The Validation of the Japanese Version of the Scoliosis Research Society-30 Questionnaire for Adolescent Idiopathic Scoliosis Patients

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Abstract:

Introduction: The Scoliosis Research Society-30 (SRS-30) is a questionnaire originally developed from the SRS-22r questionnaire and is used to evaluate adolescent idiopathic scoliosis (AIS). It comprised questions on five domains: function, pain, self-image, mental health, and satisfaction, with seven additional questions related to postoperative aspects. In addition to the original English version, translations in multiple languages have been effectively applied. Herein, we evaluated the internal consistency and external validity of the Japanese version of the SRS-30 for AIS patients.

Methods: Among the 30 questions in SRS-30, the eight additional questions from SRS-22r were translated and back-translated to create a Japanese version of the SRS-30. This translated questionnaire was then used to survey patients with AIS who underwent corrective fusion surgery one year postoperatively. The internal consistency of the responses was evaluated using the Cronbach α coefficient. Additionally, the Spearman correlation analyses were conducted to assess the correlation between the scores obtained from the SRS-30 Japanese version and SRS-22r and the Oswestry Disability Index (ODI) for the overall scale and the five domains.

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Results: A total of 81 cases (eight males and 73 females; mean age at surgery 14.4 years) were enrolled. The mean preoperative Cobb angle was 51.0°. The Cronbach α coefficient for the overall SRS-30 was 0.861, indicating high internal consistency, while the coefficients for each domain were as follows: function/activity, 0.697; pain, 0.405; self-image/appearance, 0.776; mental health, 0.845; and satisfaction, 0.559. The SRS-30 total score significantly correlated with the SRS-22r total (r=0.945, P<0.001) and the ODI (r=–0.511, P<0.001). The SRS-30 domains highly correlated with the corresponding SRS-22r domains, with correlations ranging from r=0.826 to 0.901 (all P<0.001).

Conclusions: The Japanese version of the SRS-30 demonstrated good internal and external validity. The SRS-30 can be used as an assessment tool for health-related quality of life in AIS patients.

Keywords:

Scoliosis Research Society-30, questionnaire, Scoliosis Research Society-22, adolescent idiopathic scoliosis, internal consistency, external validity, Cronbach's α coefficient, health-related quality of life

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Introduction

Approximately 2%-3% of the general population are affected by adolescent idiopathic scoliosis (AIS). The severe spinal curve deformities linked with AIS can cause psychological and physical problems, such as back pain, breathing, and circulation problems[1,2]. The severity and impact of AIS varies per person. Therefore, appropriate measurement tools are required to assess treatment effectiveness. As a measurement tool for AIS, the Scoliosis Research Society (SRS) originally developed the SRS-24 questionnaire in English, and its reliability and validity were confirmed[3-5]. The SRS-22r questionnaire was subsequently developed after several modifications[6,7]. Subsequently, the SRS-30 questionnaire was developed, including the content of the SRS-22r questionnaire with an additional seven postoperative questions. The SRS-30 is widely used to comprehensively assess the physical and psychological aspects related to scoliosis[8]. However, since the SRS-30 questionnaire was developed in English, its validity in other languages and cultural contexts must be established. This questionnaire has so far been translated and validated in Portuguese, Turkish, South Indian, Finnish, and Persian. However, the Japanese version of the SRS-30 questionnaire has not yet been validated[9-13]. Therefore, this study aimed to validate the Japanese version of the SRS-30 questionnaire for AIS.

Materials and Methods

Patient population

This study was reviewed and approved by the hospital and its affiliated institutions and adhered to the principles of the Declaration of Helsinki. As this study used medical records and was conducted on an opt-out basis with guaranteed opportunities for research subjects to refuse to participate, written or verbal consent was not required from the research subjects. A comprehensive agreement on the academic use of information, such as the type of treatment, treatment progress, or any other data acquired during treatment, was obtained from patients by the hospital during hospitalization. The agreement also included a clause stating that no identifiable information regarding the participants would be included in the manuscript. Japanese-speaking patients who underwent posterior corrective fusion for AIS at one of four university hospitals between January 2020 and December 2021 and were followed up for at least one year postoperatively were considered eligible for this study. Whole-spine standing radiographs and patient-reported outcomes (PROs) were assessed at baseline and one year postoperatively. Data on age, sex, and body mass index (kg/m^2) were also extracted. Regarding surgical data, the number of fused levels and the upper and lowest instrumented vertebral (UIV and LIV) levels were investigated.

Development of the Japanese version of the SRS-30

Following the recommended cross-cultural approach, a Japanese version of the SRS-30 was developed based on the original English version. The SRS-30 comprises the first 23 items (Section 1), while items 24-30 (Section 2) are questions exclusively for postoperative patients. The SRS-30 is a health-related quality of life (QOL) questionnaire specific to scoliosis. The 30 items cover five domains (function/activity, pain, self-image/appearance, mental health, and satisfaction). Each domain is rated on a scale of 1-5, with high scores indicating good outcomes. There are seven, six, nine, five, and three questions on function/activity, pain, self-image/appearance, mental health, and satisfaction, respectively. The average score for each domain is calculated by dividing the total score for each domain by the number of responses. The 23-item questionnaire in Section 1 comprised 22 items from the SRS-22r, with one additional item on self-image. Twenty-two items from the SRS-22r were translated into Japanese and validated[14]. Regarding the eight additional items, one of the authors (HA) translated the article from English into Japanese (forward translation). The eight translated items were evaluated and summarized by seven native Japanese-speaking spine surgeons (YY, HO, JT, KW, RS, KT, and

YA) (integration process). One of the authors (TO) with excellent English proficiency translated the Japanese translation back into English (back-translation). One of the authors (LC), whose native language is English, reviewed these back-translations and considered them equivalent to the original version (Supplementary Figures 1 and 2).

PROs

The SRS-30 and Oswestry Disability Index (ODI) were used to assess clinical outcomes preoperatively and one year postoperatively. The ODI has 10 subdomains measuring pain intensity, personal care, lifting, walking, sitting, standing, sleep, sex, social life, and travel, and is the recommended PRO for patients with spinal cord disorders[15]. The scores for each domain ranged from 0 (best outcome) to 5 (worst outcome). The total score was divided by a full score of 50 and expressed as a percentage from 0 to 100. High scores mean worse outcomes.

Radiographic measurements

Radiological parameters were measured using standing whole-spine films obtained preoperatively and one year postoperatively. Curve patterns were classified according to the Lenke classification from Lenke I to IV. Regarding the measurement of coronal parameters, the Cobb method was used for the angular measurement of the main scoliosis curve. For the sagittal parameters, the thoracic kyphosis (TK; T5-12 kyphosis) angle was measured.

Statistical analyses

To assess the suitability of the SRS-30 Japanese version, the distribution of responses to items, floor-ceiling effects, and internal and external construct validities were examined. Ceiling and floor effects were considered present when at least 15% of the respondents scored low or high, respectively. Internal construct validity was examined using the internal consistency coefficient, Cronbach, which ranged from 0 to 1.0. The Cronbach α coefficient value increases as the interrelations between the tested items increase, with values >0.7, indicating adequate internal consistency for the scale. To assess external construct validity (convergent validity), Spearman's correlation tests were performed between the SRS-30 and SRS-22r, including ODI. Negligible correlation coefficients of 0 to 0.29, low correlation of 0.30 to 0.49, moderate correlation of 0.50 to 0.69, high correlation of 0.70 to 0.89, and very high correlation of 0.90 to 1.00 were found. A P-value<0.05 was considered statistically significant. Statistical analyses were performed using the IBM SPSS Statistics (version 28.0; IBM Corp., Armonk, N.Y., USA).

Results

Participant characteristics

The baseline patient characteristics are shown in Table 1. Of the 81 patients in the study, 90.1% (n=73) were female, with a mean age of 14.4±2.0 years (median=15, min=9, max =17). Regarding curve type, Lenke type 1A was the most frequent (25.9%), followed by type 5C (23.5%). The mean Cobb angle of the main curve was 51.0±13.2°, and the mean thoracic kyphosis angle was 22.3±14.4°.

Surgical detail

All patients underwent posterior corrective fusion using pedicle screws. The mean number of fusion levels was 8.9± 3.0 (Table 2). Regarding UIV levels, T3 was the most frequent (21.0%), followed by T5 (17.3%). Regarding the LIV level, L3 was the most frequent (38.6%), followed by L1 (23.5%). The Cobb angle of the main curve improved significantly from 51.0±13.2° to 18.2±9.5° (P<0.001).

Distribution of responses to SRS-30 questionnaire items at 1 year postoperatively

Table 3 shows the distribution of responses to SRS-30, SRS-22r, and ODI. The mean SRS-30 total score was 4.2± 0.4. The mean scores for the domains function/activity, pain, self-image/appearance, mental health, and satisfaction were 4.1±0.4, 4.4±0.4, 3.8±0.5, 4.5±0.6, and 4.2±0.6, respectively. In the SRS-22r, the ceiling effect rate exceeded 15% for functions/activities, pain, self-image/appearance, mental health, and satisfaction. In contrast, for the SRS-30r, the ceiling effect rate exceeded 15% only for mental health. In the ODI, 49.3% of the participants responded with the lowest score, indicating a serious floor effect.

Internal construct validity

The Cronbach α coefficient for the SRS-30 total score obtained one year postoperatively was 0.861 (Table 4). The Cronbach α coefficients for the domains function/activity, pain, self-image/appearance, mental health, and satisfaction were 0.697, 0.405, 0.776, 0.845, and 0.559, respectively. Overall, the internal consistency of the SRS-30 questionnaire was adequate except for pain and satisfaction.

Convergent validity

When the correlation between SRS-30 and SRS-22r was examined, the total scores of the SRS-30 and the total scores of the SRS-22r significantly correlated (r=0.945, P< 0.001) (Table 5) (Fig. 1A). The domains of the SRS-30 (function/activity, pain, self-image/appearance, mental health, and satisfaction) and the corresponding domains of the SRS-22r significantly correlated, with r coefficients of 0.826, 0.826, 0.869, 1.000, and 0.901, respectively (all P< 0.001, except for mental health), respectively (Table 5) (Fig. 1B-F). A significant correlation was observed between the SRS-30 total score and ODI (r=−0.511, P<0.001).

Discussion

Questionnaires to assess QOL are often developed in English. Therefore, translating these questionnaires into other

languages is common so they can be used in countries where English is not the native language. To maintain the validity and equivalence of the translated versions of QOL questionnaires, adaptation is needed to match the cultural characteristics of each country, and the translated versions must be validated in these new cultures and languages[16,17]. Several translations and validations of the SRS-30 into languages other than English have been reported[9-13]. The present study aimed to cross-culturally translate and adapt the SRS-30 questionnaire and to evaluate its validity in native Japanese-speaking patients. The results of this study showed that the Japanese SRS-30 questionnaire was successfully developed and adapted, and the Japanese version of the SRS-30 total score had a high internal consistency, with Cronbach α=0.861 for Japanese-speaking AIS patients. Cronbach α coefficients for the five domains of the Japanese version of the SRS-30 were as follows: function/activity: 0.697, pain: 0.405, self-image/appearance: 0.776, mental health: 0.845, and satisfaction: 0.559, showing overall satisfactory internal consistency, although the consistency was low for the pain and satisfaction domain.

Table 1. Baseline Patient Background.

Variable	Total (n=81)
Age at surgery (years)	14.4±2.0
Female N (%)	73 (90.1%)
Height (cm)	157.0±8.2
Weight (kg)	47.0±8.7
Body Mass Index	18.6±2.7
Curve patterns	
Lenke type 1A	21 (25.9%)
Lenke type 1B	8 (9.9%)
Lenke type 1C	6 (7.4%)
Lenke type 2A	13 (16.0%)
Lenke type 2B	2 (2.5%)
Lenke type 2C	4 (4.9%)
Lenke type 3C	2 (2.5%)
Lenke type 5C	19 (23.5%)
Lenke type 6C	6 (7.4%)
Cobb angle of main curve (°)	51.0±13.2
Thoracic kyphosis (°)	22.3±14.4

Values are presented as mean±SD.

Table 2. Surgical Details.

Variables	Total
No. of fusion level	8.9±3.0
Upper instrumented vertebra	
T2	13 (16.0%)
T3	17 (21.0%)
T4	13 (16.0%)
T5	14 (17.3%)
T6	5 (6.2%)
T7	1 (1.2%)
T10	5 (6.2%)
T11	11 (13.6%)
T12	2 (2.5%)
Lowest instrumented vertebra	
T11	1 (1.2%)
T12	4 (4.9%)
L1	19 (23.5%)
L2	18 (22.2%)
L3	31 (38.3%)
L4	8 (9.9%)

Values are presented as mean±SD.

Table 3. The Distribution of the Japanese Scoliosis Research Society 30-item Domains and 22r-items Domains and Oswestry Disability Index.

Variable	N	Mean±SD	Ceiling%	Floor%	Percentiles				
					100%	75%	50%	25%	0%
SRS-30									
Function/activity	81	4.1±0.4	1.2%	0%	5.0	4.4	4.1	4.0	3.0
Pain	81	4.4±0.4	11.1%	0%	5.0	4.7	4.5	4.1	3.4
Self-image/appearance	81	3.8±0.5	2.5%	0%	5.0	4.2	3.8	3.4	2.9
Mental health	81	4.5±0.6	30.9%	0%	5.0	5.0	4.8	4.2	2.4
Subtotal	81	4.1±0.3	0%	0%	4.9	4.4	4.2	3.9	3.3
Satisfaction	81	4.2±0.6	13.6%	0%	5.0	4.7	4.3	4.0	2.7
Total	81	4.2±0.3	0%	0%	4.9	4.4	4.2	3.9	3.3
SRS-22r									
Function/activity	81	4.6±0.4	28.4%	0%	5.0	5.0	4.8	4.4	3.8
Pain	81	4.6±0.4	30.9%	0%	5.0	5.0	4.6	4.4	3.4
Self-image/appearance	81	4.1±0.6	17.3%	0%	5.0	4.6	4.2	3.8	2.4
Mental health	81	4.5±0.6	30.9%	0%	5.0	5.0	4.8	4.2	2.4
Subtotal	81	4.5±0.4	8.6%	0%	5.0	4.7	4.6	4.2	3.6
Satisfaction	81	4.1±0.6	16.0%	0%	5.0	4.5	4.0	4.0	2.5
Total	81	4.4±0.4	4.9%	0%	5.0	4.7	4.5	4.2	3.6
Oswestry disability index (%)	75	4.9±6.7	0%	49.3%	22.0	9.0	2.0	0.0	0.0

SD indicates standard deviation; SRS-22r, Scoliosis Research Society–22r; SRS-30, Scoliosis Research Society–30.

Hashimoto et al. translated the SRS-22 into Japanese in 2007 and validated this version[14]. They concluded that although the internal consistency of the SRS-22 was lower than that of the English version, it remained a valid instrument for the clinical evaluation of Japanese patients with AIS. A validity study of the Japanese version of the SRS-22 examined the internal consistency of the function, pain, self-image, and mental health domains, reporting scores of 0.65, 0.76, 0.74, and 0.84, respectively. Compared to this Japanese version of the SRS-22, the present study showed lower internal consistency in the pain domain but comparable results in other domains. This means that even when the Japanese version of the SRS-30 included eight questions added to the SRS-22r, homogeneity among the questions was maintained in each domain.

In another example of SRS-30 translation, Kyrölä et al. developed and validated a Finnish version of the SRS-30 questionnaire[12]. The internal consistency and reliability of the Finnish SRS-30 were good, with Cronbach α=0.853 and ICC=0.905, respectively. Carriço et al. also translated and adapted the SRS-30 into Brazilian-Portuguese[9], showing a good internal consistency with Cronbach α=0.853. In this study, the internal consistency of the overall Japanese version of the SRS-30 was good, with Cronbach α=0.861. For the function/activity domain, the Cronbach α=0.697, better than the values for the Finnish (0.735) and Brazilian-Portuguese (0.597) version. In the self-image/appearance domain, the Cronbach α in this study was 0.776, better than values for the Finnish (0.679) and Brazilian-Portuguese (0.751) version. Conversely, in the pain domain, Cronbach α =0.405 was poorer than the other language versions. This may be because the mean Cobb angle in this study population was 51.0°, which indicates mild scoliosis. Further, most patients had no preoperative pain, and a large percentage of the patients answered "Not changed" (3 points) to question #27, which asked whether pain increased or decreased after surgery, which may have reduced internal consistency. The low internal consistency of satisfaction in the SRS-30 questionnaire may be due to the small number of items in this dimension (3 items). Indeed, the SRS-30 has 5-9 items per domain in the other domains, and the Cronbach α coefficient tends to increase with the number of items. These results are similar to those of Carriço et al. and Ghandhari et al.[9,13]

Table 4. The Internal Consistency of the Japanese Scoliosis Research Society-30.

Subdomain	Number of Items	Cronbach α
Function/activity	7	0.697
Pain	6	0.405
Self-image/appearance	9	0.776
Mental health	5	0.845
Subtotal	27	0.843
Satisfaction	3	0.559
Total	30	0.861

As regards convergent validity, the SRS-22r and ODI were used in this study to validate the validity. The reliability and validity of the Japanese version of the SRS-22r have already been verified, showing a high correlation with the SRS-30 total score and corresponding domains, and the validity of the Japanese version of the SRS-30 was also confirmed. Few studies have examined the correlation between the SRS-30 and SRS22r, making this a useful finding. Moderate correlations with the ODI were also confirmed in the total SRS-30 score and the function/activity and pain domains, including the mental health domain. However, the AIS showed a few functional disabilities owing to lower back pain and a serious floor effect in the ODI assessment, which should be considered. Regarding floor and ceiling effects, this study showed higher floor and ceiling effects than the Finnish version reported by Kyrölä et al., including the Persian version reported by Ghandhari et al.[12,13] However, the present study had lower ceiling effect rates in the function/Activity and Pain domains than the Japanese version of the SRS-22r, which was acceptable[14].

SRS-22r is the most validated PROs in treating scoliosis. The advantage of using the SRS-30 over the SRS-22r is that it covers the SRS-22r and directly assesses the patient's subjective perception of pre- and postoperative changes from the postoperative questionnaire items in the SRS-30. This is a major strength in the evaluation of treatment efficacy. In

Table 5. The Correlation Coefficients between Scoliosis Research Society-30 Domains and Scoliosis Research Society-22r Domains, and ODI.

SRS-30	SRS-22r							ODI
	Function/Activity	Pain	Self-image/ Appearance	Mental health	Subtotal	Satisfaction	Total	
Function/activity	0.826	0.384	0.304	0.481	0.582	0.300	0.575	–0.503
Pain	0.347	0.826	0.242	0.433	0.567	0.254	0.556	–0.529
Self-image/appearance	0.288	0.349	0.869	0.323	0.688	0.597	0.725	N.S.
Mental health	0.490	0.564	0.325	1.000	0.769	0.291	0.745	–0.489
Subtotal	0.607	0.674	0.718	0.721	0.927	0.558	0.936	–0.538
Satisfaction	0.274	0.294	0.702	0.331	0.575	0.901	0.668	N.S.
Total	0.588	0.648	0.753	0.699	0.921	0.639	0.945	–0.511

N.S. indicates not significant; ODI, Oswestry Disability Index; SRS-22r, Scoliosis Research Society–22r; SRS-30, Scoliosis Research Society–30.

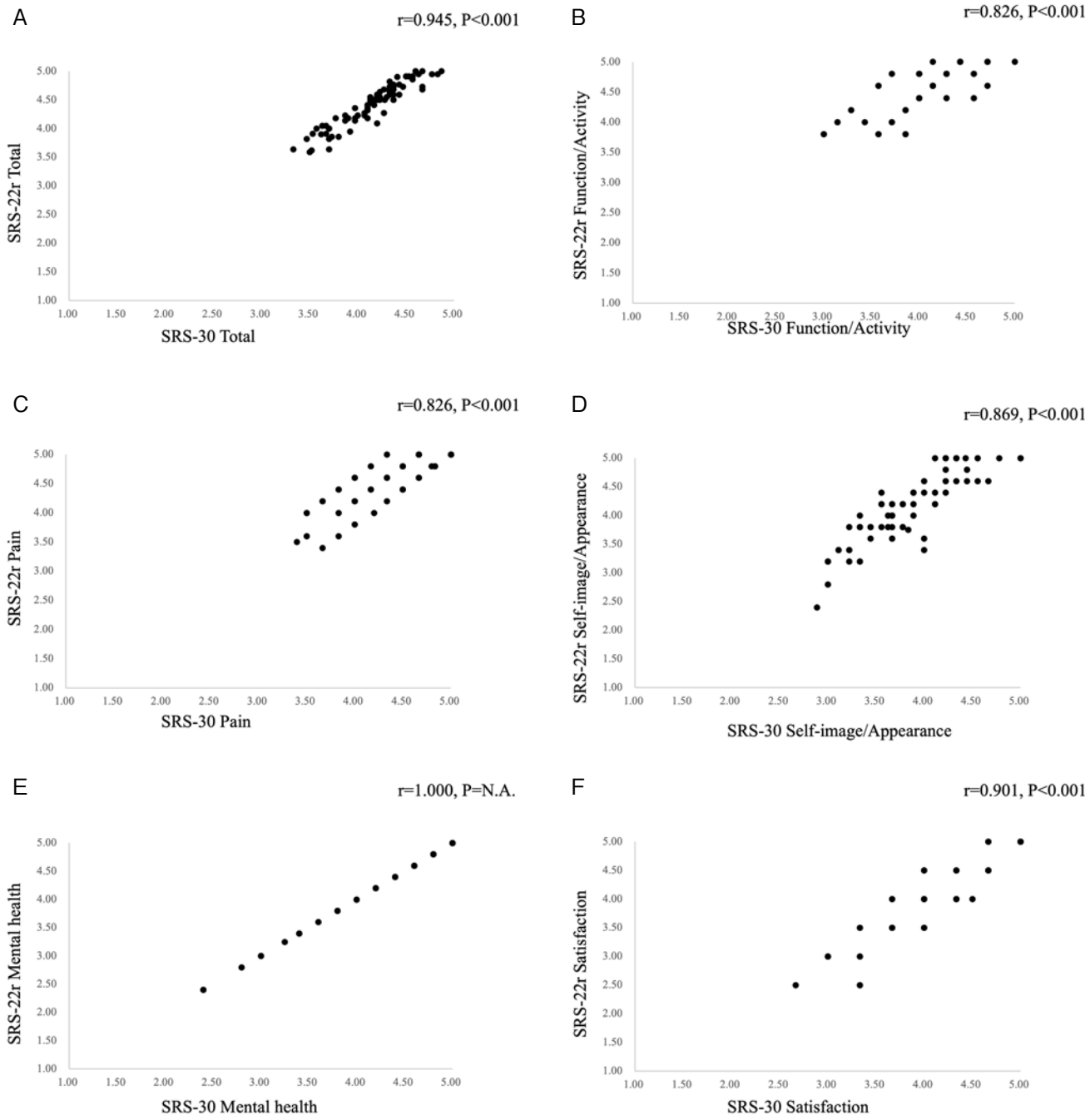

Figure 1. Scatterplot showing the correlation between Scoliosis Research Society (SRS)-30 and SRS-22r.
A: Total score; B: Function/Activity domain; C: Pain domain; D: Self-image/Appearance; E: Mental health; and F: Satisfaction with management.

addition, the postoperative questionnaire items can also be used to calculate the minimum clinically important difference (MCID) values of PROs. The MCID values for PROs have already been calculated using the postoperative section of the SRS-30[18,19]. Calculating MCID values related to mental health is difficult as there are no items related to mental health in the postoperative questionnaire. This could be an area for future research.

This study has several limitations. First, the 36-item Short-Form Health Survey (SF-36) was not included. Previous studies that translated and validated the SRS-30 into other languages used the SF-36 to validate its convergent validity. These studies reported moderate correlations between the SRS-30 and SF-36, and it also remains necessary to examine the correlation with SF-36 in this study. Second, a retest reliability assessment was not conducted. Third, the correlation between the SRS-22r questionnaire and the SRS-30 was investigated in this study, but the 22 questions overlap between the two, and this should be further investigated.

Conclusions

The Japanese version of SRS-30 has been validated in patients with AIS. The scale's internal consistency was good or

excellent in other domains, except for pain and satisfaction, for which the consistency was moderate. We believe that the Japanese version of SRS-30 is simple, easy to use, and applicable in clinical practice for future outcome studies in Japan.

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Author Contributions: HA and YY designed the study;
HA, YY, HO, JT, KW, RS, and KT acquired the data;
HA and YS analyzed the data;
HA, YY, YS, KW, and NH interpreted the data;
HA drafted the manuscript;
YY revised it critically;
KW and NH supervised the analysis.
All authors approved the final version of the manuscript.

Ethical Approval: IRB approval: This study was reviewed and approved by the Hamamatsu University School of Medicine Institutional Review Board (IRB No.19-313), the Shinshu University School of Medicine Institutional Review Board (IRB No.4681), the Niigata University Institutional Review Board (IRB No. 2015-1385), and the Jichi Medical University Institutional Review Board (IRB No.19-246) and adhered to the principles of the Declaration of Helsinki.

Informed Consent: Since this study used medical records and was conducted on an opt-out basis with guaranteed opportunities for research subjects to refuse to participate in the study, written or verbal consent was not obtained from the research subjects. A comprehensive agreement on academic use of information, such as the type of treatment, treatment progress, or any other data acquired during treatment, was obtained from the patients by the hospital during their hospitalization. The agreement also included a clause that no identifiable information regarding the participants would be included in the manuscript.

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