



Original article

A Cross-Sectional Study of Quality of Life in Early-Onset Scoliosis Using the EQ-5D-5L

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Abstract

Early-onset scoliosis (EOS) can substantially affect health-related quality of life (HRQoL). This preliminary, exploratory study assessed selected psychometric properties of the Kazakh version of the EQ-5D-5L in children and adolescents with surgically treated EOS. Methods. This cross-sectional study with a test-retest component included 51 consecutive participants aged 6–15 years. The Kazakh EQ-5D-5L was completed at baseline and again after 8–10 days. Internal consistency was assessed using Cronbach's alpha, test-retest reliability using intraclass correlation coefficients (ICCs), and inter-dimension associations using Spearman correlations. Floor and ceiling effects were calculated, and multiple linear regression was used to explore factors associated with HRQoL. All analyses were considered exploratory and hypothesis-generating due to the modest sample size.

Results. Cronbach's alpha was 0.614, indicating moderate internal consistency. The highest ICCs were observed for Anxiety/Depression (1.000), Pain/Discomfort (0.848), and Usual Activities (0.834), whereas Self-care (0.502) and Mobility (0.187) showed lower reproducibility. Ceiling effects were observed across all EQ-5D-5L dimensions, ranging from 72.5% to 90.2%. In exploratory regression analysis, congenital scoliosis was associated with a lower mean EQ-5D-5L dimension score ($\beta = -0.142$, $p = 0.044$), while age and sex were not significantly associated with the outcome.

Conclusions. The Kazakh EQ-5D-5L demonstrated moderate internal consistency and dimension-specific test-retest reliability in this preliminary study. However, the modest sample size ($n=51$) limits the generalizability of these findings and precludes definitive conclusions about the instrument's validity. The Kazakh EQ-5D-5L may be considered

as a supplementary generic HRQoL measure in clinical practice only after its measurement properties are confirmed in larger, adequately powered studies. Future research should evaluate structural validity, responsiveness, and age-related differences, including comparison with the EQ-5D-Y-5L and proxy-report versions for younger children.

Keywords: early-onset scoliosis, EQ-5D-5L, health-related quality of life, psychometric properties, test–retest reliability.

1. Introduction

Scoliosis is a musculoskeletal disorder characterized by a lateral curvature of the spine that can progressively worsen during childhood, particularly during periods of active growth. Early detection and continuous monitoring are essential to prevent severe deformities and minimize the need for surgical interventions [1,2]. Various questionnaires are used to assess clinical symptoms, functional status, and health-related quality of life (HRQoL) in patients with scoliosis, providing valuable information to support informed clinical decision-making.

Early-onset scoliosis (EOS) is defined as a spinal deformity manifesting before the age of 10 years and characterized by a lateral curvature of more than 10 degrees. EOS is a complex condition with diverse etiologies, including idiopathic, congenital, genetic, and neuromuscular factors [1]. If untreated, EOS can result in severe health consequences, including impaired lung function, restricted mobility, and an increased risk of premature mortality [2]. Treatment options for EOS vary depending on the severity of the curvature and may include bracing, growth-promoting surgeries, and spinal fusion. The effectiveness of these interventions is typically evaluated through radiographic measurements of spinal curvature [1,2].

Questionnaires are an essential tool for a comprehensive assessment of HRQoL in patients with scoliosis, offering a more holistic view of their condition beyond clinical measurements. Among these tools, the EQ-5D-5L is a widely used standardized instrument that measures health status across 5 dimensions: Mobility, Self-care, Usual Activities, Pain/Discomfort, Anxiety/Depression. Each dimension is assessed on a 5-level scale, with higher scores indicating worse health status. The responses generate a 5-digit health-state profile, while the EQ visual analogue scale provides a separate measure of self-rated overall health. The EQ-5D-5L has been widely used across different populations and has demonstrated broad cross-cultural applicability [3-7]. Although the youth version (EQ-5D-Y-5L) is available

for pediatric populations, we used the adult EQ-5D-5L to align with local clinical practice and to enable comparability with existing studies in similar populations.

Despite its widespread use, the measurement properties of the EQ-5D-5L may vary across linguistic, cultural, age, and clinical populations. These factors may influence how patients understand individual questions and select response categories. This issue is particularly relevant in children and adolescents with EOS, in whom physical limitations, pain, emotional well-being, and age-related differences in comprehension may affect questionnaire responses. Therefore, the performance of the Kazakh EQ-5D-5L should be evaluated specifically in the target linguistic and clinical population.

Evidence regarding the measurement properties of the Kazakh EQ-5D-5L in children and adolescents with surgically treated EOS remains limited, and no prior data are available to guide its use in this specific population. To address this gap, the aim of this study was to conduct a preliminary evaluation of selected psychometric properties of the Kazakh EQ-5D-5L in children and adolescents with surgically treated EOS. Given the lack of prior data and the relatively small available sample, this investigation is intended to generate hypotheses and inform the design of future large-scale validation studies, rather than to provide definitive evidence of the instrument's validity. Such preliminary data are essential to determine whether the Kazakh EQ-5D-5L is suitable for use in clinical practice and research, and to identify which aspects of the instrument require further investigation before it can be recommended as a routine outcome measure in this population.

The objective of this study was to assess selected psychometric properties of the Kazakh version of the EQ-5D-5L questionnaire in children and adolescents with surgically treated early-onset scoliosis.

2. Materials and methods

2.1 Study Design and Setting

This cross-sectional observational study with a test–retest component was conducted at a single referral center specializing in pediatric spinal disorders between October 2024 and January 2025. The study aimed to evaluate selected measurement properties of the Kazakh version of the EQ-5D-5L in children and adolescents with surgically treated early-onset scoliosis (EOS). The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.

2.2 Participants and Recruitment

Consecutive sampling was used. All consecutive patients with EOS who attended the study center during the predefined recruitment period were

assessed for eligibility. A total of 125 potentially eligible patients were screened. Of these, 62 were excluded before enrollment: 57 did not meet the eligibility criteria and 5 declined to participate. The remaining 63 eligible patients provided informed consent and were enrolled in the study. After enrollment, 1 participant was unable to complete the questionnaire because of language difficulties, and 11 questionnaires were excluded because they were incomplete or incorrectly completed. Consequently, 51 participants were included in the final analysis. All 51 participants completed both the initial assessment and the retest performed 8–10 days later; therefore, there was no loss to follow-up during the test–retest period (Figure 1).

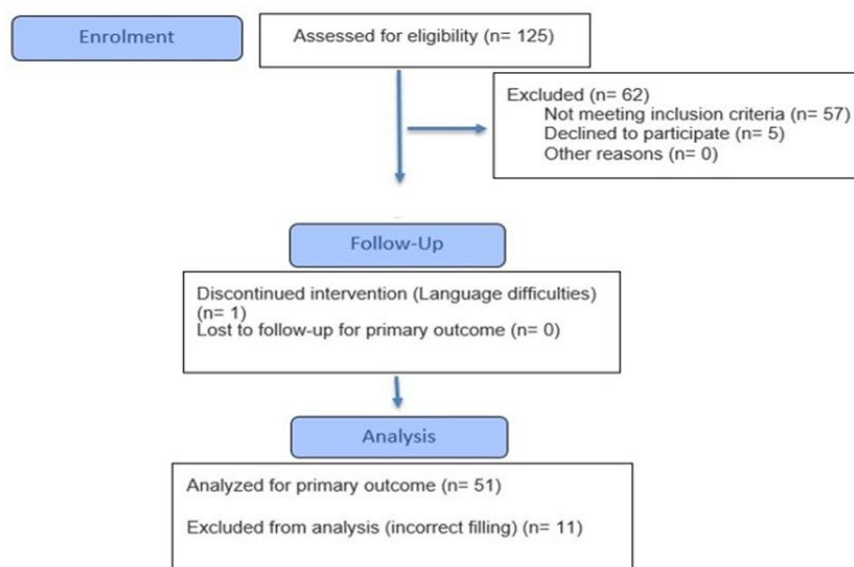


Figure 1 - Study Flowchart

2.3 Eligibility Criteria

The inclusion criteria were patients aged 6–15 years with a diagnosis of EOS who had undergone surgical correction at least 1 year before study enrollment. Patients attending routine postoperative follow-up or postoperative rehabilitation follow-up were eligible for participation. Exclusion criteria included cognitive impairment that might interfere with accurate self-reporting, as determined by the attending physician based on clinical assessment and medical history, severe comorbidities affecting mobility or psychosocial functioning, and neuromuscular or other secondary forms of scoliosis. Participants who were unable to complete the Kazakh-language questionnaire and questionnaires that were incomplete

or incorrectly completed were excluded from the final analysis.

2.4 Study Size

No formal a priori sample size calculation was performed. We used consecutive sampling of all eligible patients attending the study center during the recruitment period. The final sample comprised 51 participants with complete data. This sample size is sufficient for descriptive psychometric analyses (e.g., calculation of ICC, Cronbach's alpha, and ceiling/floor effects) but is below the recommended thresholds for exploratory or confirmatory factor analysis. Therefore, we explicitly frame this study as a preliminary investigation and do not claim to have comprehensively validated the instrument.

The results should be interpreted as exploratory and hypothesis-generating, and they need replication in larger independent samples.

2.5 Ethical Approval and Informed Consent

The study protocol was reviewed and approved by the Ethics Committee of the National Scientific Center of Traumatology and Orthopedics named after Academician N. D. Batpenov, Astana, Kazakhstan (approval No. 4/1; November 8, 2023). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Written informed consent was obtained from the parents or legal guardians of all participants. Age-appropriate verbal assent was additionally obtained from older children who were able to understand the purpose and procedures of the study.

2.6 Data Collection and Variables

Demographic and clinical data were systematically collected from patient medical records. These included age, sex, scoliosis type (idiopathic or congenital), and duration since surgical correction. Clinical data, including the magnitude of the spinal deformity measured using the Cobb angle and reported postoperative complications, were also documented, but were not included in the regression model due to the limited sample size, which precluded adjustment for multiple covariates. Age, sex, and scoliosis type were included as explanatory variables in the regression analysis. The dependent variable was the mean EQ-5D-5L dimension score, calculated as the average of the 5 EQ-5D-5L dimensions.

2.7 Questionnaire Administration and Cultural Adaptation

The EQ-5D-5L was developed as a 5-level version of the EQ-5D descriptive system to improve measurement sensitivity and reduce ceiling effects compared with the EQ-5D-3L [8]. The instrument assesses 5 dimensions of health: Mobility, Self-care, Usual Activities, Pain/Discomfort, and Anxiety/Depression. Each dimension contains 5 response levels, ranging from no problems to extreme problems or inability to perform the activity. The questionnaire was initially developed in English and was culturally adapted for the target population through forward translation, backward translation, expert review, and cognitive testing. Permission to use the EQ-5D-5L was obtained (case No. 00238582; request registration No. 67590). Although a Russian-language version was available, the Kazakh-language version was used to ensure linguistic and cultural relevance for the target population. The EQ-5D-5L was administered twice to each participant. The initial assessment was followed by a retest conducted 8–10 days later to evaluate test–retest reliability. Patients completed the

questionnaire under the supervision of trained research staff, who provided standardized instructions and ensured that the same administration procedures were followed. Research staff did not influence the participants' choice of responses. Participant confidentiality was maintained throughout data collection and analysis.

2.8 Statistical Analysis

Statistical analyses were performed using R software, version 4.4.2 for Windows, and Microsoft Excel, Microsoft 365. A 2-sided significance level of $p < 0.05$ was used for all statistical tests. Internal consistency was assessed using Cronbach's alpha as an exploratory descriptive measure. Values between 0.60 and 0.69 were interpreted as indicating moderate internal consistency, whereas values of 0.70 or higher were considered acceptable. Because the EQ-5D-5L comprises 5 conceptually distinct single-item dimensions, Cronbach's alpha was interpreted cautiously and was not regarded as definitive evidence of the overall reliability of the instrument. Test–retest reliability was evaluated using the intraclass correlation coefficient (ICC) and root mean square error (RMSE). ICC values were reported with 95% confidence intervals. Spearman correlation coefficients were calculated to explore associations among the 5 EQ-5D-5L dimensions. These inter-dimension correlations were treated as exploratory and were not interpreted as definitive evidence of convergent or discriminant validity. Exploratory factor analysis and confirmatory factor analysis were not performed because the limited sample size ($n=51$) was insufficient for robust structural validity assessment [9,10]. Such analyses would be underpowered and could produce unstable parameter estimates. Instead, we restricted our analysis to descriptive reliability and agreement metrics (ICC, RMSE, Cronbach's alpha, ceiling/floor effects, and Bland–Altman analysis), which are more robust with moderate sample sizes. A ceiling effect was defined as the proportion of participants reporting level 1, corresponding to no problems, in a given EQ-5D-5L dimension. A floor effect was defined as the proportion reporting level 5, corresponding to extreme problems or inability to perform the activity. Agreement between test and retest scores was further assessed using Bland–Altman analysis, including the calculation of the mean difference and limits of agreement. Multiple linear regression analysis was performed to explore the influence of demographic and clinical factors, including age, sex, and scoliosis type, on the mean EQ-5D-5L dimension score.

The mean dimension score was used as a summary measure to reduce the number of comparisons and

avoid issues with multiple testing, given the limited sample size.

However, we acknowledge that this approach treats ordinal data as continuous, which is a limitation. Regression results were expressed as β coefficients with corresponding p values.

Eleven incomplete or incorrectly completed questionnaires were excluded before the final analysis. Consequently, the final analytical sample consisted of 51 participants with complete initial and retest

questionnaire data. No missing-value imputation or pairwise deletion was applied to the final sample.

Because of the limited sample size, we did not perform factor analysis (EFA or CFA) to assess structural validity, as such analyses would be underpowered and could produce unstable parameter estimates [10]. Instead, we restricted our analysis to descriptive reliability and agreement metrics, which are more robust with moderate sample sizes.

3. Results

3.1 Participant Flow and Characteristics

The final analytical sample ($n=51$) is modest, and all following results should be viewed as preliminary. No missing data imputation was applied, as only complete cases were included. A total of 125 potentially eligible patients were screened. Of these, 62 were excluded before enrollment: 57 did not meet the eligibility criteria and 5 declined to participate. Sixty-three patients were enrolled in the study. After enrollment, 1 participant was unable to complete the questionnaire because of language difficulties, and 11 questionnaires were excluded because they were incomplete or incorrectly completed. Consequently, 51 participants were included in the final analysis (Figure 1). The study included 51 patients with early-onset scoliosis (EOS), with a mean age of 10.4 ± 1.9 years. Of these, 31 were female (60.8%) and 20 were male (39.2%). All 51 participants completed both the initial EQ-5D-5L assessment and the retest conducted 8–10 days later.

3.2 Internal Consistency and Test–Retest Reliability

Exploratory assessment of internal consistency yielded a Cronbach's alpha of 0.614, corresponding to moderate internal consistency. Because the EQ-5D-5L comprises 5 conceptually distinct dimensions, this

finding was interpreted cautiously. An item-total correlation analysis showed that the Mobility and Self-care dimensions had the lowest corrected item-total correlations. These dimensions may have contributed to the lower overall Cronbach's alpha; however, this finding should not be interpreted as evidence that the individual dimensions are unreliable. Test–retest reliability was evaluated using the intraclass correlation coefficient (ICC) and root mean square error (RMSE). ICC values varied across the 5 dimensions. The highest ICC was observed for Anxiety/Depression (ICC=1.000; 95% CI, 1.000–1.000; RMSE=0.000), which likely reflects limited variability in responses rather than perfect measurement reliability, followed by Pain/Discomfort (ICC=0.848; 95% CI, 0.732–0.915; RMSE=0.275) and Usual Activities (ICC=0.834; 95% CI, 0.711–0.901; RMSE=0.238). Lower ICC values were observed for Self-care (ICC=0.502; 95% CI, 0.281–0.676; RMSE=0.363) and Mobility (ICC=0.187; 95% CI, 0.032–0.426; RMSE=0.412), indicating greater variability between the initial and retest responses in these dimensions (Table 1).

Table 1 - Reliability and Internal Consistency of EQ-5D-5L

Domain	ICC	95% CI	RMSE	p-value
Anxiety/Depression	1.000	(1.000–1.000)	0.000	<0.001
Pain/Discomfort	0.848	(0.732–0.915)	0.275	<0.001
Usual Activities	0.834	(0.711–0.901)	0.238	<0.001
Self-care	0.502	(0.281–0.676)	0.363	0.008
Mobility	0.187	(0.032–0.426)	0.412	0.097

3.3 Inter-Dimension Correlations

Spearman correlation analysis was used to explore associations among the EQ-5D-5L dimensions (Figure 2). Moderate positive correlations were observed between Self-care and Usual Activities ($r=0.440$) and between Self-care and Anxiety/Depression ($r=0.395$). A weak correlation was observed between Mobility and

Anxiety/Depression ($r=0.094$). Because these analyses were exploratory, the observed correlations were not interpreted as definitive evidence of convergent or discriminant validity.

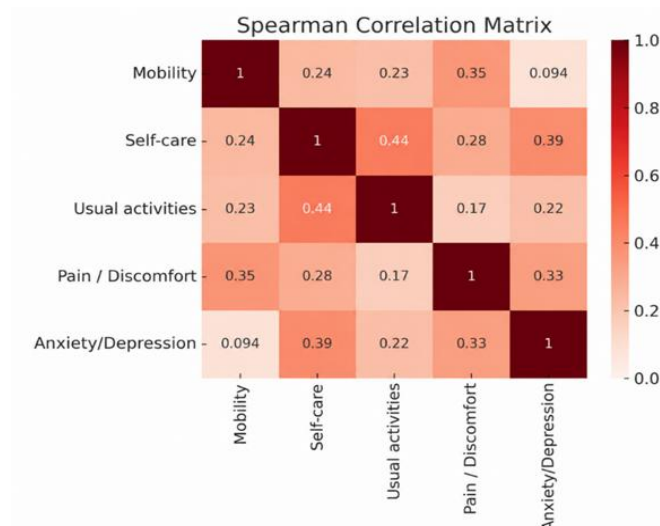


Figure 2 - Spearman Correlation Matrix between EQ-5D-5L domains

3.4 Floor and Ceiling Effects

Floor effects, defined as the proportion of participants reporting level 5, were not observed or were minimal across all dimensions. Ceiling effects, defined as the proportion of participants reporting level 1 or no problems, were observed across all EQ-5D-5L dimensions, ranging from 72.5% to 90.2%. The highest ceiling effects were observed in Mobility (90.2%) and Self-care (86.3%), followed by Usual Activities (78.4%), Pain/Discomfort (72.5%), and Anxiety/Depression (72.5%). These ceiling effects suggest that a substantial proportion of participants reported no problems in each dimension, which may limit the instrument's ability to discriminate between patients with mild versus moderate impairments.

3.5 Regression Analysis

A multiple linear regression analysis was performed to investigate the associations of demographic and clinical factors with the mean EQ-5D-5L dimension score. In exploratory regression analysis, congenital scoliosis was associated with a lower mean EQ-5D-5L dimension score ($\beta = -0.142$; 95% CI, -0.261 to -0.023 ; $p=0.044$). However, given the small sample size and the exploratory nature of the analysis, this finding should be interpreted with caution and requires confirmation in larger studies. No statistically significant associations were observed for age ($\beta = 0.052$; 95% CI, -0.032 to 0.139 ; $p=0.213$) or sex (female: $\beta = -0.037$; 95% CI, -0.149 to 0.084 ; $p=0.581$) (Table 2).

Table 2 – Regression Analysis of Mean EQ-5D-5L Dimension Score of EQ-5D-5L Scores

Predictor Variable	β Coefficient	95% CI (Lower–Upper)	p-value
Age	0.052	(-0.032 – 0.139)	0.213
Sex (female)	-0.037	(-0.149 – 0.084)	0.581
Congenital scoliosis	-0.142	(-0.261 – -0.023)	0.044

3.6 Bland–Altman Analysis

Agreement between the initial and retest mean EQ-5D-5L dimension scores was further evaluated using Bland–Altman analysis (Figure 3). The mean difference was -0.0039 , with 95% limits of agreement ranging from -0.302 to 0.295 . Most observations were located within the limits of agreement, although 1 observation was above the upper limit. The narrow limits of agreement and the small mean difference suggest acceptable agreement between the initial and retest assessments at

the group level. However, the single observation outside the limits indicates some individual variability.

3.7 EQ-VAS

The EQ visual analogue scale was used to assess participants' self-rated overall health. The mean EQ-VAS score was 81.63 ± 9.61 at the initial assessment and 82.06 ± 8.50 at the retest, with no statistically significant difference between the assessments ($p=0.422$). The EQ-VAS demonstrated a high test–retest ICC of 0.962.

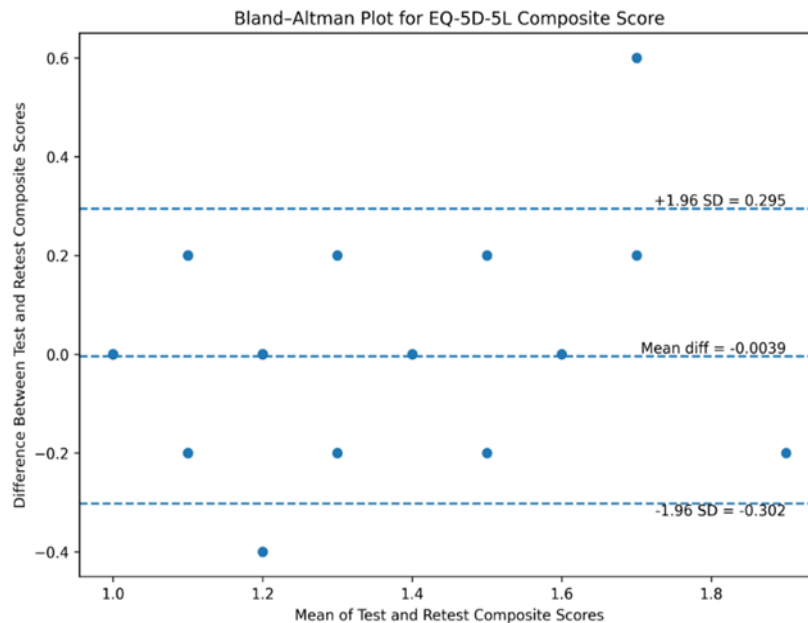


Figure 3 – Bland–Altman plot of agreement between test and retest mean EQ-5D-5L dimension scores

4. Discussion

This preliminary study provides initial evidence on selected psychometric properties of the Kazakh EQ-5D-5L in a small cohort of children and adolescents with surgically treated EOS. The main findings suggest moderate internal consistency, substantial variation in test–retest reliability across dimensions, notable ceiling effects, an association between congenital scoliosis and lower HRQoL scores, and high short-term reproducibility of the EQ-VAS. However, these results must be interpreted with caution due to the limited sample size.

Cronbach's alpha was 0.614, indicating moderate internal consistency according to the prespecified interpretation. A similar value was reported by Cheung et al. [7] in patients with low back pain, whereas Bilbao et al. [11] reported higher internal consistency in patients with hip or knee osteoarthritis. These differences suggest that the performance of the EQ-5D-5L may vary according to the clinical population, age distribution, and variability of health states. However, the EQ-5D-5L comprises 5 conceptually distinct dimensions rather than multiple items intended to measure a single underlying construct. Therefore, Cronbach's alpha should be interpreted as an exploratory measure and not as definitive evidence of the overall reliability of the instrument.

The lower corrected item–total correlations observed for Mobility and Self-care may have contributed to the moderate overall Cronbach's alpha. Nevertheless, these findings do not indicate that these dimensions should be modified or removed. The EQ-

5D-5L is a standardized instrument, and changes to its dimensions or response categories would compromise comparability with other populations and studies. Instead, the lower correlations may reflect the multidimensional structure of health status and differences in how physical, functional, and emotional problems are experienced by children and adolescents with EOS.

Test–retest reliability differed across dimensions. The highest ICC values were observed for Anxiety/Depression, Pain/Discomfort, and Usual Activities, whereas Self-care demonstrated moderate reliability and Mobility showed the lowest ICC. Previous research has also shown that the measurement performance of EQ-5D dimensions may differ across scoliosis populations and clinical settings [12]. The lower ICC for Mobility may reflect limited between-participant variability, short-term variation in perceived Mobility, ceiling effects, or age-related differences in understanding the response categories.

However, these explanations were not directly examined in the present study and should therefore be regarded as hypotheses rather than confirmed causes.

The inter-dimension correlation analysis demonstrated moderate associations between Self-care and Usual Activities and between Self-care and Anxiety/Depression, whereas the association between Mobility and Anxiety/Depression was weak. These findings indicate that the EQ-5D-5L dimensions capture related but nonidentical aspects of health status.

However, because the correlation analysis was exploratory, it cannot be regarded as definitive evidence of convergent or discriminant validity. Structural validity was not evaluated in the final analysis because the available sample was insufficient for a robust exploratory or confirmatory factor analysis.

Floor effects were absent or minimal across the EQ-5D-5L dimensions, whereas ceiling effects were observed in all dimensions. The proportion of participants reporting no problems ranged from 72.5% to 90.2%, with the highest ceiling effects in Mobility and Self-care. This pattern indicates that many participants reported relatively favorable health states at the dimension level, which may limit the ability of the EQ-5D-5L to distinguish between patients with mild or no perceived problems. Similar ceiling effects have been reported in previous studies of the EQ-5D-5L across different patient populations [13,14]. Nevertheless, the present cross-sectional study did not evaluate responsiveness; therefore, these ceiling effects cannot by themselves confirm reduced sensitivity to longitudinal clinical change.

In exploratory regression analysis, congenital scoliosis was associated with lower mean EQ-5D-5L dimension scores ($\beta = -0.142$, $p=0.044$), whereas age and sex were not significantly associated with the outcome. However, the regression model explained only a limited proportion of the observed variation ($R^2=0.152$), suggesting that HRQoL in surgically treated EOS is likely influenced by additional factors not included in the model, such as pain severity, residual deformity, pulmonary function, number and type of surgical procedures, postoperative complications, psychological status, family support, and socioeconomic circumstances. This finding is exploratory and may be due to chance or confounding, especially given the small sample and lack of adjustment for multiple comparisons. It requires replication in larger studies with comprehensive covariate adjustment.

The mean EQ-VAS remained similar between the initial assessment and the retest, and the ICC of 0.962 indicated high short-term reproducibility. This suggests that participants' overall self-rated health was relatively stable during the 8–10-day test–retest interval. The EQ-VAS provides a global assessment of perceived health and complements the dimension-specific information obtained from the EQ-5D-5L descriptive system. Previous studies have similarly demonstrated the usefulness of the EQ-VAS in adolescent and musculoskeletal populations, although its measurement performance may vary according to the clinical condition and study setting [15,16].

Overall, the findings provide preliminary evidence that the Kazakh EQ-5D-5L can be administered to

children and adolescents with surgically treated EOS and that several dimensions demonstrate satisfactory short-term reproducibility. However, the marked variation in dimension-level ICC values and the observed ceiling effects indicate that the instrument should not be regarded as fully validated for this population on the basis of the present study alone. As a generic measure of health status, the EQ-5D-5L may provide information that complements clinical and radiographic assessment, but it should not replace disease-specific instruments or comprehensive clinical evaluation. Previous orthopedic studies have also shown that the EQ-5D-5L can be useful as a generic outcome measure while retaining limitations related to responsiveness and condition-specific sensitivity [17–20].

This study contributes preliminary data regarding the use of the Kazakh EQ-5D-5L in a pediatric EOS population. Larger multicenter studies with prespecified sample-size calculations are required to evaluate its structural validity, known-groups validity, measurement error, and responsiveness. Future studies should also compare the EQ-5D-5L with age-appropriate and scoliosis-specific instruments and examine whether the EQ-5D-Y-5L or proxy-report versions provide better measurement performance in younger participants [21].

4.1 Limitations

The most important limitation of this study is the small sample size ($n=51$), which is insufficient for robust psychometric validation according to standard guidelines (e.g., COSMIN recommends at least 100 subjects for adequate reliability studies, and 200+ for factor analysis).[9] Consequently, we could not evaluate structural validity, measurement invariance, or responsiveness. This limits the generalizability of our findings and precludes any definitive conclusion about the instrument's validity in this population. Our study should be regarded as a pilot that provides preliminary estimates of reliability and agreement, which can be used to plan larger confirmatory studies.

Additional limitations should be acknowledged. First, the single-center design may limit the generalizability of the findings. No formal a priori sample-size calculation was performed; therefore, the psychometric findings should be interpreted as preliminary and require confirmation in a larger independent sample.

Second, the study included children and adolescents aged 6–15 years. Developmental differences in reading ability, comprehension, and interpretation of questionnaire items may have influenced the responses, particularly among younger participants.

The available sample size did not allow separate psychometric analyses across narrower age groups.

Third, the study was restricted to patients who had undergone surgical correction of EOS at least 1 year before enrollment. Consequently, the findings may not be directly generalizable to untreated patients, patients receiving conservative treatment, patients in the early postoperative period, or individuals with neuromuscular and other secondary forms of scoliosis.

Fourth, although the retest was conducted within 8–10 days, no independent clinical criterion was used to confirm that participants' health status remained

unchanged during this interval. Therefore, some variation between the initial and repeated assessments may have reflected genuine short-term changes rather than measurement error alone.

Finally, the cross-sectional design did not permit evaluation of responsiveness to clinical improvement or deterioration over time. Larger multicenter longitudinal studies are needed to evaluate structural validity, assess age-related differences, and determine the sensitivity of the Kazakh EQ-5D-5L to changes in health status.

5. Conclusions

In this preliminary study, the Kazakh EQ-5D-5L demonstrated moderate internal consistency and variable test-retest reliability in children and adolescents with surgically treated early-onset scoliosis. Anxiety/Depression, Pain/Discomfort, and Usual Activities showed the highest reproducibility, whereas Mobility and Self-care were less stable. Ceiling effects were observed across all dimensions, suggesting limited discrimination among patients with relatively favorable health states. The Kazakh EQ-5D-5L may be used cautiously as a supplementary generic HRQoL measure alongside clinical, radiographic, and scoliosis-specific assessments. However, the modest sample size limits the strength and generalizability of the conclusions. Larger, adequately powered studies are needed to confirm structural validity, responsiveness, measurement error, and age-related differences, including comparisons with the EQ-5D-Y-5L and proxy-report versions in younger children.

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All authors read and approved the final version of the manuscript.

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Conflict of Interest. Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Ethics approval. This study was performed in accordance with the principles of the Declaration of Helsinki. The Ethics Committee of the National Scientific Center of Traumatology and Orthopedics named after Academician N.D. Batpenov granted approval (Date 08.11.2023; No. 4/1).

Data Availability Statement. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

AI Declaration. The authors declare that no generative AI or AI-assisted technologies were used in the preparation, writing, or analysis of this manuscript. The entire work was conceived, analyzed, and written solely by the human authors.

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Ерте сколиоз кезіндегі өмір сүру сапасын EQ-5D-5L сауалнамасын қолдана отырып көлденең зерттеу

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Түйіндеме

Ерте дамыған сколиоз денсаулыққа байланысты өмір сүру сапасына айтарлықтай әсер етуі мүмкін. Бұл алдын ала зерттеу ерте сколиозға байланысты ота жасалған балалар мен жасөспірімдерде EQ-5D-5L сауалнамасының қазақ тіліндегі нұсқасының таңдалған психометриялық қасиеттерін бағалауға бағытталған.

Әдістері. Тест-ретест компоненті бар осы көлденең бір реттік зерттеуге 6 жастан 15 жасқа дейінгі 51 қатысушы қатысты. EQ-5D-5L қазақ тіліндегі нұсқасы бастапқы кезеңде және 8-10 күннен кейін қайтадан енгізілді. Ішкі консистенция Кронбах α -сы көмегімен, класішілік корреляция коэффициенттерін қолдана отырып, тест-ретест сенімділігі және Спирмен корреляция коэффициенттерін қолдана отырып, доменаралық корреляциялар арқылы бағаланды. Сонымен қатар, төменгі («еден») және жоғары («төбелік») әсерлер есептелді. Ал өмір сүру сапасымен байланысты факторларды зерттеу үшін көптік сызықтық регрессиялық талдау қолданылды. Іріктеме көлемінің аздығына байланысты барлық талдаулар зерттеуші және гипотеза тудырушы болып саналды.

Нәтижелері. Кронбах α -сы 0,614 құрады және бұл ішкі келісімділіктің орташа көрсеткішін көрсетеді. Ең жоғары класішілік корреляция коэффициенттері «Мазасыздық/Депрессия» (1,000), «Ауырсыну/Ыңғайсыздық» (0,848) және «Күнделікті өмір белсенділігі» (0,834) салаларында байқалды. Ал «Өзіне-өзі күтім жасау» (0,502) және «Қозғалғыштық» (0,187) салаларында қайталанудың төмендігі байқалды. Барлық EQ-5D-5L салаларында 72,5%-дан 90,2%-ға дейін минималды әсері мөлшері байқалды. Зерттеу регрессиялық талдауында туа біткен сколиоз EQ-5D-5L салаларында орташа баллдың төмендігімен байланысты болды ($\beta = -0,142$, $p = 0,044$), ал жасы мен жынысы нәтижемен статистикалық тұрғыдан маңызды байланыста болмады.

Қорытынды. Зерттеу нәтижесінде EQ-5D-5L-дің қазақ тіліндегі нұсқасы орташа ішкі сенімділікті және салаға тән тест-ретест сенімділігін көрсетті. Дегенмен, үлгінің қарапайым мөлшері ($n=51$) осы нәтижелердің жалпылануын шектейді және құралдың жарамдылығына қатысты түпкілікті қорытынды жасауға мүмкіндік бермейді. EQ-5D-5L-дің қазақ тіліндегі нұсқасын клиникалық тәжірибеде денсаулыққа байланысты өмір сүру сапасын бағалауға арналған қосымша жалпы құрал ретінде оның өлшеу қасиеттері ауқымды, статистикалық тұрғыда қуатты зерттеулерде расталғаннан кейін ғана қарастыруға болады. Болашақ зерттеулер құрылымдық жарамдылықты, өзгерістерге сезімталдықты және жасқа байланысты айырмашылықтарды бағалауға, соның ішінде EQ-5D-Y-5L нұсқасымен және жас балаларға арналған заңды қамқоршыларға арналған нысандармен салыстыруға бағытталуы керек.

Түйін сөздер: ерте сколиоз, EQ-5D-5L, денсаулыққа байланысты өмір сүру сапасы, психометриялық қасиеттер, тест-қайта тест сенімділігі.

Одномоментное исследование качества жизни при раннем сколиозе с использованием опросника EQ-5D-5L

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Резюме

Ранний сколиоз может оказывать существенное влияние на качество жизни, связанное со здоровьем. Настоящее предварительное поисковое исследование было направлено на оценку отдельных психометрических свойств казахской версии опросника EQ-5D-5L у детей и подростков, перенесших хирургическое лечение по поводу раннего сколиоза.

Методы. В данное одномоментное поперечное исследование с компонентом тест-ретест был последовательно включен 51 участник в возрасте от 6 до 15 лет. Казахская версия EQ-5D-5L заполнялась на исходном этапе и повторно через 8–10 дней. Внутренняя согласованность оценивалась с помощью α -Кронбаха, надежность тест-ретест — с использованием коэффициентов внутриклассовой корреляции, а междоменные связи — с помощью корреляции Спирмена. Были рассчитаны эффекты минимального («пола») и максимального («потолка») значений, а для изучения факторов, связанных с качеством жизни, применялся множественный линейный регрессионный анализ. Ввиду небольшого размера выборки все виды анализа рассматривались как поисковые и предназначенные для генерации гипотез.

Результаты. α -Кронбаха составила 0,614, что указывает на умеренную внутреннюю согласованность. Наиболее высокие значения коэффициента внутриклассовой корреляции наблюдались для доменов «Тревога/Депрессия» (1,000), «Боль/Дискомфорт» (0,848) и «Повседневная деятельность» (0,834), в то время как домены «Самообслуживание» (0,502) и «Мобильность» (0,187) продемонстрировали более низкую воспроизводимость. Минимальный эффект отмечался по всем доменам EQ-5D-5L и варьировал от 72,5% до 90,2%. В поисковом регрессионном анализе врожденный сколиоз был ассоциирован с более низким средним баллом по доменам EQ-5D-5L ($\beta = -0,142$, $p = 0,044$), тогда как возраст и пол не имели статистически значимой связи с исходом.

Выводы. В данном предварительном исследовании казахская версия EQ-5D-5L продемонстрировала умеренную внутреннюю согласованность и специфичную для отдельных доменов надежность тест-ретест. Однако скромный размер выборки ($n=51$) ограничивает возможность генерализации этих результатов и не позволяет сделать окончательные выводы о валидности инструмента. Казахская версия EQ-5D-5L может рассматриваться в качестве дополнительного общего инструмента оценки качества жизни, связанное со здоровьем в клинической практике только после подтверждения ее измерительных свойств в более масштабных исследованиях с достаточной статистической мощностью. Будущие исследования должны быть направлены на оценку структурной валидности, чувствительности к изменениям и возрастным различиям, включая сравнение с версией EQ-5D-Y-5L и формами для заполнения законными представителями для детей младшего возраста.

Ключевые слова: ранний сколиоз, EQ-5D-5L; качество жизни, связанное со здоровьем; психометрические свойства; надежность тест-ретест.