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Validation of the Korean Version of the 24-Item Early-Onset Scoliosis Questionnaire: A Multicenter Study from the Korean Research Society of Spinal Deformity

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Background: A 24-item early-onset scoliosis questionnaire (EOSQ-24) has been developed as a valid tool for assessing the physical and emotional function of patients with early-onset scoliosis (EOS). Previous studies that conducted transcultural adaptation of the original EOSQ-24 into other languages have demonstrated the high reliability of the questionnaire. However, a Korean version of the EOSQ-24 is not available, limiting optimal patient assessment in this nation. Therefore, this study was conducted to develop and validate a Korean version of EOSQ-24.

Methods: The original English version of the EOSQ-24 was cross-culturally adapted following standard guidelines. The final version of the Korean EOSQ-24 was prospectively applied to a group of patients who were native Korean speakers. Internal consistency was evaluated using the Cronbach α coefficient and item-total correlations. The mean, standard deviation, floor effect, and ceiling effect of each item were also assessed.

Results: A total of 102 caregivers of patients with EOS (45 males and 57 females) completed the Korean EOSQ-24. The patients' average age was 6.39 ± 2.16 years. The Cronbach α coefficient for the 24-item scale was 0.942, indicating excellent reliability. The corrected item-total correlation coefficients ranged between 0.449 and 0.788. The mean value of the EOSQ-24 questionnaire was 3.19. Floor and ceiling effects for all questionnaires were below 30%, which could be considered acceptable.

Conclusions: Our study successfully developed and validated the Korean version of the EOSQ-24, providing a reliable instrument for assessing the physical and emotional well-being of patients with EOS and their caregivers in the Korean context. The widespread adoption of the Korean EOSQ-24 in clinical practice and research settings can enhance the quality of care and improve outcomes for individuals affected by EOS in Korea.

Keywords: *Early onset scoliosis, Questionnaire, Validation, Translation, Korean*

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Scoliosis, a 3-dimensional deformity of the spine, causes various disabilities, including physical, emotional, and neuropsychomotor impairments.[1-3] Early-onset scoliosis (EOS) is an umbrella term that includes a variety of etiologies with natural history, such as congenital, neuromuscular, syndromic, or idiopathic scoliosis that is detected in individuals at ages below 10 years.[2,4-6] Substantial dis-

abilities could occur in patients with EOS compared to adolescent patients with scoliosis as rapid musculoskeletal growth and organ development are facilitated at a younger age.[1,5,7] Inappropriate treatment of EOS could result in impaired cardiopulmonary, intestinal function, and bowel function, as well as intense pain and short stature.[1,7] Treatment strategies of EOS have remarkably improved in recent years, which provide various options, including serial cast, brace, growth-friendly implants such as growing rods, vertical expandable prosthetic titanium ribs (VEPTRs), or magnetically controlled growing rods (MCGRs).[4,8]

However, decision-making for EOS treatment to achieve goals, including preventing deformity progression, permitting spinal growth and organ development, and minimizing negative emotional effects, is a complex process.[1,4,8] Achieving certain goals frequently conflicts with another, and indications of each treatment method are not clearly defined.[3,9,10] Frequent assessment of the physical and emotional status of both the patient and caregiver is required for optimizing treatment plans and further research.[11] For this purpose, a 24-item EOS Questionnaire (EOSQ-24) was developed in 2011 in English.[5] Many translation and validation studies have been conducted since then, and the EOSQ-24 is now available in multiple languages, including Spanish, Turkish, Chinese, Norwegian, Portuguese, and German. Furthermore, the EOSQ-24 is currently being accepted as the standard for patients with EOS assessment in the recent literature, similar to the Scoliosis Research Society-22 questionnaire for adolescent idiopathic scoliosis.[12-18]

Nevertheless, no transculturally adapted, validated version of the EOSQ-24 is available in South Korea. Therefore, objective patient assessment and evaluation of treatment results are limited in our country. Thus, the current study was conducted to develop a Korean version of the EOSQ-24 that respects standard transcultural questionnaire translation methods and validate the reliability of this questionnaire for clinical application.

METHODS

The study design was approved by the Institutional Review Board of the 3 spine centers involved in data collection (Asan Medical Center; IRB No. 2023-0890). Written informed consent was obtained from all caregivers of patients with EOS and from patients aged ≥ 7 years.

Development of the Korean Version of the EOSQ-24

Permission to develop the Korean version of the EOSQ-24 was obtained from the original English version developers (Mrs. Hiroko Matsumoto). The questionnaire consists of 24 items in 11 subdomains: general health, pain, respiratory function, mobility, body function, daily life, fatigue, emotional development, parental burden, financial impact, and satisfaction.[5] The Korean version of the EOSQ-24 also adopted this system. Translation and transcultural adaptation were performed according to the guidelines suggested by Guillemin et al.[19] and Beaton et al.[20] Two spine surgeons (CJH and SP) with a profound understanding of English initially translated the questionnaire into Korean. Synthesis of the 2 translations was performed at an expert committee conference to produce the first version of the Korean EOSQ-24. Back-translation was performed by an independent bilingual professional translator blinded to the original English version of the EOSQ-24. The back-translated version was compared with the original version and discussed at the conference. An expert committee composed of 2 original translators, a back-translator, 2 independent spine surgeons (DHL and JHC), and 2 clinical spine physician assistants (MYL and SJY) reviewed all the reports and reached a consensus to produce the pre-final version of the Korean EOSQ-24. Physician assistants conducted interviews with 5 caregivers of patients with EOS using the pre-final version. Caregivers were asked to answer the questionnaire according to their understanding and if they had any doubts regarding the contents. The final expert committee meeting was conducted with the interview data, and the pre-final version was corrected based on the data to develop the final version of the EOSQ-24 in Korean (Supplementary Figs. 1 and 2).

Study Population

All included children and caregivers were native Korean speakers. Patient demographic data, including age, sex, type of scoliosis, and treatment status, were obtained.

Internal Consistency Testing

The internal consistency of the Korean EOSQ-24 was assessed using the Cronbach α coefficient. This test indicates the homogeneity of the distinguishing factors between items within a questionnaire or subdomains of the questionnaire.[21,22] The Cronbach α coefficient was also checked for variation if an item was deleted. The optimal Cronbach α coefficient is considered to be between 0.70 and 0.95 (Table 1).[21] Corrected item-total correlations were also obtained to determine internal consistency.[21] An item-total correlation higher than 0.3 indicates a good correlation within the domain, and the discriminative validity for that item is considered good.[21]

Table 1. Interpretation of Cronbach α Coefficients

Cronbach α	Internal consistency
$0.9 \leq \alpha$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Table 2. Patient Characteristics

Variable	Value
Number of patients	102
Age (yr)	6.39 ± 2.16
Sex	
Male	45 (44.12)
Female	57 (55.88)
Diagnosis	
Congenital	37 (36.27)
Idiopathic	20 (19.61)
Neuromuscular	15 (14.71)
Syndromic	30 (29.41)
Cobb angle (°)	29.48 ± 16.07
Treatment state	
Conservative	66 (64.71)
Brace	19 (18.63)
Preoperative	6 (5.88)
Postoperative (deformity correction)	1 (0.98)
Postoperative (growing rod)	10 (9.8)
Others	0

Values are presented as mean ± standard deviation or number (%).

Ceiling and Floor Effects

Ceiling and floor effects represent the limitations of an instrument's ability to assess the full spectrum of a condition's severity within the items.[23] They represent content validity and indicate that extreme items are missing from the scale.[23] Such effects were analyzed by calculating the frequency of participants and assigning the minimum and maximum scores.[23] Floor and ceiling effects were considered acceptable if they were below 30%.[24,25]

Statistical Analysis

Continuous variables were recorded as means, standard deviations, medians, and interquartile ranges. Cronbach's α coefficient, corrected item-total correlations, and ceiling or floor effects were analyzed as previously described.[21-23] All analyses were performed using R statistical software (R Foundation for Statistical Computing).

RESULTS

A total of 102 caregivers of patients with EOS (45 males and 57 females) were asked to complete the EOSQ-24. The average age of the patients was 6.39 ± 2.16 years. All questionnaires were returned without any missing data. Diagnoses included congenital scoliosis (n = 37, 36.3%), idiopathic scoliosis (n = 20, 19.6%), neuromuscular scoliosis (n = 15, 14.7%), and syndromic scoliosis (n = 30, 29.4%). Sixty-six patients (64.7%) were undergoing routine evaluation without specific treatment, and 19 (18.6%) were being treated with a brace. Six patients (5.9%) answered the questionnaire at the preoperative evaluation visit. Furthermore, 11 patients (10.8%) underwent surgery and answered the questionnaire during routine postoperative visits (Table 2).

Internal Consistency

The Cronbach α coefficient for the 24-item scale was 0.942, indicating excellent reliability. If an item was deleted, the value of the Cronbach α coefficient ranged between 0.937 and 0.942. The corrected item-total correlation coefficients ranged between 0.449 and 0.788. All coefficients were higher than 0.3, indicating a good correlation (Table 3).

Ceiling and Floor Effects

The mean value of the EOSQ-24 questionnaire was 3.19. Values ranged between 2.06 (for Q17) and 3.99 (for Q6). The maximum floor effect was 13.7% (for Q17), and the maximum ceiling effect was 17.7% (for Q6). Floor and ceiling effects for all questionnaires were below 30%, which could be considered acceptable (Table 4).

DISCUSSION

The validation of the Korean version of the EOSQ-24 is paramount for the accurate assessment and management of EOS in Korean-speaking populations. Our study aimed to develop and validate the Korean version of the EOSQ-24 to facilitate objective patient assessment and evaluation

Table 3. Internal Consistency

Classification	Questionnaire	Corrected item-total correlation	Cronbach α if item is deleted
General health	1	0.698	0.939
	2	0.593	0.940
Pain	3	0.631	0.940
	4	0.678	0.939
Respiratory function	5	0.477	0.941
	6	0.517	0.941
Mobility	7	0.628	0.940
Body function	8	0.691	0.939
	9	0.619	0.940
	10	0.725	0.938
Daily life	11	0.612	0.940
	12	0.472	0.942
Fatigue	13	0.617	0.940
	14	0.605	0.940
Emotional development	15	0.498	0.941
	16	0.591	0.940
Parental burden	17	0.677	0.939
	18	0.632	0.940
	19	0.682	0.939
	20	0.667	0.939
	21	0.628	0.940
Financial impact	22	0.449	0.942
Satisfaction	23	0.767	0.938
	24	0.788	0.937
Minimum		0.449	0.937
Maximum		0.788	0.942

of treatment outcomes in this demographic.[5,11] Various treatment options are available for patients with EOS, including cast, brace, VEPTRs, and MCGRs.[26,27] The physical state of the growing pediatric population is often more dynamic than that of the adolescent population, and treatment indications are currently not clearly defined.[8,28,29] Given the multifaceted nature of EOS and its potential long-term implications, accurate assessment and monitoring of patients' physical and emotional well-being are crucial.[4,5,30,31] However, traditional outcome measures may not adequately capture the unique challenges faced by patients with EOS and their caregivers. Recognizing this gap, the EOSQ-24 was developed in 2011 as an English-language tool to systematically assess various dimensions of EOS, including general health, pain, respiratory function, mobility, and emotional development, among others.[5] Since its inception, the EOSQ-24 has undergone translation and efforts have been made to validate it in multiple languages, including Spanish,[13] Turkish,[14] Chinese,[16] Norwegian,[32] Portuguese,[12] and German.[18] These validation studies have consistently demonstrated the reliability and validity of the EOSQ-24 across diverse cultural and linguistic contexts, establishing it as a valuable instrument for assessing patients with EOS worldwide.[20]

However, despite the growing body of literature supporting the utility of the EOSQ-24 in various populations, there was a notable gap in its availability in South Korea. This gap limited the ability of healthcare providers in Korea to conduct objective patient assessments and effectively evaluate treatment outcomes. Recognizing the need for a transcultural adapted and validated version of the EOSQ-24 in Korea, our study sought to address this gap by developing and validating a Korean version of the EOSQ-24.

Our findings corroborate previous validation studies conducted in other languages, affirming the reliability and validity of the EOSQ-24 across diverse cultural and linguistic contexts. The high Cronbach's α coefficient (0.942) observed in our study indicates excellent internal consistency, which is consistent with findings from validation studies of the EOSQ-24 in other languages. Additionally, the corrected item-total correlation coefficients exceeding 0.3 for all items further support the questionnaire's good correlation within its domains. The robust internal consistency observed in our study underscores the reliability of the Korean version of the EOSQ-24 for assessing various dimensions of EOS, including general health, pain, respiratory function, mobility, emotional development, and parental burden. These findings suggest that the Korean EOSQ-24 is a valid and reliable instrument for capturing the multifaceted impact of EOS on patients and caregivers in the Korean context.

Previous studies regarding EOS conducted in Korea frequently lacked patient-reported outcome measures as there was no objective tool that could assess patient symptoms and satisfaction.[33,34] This caused a lack of optimization and generalizability of the results. With the development of the Korean version of EOSQ-24, the following benefits could be provided in clinical practice and studies for patients with EOS: First, using this questionnaire,

Table 4. Descriptive Statistics of the Korean Version of the 24-Item Early-Onset Scoliosis Questionnaire, Including Floor and Ceiling Values

Classification	Questionnaire	Mean ± SD	Floor (%)	Ceiling (%)
General health	1	2.42 ± 1.08	2.94	3.92
	2	2.98 ± 1.09	0.98	7.84
Pain	3	3.42 ± 1.12	0.98	12.75
	4	3.67 ± 0.86	0.98	11.76
Respiratory function	5	3.63 ± 0.97	1.96	12.75
	6	3.99 ± 0.68	0.00	17.65
Mobility	7	3.77 ± 1.09	2.94	16.67
Body function	8	3.34 ± 1.14	0.00	9.80
	9	3.71 ± 1.10	1.96	14.71
	10	3.10 ± 1.35	1.96	9.80
Daily life	11	3.18 ± 1.40	5.88	9.80
	12	2.62 ± 1.43	8.82	6.86
Fatigue	13	2.70 ± 1.11	1.96	3.92
	14	3.04 ± 1.14	0.00	8.82
Emotional development	15	3.23 ± 1.19	1.96	8.82
	16	3.56 ± 1.08	1.96	11.76
Parental burden	17	2.06 ± 1.27	13.73	0.98
	18	3.06 ± 1.33	5.88	6.86
	19	3.05 ± 1.32	5.88	7.84
	20	3.38 ± 1.11	0.98	9.80
	21	3.37 ± 1.13	2.94	8.82
Financial impact	22	3.24 ± 1.14	1.96	9.80
Satisfaction	23	3.07 ± 1.01	0.00	5.88
	24	2.92 ± 1.14	1.96	6.86

SD: standard deviation.

clinicians can systematically assess the physical and emotional well-being of patients with EOS and their caregivers, thereby guiding treatment decisions and optimizing patient care. Second, the EOSQ-24 can serve as a valuable tool for monitoring treatment outcomes over time and evaluating the effectiveness of different therapeutic interventions in the Korean population.[12,16,18] Finally, the results of clinical studies on EOS conducted in Korea can now be objectively compared with those of studies conducted in other nations. This would further promote the quality of patient care and optimize clinical practice.

Despite the strengths of our study, some limitations should be acknowledged. First, the small sample size of our study may limit the generalizability of our findings to the broader Korean population with EOS. Future studies with larger and more diverse samples are warranted to further validate the Korean EOSQ-24. Second, the proportion of patients who underwent surgery in the current study was low. Thirdly, the study lacks an in-depth analysis of sex differences among the caregivers who completed the Korean EOSQ-24. Considering that caregiving roles may be influenced by sex, it is possible that male and female caregivers could respond differently to certain items on the questionnaire. Future studies should explore these

differences to determine whether the Korean EOSQ-24 functions equivalently across sexes or if modifications are needed to better capture the experiences of both male and female caregivers. Finally, although the ceiling and floor effects observed in our study were within acceptable limits, future research should continue to evaluate the sensitivity of the questionnaire to detect changes in EOS severity and treatment outcomes. Future research should focus on longitudinal studies to assess the responsiveness of the Korean EOSQ-24 to changes in EOS status and treatment effects over time. Furthermore, cross-cultural comparisons between the Korean version of the EOSQ-24 and other language versions could provide valuable insights into potential cultural differences in the perception and impact of EOS on patients and caregivers.

In conclusion, in this study, we successfully developed and validated a Korean version of the EOSQ-24, providing a reliable instrument for assessing the physical and emotional well-being of patients with EOS and their caregivers. The widespread adoption of the Korean EOSQ-24 in clinical practice and research settings has the potential to enhance the quality of care and improve outcomes for individuals affected by EOS in Korea. Specifically, clinicians can systematically assess the well-being of patients with EOS and their caregivers, monitor treatment outcomes over time, evaluate the effectiveness of different therapeutic interventions, and objectively compare outcomes with those of studies from other nations. Such advantages would ultimately lead to improved quality of patient care and optimized clinical practice for patients with EOS in Korea.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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SUPPLEMENTARY MATERIAL

Supplementary material is available in the electronic version of this paper at the CiOS website, www.ecios.org.

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