




A comparative study on the measurement properties of Dermatology Life Quality Index (DLQI), DLQI-Relevant and Skindex-16*

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Summary

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Conflicts of interest

The authors declare they have no conflicts of interest.

Data availability

Data available on request from the authors.

*Plain language summary available online

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Background Dermatology Life Quality Index (DLQI) and Skindex-16 are among the most commonly used dermatology-specific health-related quality-of-life (HRQoL) instruments. DLQI has two common scoring methods, the original and the DLQI-Relevant (DLQI-R) modification. Head-to-head comparisons of the measurement properties of the DLQI, DLQI-R and Skindex-16 are currently lacking. **Objectives** We aim to compare the measurement properties of the DLQI, DLQI-R and Skindex-16.

Methods We analysed data from 618 patients with self-reported physician-diagnosed dermatological conditions from a cross-sectional survey carried out in Hungary in early 2020. DLQI, DLQI-R and Skindex-16 were compared in terms of ceiling and floor effects, informativity, convergent validity and known-group validity.

Results Mean DLQI, DLQI-R and Skindex-16 total scores were 3.76 ± 5.03 , 4.11 ± 5.34 and 29.36 ± 26.62 , respectively. Among patients with a DLQI/DLQI-R total score of zero, 64% reported problems on Skindex-16. Overall, 23–38% of patients with ‘not relevant’ responses on DLQI items 3 (shopping/home/gardening), 7 (working/studying), 8 (interpersonal problems) and 9 (sexual difficulties) reported problems on their corresponding Skindex-16 items. Average relative informativity (Shannon’s evenness index) was the highest for Skindex-16 (0.85), followed by DLQI-R (0.66) and DLQI (0.54). DLQI, DLQI-R and Skindex-16 demonstrated similar convergent validity. DLQI was able to better discriminate between known groups of patients based on overall skin-related HRQoL impairment, whereas DLQI-R and Skindex-16 performed better with respect to self-perceived health status.

Conclusions Skindex-16 seems to be more sensitive than DLQI/DLQI-R in capturing mild impairment in HRQoL. Our findings help to provide a fuller understanding of the difference between DLQI, DLQI-R and Skindex-16 and support the informed choice of instrument for clinical and research purposes.

What is already known about this topic?

- Dermatology Life Quality Index (DLQI) and Skindex-16 are among the most commonly used dermatology-specific instruments to measure health-related quality of life (HRQoL). DLQI has an alternative scoring, DLQI-Relevant (DLQI-R), developed in 2018.
- So far, no studies have provided a comprehensive head-to-head comparison of the measurement properties of the DLQI, DLQI-R and Skindex-16.

What does this study add?

- We systematically compared the measurement performance of DLQI, DLQI-R and Skindex-16 items and overall scales.
- Skindex-16 showed lower floor effect, better informativity, and similar convergent and known-group validity to the DLQI and DLQI-R.
- Nearly two-thirds of patients with a DLQI/DLQI-R total score of zero reported problems on Skindex-16. Many patients with 'not relevant' responses on DLQI items 3 (shopping/home/gardening), 7 (working/studying), 8 (interpersonal relations) and 9 (sexual difficulties) reported problems on their corresponding Skindex-16 items.

What are the clinical implications of this work?

- In patients with mild symptoms, DLQI and DLQI-R might not be able to capture small impairments in HRQoL, and thus, the Skindex-16 seems more suitable in this population.
- Our findings help to provide a fuller understanding of the difference between existing dermatology-specific HRQoL measures and support the informed choice of instrument for clinical practice, research, treatment and financial guidelines.

Dermatological conditions often have a substantial negative effect on patients' health-related quality of life (HRQoL). HRQoL is considered an important outcome that incorporates the patients' perceptions of their skin condition and health-related wellbeing. The assessment of HRQoL in clinical practice is recommended by several clinical guidelines.^{1–6} In most clinical trials, HRQoL data are used as secondary endpoints to complement the interpretation of primary endpoints.⁷ In dermatology, generic, dermatology-specific or condition-specific instruments may be used alone or in conjunction with one another to assess the patients' HRQoL.⁸ Dermatology-specific instruments are frequently used to measure HRQoL as they are suitable for administration in many dermatological conditions or symptoms and they can ensure the comparability of scores across different dermatological patient populations.

Over the past 30 years, multiple dermatology-specific HRQoL measures have been developed, including the Dermatology Life Quality Index (DLQI), the Skindex questionnaire family (e.g. Skindex-29, Skindex-17, Skindex-16, Skindex-mini), and Dermatology Quality of Life Scales.^{9–12} Currently, the DLQI and the Skindex questionnaires are the most frequently used dermatology-specific HRQoL measures among adult patients.^{13–15} In terms of length, Skindex-16 is the most comparable to the DLQI.¹⁶ Both the DLQI and Skindex-16 are relatively short, easy to administer and cover similar areas of HRQoL, such as itching, painful and burning skin, daily activities, work and interpersonal relationships, among others. However, the DLQI mainly focuses on functional impairments as a result of the dermatological condition, and has been reported to fail in addressing the emotional and mental impact of the disease.¹³ In contrast, items of the Skindex instruments, including Skindex-16, are better at capturing the emotional and mental problems related to dermatological conditions.^{17,18}

Few studies have provided empirical evidence on measurement performance of the DLQI vs. Skindex-16. In patients with hand-foot syndrome, vitiligo, hidradenitis suppurativa and melasma, Skindex-16 exhibited slightly better convergent validity with condition-specific HRQoL questionnaires and slightly worse convergent validity with generic HRQoL questionnaires than the DLQI.^{19–24} Furthermore, many recent studies have confirmed that the scoring modification DLQI-Relevant (DLQI-R) improves the validity of the DLQI.^{20,25–29} DLQI-R is calculated by multiplying the DLQI total score by an adjustment factor that increases with the number of 'not relevant' responses (NRRs).²⁷ A comprehensive head-to-head comparative analysis of the measurement properties of DLQI, DLQI-R and Skindex-16 has not yet been performed. Therefore, this study aims to compare the performance of DLQI, DLQI-R and Skindex-16 with regard to the following measurement properties: ceiling and floor effects, informativity, convergent validity, and validity between known groups.

Patients and methods**Study population**

We followed the STROBE checklist for observational studies.³⁰ Permission for conducting the study was granted by the Research Ethics Committee of the Medical Research Council in Hungary (reference No. 3857-4/2019/EKU). In February 2020, an online cross-sectional questionnaire survey was carried out among the Hungarian general adult population. The general purpose of the survey was to assess HRQoL and wellbeing among members of the general population and in a subgroup of the population with dermatological conditions. The survey population was recruited from members of an

online panel by a survey company. Inclusion criteria for the study were being aged ≥ 18 years and providing informed consent. Nonprobabilistic quota sampling was used, aiming for representativeness in terms of sex, age, level of education, type of settlement and region. Further details of data collection are available elsewhere.³¹ Of the 2001 respondents who successfully completed the questionnaire, 618 individuals self-reported a dermatological condition diagnosed by a physician, and thus, formed the analytical sample for this study.

Survey instrument

A two-step approach was applied in which respondents were asked about the presence of any dermatological conditions. Respondents were first asked whether they had any of the following conditions at the time of the survey: acne, basal cell carcinoma, eczema, herpes zoster, onychomycosis, psoriasis, rosacea, tinea pedis, urticaria and warts. There was an open-ended textbox that gave that gave the respondents an opportunity to specify any other skin condition(s) they had experienced. Then, those respondents who self-reported any dermatological condition were asked to identify the conditions that had been diagnosed by a physician. Respondents were further asked about their self-perceived health status (very poor, poor, fair, good and very good) and sociodemographic status. Additionally, patients completed several health, HRQoL and wellbeing outcome measures.

Outcome measures

Dermatology Life Quality Index (DLQI), DLQI-R and Skindex-16

The DLQI, DLQI-R and Skindex-16 are compared in terms of their content, recall period, scoring and interpretation in Table 1.^{11,16,27}

Global question

Respondents also answered a global question (GQ), 'How much does your dermatological condition affect your life?' on a 5-point scale (no effect, small effect, moderate effect, very large effect and extremely large effect on life).³²

World Health Organization-5 Well-Being Index

The World Health Organization-5 Well-Being Index (WHO-5) is a commonly used questionnaire that measures psychological wellbeing.^{33,34} This questionnaire has five items, each referring to the past 2 weeks. Each item has six response options (at no time = 0; some of the time = 1; less than half the time = 2; more than half the time = 3; most of the time = 4; all of the time = 5). The raw score is calculated by totalling the responses given to the five items. The raw score ranges from 0 to 25, 0 representing the worst possible wellbeing and 25 representing the best possible wellbeing. To obtain a

percentage score ranging from 0 to 100, the raw score is multiplied by four.

Patient global assessment visual analogue scale

We used a horizontal patient global assessment visual analogue scale (PG-VAS) with two endpoints of 'the worst imaginable health state' (0) and 'the best imaginable health state' (100) to measure general health status.

Statistical analyses

All analyses were first performed on the total sample, and then, for the following three subsets: (i) patients with chronic inflammatory skin diseases (acne, eczema, psoriasis, rosacea), (ii) patients with infections (herpes zoster, warts, onychomycosis, tinea pedis) and (iii) patients with other skin conditions.

Ceiling and floor effects

Ceiling and floor effects of questionnaire items or total scores were examined by determining the proportion of patients who achieved the worst and best scores on each DLQI, DLQI-R or Skindex-16, respectively.³⁵ To compare the ceiling and floor effects, nine corresponding items of DLQI, DLQI-R and Skindex-16 were matched. We further explored the distribution of responses classified into the best possible total score on one measure across the items of the other measure. High ceiling or floor effects may mean that patients at the most severe or mildest ends of the scale cannot be distinguished from one another.

Informativity

Informativity measures the amount of information that can be captured by a questionnaire item or a scale. It has two forms, absolute and relative informativity. Absolute informativity increases with the number of response options; therefore, it can be expected that Skindex-16 items have higher absolute informativity than DLQI or DLQI-R. Conversely, relative informativity will increase only if the additional response categories are actually used. The optimal amount of information can be achieved if all levels of the item are equally used (i.e. even distribution). The higher the relative informativity, the better the discriminatory power of an item. Good informativity is necessary to ensure the sensitivity of the scale over the full range of potential health states. In our study, Shannon's indices were used to assess item-level informativity of the DLQI, DLQI-R and the Skindex-16.³⁶ Examples for computing Shannon's indices are described elsewhere.²⁸

Convergent validity

Convergent validity shows the extent to which scores on a particular instrument relate to other scales that are intended to

Table 1 Characteristics of DLQI, DLQI-R and Skindex-16

	DLQI ¹¹	DLQI-R ^{27,a}	Skindex-16 ¹⁶
Recall period	Last week		Last week
Number of items	10		16
Items	Item 1 (itchy, sore, painful, stinging)		Symptoms subscale Item 1 (itching)
	Item 2 (embarrassed, self-conscious)		Item 2 (burning or stinging)
	Item 3 (shopping, home, garden)		Item 3 (hurting)
	Item 4 (clothing)		Item 4 (skin irritation)
	Item 5 (social, leisure)		
	Item 6 (sport)		Emotions subscale
	Item 7 (working, studying)		Item 5 (persistence/reoccurrence)
	Item 8 (interpersonal problems)		Item 6 (worry)
	Item 9 (sexual difficulties)		Item 7 (appearance)
	Item 10 (treatment difficulties)		Item 8 (frustration)
		Item 9 (embarrassment)	
		Item 10 (being annoyed)	
		Item 11 (feeling depressed)	
		Functioning subscale	
		Item 12 (interactions with others)	
		Item 13 (desire to be with people)	
		Item 14 (show affection)	
		Item 15 (daily activities)	
		Item 16 (work or do what you enjoy)	
Type of response scale	Severity (items 1–2), interference with functioning (items 3–10)		Frequency
Number of response options per item	4 (items 1–2) or 5 (items 3–10)		6 (all items)
Response options	Not relevant = 0 (items 3–10) Not at all = 0 (all items) A little = 1 (all items) A lot = 2 (all items) Very much = 3 (all items)		7-point bipolar scale with endpoints 'never bothered' and 'always bothered' (scored 0–6)
Scoring	$DLQI = \sum_{i=1}^{10} item_i$	$DLQI-R = DLQI \times \frac{10}{10-NRR}$	$Symptoms = \sum_{i=1}^4 item_i \times \frac{100}{6}$ $Emotions = \sum_{i=5}^7 item_i \times \frac{100}{6}$ $Functioning = \sum_{i=12}^5 item_i \times \frac{100}{6}$ $Total\ score = \frac{Symptoms + Emotions + Functioning}{3}$
Score range	0–30		0–100
Interpretation	Higher score indicates worse HRQoL		Higher score indicates worse HRQoL

DLQI, Dermatology Life Quality Index; DLQI-R, DLQI-Relevant; HRQoL, health-related quality of life; item_i, the score on the *i*th item of the questionnaire; NRR, number of 'not relevant' responses. ^aBoth DLQI and DLQI-R are based on the same DLQI questionnaire.

measure the same or similar construct.³⁵ The convergent validity of the DLQI, DLQI-R and Skindex-16 was assessed using Spearman's correlations and the convergent validity of the three instruments with the WHO-5 and PG-VAS was also assessed. The correlation coefficient (r_s) was interpreted as follows: very weak (< 0.20), weak (0.20–0.39), moderate (0.40–0.59), strong (0.60–0.79) and very strong (0.80–1).³⁷ We hypothesized that there would be at least a strong correlation between DLQI, DLQI-R and Skindex-16 and a moderate correlation of these measures with WHO-5 and PG-VAS.^{20,38,39}

Validity between known groups

We applied one-way analysis of variance (ANOVA) to compare DLQI, DLQI-R and Skindex-16 total and subscale scores across known groups of patients. We hypothesized that worse GQ rating and self-perceived health status are associated with worse HRQoL outcomes.^{20,21,40–42} Relative efficiency (RE) was computed as the ratio F-statistics in the ANOVA of the difference in HRQoL scores across the groups.⁴³ The reference value (denominator) was the F-statistic of the DLQI. If the value of RE was greater than 1, it indicated that the DLQI-R

or Skindex-16 was better at discriminating between known groups than the DLQI. All statistical analyses were performed using SPSS Statistics version 25 (IBM, Armonk, NY, USA). A P -value < 0.05 was considered statistically significant.

Results

Characteristics of the study population

The mean age was 50.5 ± 16.9 years (minimum 18 years, maximum 86 years). More than half of the patients in the sample were female ($n = 358$, 57.9%) (Table 2). Patients self-reported a total of 49 different dermatological conditions, the most common of which were warts ($n = 143$, 23.1%), eczema ($n = 140$, 22.7%), onychomycosis ($n = 113$, 18.3%), acne ($n = 83$, 13.4%) and psoriasis ($n = 82$, 13.2%). Moreover, in the open-ended text box, a further 39 different skin conditions were indicated ($n = 102$, 16.5%). The mean health status PG-VAS and WHO-5 wellbeing scores were 66.5 ± 23.4 and 41.4 ± 16.6 , respectively.

Descriptive results

The mean DLQI and DLQI-R scores were 3.76 ± 5.03 and 4.11 ± 5.34 , respectively. Of the 618 patients, 230 (37.2%) marked at least one NRR, with the highest number of NRRs occurring in patients with rosacea (54.8%) and basal cell carcinoma (51.6%), whereas the fewest number of NRRs were reported in patients with eczema (32.1%) and psoriasis (34.2%) (Table 2). The mean Skindex-16 subscale (functioning, emotions, symptoms) scores were 22.2 ± 28.3 , 35.9 ± 30.4 and 30.0 ± 28.6 , respectively. The mean Skindex-16 total score was 29.4 ± 26.6 .

Ceiling and floor effects

Ceiling effect was 0% for both the DLQI and DLQI-R total score and 1.1% for Skindex-16 total score. A high floor effect was observed for the DLQI and DLQI-R (26.5%), whereas the floor effect was merely 11.8% for the Skindex-16 total score. Of the 73 patients with a Skindex-16 total score of zero, 14 (19%) patients reported problems on DLQI/DLQI-R. Of the 164 patients with a DLQI and DLQI-R score of zero, 105 (64.0%) patients had a Skindex-16 total score higher than zero. Overall, 10–40% of patients with a DLQI or DLQI-R score of zero reported interference with their lives in Skindex-16 items. Of these, item 6 (worry, 39.6%), item 7 (appearance, 38.4%), item 10 (being annoyed, 36.6%) and item 5 (persistence/reoccurrence, 36.0%) were the most bothered areas of HRQoL (Figure 1).

For both DLQI (or DLQI-R) and Skindex-16, item-level ceiling effect was low, with the exception of item 5 (persistence/reoccurrence, 19.7%) of Skindex-16 (Table 3). Floor effect ranged between 39.3% and 70.2% for the DLQI items and between 27.5% and 57.6% for Skindex-16 items. Four of the five Skindex-16 items with matched 'severity' format DLQI pairs

Table 2 Characteristics of the study population

Variables	n (%)	Percentage of patients with at least one NRR on the DLQI (%)	Mean number of NRRs on the DLQI (SD)
Total sample	618 (100)	37.2	1.09 (2.04)
Sex			
Male	260 (42.1)	38.8	1.24 (2.29)
Female	358 (57.9)	36.0	0.97 (1.83)
Age groups (years)			
18–29	93 (15.0)	23.7	0.69 (1.63)
30–39	89 (14.4)	39.3	1.49 (2.59)
40–49	115 (18.6)	38.3	1.19 (2.25)
50–59	92 (14.9)	29.4	0.86 (1.93)
≥ 60	229 (37.1)	44.5	1.13 (1.85)
Education			
Primary school	31 (5.0)	51.6	1.19 (1.85)
Secondary school	462 (74.8)	36.6	1.08 (2.06)
College/university	125 (20.2)	36.0	1.08 (2.18)
Marital status			
Married/domestic partnership	421 (68.1)	33.0	1.05 (2.16)
Single/divorced/widower	197 (31.9)	46.2	1.16 (1.75)
Net monthly household income (HUF)			
$\leq 150\,000$	121 (19.6)	45.5	1.22 (2.02)
150 001–300 000	218 (35.3)	37.6	1.15 (2.10)
$\geq 300\,000$	195 (31.6)	28.2	0.81 (1.90)
Don't know/refused to answer	84 (13.6)	45.2	1.37 (2.17)
Diagnoses			
Warts	143 (23.1)	37.8	1.10 (2.12)
Eczema	140 (22.7)	32.1	0.91 (1.96)
Onychomycosis	113 (18.3)	38.9	1.23 (2.22)
Acne	83 (13.4)	34.9	0.93 (1.53)
Psoriasis	82 (13.2)	34.2	0.82 (1.66)
Tinea pedis	46 (7.4)	41.3	0.85 (1.70)
Basal cell carcinoma	31 (5.0)	51.6	1.26 (2.02)
Rosacea	31 (5.0)	54.8	1.32 (1.89)
Urticaria	22 (3.6)	40.9	0.77 (1.41)
Herpes zoster	11 (1.8)	36.4	1.36 (2.66)
Other	102 (16.5)	42.6	1.22 (2.05)

DLQI, Dermatology Life Quality Index; NRR, 'not relevant' response.

significantly reduced the presence of a floor effect compared with the DLQI ($P < 0.05$). All four Skindex-16 items with 'interference with functioning' format DLQI pairs reduced the presence of a floor effect compared with the DLQI ($P < 0.05$).

Overall, 17.3–40.1% of patients reporting 'not at all' in the nine matched items were bothered by some problems in Skindex-16 (Figure 2). Furthermore, 23.3%, 24.6%, 37.1% and 38.5% of patients marking an NRR in DLQI items 8 (interpersonal problems), 3 (shopping/home/garden), 9 (sexual difficulties) and 7 (working/studying), reported problems in their matched Skindex-16 items pairs, respectively (Figure 3).

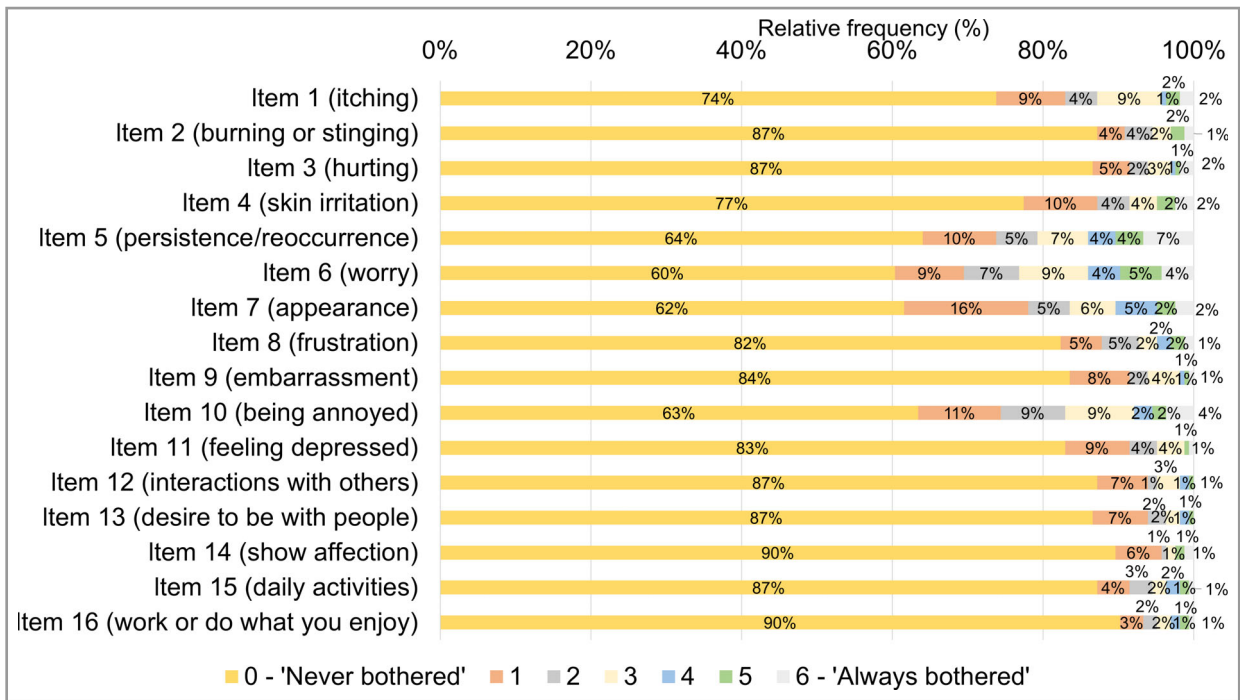


Figure 1 Distribution of Skindex-16 responses in patients with Dermatology Life Quality Index (DLQI)/DLQI-Relevant score of zero (n = 164). Percentages may not add up to 100 owing to rounding.

Table 3 Ceiling and floor effects of DLQI, DLQI-R and Skindex-16

DLQI/DLQI-R ^a			Skindex-16		
Items	FE, n (%)	CE, n (%)	Items	FE, n (%)	CE, n (%)
Item 1 (itchy, sore, painful, stinging)	243 (39.3)	22 (3.6)	Item 1 (itching)	192 (31.1) ^b	53 (8.6) ^c
			Item 2 (burning or stinging)	305 (49.4) ^b	28 (4.5)
			Item 3 (hurting)	313 (50.6) ^b	25 (4.0)
			Item 4 (skin irritation)	216 (35.0) ^b	50 (8.1) ^c
Item 2 (embarrassed, self-conscious)	316 (51.1)	20 (3.2)	Item 9 (embarrassment)	308 (49.8)	54 (8.7) ^c
Item 3 (shopping, home, garden)	434 (70.2)	11 (1.8)	Item 15 (daily activities)	320 (51.8) ^b	25 (4.0) ^c
Item 4 (clothing)	399 (64.6)	20 (3.2)	–	–	–
Item 5 (social, leisure)	417 (67.5)	13 (2.1)	–	–	–
Item 6 (sport)	381 (61.7)	13 (2.1)	–	–	–
Item 7 (working, studying)	416 (67.3)	20 (3.2)	Item 16 (work or do what you enjoy)	344 (55.7) ^b	32 (5.2) ^c
Item 8 (interpersonal problems)	433 (70.1)	8 (1.3)	Item 12 (interactions with others)	337 (54.5) ^b	27 (4.4) ^c
Item 9 (sexual difficulties)	391 (63.3)	8 (1.3)	Item 14 (show affection)	356 (57.6) ^b	35 (5.7) ^c
Item 10 (treatment difficulties)	410 (66.3)	5 (0.8)	–	–	–
			Item 5 (persistence/reoccurrence)	170 (27.5)	122 (19.7)
			Item 6 (worry)	183 (29.6)	96 (15.5)
			Item 7 (appearance)	193 (31.2)	89 (14.4)
			Item 8 (frustration)	277 (44.8)	54 (8.7)
			Item 10 (being annoyed)	193 (31.2)	70 (11.3)
			Item 11 (feeling depressed)	280 (45.3)	37 (6.0)
			Item 13 (desire to be with people)	333 (53.9)	32 (5.2)
			Symptoms subscale	148 (23.9)	15 (2.4)
			Emotions subscale	90 (14.6)	18 (2.9)
			Functioning subscale	256 (41.4)	11 (1.8)
DLQI/DLQI-R Total	164 (26.5)	0 (0.0)	Total	73 (11.8) ^b	7 (1.1) ^c

CE, ceiling effect; DLQI, Dermatology Life Quality Index; DLQI-R, DLQI-Relevant; FE, floor effect. ^aTheoretically, the ceiling effect for DLQI and DLQI-R total scores may be different; however, the sample included few patients with severe dermatological conditions, thus the two values were the same in this study. ^bIndicates a significant difference in floor effect between DLQI/DLQI-R and Skindex-16 (P < 0.05). ^cIndicates a significant difference in ceiling effect between DLQI/DLQI-R and Skindex-16 (P < 0.05).

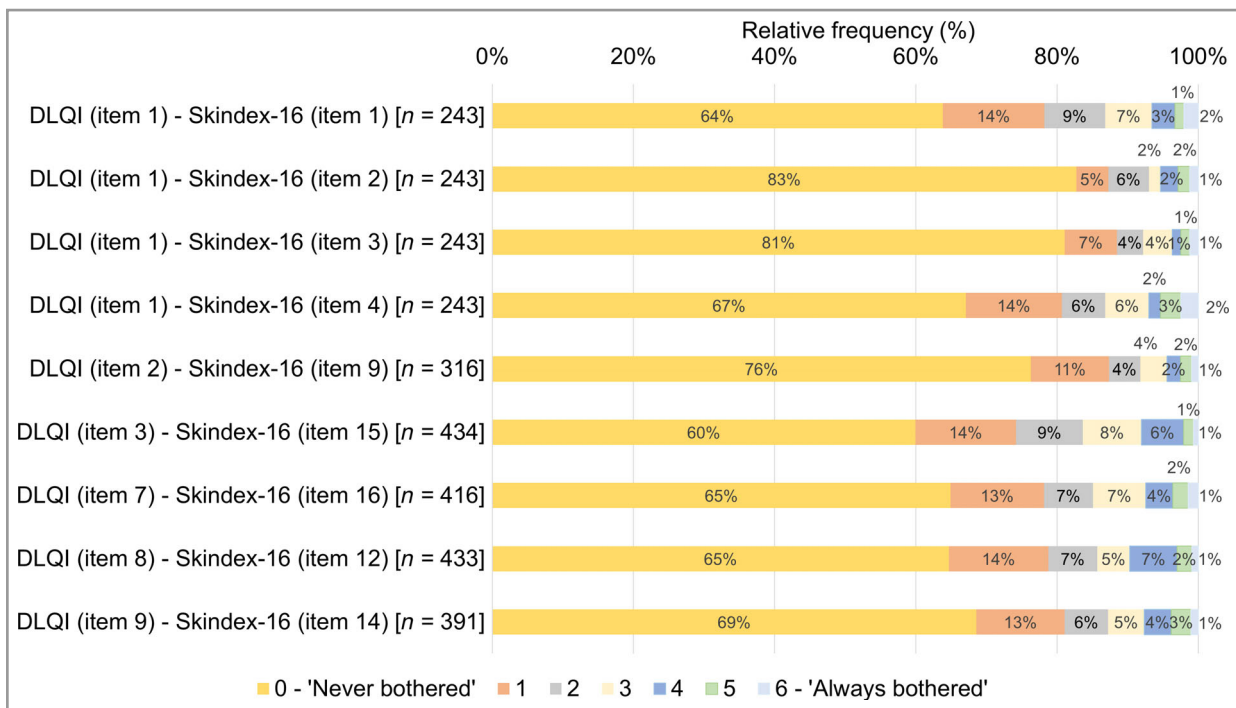


Figure 2 Skindex-16 responses of patients with 'not at all' responses on the Dermatology Life Quality Index (matched items). Percentages may not add up to 100 owing to rounding.

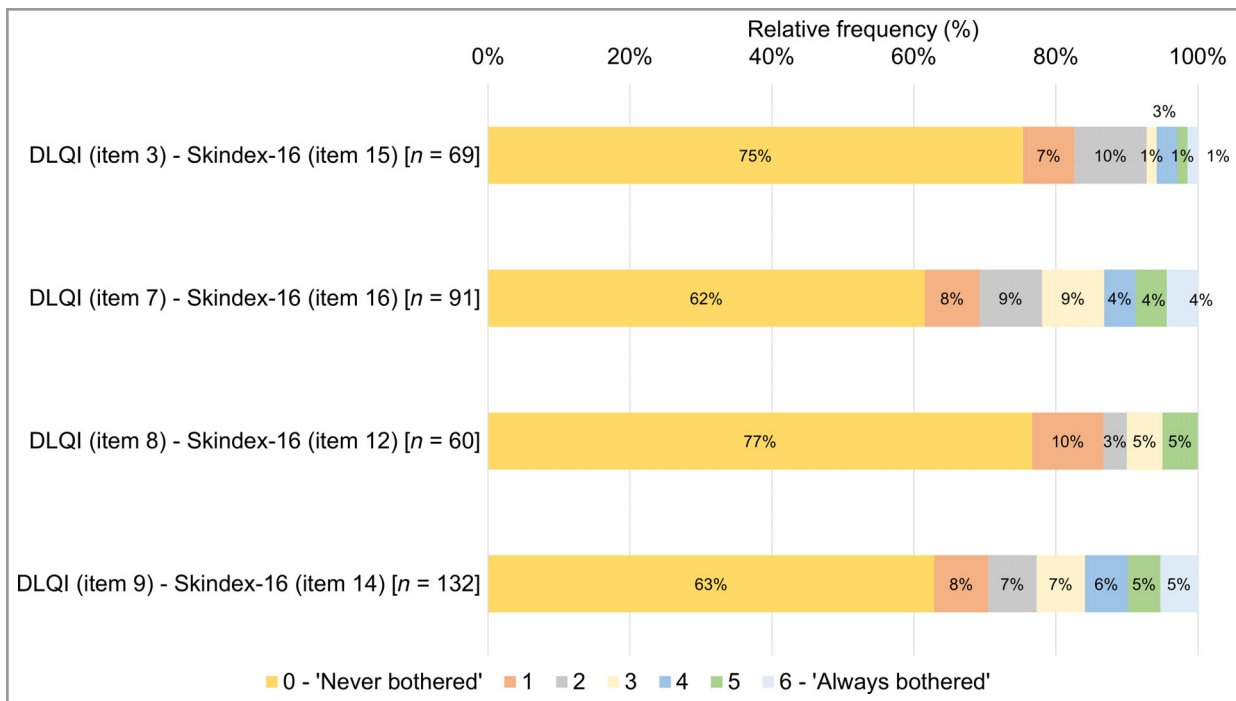


Figure 3 Skindex-16 responses of patients with 'not relevant' responses on the Dermatology Life Quality Index (matched items). Percentages may not add up to 100 owing to rounding.

Informativity

The average absolute informativity of the DLQI, DLQI-R and Skindex-16 were 1.07, 1.48 and 2.38, respectively (Table 4).

The average relative informativity values for the DLQI, DLQI-R and Skindex-16 were 0.54, 0.66 and 0.85, respectively. Compared with the DLQI, we identified higher relative informativity with DLQI-R in all items with NRRs. Three of the five

Table 4 Informativity of DLQI, DLQI-R and Skindex-16

DLQI/DLQI-R items	DLQI		DLQI-R		Skindex-16 items	Skindex-16	
	(H')	(J')	(H')	(J')		(H')	(J')
Item 1 (itchy, sore, painful, stinging)	1.64	0.82	1.64	0.82	Item 1 (itching)	2.64	0.94 ^b
					Item 2 (burning or stinging)	2.28	0.81
					Item 3 (hurting)	2.22	0.79
					Item 4 (skin irritation)	2.58	0.92 ^b
Item 2 (embarrassed, self-conscious)	1.54	0.77	1.54	0.77	Item 9 (embarrassment)	2.27	0.81 ^b
Item 3 (shopping, home, garden)	0.91	0.45	1.38	0.59 ^a	Item 15 (daily activities)	2.18	0.78 ^b
Item 4 (clothing)	1.16	0.58	1.57	0.68 ^a	–	–	–
Item 5 (social, leisure)	1.12	0.56	1.48	0.64 ^a	–	–	–
Item 6 (sport)	0.81	0.41	1.52	0.65 ^a	–	–	–
Item 7 (working, studying)	0.85	0.43	1.41	0.61 ^a	Item 16 (work or do what you enjoy)	2.09	0.74 ^b
Item 8 (interpersonal problems)	0.94	0.47	1.37	0.59 ^a	Item 12 (interactions with others)	2.12	0.76 ^b
Item 9 (sexual difficulties)	0.81	0.40	1.50	0.64 ^a	Item 14 (show affection)	2.05	0.73 ^b
Item 10 (treatment difficulties)	0.97	0.48	1.44	0.62 ^a	–	–	–
					Item 5 (persistence/reoccurrence)	2.68	0.95
					Item 6 (worry)	2.67	0.95
					Item 7 (appearance)	2.66	0.95
					Item 8 (frustration)	2.41	0.86
					Item 10 (being annoyed)	2.66	0.95
					Item 11 (feeling depressed)	2.35	0.84
					Item 13 (desire to be with people)	2.15	0.77
Total average	1.07	0.54	1.48	0.66 ^a	Total average	2.38	0.85 ^b

DLQI, Dermatology Life Quality Index; DLQI-R, DLQI-Relevant; H', Shannon's index for absolute informativity; J', Shannon's evenness index for relative informativity. The theoretical maximum of H' for DLQI, DLQI-R and Skindex-16 was 2.00, 2.32 and 2.81, respectively. ^aIndicates that J' of DLQI-R is higher than that of the DLQI. ^bIndicates that J' of Skindex-16 is higher than those of DLQI and DLQI-R.

Skindex-16 items with matched 'severity' format DLQI pairs, and all four Skindex-16 items with 'interference with functioning' format DLQI pairs showed higher relative informativity than their DLQI or DLQI-R pairs.

Convergent and known-group validity

Most hypotheses regarding convergent validity of the three HRQoL outcomes were met. Skindex-16 subscale and total scores exhibited a strong correlation both with DLQI and DLQI-R scores (range of $r_s = 0.664$ to 0.751) (Table 5). PG-VAS and WHO-5 scores showed weak negative correlations

with all dermatology-specific HRQoL measures (range of $r_s = -0.342$ to -0.241). DLQI was able to better discriminate between known groups of patients based on overall HRQoL impairment (GQ rating), while both DLQI-R and Skindex-16 performed better than the DLQI for self-perceived health status (Table 6).

Subgroup analysis

Overall, with few exceptions, variations in measurement properties across the three subgroups of patients were small (File S1; see Supporting Information). Floor effect for DLQI/DLQI-

Table 5 Spearman's correlations between outcome measures

	DLQI	DLQI-R	Skindex-16 Functioning	Skindex-16 Emotions	Skindex-16 Symptoms	Skindex-16 Total	PG-VAS
DLQI (0–30)	–	–	–	–	–	–	–
DLQI-R (0–30)	0.984	–	–	–	–	–	–
Skindex-16 Functioning (0–100)	0.699	0.685	–	–	–	–	–
Skindex-16 Emotions (0–100)	0.678	0.664	0.797	–	–	–	–
Skindex-16 Symptoms (0–100)	0.700	0.683	0.727	0.752	–	–	–
Skindex-16 Total (0–100)	0.751	0.735	0.885	0.947	0.895	–	–
PG-VAS (0–100)	–0.333	–0.342	–0.320	–0.310	–0.266	–0.317	–
WHO-5 (0–100)	–0.314	–0.315	–0.241	–0.267	–0.270	–0.284	0.425

DLQI, Dermatology Life Quality Index; DLQI-R, DLQI-Relevant; PG-VAS, patient global assessment visual analogue scale; WHO-5, World Health Organization-5 Well-Being Index. All correlation coefficients were significant ($P < 0.05$).

Table 6 Known-group validity of the DLQI, DLQI-R and Skindex-16

	Number of patients (%)	Percentage of patients with at least one NRR, %	DLQI (0–30)	DLQI-R (0–30)	Skindex-16 Functioning (0–100)	Skindex-16 Emotions (0–100)	Skindex-16 Symptoms (0–100)	Skindex-16 Total (0–100)
Self-perceived health status								
Very good	33 (5.3)	36.4	4.0 (7.8)	4.3 (7.9)	12.4 (28.0)	23.4 (29.4)	23.9 (30.9)	19.9 (27.4)
Good	198 (32.0)	30.3	2.5 (3.7)	2.7 (4.0)	15.2 (24.0)	28.6 (27.9)	23.4 (26.3)	22.4 (23.4)
Fair	264 (42.7)	37.5	3.6 (4.4)	3.9 (4.7)	22.9 (27.3)	35.8 (28.9)	29.4 (27.2)	29.4 (25.4)
Poor	107 (17.3)	46.7	5.6 (5.9)	6.1 (5.9)	31.9 (31.3)	49.1 (30.7)	41.8 (29.4)	40.9 (27.2)
Very poor	16 (2.6)	56.2	9.7 (8.4)	10.9 (9.6)	51.0 (36.4)	65.3 (37.2)	54.2 (34.4)	56.8 (34.9)
P-values ^a	–	–	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
F-statistic ^a	–	–	13.1	15.0	12.1	14.2	11.1	15.0
RE	–	–	–	1.15	0.92	1.08	0.85	1.14
Overall skin-related HRQoL impairment (GQ rating)								
No effect	212 (34.3)	40.1	0.9 (1.7)	1.1 (2.2)	5.0 (13.3)	15.2 (19.3)	11.6 (18.3)	10.6 (14.5)
Small effect	163 (26.4)	30.1	2.8 (2.9)	3.0 (3.1)	20.6 (23.7)	33.5 (25.7)	30.7 (25.4)	28.3 (22.2)
Moderate effect	175 (28.3)	41.1	5.3 (4.5)	5.8 (4.9)	31.6 (29.1)	50.1 (27.9)	40.4 (26.4)	40.7 (24.3)
Very large effect	52 (8.4)	38.5	9.4 (6.3)	10.1 (6.6)	51.9 (31.4)	67.9 (24.9)	54.9 (30.3)	58.2 (24.6)
Extremely large effect	16 (2.6)	25.0	17.0 (9.4)	17.6 (9.5)	64.8 (32.3)	76.9 (24.6)	70.8 (29.4)	70.8 (27.4)
P-values ^a	–	–	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
F-statistic ^a	–	–	118.7	111.7	68.6	88.0	64.3	95.6
RE	–	–	–	0.94	0.58	0.74	0.54	0.81

DLQI, Dermatology Life Quality Index; DLQI-R, DLQI-Relevant; GQ, global question; HRQoL, health-related quality of life; NRR, 'not relevant' response; RE, relative efficiency. ^aAnalysis of variance (ANOVA). Data are presented as mean (SD) unless otherwise stated.

R total score ranged between 20.3% (chronic inflammatory skin diseases) and 29.1% (other conditions). In contrast, there was a very minor difference in floor effect for Skindex-16 total scores across the three subgroups (range 10.3–12.6%). Similarly, no substantial differences were found in informativity of DLQI, DLQI-R and Skindex-16 across the subgroups. Skindex-16 correlated strongly with DLQI and DLQI-R in all subgroups (range of $r_s = 0.729$ to 0.808). DLQI-R consistently improved the RE of DLQI for self-perceived health status groups, but not for overall HRQoL impairment (GQ rating). In comparison, the performance of Skindex-16 was less systematic. It considerably improved the RE for self-perceived health status in the 'other' group, whereas it was outperformed by both the DLQI and DLQI-R for self-perceived health status in chronic inflammatory skin diseases and for GQ rating in infections.

Discussion

This is the first study to provide a comprehensive head-to-head comparison of the measurement properties of the DLQI, DLQI-R and Skindex-16 dermatology-specific HRQoL outcomes. Skindex-16 showed better item-level measurement properties, including floor effect and informativity, than either the DLQI or DLQI-R. However, the three measures were similar in terms of convergent and known-group validity.

The different HRQoL areas covered may account for a large part of the differences in measurement performance between the DLQI and Skindex-16. Several Skindex-16 items focus on

mental or emotional aspects of the dermatological disease, such as worrying, frustration, being annoyed or being depressed, whereas these concepts are completely lacking from the DLQI. Alternatively, HRQoL areas related to daily functioning, including clothing, sport and treatment difficulties, may not be captured by Skindex-16 items. Another difference between the two measures lies in the different item characteristics of the DLQI and Skindex-16. In contrast to the four or five response options for each DLQI item, Skindex-16 offers seven response options for each item. Prior evidence suggests that for up to seven response options, the higher the number of alternatives, the better the validity and reliability of the instrument.⁴⁴ Furthermore, compared with the 'interference with functioning' format responses of the DLQI, the frequency scale of Skindex-16 appears to improve performance in capturing problems related to the dermatological condition.

One of the most important limitations of the DLQI is the scoring of NRRs.⁴⁵ For DLQI items 3 (shopping, home, garden), 7 (working, studying), 8 (interpersonal problems) and 9 (sexual difficulties), approximately one-third of patients with NRRs reported problems on their respective Skindex-16 items. Thus, it seems that the NRR option on the DLQI represents a mix of the other four response options. This might call into question the equivalence of 'not at all' and NRRs according to the original DLQI scoring. Although the DLQI-R scoring modification may improve certain measurement properties of the DLQI,^{20,25–29,39,45,46} it cannot address the problems surrounding its content validity. The high number of NRRs reported in different diagnoses is a sign of issues with item

relevance.^{20,26–28,46–50} The relatively high floor effect also gives rise to a content validity problem implying that DLQI items might fail to capture mild HRQoL problems efficiently. The plethora of DLQI questionnaire modifications, including 21 different bolt-ons [i.e. additional questionnaire item(s) appended to the original questionnaire], may be considered as evidence for problems with comprehensiveness.²⁵ However, Skindex-16 (and the other Skindex measures) may also have content validity problems. In a recent qualitative study, for example, patients with acne reported redundant items, uncertainties regarding the meaning of the ‘never bothered’ endpoint and unlabelled response options which may lead to arbitrary response choices.⁵¹

Some limitations of the present study should be considered. Firstly, we analysed data from patients with self-reported, physician-diagnosed dermatological conditions, but no objective data on disease severity or clinical status were available. Secondly, there were few patients with severe dermatological conditions, as attested by the relatively low mean DLQI and Skindex-16 scores. Thirdly, the DLQI/DLQI-R vs. Skindex-16 item pairs used for the item-level analyses were not always completely identical in terms of content [e.g. DLQI item 9 (sexual difficulties) vs. Skindex-16 item 14 (show affection)]. Finally, owing to the cross-sectional nature of the study, we were not able to compare test–retest reliability or responsiveness of the instruments.

Our findings help to provide a fuller understanding of the difference between the DLQI, DLQI-R and Skindex-16 and support the informed choice of instrument in clinical practice, research, treatment and financial guidelines. The DLQI is widely used in national and international treatment guidelines for several conditions, such as psoriasis, atopic dermatitis and hidradenitis suppurativa, in nearly 50 countries.⁵ In contrast, Skindex questionnaires have so far been recommended in only a few countries.^{52–54} Based on our findings, it is not possible to universally recommend any of these measures over the others. Measurement properties of skin-specific HRQoL instruments may vary across different skin conditions, and one instrument may be particularly pertinent for one condition, but not for others. The variations found in the subgroup analyses performed as part of this study lend some support to this view. However, regardless of diagnosis, for patients with mild symptoms, DLQI and DLQI-R seem to be insensitive to small impairments in HRQoL, and thus, Skindex-16 may be more suitable for this population. Future studies are recommended to repeat these analyses for specific skin conditions, preferably in clinical settings, whereby severity assessments can be performed that would allow more condition-specific analyses of validity.

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Supporting Information

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File S1 Supplementary Appendices.

Powerpoint S1 Journal Club Slide Set.