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Mapping and validation of generic PedsQL scores to utility values for individuals with sickle cell disease

Boshen Jiao[1], **Jane S. Hankins**[2], **Beth Devine**[1,3], **Martha Barton**[2], **M. Bender**[4,5], **Anirban Basu**[1,3]

[1]The Comparative Health Outcomes, Policy, and Economics (CHOICE) Institute, University of Washington

[2]Department of Hematology, St. Jude Children's Research Hospital

[3]Department of Health Services, University of Washington

[4]Department of Pediatrics, University of Washington

[5]Clinical Research Division, Fred Hutchinson Cancer Research Center

Abstract

Purpose—There is a paucity of empirically estimated health state utility (HSU) values to estimate health-related quality of life among individuals with sickle cell disease (SCD). This study aims to map the Pediatric Quality of Life Inventory generic core scales (PedsQL GCS) to HSUs for children and adolescents with SCD in the United States, using published algorithms, and to assess the construct validity of these HSUs against SCD-specific PedsQL scores.

Methods—We used the published mapping algorithms identified in four published articles, in which the PedsQL GCS was mapped to either the EuroQol-5 Dimension 3-Level, Youth Version or the Child Health Utility 9-Dimension to obtain HSUs. We employed the algorithms to calculate HSUs for a sample of children and adolescents from the Sickle Cell Clinical Research and Intervention Program. To assess the construct validity of the mapped HSUs in SCD patients, we computed Spearman's correlation coefficient comparing the HSUs with the PedsQL SCD total score and separately with each PedsQL SCD dimension-specific score.

Results—The mean mapped HSU was 0.792 (95% CI:0.782–0.801). It was significantly higher among children aged 5–12 years than children aged 13–17 years. The Spearman's correlation

CORRESPONDING AUTHOR: Anirban Basu, PhD, PharmD, MBA, basua@uw.edu, Phone: +1 (206) 616-2986, Address: 1959 NE Pacific Street, H-375Q; Box 357630, Seattle, WA, 98195-7630.

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No contributing authors have a conflict of interest.

Code availability
Codes are available upon request.

Ethics approval
The study protocol was approved by the St. Jude Children's Research Hospital Institutional Review Board

Consent to participate
The authors affirm that signed informed consents were obtained from all individual participants included in this study.

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The authors affirm that individual participants provided informed consent for publication of their data.

coefficient for HSUs versus PedsQL SCD total scores was 0.64 (95% CI: 0.57–0.71). Correlations ranged from 0.40 (95% CI: 0.32–0.48) to 0.60 (95% CI: 0.54–0.66) for HSUs versus PedsQL SCD dimension-specific scores.

Conclusions—The existing mapping algorithms show acceptable construct validity in children and adolescents with SCD. Additional algorithms are needed for adults and for specific SCD comorbidities.

INTRODUCTION

Sickle cell disease (SCD) refers to a group of genetically inherited disorders of hemoglobin affecting over 20 million people worldwide [1]. In the United States (U.S.), approximately 100,000 people live with SCD; most are of African descent [1]. SCD can lead to a number of acute and chronic complications including acute pain episodes, stroke, acute chest syndrome, chronic pain, symptomatic anemia, and increased risk of infections and organ damage [1, 2]; each associated with significant impairment of health-related quality of life (HRQL) [3–5].

HRQL can be measured by defining the relevant health states and eliciting values that represent the utility of each of these states. Such health state utility (HSU) values are most often elicited using survey instruments that exist for this purpose. Those most often employed are the EuroQol-5 Dimension (EQ-5D), Short Form-6 Dimension (SF-6D), and the Health Utilities Index (HUI) [6]. There is also a growing range of instruments designed for children and adolescents including the EQ-5D, Youth Version (EQ-5D-Y) and Child Health Utility-9 dimensions (CHU-9D) [7]. Previous studies have elicited average HSUs or HSUs associated with pain in SCD patients using EQ-5D or SF-6D [8–11]. However, none of the instruments are SCD-specific. It is also worth noting that the existing SCD-specific HRQL instruments, such as Adult Sickle Cell Quality of Life Measurement Information System (ASCQ-me) [12] and Pediatric Quality of Life Inventory SCD module (PedsQL SCD) [13], have not yet been mapped to HSUs.

HSUs are incorporated in cost-utility analyses (CUA) for the calculation of quality-adjusted life years (QALYs). For example, the Institute for Clinical and Economic Review, a U.S.-based health technology assessment agency, recently published a CUA assessing the new SCD-modifying therapies, crizanlizumab, voxelotor and L-gluatmine for SCD. In this CUA, baseline average HSUs and HSUs associated with specific comorbidities in patients with SCD [14]. However, the HSUs used in this model relied heavily on utilities obtained from studies conducted in non-SCD-specific populations, suggesting lack of empirically estimated HSUs for SCD patients.

When HSU values are not available, one can map one or more scores on a health status instrument to utility scores if a mapping algorithm is available. The PedsQL is one such example. Several studies have developed and validated algorithms that map the PedsQL score generic core score (GCS) to HSU values elicited using the EQ-5D-Y, 3-Level (EQ-5D-Y-3L) or the Child HUI-9 dimensions (CHU-9D) [15–18]. These mappings have been completed in a general population of children [15, 17, 18] or children with corticosteroid-sensitive nephrotic syndrome [16], but never in children with SCD. A recent systematic

review shows that few study has employed the existing algorithms to estimate HSU for SCD populations [19]. Moreover, the construct validity of those algorithms to SCD populations remains unexplored. Here, the construct validity represents the degree to which mapped HSUs measure HRQL among individuals with SCD. Our objectives were to map the PedsQL GCS scores to HSUs in SCD patients using the existing algorithms, and to assess the construct validity of these algorithms by comparing the mapped HSUs against the PedsQL SCD scores.

METHODS

HRQL Measures

The PedsQL GCS is a non-preference-based, 23-item, generic measure of HRQL in children and adolescents aged 2–18 years [20]. A child self-report version is available for children aged 5–18 years, and a parent-proxy report version for all eligible children [20]. Four dimensions of pediatric HRQL functioning are assessed: physical (8 items), emotional (5 items), social (4 items), and school (4 items) [20]. Participants' responses are rated on a 0–4 scale: 0 indicates "never a problem", 1 for "almost never a problem", 2 for "sometimes a problem", 3 for "often a problem", and 4 for "almost always a problem" [20]. The ratings are reverse-scored and linearly transformed into a score ranging from 0to 100. A higher total score indicates better HRQL [20]. Both dimension-specific and total scores can be calculated; the mean is computed as the sum of the relevant item-specific scores over the number of relevant items answered. If more than 50% of the items for the calculation are missing, scores are not computed.

Our analysis also utilized the 43-item PedsQL SCD modules. The PedsQL SCD modules are comprised of nine modules: pain and hurt (9 items), pain impact (10 items), pain management and control (2 items), worry I (5 items), worry II (2 items), emotions (2 items), treatment (7 items), communication I (3 items), communication II (3 items) [13]. The same reverse-scoring, linearly transformation method, and score calculation is used [13].

The EQ-5D-Y-3L and CHU-9D were used as the HSU elicitation instruments in the included mapping studies [15–18]. The EQ-5D-Y is a generic preference-based measure of HRQL [21]. The EQ-5D-Y modifies EQ-5D's wording to become more child-friendly. It is comprised of five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression [21]. Each dimension is examined by a single question on a three-point scale (no problems, some problems, a lot of problems) [21]. The CHU-9D is another generic preference-based measure of HRQL designed for children. It is comprised of nine dimensions: worried, sad, pain, tired, annoyed, schoolwork, sleep, daily routine, and ability to join in activities [7]. Similarly, one question is asked for each dimension and the response is rated from 1 (no problems) to 5 (severe problems) [7]. We qualitatively assessed whether the dimensions of EQ-5D-Y-3L or CHU-9D overlap with PedsQL GCS or PedsQL SCD. Specifically, we examined whether the concept measured by each question under each dimension of PedsQL GCS or PedsQL SCD aligned with each dimension of EQ-5D-Y-3L or CHU-9D.

Existing Mapping Algorithms

We searched the databases of PubMed and Embase (search terms can be found in Supplementary Materials Appendix 1) and initially identified five studies that had previously developed mapping algorithms to estimate HSUs from the PedsQL GCS [15–18, 22]. We excluded one study, as it focused on children with autism and used autism-specific variables [22]. We examined the remaining four studies. A summary of the characteristics of the included four studies and their mapping algorithms are presented in Supplementary Materials Appendix 2. These studies focused on various age ranges, collectively spanning 5–17 years. Three of them used the child self-report [15, 17, 18] and one used the parent-proxy report [16]. Three studies mapped the PedsQL GCS to the CHU-9D utility [16–18], and one mapped to the EQ-5D-Y-3L utility [15]. All the studies reported more than one mapping algorithm [15, 16, 18]. Both Mpundu-Kaambwa et al [17] and Sweeney et al [18] reported three algorithms, but one of them from each study was not included in our analysis because it contains PedsQL GCS item-specific variables that are not available in our data.

Data

Our study utilized the data from the Sickle Cell Clinical Research and Intervention Program (SCCRIP). SCCRIP is a lifetime cohort study that enrolls participants diagnosed with SCD of any genotype and prospectively follows them prospectively for health outcomes [23]. SCCRIP enrolled patients from five institutions in four states in the U.S. (e.g., Illinois, Louisiana, North Carolina, and Tennessee). Our dataset included scores on the PedsQLl GCS and PedsQL SCD for 859 patients who completed these questionnaires between November 2014–December 2019. These were completed either by self- or parent-proxy report, according to the participant's age. We only included the participants whose ages and respondent types aligned with the included mapping studies (e.g., 10–17 years using child self-report and 5–13 years old using parent proxy report). Our final sample contains 533 children and adolescents with SCD. A flow chart of sample selection is presented in Figure 1.

HSU Calculation

Each mapping algorithm was developed from a sample with a specific age range and respondent type. Thus, we applied the algorithm deterministically to the PedsQL GCS scores reported by participants of the corresponding ages and respondent types. The details can be found in Table 1. For example, using the algorithm developed by Khan et al, we calculated HSUs for participants who were 11–15 years and have self-report scores [15]. Some algorithms' corresponding ages and respondent types overlap, and thereby, more than one algorithms were employed for those participants. The same person was assigned multiple HSUs, and then we averaged the HSU scores. Also, the self-report-based mapping algorithms (Khan et al [15] and Sweeney et al [18]) and the proxy-report-based mapping algorithms (Lambe et al [16]) overlap for the age from 10 to 13 years. Some participants in this age range have both self-reported and proxy-reported PedsQL scores. As a result, they would have both self-reported and proxy-reported HSUs. In these instances, we used only the self-report HSUs (Figure 1). Thus, each participant only has one final HSU.

A supplementary analysis was performed in those participants would have both 'self-reported HSU' and 'proxy-reported HSU', aiming to test whether the two types of HSU differed from each other. The details of this analysis can be found in the Supplementary Materials Appendix 3. For each of those participants, we calculated the ratio of the 'self-reported HSU' to 'proxy-reported HSU'. We found the mean of the ratios (0.87, 95% CI: 0.85–0.89) was significantly less than 1. In the main analysis, therefore, for those in whom only the proxy report was available, we deflated the 'proxy-reported' HSUs by 13%. Standard errors and 95% confidence intervals (CI) were obtained using 1,000 bootstrapped replicates.

Construct Validity

Previous studies examined the construct validity of HSUs by exploring correlation between HSUs and well-established HRQL measures [24–26]. Following this approach, we assessed the construct validity of our mapped HSUs against the PedsQL SCD total scores by calculating Spearman correlation coefficients. The PedsQL SCD total score variable did not have missing values in the final sample. Next, we correlated HSUs with each of the PedsQL SCD dimension-specific scores. All PedsQL SCD dimension-specific scores had minor missingness: pain and hurt (0.2%), pain impact (0.2%), pain management and control (1.5%), worry I (0.6%), worry II (1.1%), emotions (0.9%), treatment (0.4%), communication I (0.4%), communication II (1.3%). We dropped observation with missing values for this analysis.

Subgroup Analysis

We computed the mean HSU within each of the subgroups defined by the baseline demographic and clinical characteristics, such as age, sex, race, and SCD genotypes. We also carried out the subgroup analyses for the correlations between the HSUs and the PedsQL SCD total scores.

RESULTS

Qualitative Comparison of the HRQL Measures

We assessed the overlapped dimensions of the HSU elicitation and PedsQL instruments (Appendix 4 in Supplementary Materials). Qualitatively, the dimensions measured by CHU-9D or EQ-5D-Y-3L are each aligned with the PedsQL GCS. The dimensions of CHU-9D or EQ-5D-Y-3L also overlap with most of the dimensions of PedsQL SCD. CHU-9D or EQ-5D-Y-3L does not explicitly measure the items in the dimension of communication I of PedsQL SCD, such as "it is hard for me to tell others when I am in pain" (although this might be implicitly measured by the emotion-related dimensions of the HSU instruments).

Descriptive Statistics

Participant demographic and clinical characteristics, PedsQL scores and the HSUs can be found in Table 2. The mean age of the children was 11 years (SD 4), 50.8% were male, and 99.2% were Black. 57.6% of the children had sickle cell anemia (HbSS or HbSβ^0-thalassemia), 26.6% had sickle hemoglobin-C disease (HbSC), 9.0% had sickle beta-plus

thalassemia (HbSβ^+-thalassemia), and 4.7% had sickle hemoglobin-O disease (HbSO). In terms of respondent type, 71.3% were from child self-report. The mean PedsQL GCS total score was 75 (SD 14), and the PedsQL SCD total score was 73 (SD 17). The PedsQL SCD dimension-specific scores ranged from 64 (SD 23) for pain impact to 85 (SD 22) for worry II.

Mapping

Table 3 presents the mean final mapped HSUs among all the individuals and within each of the demographic and clinical subgroups. Overall, the mean HSU was 0.792 (95% CI:0.782–0.801). HSU was higher among the children aged 5–12 years (0.816; 95% CI: 0.807–0.825) than the ones aged above 12 years (0.734; 95% CI: 0.710–0.750).

Construct Validity

Figure 2 displays the scatterplot depicting the correlation of the HSUs mapped from each algorithm and the final HSUs with the PedsQL SCD total score; the Spearman's correlation coefficients ranged from 0.57 (95% CI: 0.55–0.59; ordinary least squares by Lambe et al [16]) to 0.72 (95% CI: 0.55–0.59; censored least absolute deviations by Sweeney et al [18]). Table 3 lists the subgroup-specific Spearman's correlation coefficients based on the final HSUs. The coefficients appeared to be consistent across the subgroups. Figure 3 presents the correlation coefficients for the final HSUs versus the PedsQL SCD dimension-specific scores, ranging from 0.40 (95% CI: 0.32–0.48; communication I) to 0.60 (95% CI: 0.54–0.66; pain hurt). All the correlations were statistically significant ($p < 0.001$).

DISCUSSION

Using the existing mapping algorithms, we mapped the empirically collected PedsQL GSC scores to HSUs for children and adolescents with SCD cared for in the SCCRIP cohort. We also assessed the construct validity of the mapped HSUs against PedsQL SCD scores. The significant positive correlation between HSUs and PedsQL SCD total scores suggests good construct validity of using those mapping algorithms among SCD patients. The significant positive correlation was also found when comparing HSUs with each of the PedsQL SCD dimension-specific scores.

Anie et al developed an algorithm mapping a visual analogue (VAS) pain score to HSUs in adult SCD patients in the U.K. [8]. Lubeck et al applied this algorithm to the setting of U.S. and reported a mean HSU of 0.69 for children with SCD [27]. They derived the VAS pain scores from a published study that was based on a sample of children aged 10–17 years [28]. Our mean HSU among the older children is consistent with that from Lubeck et al.

Preventing SCD complications can not only lower the risk of death, but also promote improved quality of life [4, 5]. Hence, to better value SCD interventions, using the QALY as a health outcome measure is desirable in the setting of CUAs. However, there is a dearth of empirically estimated HSUs associated with SCD [19]. Our study provides a practical and valid approach to estimating HSUs for QALY calculation for SCD patients using PedsQL GSC scores, which will support future development of CUAs in this field.

Our study mapped HRQL measures to HSUs in children and adolescents. Other HRQL measures may be useful for obtaining HSUs in adults. For example, ACSQ-Me has shown good validity when mapped to the SF-36 [29]. Although the SF-36 is not in itself a preference-based instrument, algorithms exist to convert it to a preference-based instrument — the SF-6D [30]. Future efforts can then be made to map ACSQ-Me to the SF-6D. Moreover, the Patient-Reported Outcomes Measurement Information System (PROMIS) has been administered to SCD patients [31–33]. HSUs can be attached to health states described by PROMIS using a PROMIS-Preference scoring system based on multi-attribute utility theory [34].

This present study has some key strengths. This is the first attempt to assess the construct validity of the existing PedsQL-HSU mapping algorithms in the SCD population. We compared the mapped HSUs against a comprehensive HRQL measure designed specifically for children and adolescents with SCD, containing not only the PedQL SCD total score, but also PedQL SCD dimension-specific scores. It is also worth noting the large variation across the mapping studies in terms of study population (e.g., different age ranges) and reporting (e.g., Khan et al.[15] reported PedsQL on a scale of 0 to 1, whereas Lambe et al.[16] employed a scale of 0 to 100). To overcome this challenge and ensure the replicability, we provided sufficient and transparent details to elucidate our mapping exercises corresponding to each study. Additionally, our sample covers a wide age range of children and adolescents. Finally, the PedsQL data in SCCRIP were collected from four institutions in five states in the U.S., hence has good geographic representation.

Our study also has a few limitations. First, the academic setting in which SCD patients are treated in SCCRIP may make them different from those treated in other settings or in other locales, thus limiting generalizability. Second, the existing mapping algorithms only focused on children and adolescents. Future studies should develop mapping methods for adults with SCD, by either extrapolating the current algorithms or using other HRQL measures such as ACSQ-Me or PROMIS. Third, our study did not assess the external validity of the published mapping algorithms in SCD population, i.e., the predictive accuracy of the algorithms in this context. This needs to be done by comparing mapped versus observed HSUs among those individuals. Finally, we did not examine HSUs associated with a specific SCD acute event, such as VOC, or with one or more SCD-related chronic comorbidities.

CONCLUSIONS

The existing algorithms that map the PedsQL GCS to HSUs show acceptable construct validity among children and adolescents with SCD. These algorithms can be employed to estimate HSUs in SCD patients and facilitate QALY calculations in CUAs of SCD interventions. Future studies should develop algorithms in adults with SCD and for specific SCD complications.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Availability of data and material

The data are not publicly available due to security protocols and privacy regulations.

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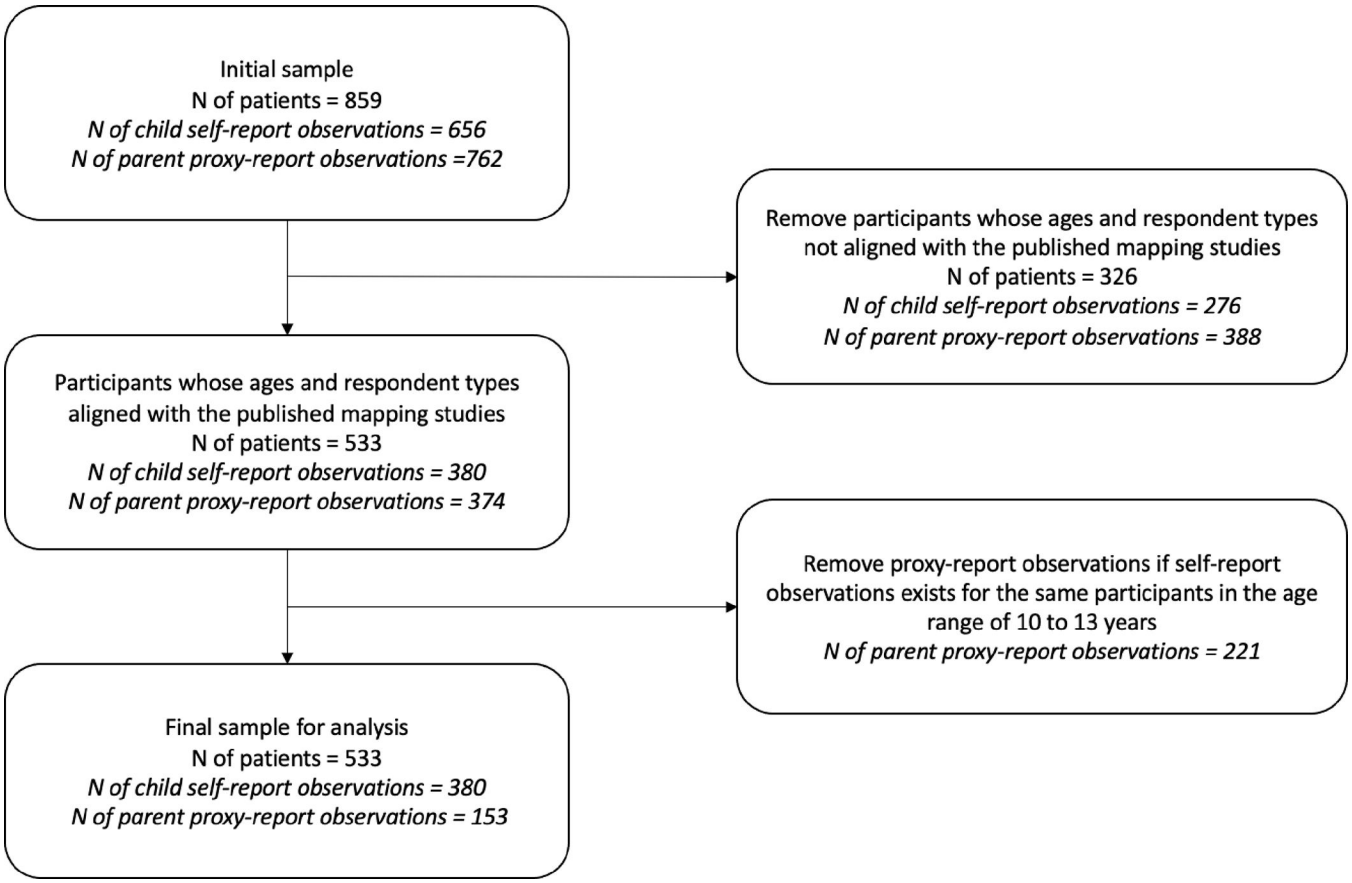

Figure 1. Flow diagram of sample selection

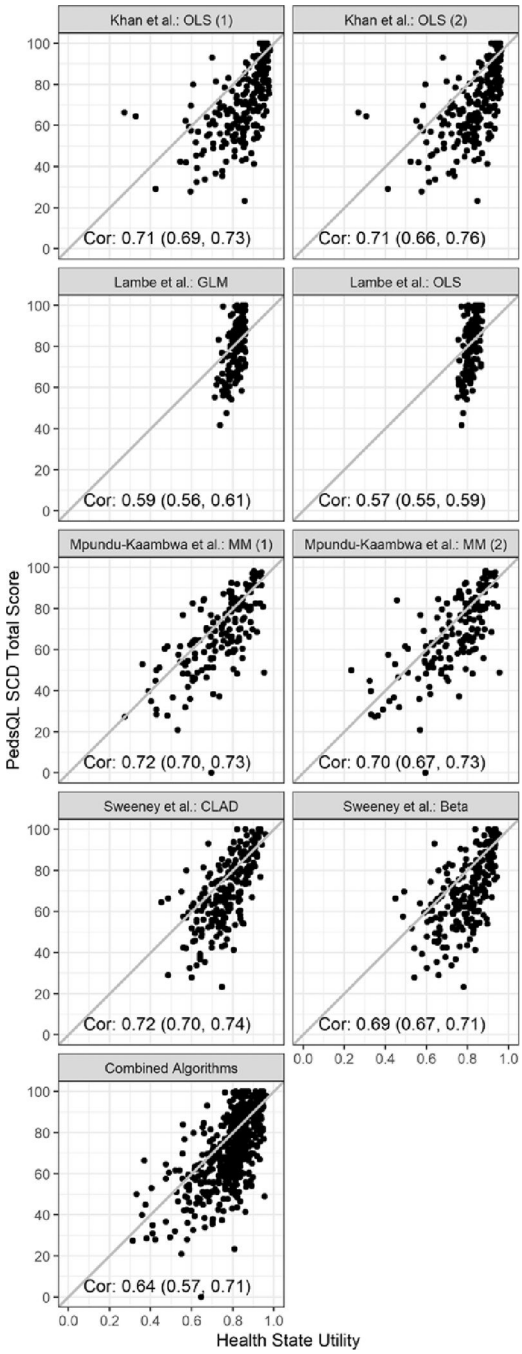

Figure 2. Correlations of health state utilities mapped from each algorithm and the combined algorithms with PedsQL SCD total score

Note: The header of each panel indicates the mapping algorithm, of which the details can be found in Table 1. The text in each panel indicates the Spearman's correlation coefficient and 95% confidence interval.

Abbreviations: PedsQL = Pediatric Quality of Life Inventory; SCD = sickle cell disease

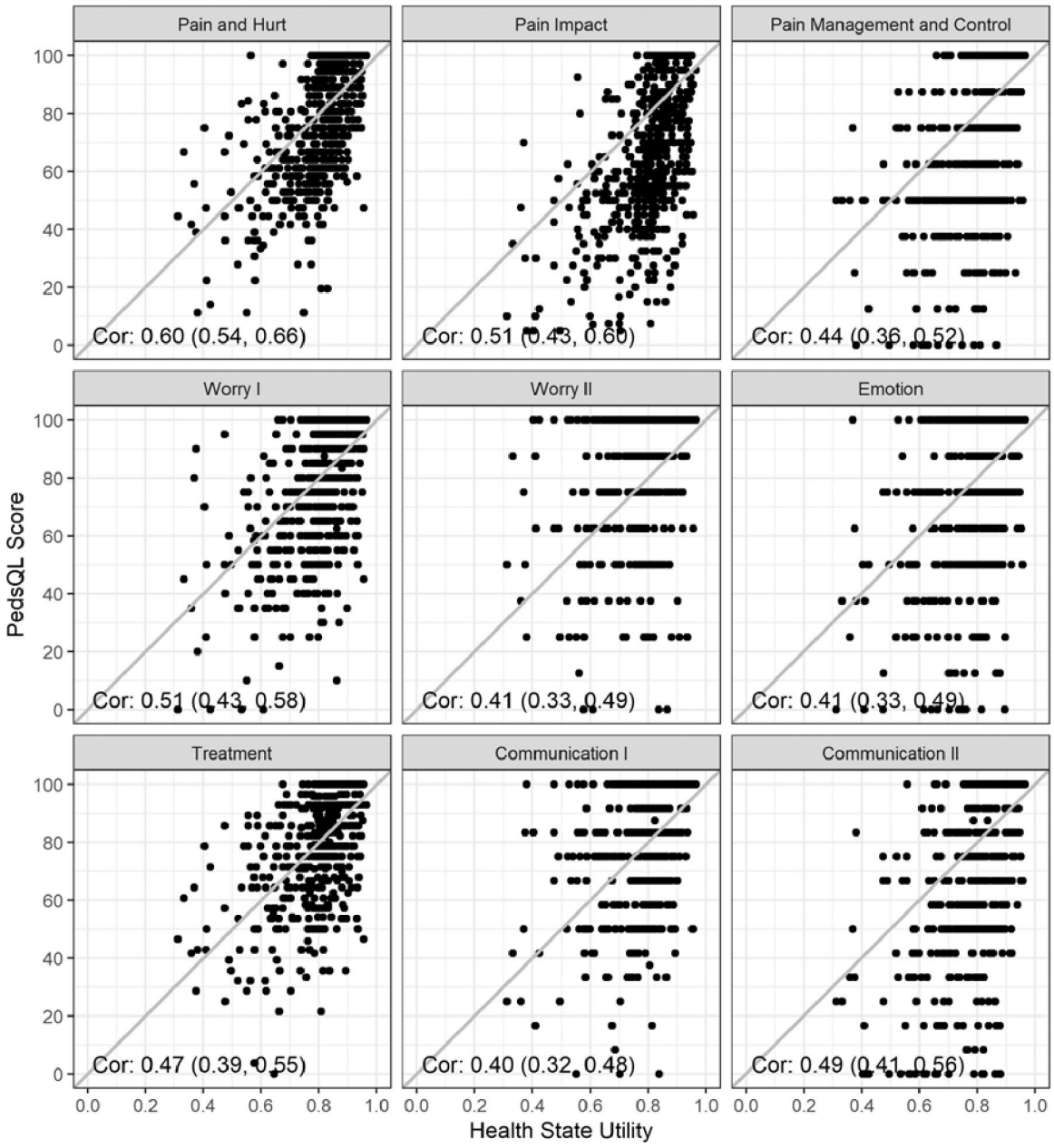

Figure 3. Correlations of final health state utilities with PedsQL SCD module-specific score

Note: The header of each panel indicates the PedsQL SCD module, of which the details can be found in Table 1. The text in each panel indicates the Spearman's correlation coefficient and 95% confidence interval.

Abbreviations: PedsQL = Pediatric Quality of Life Inventory; SCD = sickle cell disease

Table 1.

Algorithms used to map PedsQL score to HSU for each age group

Age group of individuals with SCD	N	Self-report/ Proxy-report	Mapping study	Algorithms used to convert PedsQL to HSU
5–9	153	Proxy-report	Lambe et al., 2017[16]	• LOGIT = 0.7135215 + 0.0279345 * Age − 0.0546336 * Gender + 0.000162 * PedsQL PF Squared + 0.000477 * PedsQL EF Squared - 0.000040 * PedsQL SF Squared − 0.0001646 PedsQL SchF Squared − 0.000110 * PedsQL PF * EF − 0.000114 * PedsQL PF * SF + 0.000037 * PedsQL PF * SchF − 0.000246 * PedsQL PF * SF − 0.000116 * PedsQL PF * SchF + 0.000436 * PedsQL SF * SchF • HSU = exp(LOGIT)/(1+exp(LOGIT))
				• HSU = 0.7422337 + 0.0007133 * PedsQL PF + 0.0016477 * PedsQL EF − 0.00011 * PedsQL SF + 0.000261 * PedsQL SchF
10	0	-	-	-
11–12	223	Self-report	Khan et al., 2014[15]	• HSU = −0.335861 – 0.006136 * Age − 0.009385 * Gender + 0.009067 * PedsQL PF + 0.006807 * PedsQL EF + 0.005630 * PedsQL SF + 0.005802 * PedsQL SchF + 0.000020 * PedsQL PF Squared − 0.000049 * PedsQL EF Squared + 0.000011 * PedsQL SF Squared − 0.000017 * PedsQL SchF Squared − 0.000005 * PedsQL PF * EF − 0.000053 * PedsQL PF * SF − 0.000066 * PedsQL PF * SchF − 0.000011 * PedsQL EF * SF + 0.000061 * PedsQL EF * SchF − 0.000026 * PedsQL SF * SchF
				• HSU = −0.428496 + 0.009127 * PedsQL PF + 0.006611 * PedsQL EF + 0.005705 * PedsQL SF + 0.006011 * PedsQL SchF + 0.000020 * PedsQL PF Squared -0.000048 * PedsQL EF Squared + 0.000011 * PedsQL SF Squared − 0.000017 * PedsQL SchF Squared − 0.000004 * PedsQL PF * EF − 0.000055 * PedsQL PF * SF − 0.000066 * PedsQL PF * SchF − 0.000009 * PedsQL EF * SF + 0.000059 * PedsQL EF * SchF − 0.000027 * PedsQL SF * SchF
11–12	223	Self-report	Sweeney et al., 2020[18]	• HSU = 0.2244533 + 0.0167794 * Male + 0.7507663 * (PedsQL Total/100)
				• BETA = 1.611745 − 0.1198546 ∗ Age + 0.1686639 ∗ Male − 4.724501 ∗ (PedsQL PF/100) + 2.447472 ∗ (PedsQL EF/100) + 0.9967647 ∗ (PedsQL SchF + 4.144465/100) ∗ (PedsQL PF/100) Squared • HSU = exp(BETA)/(1+exp(BETA))
13–15	0	-	-	-
16–17	157	Self-report	Mpundu-Kaambwa et al., 2017[17]	• HSU = −0.135516 + 0.264648 * (PedsQL PF/100) + 1.196678 * (PedsQL EF/100) + 0.203405 (PedsQL SchF/100) − 0.572612 * (PedsQL EF/100) Squared
				• HSU = −0.210178 + 1.707043 ∗ (PedsQL Total/100) − 0.543056 ∗ (PedsQL Total/100) Squared

Abbreviations: CI = confidence interval; EF = emotional functioning, HSU = health state utility, PedsQL = Pediatric Quality of Life Inventory, PF = physical functioning, SchF = school functioning, SCD = sickle cell disease; SF = social functioning

Table 2.

Descriptive statistics of demographic and clinical characteristics, and PedsQL scores

Variable	Mean (SD) or N (%)
Age (years)	11 (4)
Sex	
Female	262 (49.2%)
Male	271 (50.8%)
Race	
Black	529 (99.2%)
Other	4 (0.8%)
SCD genotype	
Sickle Cell Anemia (HbSS or HbSβ^0-thalassemia)	307 (57.6%)
Sickle Hemoglobin-C Disease (HbSC)	142 (26.6%)
Sickle Beta-Plus Thalassemia (HbSβ^+-thalassemia	48 (9.0%)
Sickle Hemoglobin-O Disease (HbSO)	25 (4.7%)
Other	11 (2.1%)
Respondent Type	
Child self-report	380 (71.3%)
Parent proxy-report	153 (28.7%)
PedsQL GCS Total Score	75 (14)
Physical functioning	77 (16)
Emotional functioning	75 (19)
Social functioning	83 (17)
School work functioning	64 (18)
PedsQL SCD Total Score	73 (17)
Pain and hurt	73 (19)
Pain impact	64 (23)
Pain management and control	69 (26)
Worry I	76 (22)
Worry II	85 (22)
Emotions	77 (26)
Treatment	78 (19)
Communication I	82 (22)
Communication II	70 (28)

Abbreviations: GCS = general core scale; PedsQL = Pediatric Quality of Life Inventory; SCD = sickle cell disease; SF = social functioning; SD =standard deviation

Table 3.

Mean final HSUs and correlations between HSUs and PedsQL SCD total scores among all individuals with SCD, and within demographic and clinical subgroups

Group	Mean HSU (95% CI)	Spearman's correlation coefficient between HSU and PedsQL SCD total score (95% CI)
All	0.792 (0.782– 0.801)	0.64 (0.57–0.71)
Age group (years)		
5–12	0.816 (0.807–0.825)	0.59 (0.50–0.69)
13–17	0.734 (0.710–0.757)	0.71 (0.61–0.81)
Sex		
Female	0.781 (0.768–0.794)	0.70 (0.61–0.79)
Male	0.802 (0.791–0.814)	0.58 (0.48–0.68)
Race		
Black	0.791 (0.782–0.801)	0.64 (0.57–0.72)
SCD genotype		
Sickle Cell Anemia (HbSS or HbSβ^0-thalassemia)	0.788 (0.776–0.799)	0.65 (0.55–0.74)
Sickle Hemoglobin-C Disease (HbSC)	0.797 (0.780–0.815)	0.66 (0.54–0.78)
Sickle Beta-Plus Thalassemia (HbSβ^+-thalassemia	0.799 (0.774–0.824)	0.54 (0.30–0.78)
Sickle Hemoglobin-O Disease (HbSO)	0.796 (0.749–0.842)	0.61 (0.29–0.94)

Abbreviations: CI = confidence interval; HSU = health state utility, PedsQL GCS = Pediatric Quality of Life Inventory general core scale; PedsQL = Pediatric Quality of Life Inventory, SCD = sickle cell disease