMASI by mapping function.

AUTHOR CONTRIBUTIONS

KH, LF, VI, ML, AR, LP, MJ and SB performed the research. KH, SC, MA and SB designed the research study. KH, SC, LF and SB analysed the data. KH, SC and SB wrote the paper.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

ETHICS STATEMENT

The study protocol was approved by the cantonal ethic commission of Bern, Switzerland (KEK number 2022-00136). Informed written consent was obtained from all individual participants included in the study.

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REFERENCES

1. McKesey J, Tovar-Garza A, Pandya AG. Melasma treatment: an evidence-based review. *Am J Clin Dermatol*. 2020;21(2):173-225.
2. Handel AC, Miot LD, Miot HA. Melasma: a clinical and epidemiological review. *An Bras Dermatol*. 2014;89(5):771-782.
3. Tay EY, Gan EY, Tan VWD, et al. Pilot study of an automated method to determine melasma area and severity index. *Br J Dermatol*. 2015;172(6):1535-1540.
4. Zaky MS, Obaid ZM, Khalil EA, Elsaie ML. Microneedling-assisted topical tranexamic acid solution versus 4% hydroquinone for treating melasma: a split-face randomized study. *J Cosmet Dermatol*. 2021;20(12):4011-4016.
5. Liu Y, Wu S, Wu H, Liang X, Guo D, Zhuo F. Comparison of the efficacy of melasma treatments: a network meta-analysis of randomized controlled trials. *Front Med (Lausanne)*. 2021;8:713554.
6. Majid I, Haq I, Imran S, Keen A, Aziz K, Arif T. Proposing melasma severity index: a new, more practical, office-based scoring system for assessing the severity of melasma. *Indian J Dermatol*. 2016;61(1):39-44.
7. Pandya AG, Hynan LS, Bhore R, et al. Reliability assessment and validation of the melasma area and severity index (MASI) and a new modified MASI scoring method. *J Am Acad Dermatol*. 2011;64(1):78-83, 83.e1-2.
8. Bossart S, Cazzaniga S, Willenberg T, et al. Skin hyperpigmentation index: a new practical method for unbiased automated quantification of skin hyperpigmentation. *J Eur Acad Dermatol Venereol*. 2020;34(7):e334-e336.
9. Bossart S, Cazzaniga S, Willenberg T, et al. Reliability assessment and validation of the skin hyperpigmentation index compared to the physician global assessment score. *Dermatology*. 2021;238:688-691.
10. AboAlsoud ES, Eldahshan RM, AbouKhodair Mohammed H, Elsaie ML. Safety and efficacy of topical metformin 30% cream versus triple combination cream (Kligman's formula) in treating melasma: a randomized controlled study. *J Cosmet Dermatol*. 2022;21(6):2508-2515.

11. Chen IL, Wang YJ, Chang CC, et al. Computer-aided detection (CADe) system with optical coherent tomography for melanin morphology quantification in melasma patients. *Diagnostics (Basel)*. 2021;11(8):1498.
12. Lee JA, Osmanovic S, Viana MA, Kapur R, Meghpara B, Edward DP. Objective measurement of periocular pigmentation. *Photodermatol Photoimmunol Photomed*. 2008;24(6):285-290.
13. Stamatas GN, Zmudzka BZ, Kollias N, Beer JZ. Non-invasive measurements of skin pigmentation in situ. *Pigment Cell Res*. 2004;17(6):618-626.
14. Sayed KS, Tuqan S, Hilal RF. Q-Switched Nd:YAG (532 nm) laser versus intra-dermal tranexamic acid for treatment of facial ephelides: a split face, randomized, comparative trial. *Lasers Surg Med*. 2021;53(3):324-332.
15. Shokrollahi K. The laser test patch: principles and philosophy to maximize efficacy and reduce complications and scarring from laser treatments. *Ann Plast Surg*. 2016;77(4):373-375.

How to cite this article: Heidemeyer K, Cazzaniga S, Feldmeyer L, et al. Skin hyperpigmentation index in melasma: A complementary method to classic scoring systems. *J Cosmet Dermatol*. 2023;22:3405-3412. doi:10.1111/jocd.15866