

The Validity and Reliability of Patient-provided Photographs for Diagnosing and Assessing the Severity of Hand Eczema

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Hand eczema (HE) is a common skin disease, diagnosed through clinical evaluation. However, the increasing need to deliver healthcare remotely, along with the demand for valid and reliable evaluations of HE in research, prompts exploration of the potential benefits of remote assessment. This study assessed the criterion validity and inter- and intra-rater reliability of patient-provided photographs to diagnose and assess the severity of HE. The presence and severity of HE were assessed by 1 of the 2 clinical raters. Following instructions, patients took 4 photographs of their hands. All photographs were assessed twice by the clinical raters and 2 additional raters. In total, 98 patients were included. The sensitivity, specificity, positive and negative predictive value were respectively 85.1%, 79.2%, 92.6%, and 63.3%. Kappa values of 0.35 and 0.66 were found for inter- and intra-rater reliability. The intraclass correlation coefficients based on the Hand Eczema Severity Index (HECSI) were >0.90. Kappa values for the criterion validity and inter- and intra-rater reliability using the photographic guide were respectively 0.71, 0.58–0.77, and 0.77. The findings indicate that patient-provided photographs are valid and reliable for remote assessment of HE and could be of benefit in healthcare and research by reducing in-person visits and enabling continuous monitoring.

Key words: hand dermatitis; hand eczema; telemedicine; teler dermatology; reliability and validity; remote assessment.

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Hand eczema (HE) is a common skin disease with a self-reported lifetime and 1-year prevalence of respectively 15% and 9% within the general population (1). However, HE is diagnosed through clinical evaluation, and the diagnostic work-up includes thorough history-taking and examination (2). At the same time,

SIGNIFICANCE

The increasing need to deliver healthcare remotely prompts exploration of the potential benefits of remote assessment of hand eczema. This study found that 85% of patients with hand eczema could be adequately diagnosed using patient-provided photographs, and 79% without hand eczema could be correctly identified as not having the disease. The findings of this study also indicate that patient-provided photographs can be used as a valid and reliable method for severity assessment, using the Hand Eczema Severity Index (HECSI) and the photographic guide. Remote assessment may add value in healthcare and research by reducing in-person visits and enabling continuous monitoring.

there has been a growing need to deliver healthcare remotely (3). Remote assessment can contribute to improved accessibility to healthcare resources, reduced travel burden, cost savings, and enhanced quality of care (4).

Additionally, there is a demand for valid and reliable evaluations of HE in research. However, the prevalence of HE identified by self-reports is in general considered to be underestimated (5–10), along with varying results regarding validity of self-reported severity (11–16). Yet, real-time examination is often not feasible, which prompts the need for alternative methods such as remote assessment.

In dermatology, remote assessment has been demonstrated as a valid and reliable method for evaluating the presence and/or severity of various diseases, such as psoriasis or atopic dermatitis (AD) (17–21). In HE, remote assessment may be particularly applicable, as the hands represent a defined body surface and are relatively simple for patients to photograph. However, studies on the application of remote assessment of HE are limited and have primarily focused on assessments not involving patient-provided photographs (22–26). Therefore, the aim of this study was to assess the criterion validity and inter- and intra-rater reliability of using patient-provided photographs to diagnose and to assess the severity of HE.

MATERIALS AND METHODS

Design, setting, and study population

This validation study was conducted at the dermatology outpatient clinic at the University Medical Center Groningen (UMCG) in The Netherlands. Adult patients with and without HE with a scheduled visit were eligible. To allow for subgroup analyses for different severity categories (almost clear, moderate, and severe to very severe), an overall equal distribution across these categories was ensured. Exclusion criteria were lack of proficiency in Dutch and inability to photograph both the right and the left hand. Other skin diseases (of the hands) did not serve as exclusion criteria. All patients gave written informed consent. The study was approved by the central ethics review board of the UMCG as a non-interventional study (ref 11092).

Clinical assessment

At the outpatient clinic, all patients were assessed by 1 of the 2 clinical raters (MLAS, LL), which is considered the gold standard (**Fig. 1**). Both clinical raters were physicians and highly experienced in the assessment of HE (Table SI). They used a standardized form to assess the presence, clinical subtype, and severity of HE. In accordance with clinical practice, clinical raters could ask for clarification on whether potentially temporary skin lesions were caused by specific activities, such as gardening, and on the duration of these lesions' presence. The clinical subtype was categorized according to the guidelines by Thyssen et al. (2), expanded by 2 categories ("chronic dry fissured HE" and "not classifiable") based

on the guidelines from the Danish Contact Dermatitis Group (27). The severity was based on the Hand Eczema Severity Index (HECSI), a validated instrument taking into account the extent and intensity of clinical signs of HE, ranging from 0–360 points, and the validated photographic guide by Coenraads et al, including 4 groups of photographs representing almost clear, moderate, severe, and very severe HE (28, 29). A standardized instruction guide on how to use the HECSI was provided (Appendix S1). Other characteristics collected were sex, age, and Fitzpatrick skin type (30). All data were entered into the Research Electronic Data Capture tool (REDCap) (31).

Photography of the hands

At the outpatient clinic, participants took 4 photographs of their hands (left/right, dorsal/palmar), following standardized written and visualized instructions (Appendix S2). The instructions had been tested for understandability among patients with HE, and included recommendations from a photographer experienced in clinical photography. As the study sought to replicate a scenario in which patients take photographs remotely, participants were encouraged to capture the photographs independently. However, if they failed to adhere to the written instructions, additional verbal instructions were provided by the study coordinator (MJB). The reasons for this were documented to provide insight into underlying causes of non-compliance with the instructions. All photographs were taken in a well-lit room at the outpatient clinic, by using a smartphone (iPhone 14 Pro Max [48 megapixels]) (32). All photographs were taken in an upright position, without using flashlight or zooming in or out. Photo-

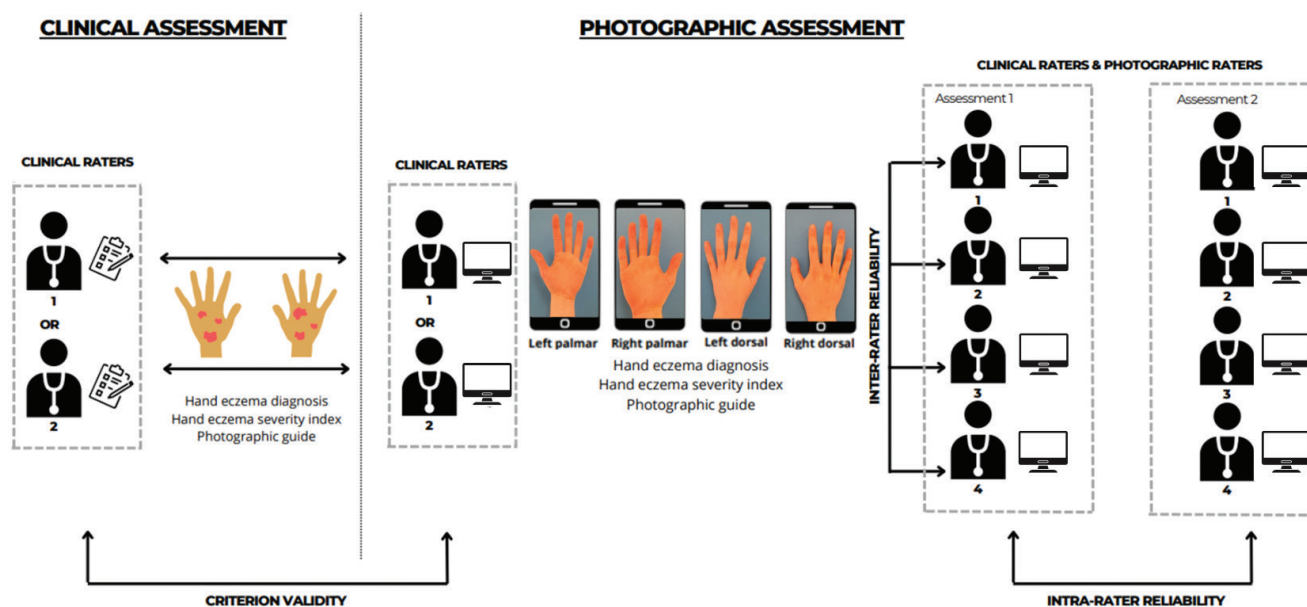


Fig. 1. Overview of the study. Criterion validity for diagnosing hand eczema was based on the first photographic assessment of the identical rater who conducted the clinical assessment. Inter- and intra-rater reliability were based on the photographic assessment of all 4 raters combined. Severity of hand eczema was assessed by using the Hand Eczema Severity Index (HECSI) (28) and the photographic guide by Coenraads et al. (29).

graphs were taken against a blue screen, with a small distance between the hand and the screen to minimize the appearance of shadows. Participants were asked to spread and stretch out the fingers, and make sure that the fingertips and wrists were visible. To minimize the risk of recall bias among raters and to ensure that all parts of the hands were clearly visible, participants were asked to roll up their sleeves and remove jewellery, watches, or other identifiable objects.

Photographic examination

Each set of 4 photographs was assessed twice and independently by the 2 clinical raters, and by 2 additional raters experienced in the assessment of HE (MLAS, LL, EW, KP) (see Table SI). To prevent recall bias, the photographic assessments took place at least 4 weeks after the clinical assessment, and with an interval of at least 4 weeks in between. A standardized form was used to assess the presence of HE and the severity (HECSI and the photographic guide) (28, 29). Prior to the study, a practice session was organized to standardize scoring of the HECSI. The raters received a total of at maximum 25 sets of photographs each time, in a random order.

Sample size calculations

Calculation of the required sample size was performed with power analysis and sample size software (PASS) (33). This calculation was based on the assumed sensitivity and specificity for diagnosing HE using patient-provided photographs, including stratification by severity category based on the photographic guide. In addition, the assumed criterion validity and inter-rater and intra-rater reliability for the severity assessment based on the patient-provided photographs was taken into account (based on intraclass correlation coefficient (ICC) values) (Appendix S3). Based on the assumption of 20% dropout, for example, due poor quality of photographs, a sample size of at least 93 patients would be required, including 24 participants without HE and 69 patients with HE (almost clear: 23; moderate: 23; severe to very severe: 23).

Statistical analysis

Data analyses were performed using the Statistical Products and Service Solutions package version 28 (IBM Corp, Armonk, NY, USA). Criterion validity was assessed by comparing the diagnosis and severity of HE based on patient-provided photographs with the clinical examination (34). This comparison was based on the first round of photographic assessment performed by the identical rater who conducted the clinical assessment. Inter-rater reliability was defined as the degree to which different raters provided consistent assessments based on the photographs (34). Intra-rater reliability was defined as the consistency of a single rater's assessments based on photographs when evaluated on different occasions (34). Both inter- and intra-rater reliability were based on the photographic assessment of all 4 raters combined. Intra-rater reliability was additionally assessed for each photographic rater separately.

An overview of the statistical procedures conducted is shown in Table I. In the present study, an ICC value of <0.50 indicates poor, 0.50–0.75 moderate, 0.75–0.90 good, and ≥0.90 excellent agreement (35). Kappa values <0.2 indicate slight, 0.2–0.4 fair, 0.4–0.6 moderate, 0.6–0.8 substantial, and ≥0.8 almost perfect agreement (36).

RESULTS

Study population

In total, 99 patients were eligible for inclusion. Due to an incomplete set of photographs, 1 patient was excluded, leaving a total study population of $n=98$ (Table II). The mean age of the included patients was 44.0 ± 17.4 years. More than half were male (55.1%) and most patients had skin type I–III (92.9%). A total of 74 patients (75.5%) were diagnosed with HE, with a mean HECSI score of 46.8 ± 46.0 . The majority had chronic dry fissured HE (68.9%). During the photography, most patients received additional instructions regarding required distance between the blue screen and the hands (46.9%).

Table I. Overview of statistical tests used to assess the criterion validity and inter- and intra-rater reliability for diagnosing hand eczema and assessing the severity based on patient-provided photographs

		Severity of hand eczema	
Item	Diagnosis of hand eczema	Hand Eczema Severity Index ^a	Photographic guide ^b
Criterion validity	Sensitivity (%)	Intra-class correlation coefficient (ICC) (two-way random; absolute agreement; average measures)	Weighted kappa Cross-table
	Specificity (%)		
	Positive predictive value (%)		
	Negative predictive value (%)		
Inter-rater reliability	Percentage of agreement (%)	Intra-class correlation coefficient (ICC) (two-way random; absolute agreement; average measures)	Percentage of agreement (%) Weighted kappa Intra-class correlation coefficient (ICC) (two-way random; absolute agreement; average measures)
	Fleiss's kappa		
Intra-rater reliability	Percentage of agreement (%)	Intra-class correlation coefficient (ICC) (two-way mixed; absolute agreement; average measures)	Percentage of agreement (%) Weighted kappa Intra-class correlation coefficient (ICC) (two-way mixed; absolute agreement; average measures)
	Cohen's kappa		

^aSeverity assessment was based on the Hand Eczema Severity Index (HECSI) by Held et al. (28). ^bSeverity assessment was based on the photographic guide by Coenraads et al. (29).

Table II. Baseline characteristics of total study population, stratified for patients with hand eczema and without hand eczema

Factor	Total study population (n = 98) n (%)	Hand eczema (n = 74) n (%)	No hand eczema (n = 24) n (%)	p-value
Age, years (mean ± SD)	44.0 ± 17.4	43.7 ± 17.1	44.9 ± 18.3	0.95
Age groups				
18–25 years	15 (15.3)	12 (16.2)	3 (12.5)	1.00
25–35 years	24 (24.5)	17 (23.0)	7 (29.2)	0.54
35–45 years	12 (12.2)	10 (13.5)	2 (8.3)	0.73
45–55 years	11 (11.2)	7 (9.5)	4 (16.7)	0.46
55–65 years	23 (23.5)	19 (25.7)	4 (16.7)	0.42
> 65 years	13 (13.3)	9 (12.2)	4 (16.7)	0.73
Sex				
Males	54 (55.1)	40 (54.1)	14 (58.3)	0.71
Females	44 (44.9)	34 (45.9)	10 (41.7)	
Skin type ^a				
Type I–III	91 (92.9)	69 (93.2)	22 (91.7)	1.00
Type IV–VI	7 (7.1)	5 (6.8)	2 (8.3)	
Diagnosis of hand eczema	74 (75.5)	74 (100.0)	–	–
Clinical subtype of hand eczema ^b				
Hyperkeratotic hand eczema	7 (7.1)	7 (9.5)	–	–
Acute recurrent vesicular hand eczema	13 (13.3)	13 (17.6)	–	–
Pulpitis	3 (3.1)	3 (4.1)	–	–
Nummular hand eczema	0 (0.0)	0 (0.0)	–	–
Chronic dry fissured hand eczema ^c	51 (52.0)	51 (68.9)	–	–
Not classifiable	0 (0.0)	0 (0.0)	–	–
Severity of hand eczema (HECSI), mean ± SD ^{d,e}	46.8 ± 46.0	46.8 ± 46.0	–	–
Severity of hand eczema (photographic guide) ^f				
Almost clear	25 (25.5)	25 (33.8)	–	–
Moderate	25 (25.5)	25 (33.8)	–	–
Severe to very severe	24 (24.5)	24 (32.4)	–	–
Additional instructions				
Removal of jewellery	11 (11.2)	7 (9.5)	4 (16.7)	–
Rolling up sleeves	8 (8.2)	4 (5.4)	4 (16.7)	–
Hands not completely in front of blue screen	11 (11.2)	8 (10.8)	3 (12.5)	–
Not enough distance between blue screen and hand	46 (46.9)	30 (40.5)	16 (66.7)	–
Fingers not spread	7 (7.1)	6 (8.1)	1 (4.2)	–
Fingers not stretched out	6 (6.0)	5 (6.8)	1 (4.2)	–
Smartphone not held in upright position	3 (3.1)	3 (4.1)	0 (0.0)	–
Hands not square to camera	20 (20.4)	17 (23.0)	3 (12.5)	–
Fingers not visible	31 (31.6)	24 (32.4)	7 (29.2)	–
Wrists not visible	38 (38.8)	30 (40.5)	8 (33.3)	–
Incorrect number of pictures	8 (8.2)	5 (6.8)	3 (12.5)	–
Too much distance between camera and hands	1 (1.0)	1 (1.4)	0 (0.0)	–
Made pictures from lateral/medial side hands	2 (2.0)	2 (2.7)	0 (0.0)	–
Needed assistance	12 (12.2)	8 (10.8)	4 (16.7)	–

^aSkin type was based on published work by Fitzpatrick et al. (30). ^bClassification of clinical subtype was based on published work by Thyssen et al. and Johansen et al. (2,27). ^cChronic dry fissured hand eczema refers to the clinical subtype of hand eczema as described by Johansen et al. (27), rather than the duration of hand eczema. ^dSeverity assessment was based on the Hand Eczema Severity Index (HECSI) by Held et al. (28). ^eOnly among patients with hand eczema. ^fSeverity assessment was based on the photographic guide by Coenraads et al. (29).
n: number; SD: standard deviation.

Table III. Criterion validity and inter- and intra-rater reliability for diagnosing hand eczema based on patient-provided photographs

	Criterion validity ^a				Inter-rater reliability ^b		Intra-rater reliability ^b	
	Sensitivity, % (95% CI)	Specificity, % (95% CI)	Positive predictive value, % (95% CI)	Negative predictive value, % (95% CI)	Agreement, % (95%CI)	Fleiss's kappa ^c (0.27–0.43)	Agreement, % (95%CI)	Cohen's kappa ^c (0.57–0.76)
Total	85.1 (77.0–93.2)	79.2 (63.0–95.4)	92.6 (86.4–98.8)	63.3 (46.1–80.6)	63.3 (53.8–72.8)	0.35 (0.27–0.43)	88.8 (85.6–91.8)	0.66 (0.57–0.76)
Severity of hand eczema (photographic guide) ^d								
Almost clear	56.0 (36.5–75.5)	–	–	–	44.0 (24.5–63.5)	0.21 (0.05–0.37)	82.0 (74.5–89.5)	0.54 (0.36–0.73)
Moderate	100.0 (86.0–100.0)	–	–	–	100.0 (86.0–100.0)	–	98.0 (95.3–100.0)	–
Severe to very severe	100.0 (86.0–100.0)	–	–	–	100.0 (86.0–100.0)	–	97.9 (95.0–100.0)	–

^aCriterion validity is based on the first photographic assessment conducted by the identical rater who conducted the clinical assessment. ^bInter- and intra-rater reliability are based on the photographic assessments of all raters combined. ^cFor the categories of moderate and severe to very severe hand eczema, there was no variability in the ratings for these categories. Fleiss's and Cohen's kappa could therefore not be calculated. ^dSeverity assessment was based on the photographic guide by Coenraads et al. (29).
CI: confidence interval.

Diagnosis of hand eczema

Criterion validity. The sensitivity, specificity, positive and negative predictive value of diagnosing HE based on photographs were respectively 85.1%, 79.2%, 92.6%, and 63.3% (**Table III**). All patients who were incorrectly classified as not having HE actually had almost clear HE, according to the clinical assessment. When focussing on patients with almost clear HE, a sensitivity of 56.0% was found. The sensitivity for moderate and severe-to-very severe HE was 100%.

Inter- and intra-rater reliability. Fair agreement among all photographic raters was found regarding the diagnosis of HE based on photographs. In addition, fair agreement was found when focusing only on patients with almost clear HE. For cases with moderate and severe to very severe HE, agreement was 100.0%. Substantial intra-rater agreement was found. When looking at patients with almost clear HE, moderate intra-rater agreement was found. The intra-rater agreement was 98.0% and 97.9% among patients with moderate and severe-to-very severe HE separately. The intra-rater reliability by all 4 photographic raters separately ranged from 84.7–90.8% (**Table SII**).

Severity of hand eczema (HECSI)

Criterion validity. For criterion validity, the use of the HECSI to assess the severity of HE based on patient-provided photographs demonstrated excellent agreement (**Table IV**). The analyses including patients with almost clear and moderate HE separately showed respectively good and moderate agreement. Good agreement was found among patients with severe to very severe HE only. The correlation between the clinical and photographic

assessment is presented in **Fig. 2A**, and visualized with a Bland–Altman plot in **Fig. 2B**.

Inter- and intra-rater reliability. Photographic severity based on the HECSI showed excellent inter- and intra-rater reliability. For the different categories of HE severity the ICC value representing inter-rater reliability ranged from 0.65–0.86, and from 0.79–0.92 for intra-rater reliability. The intra-rater reliability by all 4 photographic raters separately ranged from 0.91–0.97 (**Table SIII**).

Severity of hand eczema (photographic guide)

Criterion validity. Substantial agreement was found for the severity assessment using the photographic guide (see **Table IV**). Of the patients with almost clear HE, according to the clinical assessment, 64.3% were correctly classified as having almost clear HE based on the photographic assessment (**Table SIV**). From the patients with moderate HE, 68.0% were also classified as having moderate HE based on the photographs. Of the patients with severe to very severe HE, a total of 91.7% were classified as having severe to very severe HE based on the photographs.

Inter- and intra-rater reliability. Among all 4 photographic raters agreement was found in 47.5%, with excellent inter-rater reliability. Near perfect agreement, in which at least 3 photographic raters agreed with each other, was found in 81.7%. Weighted kappa values of 0.58–0.77 were found. The agreement between the first and second round of photographic assessments was substantial/excellent. The percentage of intra-rater agreement for all 4 photographic raters separately ranged from

Table IV. Criterion validity and inter- and intra-rater reliability for severity assessment of hand eczema based on patient-provided photographs using the Hand Eczema Severity Index^a and the photographic guide^b

	Hand Eczema Severity Index (HECSI) ^a						
	Criterion validity ^c ICC (95%CI)	Inter-rater reliability ^d			Intra-rater reliability ^d		
		SEM	ICC (95%CI)		SEM	ICC (95% CI)	
Total	0.92 (0.81–0.96)	10.0	0.93 (0.88–0.96)		7.3	0.96 (0.95–0.97)	
Stratified by photographic guide severity categories ^b							
Almost clear	0.75 (0.27–0.92)	4.9	0.65 (0.22–0.89)		4.6	0.79 (0.66–0.87)	
Moderate	0.69 (0.13–0.88)	7.0	0.81 (0.63–0.91)		5.7	0.86 (0.79–0.91)	
Severe to very severe	0.86 (0.60–0.94)	15.9	0.86 (0.68–0.94)		11.8	0.92 (0.88–0.95)	
Clinical signs HECSI							
Erythema	0.87 (0.77–0.93)	0.9	0.88 (0.80–0.93)		0.9	0.90 (0.88–0.92)	
Papulation/induration	0.79 (0.38–0.90)	1.0	0.85 (0.76–0.90)		1.0	0.85 (0.82–0.88)	
Vesicles	0.80 (0.68–0.88)	0.7	0.88 (0.82–0.93)		0.6	0.88 (0.84–0.90)	
Fissures	0.82 (0.70–0.89)	0.7	0.82 (0.72–0.89)		0.6	0.88 (0.85–0.91)	
Scaling	0.86 (0.75–0.92)	1.1	0.79 (0.56–0.89)		0.7	0.91 (0.89–0.93)	
Oedema	0.78 (0.63–0.87)	0.9	0.82 (0.71–0.89)		0.6	0.91 (0.88–0.93)	
Photographic guide ^b							
	Criterion validity ^c Weighted kappa (95% CI)	Inter-rater reliability ^d Agreement, % (95% CI)			Intra-rater reliability ^d Agreement, % (95% CI)		ICC (95% CI)
Total	0.71 (0.58–0.84)	47.5 (35.0–60.0)	0.58–0.77	0.91 (0.87–0.94)	80.5 (75.9–85.1)	0.77 (0.72–0.83)	0.92(0.89–0.93)

^aSeverity assessment was based on the Hand Eczema Severity Index (HECSI) by Held et al. (28). ^bSeverity assessment was based on the photographic guide by Coenraads et al. (29). ^cCriterion validity is based on the first photographic assessment conducted by the identical rater who conducted the clinical assessment. ^dInter- and intra-rater reliability is based on the photographic assessments of all raters combined. Weighted kappa values for inter-rater reliability represent the range of agreement scores from the 4 separate pairwise comparisons between raters. CI: confidence interval; ICC: intra-class correlation coefficient; SEM: standard error of measurement.

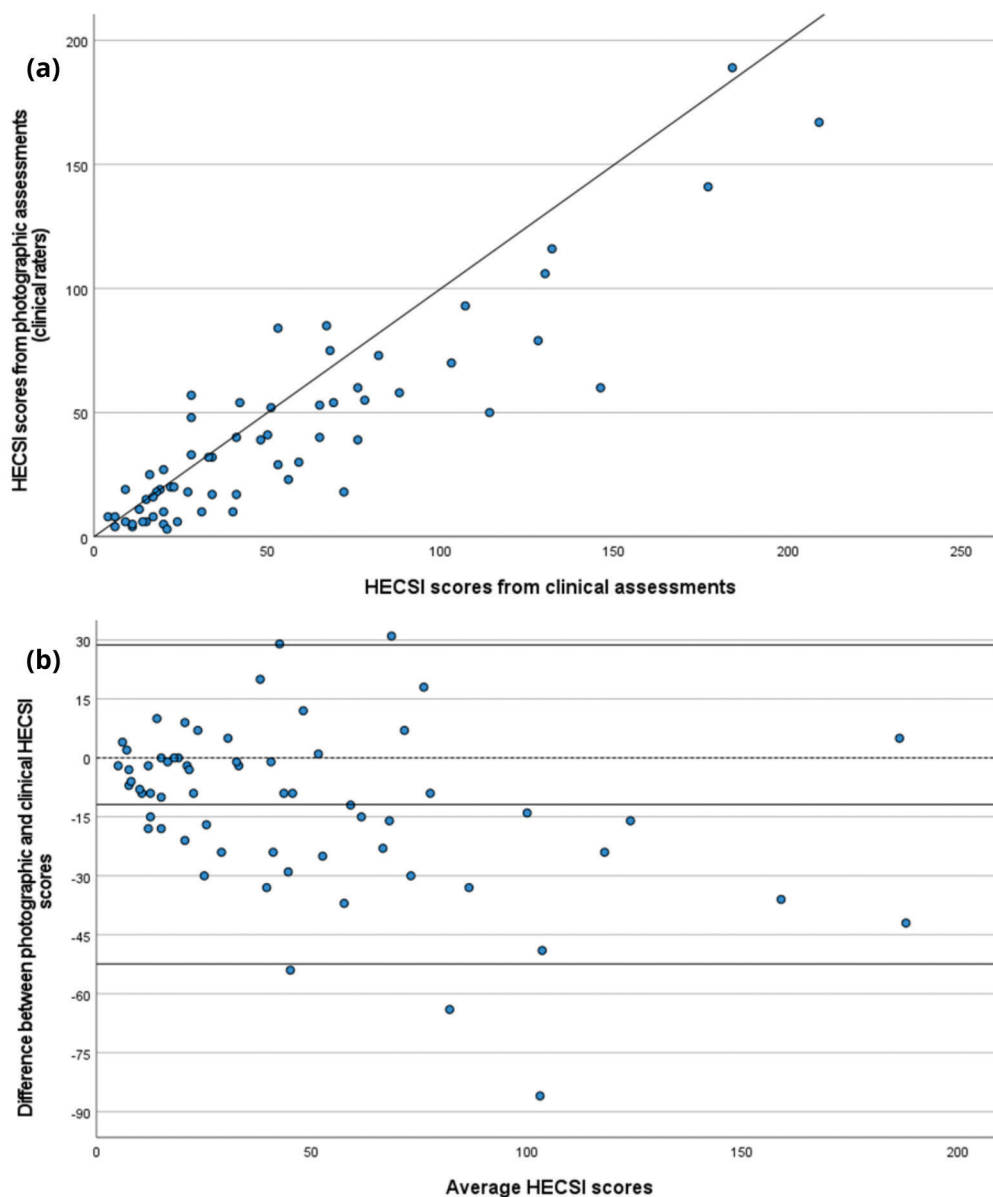


Fig. 2. Criterion validity of patient-provided photographs for assessing hand eczema severity using the Hand Eczema Severity Index (HECSI) (28). (A) Correlation between clinical and first photographic severity assessment of hand eczema; (B) Bland-Altman plot showing relationship between the differences between clinical and first photographic assessment of hand eczema severity.

69.6–87.1%, with weighted kappa values of 0.64–0.85 (Table SV).

DISCUSSION

This study evaluated the validity and reliability of diagnosing and assessing the severity of HE based on patient-provided photographs. The findings demonstrated good sensitivity and specificity, and indicate that patient-provided photographs could be a valid and reliable tool for severity assessment using the HECSI and photographic guide.

A few studies have assessed the validity or reliability of remote assessment of HE (22–26); however, they are

not directly comparable to the present study, as they did not use patient-provided photographs (22, 23, 25, 26), only included specific populations (e.g., healthcare workers) (22, 23, 25, 26), were limited by small sample sizes (23, 26), did not include or only included a limited number of more severely affected patients (22, 23, 26) or used different instruments (e.g., the Hand Dermatitis Screening Tool [HDST]) (22, 23). Furthermore, substantial variations in study protocols exist (e.g., comparison of the assessments from different raters (22, 24), or focus on worsening vs improvement (26)). Only 2 studies focused on diagnosing HE based on photographs (not patient-provided), using a severity scale as diagnostic tool (the HDST and the photographic guide by Coen-

raads et al., respectively). In the first study, agreement was obtained regarding diagnosis of HE in about 60% of the participants, with an occupational health nurse conducting in-person assessments and a dermatologist diagnosing based on photographs (22). In the second study, moderate inter-rater agreement was found for the diagnosis of HE, based on photographic assessments conducted by 2 dermatologists (kappa 0.5) (25). Studies on remote assessment using the HECSI showed mixed findings: 1 study reported moderate intra-rater reliability based on photographs from a database containing images of the hands of metal workers ($\rho=0.572$) (23), while a second study (using patient-provided photographs), found strong validity ($r=0.898$) (24). A third study found that the HECSI may lack intra-rater reliability in detecting subtle skin changes, based on photographs taken by study personnel (26). For the HDST, limited validity was found for severity assessed by a dermatologist using photographs taken by study personnel, compared with clinical assessment by an occupational health nurse (kappa 0.20) (22).

The present study demonstrated a sensitivity of 85.1% and a specificity of 79.2% for diagnosing HE remotely. Notably, all patients with moderate and severe to very severe HE were accurately classified as having HE. Compared with studies using self-reports, which show high variability in sensitivity (7–87%) and specificity (79–100%) (likely due to differences in study populations, e.g., high-risk occupations vs the general population, and different screening tools), the present findings suggest that remote assessment could offer a valuable alternative, particularly because of its high sensitivity (5–10). Although the specificity is somewhat lower, it remains acceptable given that false-positive cases can often be corrected through follow-up assessments, and the specificity remains within the range observed in self-report based methods. In future research, it would be interesting to assess whether the psychometric properties, especially specificity, could be further improved combined with self-reported symptom-based data, such as itching or pain, particularly for individuals with minimal signs that could indicate HE (10, 37).

Additionally, the present study suggests that the severity of HE can be validly and reliably assessed remotely, especially in moderate and severe-to-very severe HE. In line with the present study, 2 studies by Ragamin et al. (2023) and Ali et al. (2022), which assessed the psychometric properties of patient-provided photographs for AD severity, found that severity could be validly and reliably assessed remotely (17, 21). However, in the studies of Ragamin et al. and Ali et al., patients were asked to provide respectively full-body photographs and photographs of lesions selected by a clinical assessor, which may lead to lower validity and reliability when patients must independently decide which lesions to photograph. In contrast, for HE, patients do not need to differentiate

between healthy and unhealthy skin, and are less affected by challenges related to hard-to-reach body areas.

In the first place, remote assessment of HE may add value in healthcare. While remote assessment may not be ideal for diagnosing HE in this setting, due to the risk of misidentifying other skin diseases, remote assessment may still be useful for monitoring its fluctuating course. Specifically, in occupational healthcare, remote assessment may support screening programmes, where misclassification is manageable through follow-up.

Second, remote assessment of HE allows for frequent data collection in research, and can serve as an alternative when real-time examination is not feasible. Nevertheless, it should be considered that assessment of large amounts of photographs could be time-consuming. In the future, artificial intelligence (AI) may therefore offer promising alternatives, providing even more reliable estimates of clinical signs (e.g., intensity of erythema) (38, 39).

Strengths and limitations

The major strengths are that the present study assessed criterion validity, alongside inter- and intra-rater reliability of patient-provided photographs, across both diagnosis and severity by using the HECSI and the photographic guide (28, 29). Furthermore, inclusion of an adequate number of patients across different severity categories allowed for sub-analyses. Moreover, raters with varying levels of clinical experience, from 3 different clinical sites in The Netherlands and in Germany, participated. However, some limitations should be taken into account. First, inclusion of patients took place in a tertiary referral centre, which could limit the generalizability of our findings, as this population might be more motivated to ensure high-quality photographs, recognizing potential benefits. Although raters were not strictly randomly selected, they were representative of clinicians assessing HE, supporting the use of the two-way random-effects model while acknowledging some limitation in generalizability. Furthermore, the assessment of the raters may have been influenced by the study's focus on HE, which could have biased them either towards more readily assigning this diagnosis or, conversely, towards being more critical to avoid overdiagnosis. However, the raters did not receive any feedback on their individual assessments during the study, which may have reduced the risk of systematic bias. In addition, the positive and negative predictive values should be interpreted cautiously, as they depend on disease prevalence, which varies widely across populations and could not be precisely accounted for in our purposive sampling approach. Additionally, limited variability in the data regarding skin type and clinical subtype of HE did not allow for subgroup analyses. Moreover, photographs were taken in a standardized, supervised setting, which may not fully reflect real-world conditions, and

the majority of patients needed additional instructions. As most corrections were only minor (e.g., invisibility of a small part of a fingertip), this does not necessarily indicate that the photographs would have been of poor quality otherwise. Nevertheless, health professionals and researchers should be mindful of digital and health literacy challenges, which could not only contribute to difficulties in completing (digital) questionnaires, but also to challenges in taking photographs, and might consider interactive approaches such as instruction videos or real-time digital feedback (40).

Conclusion

The findings of this study indicate that patient-provided photographs are a valid and reliable method to assess the diagnosis and severity of HE. Remote assessment may be of added value in healthcare and research, potentially reducing the need for in-person visits and enabling continuous monitoring. Future research should examine the validity and reliability in different settings, evaluate whether adherence of the instructions on how to take photographs could be improved through interactive approaches, and explore the potential role of AI.

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