

The validity and reliability of the SRS-22r questionnaire in patients with scoliosis receiving physical therapy

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ABSTRACT

Background: The malalignment of the spine affects both the physical and mental health of patients with scoliosis. The refined version of the Scoliosis Research Society questionnaire (SRS-22r) is a common tool used for assessing the health-related quality of life (HRQOL) in this patient population. However, the Thai version of this questionnaire has not been tested for psychometric properties in scoliosis patients receiving physical therapy.

Objective: This study aimed to evaluate the concurrent validity, internal consistency, and test-retest reliability of the SRS-22r in patients with scoliosis undergoing physical therapy.

Materials and methods: Twenty-nine patients diagnosed with scoliosis responded to three instruments, including the SRS-22r, Short Form 36 version2 (SF-36v2), and the Hospital Anxiety and Depression Scale (HAD). Participants also completed the SRS-22r again seven days later.

Results: The SRS-22r domains showed no floor or ceiling effects, except for treatment satisfaction, while the SF-36v2 and HAD showed greater ceiling or floor effects in many domains. A good to excellent correlation was observed between total scores and domain scores of SRS-22r and SF-36v2, as well as SRS-22r and HADS. The Cronbach's alpha was satisfactory, with an average of 0.772 for all domains of SRS-22r. The ICCs for the two-time responses of the SRS-22r were excellent for the total score and the self-image, pain, mental health, and physical function domains, with average ICCs of 0.771. The treatment satisfaction domain had lower Cronbach's alpha, Pearson correlation coefficient, and ICCs than the other domains.

Conclusion: The SRS-22r was valid and reliable when applied to patients receiving physical therapy. However, modifying the treatment satisfaction measure may be considered.

Introduction

Idiopathic Scoliosis (AIS) is a condition of spinal deformity with a lateral curve greater than 10 degrees. The estimated worldwide prevalence is 0.47 to 5.20, depending on the evaluation method^{1,2}. A survey of Thai adolescents found an occurrence of 4.62 to 22%.^{3,4}

The effects of spinal deformities on physical pain, emotional difficulties, and health-related quality of life (HRQOL) have been reported.⁵⁻⁹ Physically, individuals with scoliosis reported that they had back pain and related physical symptoms⁵. Psychologically, the low self-esteem, difficult relationship with other people and depression could be ensued.^{6,9} Compared to people of the same age, patients with scoliosis reported having less happiness in life, lower confidence, and poorer physical health.⁸ In adults, individuals with large curves have reduced health-related quality of life.^{10,11} Adults with scoliosis also reported that the condition influenced their educational and career choices.¹⁰ Therefore, the Scoliosis Research Society (SRS) and many authors recommend that clinicians evaluate clients' HRQOL in clinical practice.¹²⁻¹⁵ The SF-36 is the most widely used tool to assess HRQOL in patients with various health conditions. Also, if the psychological aspect is focused on, the HADS was also commonly applied among patients seeking medical attention for nonpsychiatric disorders.

A tool specifically designed to measure HRQOL in patients with AIS has been developed. Since 1999, the SRS has proposed a questionnaire for assessing the HRQOL of patients who received surgical treatment.¹⁵ The original version, SRS-24, comprises 7 domains: pain, general self-image, post-operative self-image, general function, postoperative function, function

from back condition, general level of activity, and treatment satisfaction. Psychometric studies reported disadvantages of the SRS-24, including low internal consistency in some domains and no reports of test-retest reliability, criterion and discriminant validity, or responsiveness to change.¹⁵ Moreover, the questions require considerable recall, limit answer options, and are redundant across domains.¹⁶ Therefore, the SRS-24 questionnaire was modified into the updated versions of the Modified-SRS and, finally, the SRS-22.¹⁶

In 2003, the SRS-22 and its refined version, SRS-22r, were proposed by eliminating the questions with low internal consistency and recategorizing the questions among domains.^{12,17} The psychometric properties of SRS-22r were determined by comparing it with the standard HRQOL questionnaire, SF-36, in patients with AIS post-surgery. Since this tool is more focusing on the health issue relevant to AIS, the results showed that the reliability of Cronbach alpha and ICC were better than SF-36.¹⁷ Concurrent validity, measured by Pearson correlation coefficients between the SRS-22 and SF-36 domains, was greater than 0.70. Internal consistency, reproducibility, and validity were also satisfied.¹⁷

In Thailand, three research groups have translated and cross-culturally adapted the SRS-22r for use in Thai AIS patients.¹⁸⁻²⁰ The psychometric properties of the first version were reported with acceptable validity and reliability among 30 patients, most of whom received surgery.¹⁸ Another adapted Thai version of the SRS-22r questionnaire was also proven to be valid and reliable in patients with AIS post-surgery.¹⁹ Another Thai version of the SRS-22r questionnaire was tested for psychometric properties in patients with AIS who were treated with spinal bracing.²⁰ The

authors concluded that the questionnaire had good psychometric properties for evaluating patients with scoliosis receiving conservative treatments.²⁰

Nowadays, patients with AIS and adults with scoliosis commonly seek physical therapy. These patients have different clinical characteristics than those who are candidates for surgery and spinal orthosis, since they usually have a relatively lower Cobb angle but a high potential for curve progression. Physical therapy also includes a prolonged course of therapeutic exercise and a comprehensive postural training program, which requires high compliance. These factors may influence the psychometric properties of the HRQOL tool, especially the treatment satisfaction section. However, the psychometric properties of the SRS-22 questionnaire have not been reported among these clients.

Therefore, the objective of this study was to test the psychometric properties, i.e., concurrent validity, internal consistency, and test-retest reliability, of the SRS-22r in patients with AIS who were receiving physical therapy treatment.

Materials and methods

The cross-sectional observational design was adopted to examine the psychometric properties of the SRS-22r questionnaire. The research protocol was approved by the Mahidol University Central Institutional Review Board (MUCIRB) (COA 2021/057.1103). The participants were patients with AIS with the following inclusion criteria: age 12-59 years, diagnosed with AIS determined by Cobb's angle greater than 10 degrees, and receiving physical therapy treatments. Exclusion criteria included other musculoskeletal conditions such as arthritis or fracture, and conditions that affect bone growth, such as neurological or metabolic conditions.

The sample size was calculated based on the intraclass correlation coefficient (ICC) of test-retest reliability. With the criteria set for the calculation including the minimal acceptable reliability of 0.8, expected reliability of 0.5, significance level (α) of 0.05, power ($1-\beta$) of 0.8, and number of response repetitions of 2, the required sample size was 28. The expected dropout rate of 5% was considered; the total sample size for data collection was 29.

The instruments included a data collection form for personal and health information and Thai versions of three questionnaires: SRS-22r, Short Form 36 version 2 (SF-36v2), and the Hospital Anxiety and Depression Scale (HADS).

The SRS-22r questionnaire used in this study was a refined Thai version developed from three previous Thai-translated versions of the SRS-22r. The instructions and items were analyzed for differences. Three physiotherapists with more than 10 years of experience treating scoliosis patients determined the appropriateness of the wording, and they reached

consensus on any differences. The questionnaire comprises 5 domains covering function, pain, mental health, self-image, and treatment satisfaction. For the function domain, the questions mainly evaluate specific functions related to the condition of the spine and activity level. The pain domain assesses pain experienced in the past one and six months, use of pain medication, and the sick days due to back pain. The mental health domain evaluates feelings that reflect psychological aspects associated with the condition. The self-image domain explores aesthetic and self-appearance perceptions related to the scoliotic spine. Lastly, the survey also asked about satisfaction with the physical therapy treatment results. The function, pain, mental health, and self-image domains each contain five questions, while the treatment satisfaction domain consists of two questions. Scoring ranges from 1 to 5, with higher scores indicating better responses. The total range is 22-110.

Two HRQOL instruments, SF-36v2 and HADS, were used for the concurrent validation process. The SF-36v2 is the most commonly used generic tool for assessing quality of life in patients with various health problems, including scoliosis.¹⁴ Also, the HADS was suggested to be a reliable, valid, and practical tool to quantify psychological issues among patients seeking medical attention for nonpsychiatric disorders.²¹ This tool has been reported to be used in scoliosis, mostly in pre- or post-operative conditions.

Procedure

Participants learned about the study through a poster displayed at the scoliosis clinic, Physical Therapy Center, Mahidol University. Word of mouth was also used for recruitment. The patients who met the inclusion criteria were informed about the study protocol and asked to sign the informed consent. For participants aged less than 18, their parent was also informed and signed the consent form. The demographic and medical history were recorded. The physical evaluation included postural assessment, trunk rotation angle, and leg length. Afterward, participants completed three online questionnaires (SRS-22r, SF-36v2, and HAD) on a tablet computer. After data collection, participants received a physical therapy session, usually including therapeutic exercises and postural training. Participants also completed the SRS-22r seven days after the first administration to assess test-retest reliability.²²⁻²⁵ The researcher reminded participants to complete the form via text message.

Data analysis

The data were analyzed using SPSS v.21 (IBM SPSS Statistics for Windows, Armonk, NY, USA). The descriptive statistics of mean, standard deviation, minimum, and maximum were calculated to determine the data distributions as well as the ceiling and floor effects. The SRS-22r domain scores were converted to

a 0-100 scale to compare with the SF-36V2 scores. The threshold of 7% of the minimal and maximal scores was used for identifying the floor and ceiling effects.¹⁷ The concurrent validity of SRS-22r score was determined by its correlation with the scores of SF-36v2 and HAD Scale. The Pearson correlation coefficients (*r*) of total scores as well as the domain scores were reported. The *r* coefficient was interpreted as excellent (0.75), good (0.50-0.75), moderate (0.25-0.50), and poor (<0.25).²⁶

The internal consistency was determined by Cronbach's alpha of SRS-22r score. The level of internal consistency was defined as very satisfactory (Cronbach's alpha 0.80- 0.89), good (Cronbach's alpha 0.50–0.79), and low (Cronbach's alpha < 0.5).¹⁶ The intraclass correlation coefficient (ICC (2,1)) of the total and domain scores was calculated from the SRS-22r scores, which were evaluated twice with a 1-week interval. For test-retest reliability, we defined the ICC as excellent (≥ 0.75), good (0.40-0.75), or poor (≤ 0.40).²⁷

Results

This study enrolled 29 participants with idiopathic scoliosis. The characteristics of the participants with different scoliotic curve types are presented in Table 1 and Figure 1. Most of them were female, with an average age of 19 years. More participants (65.5%) were under 18 years old. Around 45% had a single curve, while 55% had double curves. Those with a single curve mostly had a major right thoracic curve (84.6%), while those with a double curve had a major left lumbar curve (93.8%). The average degree of the right thoracic curve (31.69 ± 15.99) was greater than that of the left lumbar curve (25.69 ± 8.41) in the double-curve group. The angle of trunk rotation (ATR) measured on the major curve was also greater in the right thoracic curve (12.08 ± 4.41) of the single-curve group compared with the left lumbar curve (6.69 ± 4.56) in the double-curve group.

Table 1. Characteristics of participants with idiopathic scoliosis.

	All (N=29)	Single curve (N=13)	Double curve (N=16)
Age [years, mean (SD)]	18.9 (8.47)	17.54 (6.50)	20.00 (9.85)
Cobb angle major curve [degree, mean (SD)]	28.38 (12.52)	31.69 (15.99)	25.69 (8.41)
Cobb angle minor curve [degree, mean (SD)]	20.33 (9.12)	18.38 (11.16)	21.90 (7.35)
Scoliometer major curve [degree, mean (SD)]	10.76 (4.57)	12.08 (4.41)	6.69 (4.56)
Scoliometer minor curve [degree, mean (SD)]	4.69 (2.619)	4.08 (2.15)	5.21 (2.94)

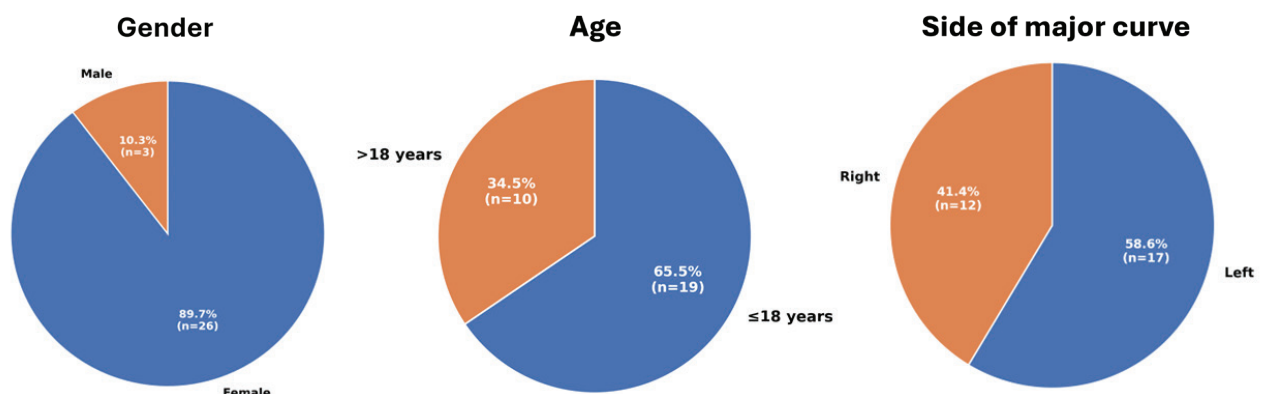


Figure 1. Distributions of gender, age and side of major curve of participant with adolescent idiopathic scoliosis (N=29)

Table 2 shows the score and distribution of three questionnaires administered. The SRS-22r has five domains, the SF-36v2 has eight domains, and HADS has two domains. All SRS-22r domains showed no or low floor effect (less than 7%). One domain of SRS-22r, treatment satisfaction, showed a ceiling effect (13.8%),

and the depression domain of HADS also showed a floor effect (13.8%). However, most SF-36v2 domains showed a high ceiling effect (more than 7%), including physical function, role physical, bodily pain, social function, and role emotion.

Table 2. Scores of SRS-22r, SF-36v.2, and HADS.

Questionnaire and Domains (Maximal score)	Mean	SD	Range (Min-Max)	% with	
				Floor effect	Ceiling effect
SRS-22r (110)	85.34	8.22	66-96	0%	0%
Pain (25)	18.48	2.53	13-23	0%	0%
Mental health (25)	18.28	1.96	14-22	3.4%	0%
Self-image (25)	21.69	2.38	17-25	0%	3.4%
Functional activity (25)	18.62	2.69	12-22	0%	0%
Treatment satisfaction (10)	8.28	1.19	6-10	0%	13.8%
SF36					
Physical function (100)	83.79	17.20	30-100	0%	17.2%
Role physical (100)	87.28	15.08	50-100	0%	44.2%
Body pain (100)	84.57	15.66	45-100	0%	37.9%
General health (100)	68.10	19.14	25-100	0%	3.4%
Vitality (100)	57.54	23.76	0-81	3.4%	0%
Social function (100)	78.02	23.78	13-100	0%	37.9%
Role emotion (100)	81.32	21.55	33-100	0%	44.8%
Mental health (100)	81.32	21.55	33-100	6.9%	0%
HADS					
HADS depression (21)	3.62	3.19	0-11	13.8%	0%
HADS anxiety (21)	6.28	3.80	0-15	3.4%	0%

Note: SRS-22: Scoliosis Research Society-22; SF-36v2: Thai version short form survey version 2, HAD: Hospital Anxiety and Depression Scale. SRS 22 score: 5 = worst, 25 = best, SF-36 score: 0 = worst, 100 = best, HAD score: 0 = best, 21 = worst

Concurrent validity

Table 3 presents the concurrent validity of the SRS-22r based on comparisons with the SF-36V2 and HAD. Excellent correlation ($r > 0.75$) was observed between total scores of SRS-22r and SF-36v2, the functional activity domain of SRS-22r, social function

and mental health of SF-36v2, as well as the depression score of HAD. A good correlation ($r = 0.50-0.75$) was found between 14 pairs of SRS-22r and SF-36v2 domains. Notably, the treatment satisfaction domain of the SRS-22 was not significantly correlated with any domain of the SF-36v2 or HAD.

Table 3. Correlations between SRS-22 domains with SF-36 domains for concurrent validity

	SRS-22r Pain	p values	SRS-22r Mental health	p values	SRS-22r Self-image	p values	SRS-22r Functional activity	p values	SRS-22r Treatment satisfaction	p values	SRS-22r Total score	p values
SF-36v2												
Total score	0.683	0.000*	0.518	0.004*	0.544	0.002*	0.838	0.000*	0.268	0.159	0.804	<0.001*
Physical function	0.469	0.010*	0.127	0.513	0.401	0.031*	0.599	0.001*	0.322	0.089	0.533	0.003*
Role physical	0.202	0.294	0.349	0.063	0.359	0.056	0.284	0.136*	-0.009	0.963	0.341	0.070
Body pain	0.486	0.008*	0.431	0.020*	0.538	0.003*	0.441	0.017*	-0.027	0.890	0.548	0.002*
General health	0.468	0.011*	0.302	0.111	0.236	0.218	0.641	<0.001*	0.243	0.204	0.529	0.003*
Vitality	0.542	0.002*	0.461	0.012*	0.347	0.065	0.695	<0.001*	0.089	0.645	0.618	<0.001*
Social function	0.702	0.000*	0.661	<0.001*	0.586	0.001*	0.814	<0.001*	0.285	0.135	0.851	<0.001*
Role emotion	0.433	0.019*	0.429	0.020*	0.499	0.006*	0.679	<0.001*	0.370*	0.048	0.656	<0.001*
Mental health	0.709	0.000*	0.531	0.003*	0.465	0.011*	0.756	<0.001*	0.208	0.279	0.757	<0.001*
HAD												
Depression	-0.645	0.000*	-0.519	0.004*	-0.520	0.004*	-0.820	<0.001*	-0.206	0.283	-0.771	<0.001*
Anxiety	-0.579	0.001*	-0.399	0.032*	-0.592	0.001*	-0.643	<0.001*	-0.183	0.342	-0.682	<0.001*

Note: SRS-22: Scoliosis research society-22, SF-36v2: Thai version short form survey version 2, HAD: Hospital anxiety and depression scale.

Table 4 presents the results of the SRS-22r reliability analysis. The internal consistency, as indicated by Cronbach's alpha, was very satisfactory for the domain of pain. Mental health, physical function, and treatment satisfaction scores showed good consistency. The average Cronbach's alpha of all domains was 0.772. However, the total score and self-image domain had high Cronbach's alpha values of

0.932 and 0.914, respectively.

Test-retest reliability, as represented by ICCs, was excellent for the total score and the self-image, pain, mental health, and physical function domains. The average ICC across all domains was 0.771. However, the reliability of the treatment satisfaction score was lower than that of the other domains but still good.

Table 4. Reliability of SRS-22r (N=29).

SRS22	Cronbach's alpha	ICC	95% CI	p value
Total score	0.932	0.932	0.857-0.968	<0.001
Pain	0.837	0.835	0.652-0.922	<0.001
Mental health	0.781	0.778	0.534-0.895	<0.001
Self-image	0.914	0.914	0.819-0.960	<0.001
Physical function	0.781	0.778	0.534-0.895	<0.001
Treatment satisfaction	0.548	0.552	0.044-0.790	0.02

Discussion

The SRS-22r is a simple questionnaire commonly used to assess HRQOL in patients with idiopathic scoliosis. It has been translated into many languages, including Thai, and was validated in Thai patients who received surgical and brace treatments.¹⁸⁻²⁰ This study showed that the SRS-22r was also valid and reliable when applied to patients receiving physical therapy.

Score distribution

The score distribution of SRS-22r among scoliotic patients receiving physical therapy in this study was acceptable. All domains of the tool, except treatment satisfaction, showed no floor or ceiling effects. This reflected the tool's ability to detect perceptions across diverse aspects of HRQOL in this patient population. Meanwhile, the SF-36, a generic HRQOL assessment tool, showed an undue ceiling effect in five of eight domains. One of the two HAD domains also showed a floor effect.

Similar to this study, the ceiling effect of the treatment satisfaction domain of the SRS-22r has been reported in all previous Thai translation studies.¹⁸⁻²⁰ The ceiling effect in treatment satisfaction has also been observed in other language versions.^{22,25,26,28-37} This may reflect patients' confidence and approval of treatments at the institutes that served as research centers. Our setting was also a physical therapy center belonging to an academic institute, which may have been more trustworthy to patients.

The ceiling effects of the other three domains were observed in previous reports of Thai versions, including function, pain, and treatment satisfaction. This might be due to the different characteristics of patients in the previous studies which were ones receiving surgery^{18,19} or brace treatments.²⁰ A systematic review in 2015 showed that the SRS-22 translations in many languages suffered from ceiling effects, specifically the

subscales of pain, function, mental health, self-image and treatment satisfaction.^{25,26,28-37} They discussed that this ceiling effect might lead to overestimated reliability. Fortunately, the SRS-22 score distribution did not show floor or ceiling effects in our patient population, confirming the scale's applicability to patients receiving physical therapy. However, additional ways to evaluate treatment satisfaction might be needed.

Concurrent validity

The concurrent validity of the SRS-22r was supported by the good to excellent correlations between the SRS-22r and the SF-36v2, as well as the HAD. These significant correlations were observed in both total and domain scores of the tools. This reflects the good validity of the SRS-22r score when applied to patients receiving physical therapy.

Previous studies have confirmed the concurrent validity of the Thai version of the SRS-22r in patients post-surgery and using a spinal brace.²⁰ Previous studies found generally good correlations between SRS-22r and SF-36v2 across all domains ($r=0.50-0.75$).¹⁸⁻²⁰ The validity of SRS-22r has been confirmed by its correlation with SF-36 or SF-12 in other languages.^{24,26,28-31,33-37,39,40,42} All different language versions present acceptable validity in scoliosis patients who received both conservative and surgical interventions.

Psychologically, the SRS-22r score showed good correlation with HAD anxiety and excellent correlation with depression scores. The same trend of excellent correlation between SRS-22r and the mental health domain score of the SF-36v2 was also observed. This may reflect the HRQOL trait with the psychological construct of the SRS-22r score in patients with AIS.

The treatment satisfaction domain of the SRS-22r was not confirmed for concurrent validity, as it showed no correlation with any domain of the SF-36v2 or HAD. The low and no significant correlation of this domain

has been reported in the previous studies of Thai versions¹⁸⁻²⁰ as well as other languages.¹⁴ Given that these questions address a different concept of HRQOL, these results were expected. However, the questions were specific and important for determining the overall HRQOL of patients with scoliosis. Therefore, these two treatment-satisfaction questions should still be included in the scoliosis-specific questionnaire.

Internal consistency

The SRS-22r appeared to have excellent consistency (Cronbach's alpha >0.70) in three domains, i.e., pain, mental health, and physical function, when administered in scoliotic patients receiving physical therapy treatment. The consistency of the treatment satisfaction scores was lower than that of the other domains, but Cronbach's alpha was still acceptable. Interestingly, the total score and self-image domain had very high Cronbach's alpha, reflecting redundancy among the questions. Consistency reports in previous studies of Thai versions of the SRS-22r were also acceptable, ranging from 0.70 to 0.84.¹⁸⁻²⁰ The average Cronbach's alpha of 0.774 in this study was similar to values reported in previous studies of Thai versions by Sathira (0.760), Leepattana (0.776), and Samala (0.650). The internal consistency of translated versions of the SRS-22 in other languages was also consistently reported as high and acceptable.¹⁴ Interestingly, the Cronbach's alpha of the treatment satisfaction domain was only 0.28 among Thai patients treated with a spinal brace, compared with higher consistency when tested in patients receiving spinal surgery in the other two studies.^{18,19} However, the treatment satisfaction domain usually showed lower internal consistency, which may be due to fewer questions than other domains.¹⁹ Variations in patient characteristics, such as age and curve severity, may also influence treatment satisfaction reports.

Test-retest reliability

The test-retest reliability of the SRS-22r was satisfactory for most domains and the total score. The lowest test-retest reliability was in the treatment satisfaction domain, with an ICC of 0.552. This trend has also been shown in previous studies of Thai versions of the SRS-22r. The test-retest reliability in three previous studies was all treatment satisfaction, with ICCs ranging from 0.62 to 0.90.¹⁸⁻²⁰ Translated versions of the SRS-22 in other languages were also consistently reported to have high test-retest reliability.¹⁴ Interestingly, the ICC for the treatment satisfaction domain was also low (ICC=0.43) in the study of patients receiving brace treatment.²⁰ The trend of lower Cronbach's alpha and ICCs might reflect that treatment satisfaction among patients receiving conservative treatments (i.e., physical therapy or a spinal brace) is less reliable than among those who have already finished surgical treatment and are in the

follow-up period. This might be related to apprehension about disease progression, which continues in patients who are still undergoing conservative treatment. Those who received surgery might feel that their condition has been resolved.

Limitations

This study had some limitations. The participant sample was mostly female and young. The psychometric results of the SRS-22r in this study may not generalize to male and older scoliosis patients. Gender and age differences could influence HRQOL perceptions and, in turn, affect the psychometric properties of the measurement tool. Also, some participants did not return the retest questionnaire, so the sample size was relatively small. However, the number of participants was considered adequate for the test-retest reliability trial.

Conclusion

the psychometric properties (reliability and validity) of the SRS-22r Thai version were acceptable in patients with scoliosis receiving physical therapy. The tool is therefore recommended for use in these patients. However, the questions evaluating treatment satisfaction in this tool may need modification, as this domain showed relatively low internal consistency, test-retest reliability, and unconfirmed concurrent validity with the generic HRQOL tool.

Ethical approval

Mahidol University Central Institutional Review Board approved the research protocol (COA 2021/057.1103). All participants gave written informed consent.

Declaration of generative AI and AI-assisted technologies

The authors used ChatGPT (OpenAI) to assist with language editing and preparing the graphical abstract. The authors reviewed and edited all AI-assisted content and took full responsibility for the accuracy, originality, and integrity of the final manuscript.

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Conflict of interest

All authors declare no conflict of interest.

CRedit authorship contribution statement

Arpanat Pholkamol: conceptualization, methodology, investigation, writing-original draft, review and editing; **Nantuchporn Khambunruang:** methodology, investigation, writing-review and editing; **Noochjaree Siri:** methodology, writing-review and editing, supervision; **Mantana Vongsirinavarat:** conceptualization, methodology, supervision, writing-original draft, review and editing, project administration.

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