

Cross-cultural adaptation and validation of the Localised Scleroderma Quality of Life Instrument (LoSQL): an international study

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Cross-cultural adaptation and validation of the Localised Scleroderma Quality of Life

Instrument (LoSQI): An international study

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Abstract

Background

Juvenile localised scleroderma (jLS) is a rare disease which impacts negatively on health-related quality of life (HRQoL). We aimed to undertake the cross-cultural adaptation and validation of a novel disease-specific HRQoL measure, the Localised Scleroderma Quality of Life Instrument (LoSQI).

Methods

In phase I, cross-cultural adaptation was completed using established methodology involving forward/backward translation and cognitive interviews to develop a final version in each language.

In phase II, validation was performed using the translated versions. Statistical analyses addressed confirmatory factor analysis, item-level analysis and construct validity.

Results

There were 236 participants included in the study (162 participants from 20 sites in the cross-cultural adaptation phase; 213 patients from 36 sites in the validation phase; with 139 participants taking part in both phases). Of the phase II participants 67% were female with a median age at diagnosis of 7.3 years and median disease duration of 16.3 months. Linear scleroderma of the limb/trunk was the most common subtype (41%) and methotrexate (55%) was the most used systemic immunomodulation.

Cross-cultural adaptation was completed in 16 languages. Six languages required minor modification after pre-testing. Harmonisation across languages identified some overlap between certain item pairs. The recall period and response periods were found to be appropriate. Participant feedback was positive with 97% approving the utility of the measure and 95% finding it easy to complete.

Confirmatory factor analysis further supported the use of two subscales, consistent with a prior quantitative assessment: Pain and Physical Functioning, and Body Image and Social Support.

The construct validity findings align with prior research, showing moderate to strong correlations between both LoSQI subscales and skin HRQoL measure (CDLQI). Weaker or no associations with physician-reported disease activity supports that the measure reflects patient- and parent-reported impact rather than clinical activity.

Conclusion

The LoSQI has been successfully translated into 16 language versions. Qualitative and quantitative evidence support the validity of the versions of the LoSQI indicating its usefulness as a patient-reported outcome (PRO) to evaluate meaningful impacts of localized scleroderma which may be overlooked by generic tools in both clinical care and research.

Key words: juvenile localised scleroderma, cross-cultural adaptation, clinician-reported outcomes, patient-reported outcomes, Localised Scleroderma Quality of Life Instrument (LoSQI), health-related quality of life (HRQoL)

Background

Juvenile localised scleroderma (jLS) or morphea is characterised by chronic inflammation within the skin and subcutaneous tissues leading to fibrosis (1). It is associated with significant complications including joint contractures, limb length discrepancy and facial atrophy that impact

quality of life. Patient-reported outcomes (PRO) are not well established within research settings and are not part of routine clinical care in many centres (2, 3).

A qualitative study in children with facial localised scleroderma identified significant psychosocial challenges including perceptions of being different (4). A further qualitative study in all subtypes showed that jLS affected Health-related Quality of Life (HRQoL) across several distinct domains including skin symptoms, body image, bullying from peers, functional difficulties and high burden from treatments (5). Several studies have measured HRQoL in jLS, most commonly using the Children's Dermatology Life Quality Index (CDLQI) (6-10). This measure is limited to only capturing impact of skin involvement and not HRQoL from extra-cutaneous manifestations (ECM) which are common in jLS (11). The presence of ECMs is associated with higher parental assessment of disease impact and impacts on HRQoL (5, 11). Psychometric analysis shows that the CDLQI incompletely measures important concepts of HRQoL that are unique to jLS (12).

The Localised Scleroderma Quality of Life Instrument (LoSQI) has been developed in partnership with patients and families to capture aspects of disease which may not be well defined within generic HRQoL measures (5, 13-15). The initial development and validation process was iterative, patient-centred, and consistent with best practices in PRO development. Previous quantitative validation of the LoSQI supported the use of two subscales: Pain and Physical Functioning, and Body Image and Social Support (14). The LoSQI also includes a Medication Subscale aimed at understanding the impact of medication side-effects and apprehension on HRQoL.

Currently, the LoSQI is the only jLS-specific PRO, and the only PRO that includes both qualitative and quantitative validity evidence for use with this population (13, 14). However, the measure requires cross-cultural adaptation for international use in both clinical and research settings.

Our aims were to leverage an international consortium of jLS clinicians to undertake cross-cultural adaptation of the LoSQI across multiple languages and then quantitatively validate its use in an international multicentre prospective cohort study. The goal was to generate multiple translated

versions, with documented validity support, available for use in clinical and research contexts. Here we report the cross-cultural adaptation and cross-sectional validation of the LoSQI.

Methods

Sites

Centres belonging to the Paediatric Rheumatology International Trials Organisation (PRINTO) were invited to participate. In most cases, one lead site in each country undertook cross-cultural adaptation work with several sites participating in quantitative data collection.

Participants

Patients aged 8-18 years with JLS diagnosed by a paediatric rheumatologist were eligible for recruitment if they understood written native language to the level of an 8-year-old child and consent/assent was obtained from parents/caregivers and patients. Exclusion criteria included any co-morbidity not related to JLS or its complications which may impact on PRO. Participants could be enrolled in either phase I (cross-cultural adaptation), phase II (validation) or both phases.

Ethics

The protocol was approved by the institutional ethics committees of the participating paediatric rheumatology centres as required by the national laws of each country and in accordance with the Declaration of Helsinki.

Overview

This project was divided into two phases: Phase I, the cross-cultural adaptation involving translation procedures and cognitive testing in the target population(16); and phase II, the validation phase, comprising clinical data collection on demographics, clinician-reported outcomes (ClinRO) and patient-reported outcomes (PRO) at two study visits.

Phase I: Cross-cultural adaptation

Cross-cultural adaptation followed methodology described by Guillemin et al (17, 18). In brief this included for each national language:

1. Translation and developer review

Forward translation by two translators: Two independent translators translated the LoSQI from American English into the target language, using wording understandable to an 8-year-old child. The translators then met to agree on a first unified forward translation.

Backward translation by one translator: An independent translator, whose first language was American English and who was fluent in the target language, back-translated the unified version into English using child-friendly wording. This translator did not see the original questionnaire.

Review of backward translation: Two original LoSQI developers (CZ & KA) reviewed the backward translation to ensure that instructions, items, and concepts remained accurate and understandable. This review supported semantic, idiomatic, experiential, and conceptual equivalence. Any suggested changes were directed back to the translators.

Second unified forward translation.

Forward and backward translators discussed reviewer feedback and reached consensus on a second unified version of the questionnaire.

2. Pre-testing in the target population using cognitive interviews

The second unified version in each national language was administered to children aged 8–18 years with jLS. A healthcare professional administered the survey and conducted cognitive interviews to assess each child's comprehension of the survey items. A standardized script guided data collection across five areas: i) instructions; ii) items; iii) response options; iv) construct representation; v) recall period. Responses were recorded using a structured grid.

Ongoing analysis identified problematic items and guided revisions during testing. The study team reviewed and revised any questions in which >20% of patients expressed difficulty understanding the item stem or response options. Modifications were considered 'minor' if they were small, non-substantive modifications solely intended to improve clarity, comprehensibility, or cultural appropriateness, without altering the underlying concepts, content validity, or scoring structure of the original instrument. Other substantive changes not meeting this definition were defined as 'major'.

Third unified forward version:

A final consensus discussion was held to review cognitive testing results and agree on the final unified version for each translated version.

Sample size

Sample sizes per round of cognitive interviews are typically 6-12 people depending on the diversity of the target population (16). Since we were confirming understanding of an established tool (and not fully evaluating a new tool), we aimed to include 4-6 children within two developmentally appropriate age groups (4-6 children aged 8-12 years old and 4-6 children aged 13-18 years old) for each language version.

Harmonisation of results across all language versions

A review of the results across the language versions was undertaken to examine any problematic items across various languages.

Phase II: Validation of LoSQI in an international multi-centre prospective study

Data collection

The third unified language version of the LoSQI was administered in clinics at baseline and 4 months (+/- 2 months) time points. Where only minor modifications were made to the second unified translated version, the baseline visit for Phase II could be the same as the baseline visits

for Phase I (cognitive interview). Baseline data included demographics, age at onset/diagnosis, medication information and subtype of JLS defined by Padua classification (19).

Additional outcomes were collected at each visit including ClinRO: Activity and damage scores (localised scleroderma cutaneous activity tool (LoSCAT), physician's global assessment of disease activity visual analogue scale (VAS) 0-10cm (PGA-A), physician's global assessment of disease damage VAS 0-10cm (PGA-D), extracutaneous manifestations (using the Total Morbidity Score which has since been renamed as the Localized Scleroderma Total Severity Scale, i.e., LoTSS (20-23). At the 4-month visit, change in disease activity and overall health from last visit was also collected, measured as a ClinRO Likert scale.

Additional PROs included Childhood Health Assessment Questionnaire (CHAQ), Patient-Reported Measurement Information System (PROMIS®) measures (paediatric self-report fixed short forms: Pain Interference, Upper Extremity Function, Mobility, Anxiety, Depressive Symptoms, Fatigue, Global Health 7-item), CDLQI, parent/patient global/pain/symptom VAS and Likert scale of experience of completing LoSQI (24-26). CDLQI and PROMIS measures were only collected where a translated version was available for the language spoken at that site. Data collection was facilitated via a web platform developed as an in-kind contribution as part of the grant funding agreement.

Data entered online (as per local Institutional Review Boards and National Competent Authorities recommendations) was anonymous and encrypted, therefore the study staff were unable to view personal data or identify individual patients.

Statistical analysis

Descriptive statistics and further statistical analyses were performed using R version 4.5.2 (full list of packages used are listed in Additional file 1 (Table S1).

Categorical demographic and clinical data were summarised as frequencies and percentages. Central tendency of continuous and discrete numerical data was described as either median and interquartile range (IQR) or mean and standard deviation (SD).

Responses for the LoSQI items were calculated as counts and percentages across the whole cohort, maintaining the response categories (0 for 'not bothered' to 3 for 'bothers a lot'). As few responses were received for scores of '2' and '3', the LoSQI item responses were dichotomised to '0' ('not bothered') and '1' (combined the scores of 1-3 as 'bothered'). Tetrachoric correlation analysis (for binary variables) was conducted and strongly correlated items (>0.9) were selected as candidates for removal.

We evaluated the internal structure of the scale using confirmatory factor analysis (CFA) using the structure suggested by the multi-site validation conducted within an American study using the dichotomised data (14). CFA models were fitted to the two subscales separately. Model fits statistics were assessed (Chi-square, Comparative Fit Index (CFI) ≥ 0.95 , Tucker-Lewis Index (TLI) ≥ 0.95 , Root Mean Square Error of Approximation (RMSEA) ≤ 0.08 , Standardized Root Mean Square Residual (SRMR) ≤ 0.08) (27).

Item-level analysis was performed to determine variability and appropriate functioning of items. Item Response Theory (IRT) 2PL model was applied on the dichotomised data for the two subscales (1 - Pain and Physical Functioning; 2 -Body Image and Social Support)(14). As there was consistency with the original LoSQI model, the original LoSQI scoring system was used to calculate values for patients on both subscales.

Pearson's correlation analysis was performed to assess correlations of LoSQI subscale T-scores with patient-, parent- and physician- reported measures to evaluate the construct validity of the LoSQI subscales. We hypothesized that subscales will show moderate correlations with other

PROs but not necessarily clinician reported disease activity measures consistent with initial North American LoSQI validation studies(14).

Results

Sites and Participants

Data presented here includes 236 participants recruited from 20 sites (phase I; 162 participants) and 36 sites (phase II; 213 participants) across 17 countries (Figure 1, world map). Twenty-three participants took part in phase I only, 74 took part in phase II only and 139 took part in phase I and II.

Legend for Figure 1. A. World map representing the countries included in the LoSQI study and B showing Europe in more detail. The total number of participants included in the study per country, less than 10 or greater than 10, are highlighted in lighter blue and darker blue, respectively. This was generated using R package ‘rworldmap’ (version 1.3.8).

Table 1 describes the 213 participants recruited to phase II, of which the majority (67%) were female and White European (67%). The median age at diagnosis was 7.3 years and median disease duration at the baseline visit was 16.3 months. Linear scleroderma of the limb/trunk was the most common subtype affecting 88/213 (41%) followed by linear facial/scalp in 61/213 (29%) and mixed subtype in 58/213 (27%). Methotrexate (117/213; 55%) was the most frequently used systemic immunomodulation followed by mycophenolate mofetil (53/213; 25%), tocilizumab (25/213; 12%) and abatacept (7/213; 3%).

Insert Table 1

Phase I: Cross-cultural adaptation

Figure 2 shows the stages of cross-cultural adaptation across language versions.

Legend for Figure 2. Schematic showing the stages of cross-cultural adaptation of the LoSQI

1. Translation and developer review.

Second unified versions of the LoSQI were completed for 26 languages (five of which were local language adaptations only: Argentinian Spanish from Castilian Spanish, Egyptian Arabic from Arabic and Australian English, British English, Singaporean English from American English). Developer review of the back translations resulted in minor modifications to five language versions, prior to cognitive interviews.

Ten languages did not progress to complete cross-cultural adaptation (Arabic, Egyptian Arabic, Australian British, Farsi, Flemish, French, Greek, Hebrew, Lithuanian, Slovenian), related to capacity issues to deliver the study at the local site.

2. Pre-testing in the target population using cognitive interviews

To date, cross-cultural adaptation was completed for 16 languages (Figure 2), and each were reviewed by a median of 9 participants (range: 8-18), with 161 participants in total participating in the cognitive interviews (60 aged 8-12 years; 101 aged 13-18 years).

The LoSQI Medication Subscale was completed by 140/161 (87%) of phase I participants as this is only relevant if a medication for localised scleroderma is currently being taken. Overall, in these 16 language adaptations which progressed to cognitive interview, instructions, items, response options, and the recall period were well understood. Ten of the language versions did not require any language/country specific recommendations after the cognitive interview stage. Six language versions were modified based on feedback obtained during the cognitive interviews, but all modifications were classified as 'minor' based on a priori definition (Table 2). More detailed descriptions of the cross-cultural adaptation for each language are available in the individual language additional files (Additional files 2-17).

Insert Table 2

During the final harmonization review, certain issues were identified across language versions (Table 3). Some item pairs were felt to overlap (e.g., items 6 '*problems using my hands*' and item 7 '*problems using my hands for a long time*'; and items 18 and 19 '*getting teased*' and '*getting bullied*'). Item 5 '*problems doing active things*' and items 6/7 '*problems using my hands*' were deemed irrelevant by two and three participants, respectively. Participants suggested some concepts that could be added to the measure (e.g., enquiring about surgical correction such as fat transfer (n=1), differences in physical appearance from peers (n=1), route of administration of medication and related burden (n=1), missing holidays (n=1) and side-effects from medication such as diarrhoea, hair loss (n=1)) but frequency of participants reporting 'missing concepts' was overall low (5/161; 3%).

Insert Table 3

Phase II: Validation

Overall, only 4% of participants (8/213) reported 'trouble completing the LoSQI', with overall opinions being positive (Table 4). Patients indicated willingness to complete the LoSQI once or twice a year (73%), with one fourth of the children indicating that they would be willing to complete it at every visit. Further, only one participant did not finish completing all items on the LoSQI.

Table 4. Results of patient-reported Likert scales on the LoSQI completed at baseline visit (n=177)

	Agree	Neither agree or disagree	Disagree	
I had trouble completing the LoSQI	8 (4.5)	25 (14.1)	144 (81.4)	
I found it helpful to fill in the LoSQI	110 (62.1)	61 (34.5)	6 (3.4)	
I would be happy to fill in the LoSQI at my clinic visit	131 (74)	39 (22)	7 (4)	
How often do you think the LoSQI should be filled in?	Every visit	Twice a year	Once a year	Never

	45 (25.4)	77 (43.6)	53 (29.9)	2 (1.1)
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Total number who completed Likert scales n=177; % in brackets

Item level descriptives

As expected, we saw a high frequency of ‘does not bother me’ responses on all items (Table 5). The most commonly endorsed items were item 4 (*‘my skin feeling different’*) and item 20 (*‘having to miss school’*) with 47% and 53% of patients, respectively, indicating these issues bothered them at least ‘a little’.

Insert Table 5

Responses to the Medication Subscale showed that only 2/165 (1%) reported no medication side-effects and 58/165 (35%) indicated that worry about side-effects bothered them. The side-effects which were more likely to bother participants were *‘feeling sick’* (48/165; 29%) and *‘not feeling like eating’* (48/165; 29%). However, 159/165 (96%) responded positively to belief that medication would *‘help me get better’*. Item level response frequency for all items including Medication Subscale is available in Table 5.

Item level Reduction

Based on previous quantitative validation of the LoSQI in a North American cohort and the harmonization results, one item was removed from any duplicative item pairs (defined as having correlations >0.8) (14). Removed items included item 7 (0.84) *‘problems using my hands for a long time’*, item 13 (0.86) *‘feeling embarrassed about how my body looks’*, and item 19 (0.82) *‘Being bullied about the way I look’*.

Confirmatory factor analysis and construct validity

The final factor structured replicated the original North American LoSQI development (14), and included separate models for each LoSQI subscale score (Pain and Physical Functioning; Body Image and Social Support). Overall, the fit statistics were acceptable (Model 1: $\chi^2(44) = 73.632$,

$p = \text{NA}$; CFI = 0.939; TLI = 0.923; RMSEA = 0.069; SRMR = 0.121; Model 2: $\chi^2(5) = 1.023$, $p = \text{NA}$; CFI = 1.000; TLI = 1.052; RMSEA = 0.000; SRMR = 0.018). There was a weak, positive relationship between the two subscale scores with $r(210) = 0.44$, $p < .001$. Table 6 shows the threshold values from CFA model for both subscale scores. Final factor solutions can be found in the additional file 1 (Tables S2-S7).

Table 6. Summary of threshold values from Confirmatory Factor Analysis model for LoSQI subscale 1 (Pain and Physical Functioning) and subscale 2 (Body Image and Social Support)

Subscale	Item Number	Item	Estimate
Subscale 1: Pain and physical functioning	1	Itchy skin	0.720
	2	Painful skin	0.766
	3	Uncomfortably tight skin	0.602
	4	Skin feeling different	0.083
	5	Problems doing active things	0.815
	6	Problems using hands	1.544
	8	Worry about being able to do activities	0.645
	9	Problems when doing fun things	1.470
	10	Muscles hurting	0.848
	11	Joints aching	0.689
	12	Stiff joints	0.918
Subscale 2: Body image and social support	14	Feeling nervous	0.263
	15	Feeling different	0.251
	16	Feeling upset	0.350
	17	Covering up my scleroderma	0.492
	18	Getting teased	0.993

Due to consistency with the North American version of the LoSQI, responses from patients in this sample were scored using the original scoring algorithm (14). Overall, for the sample at baseline, LoSQI T-scores were as follows: median 51.8 (IQR 15.3), mean 50.5 (SD 7.3) with a range of 41.3-67.8 for Pain and Physical Functioning and median 52.2 (IQR 16.1), mean 52.8 (SD 8.8) with a range of 43.6-68.4 for Body Image and Social Support. The strength of the relationships between the LoSQI subscales and the other measures were consistent with a priori hypothesis (Table 7).

Table 7. Pearson's correlation for patient-, parent-and physician-reported outcome measures on subscales 1 and 2.

Patient/parent reported	LoSQI subscale 1: Pain and Physical Functioning, r	LoSQI subscale 2: Body Image and Social Support, r	n
CDLQI	0.582	0.594	158
CHAQ	0.439	0.265	177
Patient global well-being VAS over past month	0.501	0.450	169
Parent impact of condition VAS	0.424	0.461	169
Physician reported			
mLoSSI	0.267	0.115	212
LoSDI	0.206	0.140	212
PGA-A	0.338	0.177	212
PGA-D	0.316	0.394	212

Discussion

By leveraging a large international network of clinicians and specialty clinics, we undertook cross-cultural adaptation and validation of a disease-specific PRO with representation of 17 countries, 35 sites, and over 200 paediatric localized scleroderma patients worldwide. This study has resulted in harmonized, cross-cultural adaptations of 16 new language versions of the LoSQI, a tool which is useful both in clinical care and in research settings.

Demographic and disease subtypes were consistent with other reported cohorts and are likely to be representative of the target population (14, 28-30).

Qualitative analysis of the cognitive interviews conducted during pre-testing identified issues necessitating minor item revisions in six language versions. These issues primarily related to translated terms that were not readily understood and for which alternative wording was suggested, as well as minor grammatical errors. The response options, construct representation and recall period were generally acceptable to most participants.

Harmonisation across language versions identified instances of overlapping content, particularly between items 6 and 7 (problems using hands; problems using hands for a long time) and items 18 and 19 (being teased; being bullied). These issues had also arisen in the original North

American version of the LoSQI (14). As a result of these findings items 7, 13 and 19 will be removed from all future language versions of the LoSQI. In addition, some children reported difficulty understanding items 1–4 relating to skin-related sensations, particularly in distinguishing between the different concepts addressed (itch, pain, uncomfortable tightness, and skin feeling different). Within the Medication Subscale, item 9 (“feeling like I am in a fog or it’s hard to think”) was identified as challenging to understand in four language versions.

Psychometric evaluation of the LoSQI subscales showed alignment with the North American version. The final model used for that original version demonstrated good model fit in this larger sample including 16 countries. Confirmatory factor analysis further supported the use of two subscales, consistent with the prior North American quantitative assessment: Pain and Physical Functioning and Body Image and Social Support (14). This division into two subscales may enhance the clinical utility of the LoSQI by facilitating more targeted interpretation, for example identifying children who may benefit from pain management, physiotherapy, or occupational therapy based on elevated Pain and Physical Functioning scores, while highlighting those who may benefit from clinical psychology input through the Body Image and Social Support subscale. We agreed with the previous approach of excluding items 20 and 21 (missing school for medical appointments and having blood tests) from the two-subscale model; however, we also consider these to be important stand-alone items that capture specific aspects of the impact of disease management on the child, especially since item 20 was one of the most frequently endorsed ‘bothersome’ items.

The construct validity findings were also consistent with previous work, which reported moderate-to-strong correlations between both LoSQI subscales and CDLQI, weaker or absent correlations with physician-reported disease activity, and weak correlations with disease damage, supporting the construct validity of the measure as reflecting patient- and parent-reported impact of disease rather than clinical activity.

The study aimed to recruit at least four children from each age group (8–12 years and 13–18 years) for the cognitive interviews; however, some language versions included fewer participants in the younger age group, which may have influenced pre-testing responses within this cohort. Despite this, healthcare professionals conducting the interviews considered responses to be broadly comparable across age groups and unlikely to have affected the overall findings.

Participant feedback on the LoSQI was largely positive demonstrating that it is acceptable to patients, with most respondents indicating a preference for completing the measure twice yearly in a clinical setting.

Future work should explore whether more frequent assessments integrated into clinical trial schedules would be acceptable to families. This will be informed by future publications from this study, which will examine the validation of the Medication Subscale, longitudinal validity and responsiveness of the LoSQI, the burden of extracutaneous manifestations and evaluation of PROMIS measures in this large international cohort of jLS patients.

Conclusion

The LoSQI has been successfully cross-culturally validated into 16 language versions. Along with the original American English version, the LoSQI can be a useful tool for capturing the important aspects of HRQoL directly from patients which are known to be inadequately assessed by generic HRQoL measures. Future work includes longitudinal validation, responsiveness to change and validation of the LoSQI's Medication subscale.

Abbreviations

CARRA: Childhood Arthritis and Rheumatology Research Alliance

CDLQI: Children's Dermatology Life Quality Index

CFA: Confirmatory factor analysis

CHAQ: Childhood Health Assessment Questionnaire

ClinRO: Clinician-reported outcome

DMARD: disease-modifying anti-rheumatic drug

ECM: extra-cutaneous manifestations (ECM)

HRQoL: health-related quality of life

IQR: interquartile range

JLS: Juvenile localised scleroderma

LoSCAT: localised scleroderma cutaneous assessment tool

LoSDI: localised scleroderma damage index

LoSQI: localised scleroderma quality of life instrument

LoTSS: The Localized Scleroderma Total Severity Scale

mLoSSI: modified localised scleroderma skin severity index

PGA-A: physician's global of disease activity

PGA-D: physician's global of disease damage

PReS: Pediatric Rheumatology European Society

PRINTO: Paediatric Rheumatology INternational Trials Organisation

PRO: patient reported outcome

PROMIS: Patient-Reported Outcomes Measurement Information System

SD: standard deviation

VAS: visual analogue scale

Declarations

Ethics approval and consent to participate: Ethical approval was obtained by the institutional ethics committees of the participating paediatric rheumatology centres as required by the national laws of each country. Details are available in additional data on each language version of the LoSQI (additional files 2-17). Consent and, where appropriate assent were obtained as per national laws of each country.

Consent for publication: Not applicable

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Table 1. Demographics and clinical details of participants recruited to validation phase.

Variables	N (%)
	Total N=213
<i>Demographics</i>	
Median age of onset, years (IQR)	7.3 (4.7, 9.5)
Median age at diagnosis, years (IQR)	8.8 (6.2, 11.3)
Median age at first visit, years (IQR)	9.5 (7.1, 12.3)
Median delay from first symptoms to diagnosis, years (IQR)	0.9 (0.3, 2.0)
Median disease duration at first visit in months (IQR)	16.3 (5.6, 34.1)
<i>Sex/Gender</i>	
Male	70 (32.9%)
Female	143 (67.1%)
<i>Ethnicity</i>	
European	143 (67.1%)
Southeast Asian	20 (9.4%)
Middle Eastern	8 (3.8%)
Hispanic	8 (3.8%)
Mixed	6 (2.8%)
Indian	3 (1.4%)
African	2 (0.9%)
North African	2 (0.9%)
Native American	2 (0.9%)
Other	19 (8.9%)
<i>Subtype of localised scleroderma</i>	
Circumscribed morphea (deep)	14 (6.6%)
Circumscribed morphea (superficial)	38 (17.8%)

Linear scleroderma facial/scalp	61 (28.6%)
En coup de sabre	34 (16.0%)
Parry Romberg Syndrome	17 (8.0%)
Linear scleroderma limb/trunk	88 (41.3%)
Generalised morphea	41 (19.2%)
Pan-sclerotic morphea	8 (3.8%)
Mixed subtype	58 (27.2%)
<i>Disease activity measures</i>	
mLoSSI mean (SD)	6.5 (11.1)
PGA-A mean (SD)	2.0 (2.5)
<i>Disease damage measures</i>	
LoSDI mean (SD)	11.2 (11.5)
PGA-D mean (SD)	3.3 (2.5)
<i>Patient-reported outcomes</i>	
CHAQ median (IQR); <i>n</i> =178	0 (0,0)
CDLQI median (IQR); <i>n</i> =159	2 (0,5)
Patient global VAS mean (SD); <i>n</i> =170	2.1 (2.5)
<i>Parent-reported outcomes</i>	
Parent global impact VAS mean (SD); <i>n</i> =170	2.7 (2.9)
<i>Systemic DMARDS/biologics/small molecules at baseline</i>	
Methotrexate	117 (54.9%)
Mycophenolate mofetil	53 (24.9%)
Tocilizumab	25 (11.7%)
Abatacept	7 (3.3%)
Hydroxychloroquine	9 (4.2%)
Azathioprine	1 (0.5%)
Infliximab	1 (0.5%)
Intravenous immunoglobulin	2 (0.9%)
Other immunomodulators:	
Tofacitinib	3 (1.4%)
Imatinib	1 (0.5%)
Dupilumab	1 (0.5%)
Intravenous immunoglobulin	6 (2.8%)

Unless specified, data is from 213 participants. Missing data for CHAQ was 35/213 (16.4%) and CDLQI was 54/213 (25.4%). CHAQ and CDLQI were only collected where a translated version was available for the language spoken at that site. Missing data for patient and parent VAS were both 43/213 (20.2%). Wording used for patient global VAS: 'How much has your condition (localized scleroderma) affected you OVERALL in the PAST MONTH?', range 0-10; wording for parent global impact VAS: 'How much IMPACT has your child's disease had on their life in the PAST MONTH?', range 0-10.

CDLQI, Children's Dermatology Life Quality Index (range 0-30); CHAQ, Childhood Health Assessment Questionnaire (range 0-3); DMARD, disease-modifying anti-rheumatic drug; PGA-A, physician's global of disease activity; PGA-D, physician's global of disease damage; IQR, interquartile range; LoSDI, localised scleroderma damage index; mLoSSI, modified localised scleroderma skin severity index; SD, standard deviation; VAS, visual analogue scale

Table 2. Summary of issues identified during pre-testing cognitive interviews which led to item revisions

Language version	Item amended	Reason
Brazilian Portuguese	Item 3. Uncomfortable tight skin	Change wording of 'tight' to more suitable word
	Item 12. Stiff joints	Change wording of 'stiff' to more suitable word
	Item 18. Getting teased about the way I look	Change wording of 'teased' to more suitable word
	Item 19. Being bullied about the way I look	Change wording of 'bullied' to more suitable word
Danish	Instructions	Change wording of 'instrument' in title to more suitable word
	Medication subscale: Since my last visit to the doctor, my medicine side effects are ...	Change wording Translation not that understandable
	Medication subscale: Item 3. Feeling sick	Change wording Translation not that understandable
Dutch	Instructions	Typographical error
	Item 4. My skin feeling different	Change wording - word 'zich' incorrect and was corrected
	Item 17. Covering up my scleroderma with things like long sleeves, trousers, makeup, or retainers.	Remove reference to retainers as not understood
	Medication subscale: Item 3. Feeling sick	Remove word direct
	Medication subscale: Item 5. My stomach hurting	Change wording Translation not that understandable

German	Stem to main instructions	Change wording - 'not bothered' translated incorrectly
	Item 19. Being bullied about the way I look	Change wording of 'bullied' to more suitable word
Hindi	Item 3. Uncomfortable tight skin	Addition of English wording English word for 'tight' added as well as Hindi word for 'tight'
	Item 19. Being bullied about the way I look	Addition of English wording English word for 'bullied' added as well as Hindi word for 'bullied'
Polish	Item 6. Problems using my hands	Change wording Translation not that understandable
	Item 7. Problems using my hands when I do things <u>for a long time</u>	Change wording Translation not that understandable
	Item 19. Being bullied about the way I look	Change wording of 'bullied' to more suitable word

Table 3. Harmonization across language versions: Cross-language recommendations.

Item / Component	Issue Category	Issue frequency	Recommendation
Items 1-4: 1. Itch skin 2. Painful skin 3. Uncomfortably tight skin 4. Skin feeling different	Duplicative content / repetitive items	Spain-Spanish (n=4)	Evaluate item performance quantitatively

Item 3. Uncomfortably tight skin	Understanding / comprehension issue	India-Hindi (n=9) Brazil-Portuguese (n=5) Italian (n=2)	Change made to Hindi and Brazilian Portuguese versions for word 'tight'
Item 4. Skin feeling different	Understanding / comprehension issue	Dutch (n=3) Spanish-Spain (n=4) British English (n=2) Polish (n=1)	Evaluate item performance quantitatively
Item 6. & 7.* 6. Problems using my hands when I do things like write, text, or type; 7. Problems using my hands when I do things like write, text, or type for a long time	Duplicative content / repetitive items	Norwegian (n=1) Italian (n=2) Brazil-Portuguese (n=1) Danish (n=1) German (n=12) Singaporean English (n=1) Spain-Spanish (n=1)	Consider removing one item in final version; evaluate item performance quantitatively
	Understanding / comprehension issue	Polish (n=1) German (n=2)	
Item 12. Stiff joints	Understanding / comprehension issue:	Brazil-Portuguese (n=3)	Change made to Brazilian Portuguese version for word 'stiff'
Item 17. Covering up my scleroderma with things like long sleeves, long pants, makeup, or retainers	Understanding / comprehension issue: "retainers"	India-Hindi (n=1) Dutch (n=1)	Recommended remove 'retainers' from version-Netherlands, continue to consider if this should be made across all versions
Item 18. & 19.* 18. Getting teased about the way I look	Duplicative content / repetitive items	Norwegian (n=2) Dutch (n=1) Brazil-Portuguese (n=3)	Consider removing one item in final version; evaluate item performance quantitatively

19. Being bullied about the way I look		German (n=8)	
	Understanding / comprehension issue	Polish (n=13) Brazil-Portuguese (n=5) India-Hindi (n=9) on item 19.	Update these items on Polish, Brazilian Portuguese for both items 18 and 19 and Hindi language version for item 19
Medication subscale Item 9. Feeling like I am in a fog or its hard to think clearly.	Understanding / comprehension issue	Dutch (n=1) Spanish-Spain (n=1) Singaporean English (n=1) Brazil-Portuguese (n=1)	Explore this item quantitatively - this may be a hard symptom for children to understand, especially if they have not experienced it directly

*Please note, these issues also came up frequently during the content-representation discussion within the cognitive interviews.

Table 5. Item level response frequency (n=212 for main LoSQI items and n=165 for medication subscale)

	0 = does not bother	1 = bothers a little	2 = bothers a medium amount	3 = bothers a lot
Q1 Itchy skin	162 (76.4%)	40 (18.9%)	7 (3.3%)	3 (1.4%)
Q2 Painful skin	165 (77.8%)	31 (14.6%)	10 (4.7%)	6 (2.8%)
Q3 Uncomfortably tight skin	154 (72.6%)	31 (14.6%)	15 (7.1%)	12 (5.7%)
Q4 Skin feeling different	113 (53.3%)	66 (31.1%)	17 (8.0%)	16 (7.5%)
Q5 Problems doing active things	168 (79.2%)	28 (13.2%)	6 (2.8%)	10 (4.7%)
Q6 Problems using my hands	199 (93.9%)	11 (5.2%)	1 (0.5%)	1 (0.5%)
Q7 Problems using my hands for a long time	188 (88.7%)	16 (7.5%)	7 (3.3%)	1 (0.5%)
Q8 Worry about doing certain activities	157 (74.1%)	35 (16.5%)	14 (6.6%)	6 (2.8%)
Q9 Problems doing fun things	197 (92.9%)	10 (4.7%)	4 (1.9%)	1 (0.5%)
Q10 Muscles hurting	170 (80.2%)	27 (12.7%)	8 (3.8%)	7 (3.3%)
Q11 Aches in joints	160 (75.5%)	41 (19.3%)	8 (3.8%)	3 (1.4%)

Q12 Stiff joints	174 (82.1%)	26 (12.3%)	7 (3.3%)	5 (2.4%)
Q13 Feeling embarrassed about how my body looks	108 (50.9%)	47 (22.2%)	26 (12.3%)	31 (14.6%)
Q14 Feeling nervous around new people	128 (60.4%)	41 (19.3%)	19 (9.0%)	24 (11.3%)
Q15 Feeling different	127 (59.9%)	43 (20.3%)	25 (11.8%)	17 (8.0%)
Q16 Feeling upset	135 (63.7%)	37 (17.5%)	24 (11.3%)	16 (7.5%)
Q17 Covering up my scleroderma	146 (68.9%)	28 (13.2%)	14 (6.6%)	24 (11.3%)
Q18 Getting teased about how I look	178 (84.0%)	13 (6.1%)	9 (4.2%)	12 (5.7%)
Q19 Getting bullied about how I look	182 (85.8%)	13 (6.1%)	8 (3.8%)	9 (4.2%)
Q20 Having to miss school	97 (45.8%)	70 (33.0%)	26 (12.3%)	19 (9.0%)
Q21 Getting my blood taken	125 (59.0%)	51 (24.1%)	19 (9.0%)	17 (8.0%)
Medication subscale				
	Better	Same	Worse	No side-effects
My medications side effects are	69 (41.8%)	90 (54.5%)	4 (2.4%)	2 (1.2%)
In the past 7 days	0 = does not bother	1= bothers a little	2 = bothers a medium amount	3 = bothers a lot
MS1 Worry about side effects	107 (64.8%)	40 (24.2%)	9 (5.5%)	9 (5.5%)
MS2 Embarrassed that need to take medications	136 (82.4%)	17 (10.3%)	8 (4.8%)	4 (2.4%)
MS3 Feeling sick	117 (70.9%)	25 (15.2%)	15 (9.1%)	8 (4.8%)
MS4 Feeling hungry	128 (77.6%)	22 (13.3%)	9 (5.5%)	6 (3.6%)
MS5 Stomach hurting	127 (77.0%)	23 (13.9%)	9 (5.5%)	6 (3.6%)
MS6 Not feeling like eating	122 (73.9%)	31 (18.8%)	10 (6.1%)	2 (1.2%)
MS7 Vomiting	132 (80.0%)	16 (9.7%)	11 (6.7%)	6 (3.6%)
MS8 Feeling tired	144 (87.3%)	37 (22.4%)	16 (9.7%)	13 (7.9%)
MS9 Hard to think	144 (87.3%)	9 (5.5%)	8 (4.8%)	4 (2.4%)

MS10 Headaches	128 (77.6%)	19 (11.5%)	10 (6.1%)	8 (4.8%)
MS11 Gaining Weight	135 (81.8%)	15 (9.1%)	9 (5.5%)	6 (3.6%)
	Strongly agree	Agree	Disagree	Strongly Disagree
MS12 I believe my medicine will help me get better	69 (41.8%)	90 (54.5%)	4 (2.4%)	2 (1.2%)



