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## Effects of living environment on the postoperative Scoliosis Research Society-24 results in females with adolescent idiopathic scoliosis

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- A** Study Design
- B** Data Collection
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- D** Data Interpretation
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### Summary

#### Background:

There are many factors influencing postoperative health-related quality of life of adolescent idiopathic scoliosis patients, including the degree of the deformity, culture, differences in geography, rural versus urban living environments, and social factors. The objective of this study was to analyze the significance of geographic factors and their differences influencing the postoperative quality of life in females with adolescent idiopathic scoliosis residing in urban and rural environments, by use of the Polish version of the SRS-24 questionnaire.

#### Material/Methods:

Forty urban and 20 rural postoperative patients with adolescent scoliosis with a minimum 2-year follow-up period after surgery were included in the study. The process of cross-cultural adaptation was performed according to the IQOLA Project.

#### Results:

General results of the Polish SRS-24 equalled 4.1 (SD 0.5) and 4.0 (SD 0.5) in the rural and urban groups of patients, respectively. The 2 groups do not differ in incidence of floor and ceiling effects. The Cronbach's alpha values are excellent for the general result of SRS-24 in urban and rural groups (0.85 and 0.85, respectively). The sub-groups differed significantly in the self-image after surgery domain ( $p=0.048$ ).

#### Conclusions:

Patients from the rural group scored higher in the self-image after surgery domain but reported higher pain levels when compared to urban patients. The associations between SRS-24 results and radiographic parameters in the rural group of patients were strong, compared with moderate relations reported in the urban group.

#### key words:

**SRS-24 • self-image • pain • adolescent idiopathic scoliosis • living environment**

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## BACKGROUND

There are many factors influencing postoperative health-related quality of life (HRQL) of adolescent idiopathic scoliosis (AIS) patients, including the degree of the deformity, culture, differences in geography, rural versus urban living environments, and social factors. Family environment may affect quality of life as well. In addition, family environment and cultural differences may also affect patients' interpretation of the questions on any HRQL questionnaire, as evidenced by validity studies performed on translated versions of the Scoliosis Research Society-22 (SRS-22 questionnaire). Scores of the HRQL scales in different ethnic groups within the same country can also be different [1–5].

Effects of socio-demographic factors on postoperative HRQL in adolescent idiopathic scoliosis patients have been mainly analyzed by means of the SRS-22 instrument [6]. Wang et al. performed an analysis of differences in postoperative quality of life between adolescent patients with idiopathic scoliosis residing in urban and rural environments using the Scoliosis Research Society-22 scale [7]. He found that in general the assessment results of the postoperative quality of life in AIS patients differed between those living in urban and rural environments. He pointed out that the effects of environment should be considered when using the SRS-22 scale to evaluate postoperative AIS patients; however, scores on pain and mental health domains were not significantly different between the 2 groups [7]. This suggests that the influence of geographic factors on SRS-22 results remains unclear. In a similar study conducted by Verma et al, the objectives were to evaluate the influence of variable demographic factors on the SRS-22 results. He indicated that race, income, gender, and single- versus dual-parent households affected the SRS-22 results, with a meaningful clinical difference [8].

The main objective of the present study was to analyze the significance of geographic factors and potential differences in postoperative quality of life, between adolescent patients with idiopathic scoliosis residing in Polish urban and rural environments. The SRS-24 was developed by Haher et al. as a simple, disease-specific questionnaire for adolescent idiopathic scoliosis patients treated surgically, and was found to be reliable and valid [6]. As there is no Polish language version of SRS-24 questionnaire available, we performed a preliminary validation process of this assessment tool. Until now no report, to our knowledge, has addressed the validity of the SRS-24 instrument in patient populations from different living environments.

## MATERIAL AND METHODS

Postoperative AIS female patients were enrolled consecutively into this retrospective study (n=60). All patients were assessed at the minimum 2-year follow-up after the surgical treatment. The length of the study period was 21 months.

Patients were treated surgically with posterior correction and fusion by a single experienced physician. Scoliosis correction was the first spine surgery performed in these subjects. Other diseases leading to deformity of the trunk were considered to be exclusion criteria. Proximal fusion reached Th5 level in 29 patients, Th4 in 24 patients, Th3

and Th6 in 3 patients each, and Th7 in 1 patient. Distal fusion reached L2 level in 15 patients, T12 in 14, L1 and L3 in 13 each, T11 in 3 and L4 in 2. In the post-operative period, 2 patients suffered from pneumothoraces and 2 other patients suffered from hemopneumothoraces.

### Urban and rural groups of patients

Patients were divided into either the urban group or the rural group based on the information provided in the questionnaire. The urban group included 40 patients, while the rural group included 20 patients.

No significant differences between urban and rural patient populations regarding age at surgery, Cobb angle in the thoracic or lumbar spine, thoracic or lumbar apical translation, kyphosis angle, lordosis angle or rib hump angle were observed ( $p>0.05$ ). The 2 groups of patients differed significantly in regards to Cobb's angle of the proximal thoracic curve both before and 2 years after surgery ( $p=0.011$  and  $p=0.004$ , respectively). Preoperative and postoperative radiographic measures of deformity and demographic characteristics of urban and rural populations are summarized in Table 1.

The study received approval from the Bioethics Commission and written informed consent was obtained from all participants. The examined patients and their parents received in-depth information on the aim of the study and were guaranteed anonymity.

### Methods

The Scoliosis Research Society-24 questionnaire is a widely recognized tool for assessing the current health state and treatment outcomes in patients with idiopathic scoliosis treated surgically. It consists of 24 questions grouped in the 7 following domains [6]:

- a) pain (7 questions),
- b) general self-image (3 questions),
- c) self-image after surgery (3 questions),
- d) function after surgery (2 questions),
- e) general function (3 questions),
- f) function activity (3 questions),
- g) satisfaction with surgery (3 questions).

SRS-24 scale is comprised of questions of varying ranges on the part of the patient (three to nine response options), as well as two choice, yes-and-no-type questions. Items within a subscale can be added to obtain an overall score for each domain, with higher scores representing a better outcome. Similarly, a total score can be calculated by summing the domain scores [6].

SRS-24 was found to be both reliable (for each domain) and valid [6,9]. The construct validity of the instrument was determined by comparing mean responses of patients with scoliosis with the control group. Asher et al. modified the Scoliosis Research Society-24 questionnaire to create the Scoliosis Research Society-22 [1]. They consolidated seven to four general domains of pain, self-image, function, and satisfaction, and added a fifth domain, mental health, based on questions adopted from the SF-36. With these modifications, internal consistency of SRS-22 was equal to or greater

**Table 1.** Demographic and clinical characteristics of urban and rural study participants.

Parameters	Urban group				Rural group				p value
	Mean	Min.	Max.	SD	Mean	Min.	Max.	SD	
Age at the surgery	15.7	12.3	30.5	3.7	15.3	12.2	23.1	3.0	0.689
<b>Before surgery</b>									
Cobb angle in thoracic spine	57.3	45.0	95.0	9.7	55.0	43.0	90.0	11.8	0.183
Cobb angle in lumbar spine	31.8	10.0	56.0	10.0	29.8	17.0	43.0	7.9	0.567
Cobb angle in proximal thoracic spine	27.1	14.0	52.0	7.1	21.7	11.0	33.0	6.4	0.011**
Thoracic apical translation *	4.5	1.5	10.5	1.9	5.7	2.3	13.3	2.5	0.080
Lumbar apical translation*	1.6	0.0	4.5	1.0	1.4	0.0	3.2	0.9	0.541
T2-T12 kyphosis angle	25.0	5.0	54.0	10.7	21.2	7.0	38.0	10.0	0.230
T5-T12 kyphosis angle	22.1	4.0	51.0	10.0	18.7	5.0	37.0	9.5	0.246
T2-T5 kyphosis angle	6.2	1.0	16.0	4.2	5.2	-21.0	18.0	7.8	0.838
T12-L2 kyphosis angle	-5.2	-19.0	12.0	5.9	-7.3	-58.0	7.0	13.1	0.826
Lordosis angle	-54.9	-75.0	-28.0	9.8	-55.3	-67.0	-10.0	13.4	0.367
Rib hump angle	13.2	1.0	22.0	4.5	12.9	7.0	23.0	4.9	0.495
<b>2 years after surgery</b>									
Cobb angle in thoracic spine	28.2	16.0	66.0	10.0	26.3	12.0	37.0	7.0	0.718
Cobb angle in lumbar spine	16.6	4.0	41.0	9.7	13.9	2.0	31.0	8.9	0.331
Cobb angle in proximal thoracic spine	20.0	9.0	44.0	6.8	14.6	5.0	30.0	6.8	0.004**
Thoracic apical translation *	2.3	0.1	5.6	1.3	2.6	0.6	4.8	1.2	0.384
Lumbar apical translation*	1.4	0.1	5.3	1.0	1.2	0.0	2.5	0.7	0.495
T2-T12 kyphosis angle	34.4	20.0	55.0	7.9	30.8	11.0	52.0	9.5	0.165
T5-T12 kyphosis angle	29.1	13.0	52.0	8.4	26.1	12.0	42.0	10.2	0.376
T2-T5 kyphosis angle	9.9	2.0	24.0	5.2	8.7	0.0	18.0	6.1	0.495
T12-L2 kyphosis angle	-1.4	-15.0	8.0	4.9	-1.2	-11.0	8.0	5.0	0.730
Lordosis angle	-55.4	-80.0	-31.0	9.7	-57.9	-74.0	-43.0	8.1	0.272
Rib hump angle	6.9	1.0	17.0	4.1	7.1	2.0	19.0	3.8	0.766

\* The degree of the apical translation of center sacral vertical line (CSVL) according to the Harms Study Group; \*\*  $p > 0.05$ .

than internal consistency found for comparable domains of the original SRS Outcomes Instrument [6]. The process of adapting the SRS-22 to Polish cultural conditions has already been successfully conducted and a subsequent report has been published [10].

As there is no Polish language version of SRS-24 questionnaire available, we performed a preliminary validation process of SRS-24 in order to produce an assessment tool that is equivalent to the original English version. The cross-cultural adaptation of the questionnaire was performed according to the guidelines set up by the International Quality of Life Assessment (IQOLA) [11]. In the first stage, 2 independent translators converted the originals into Polish. Stage 2 consisted of a comparison of originals and 2 translated

versions. During that stage, the team of 2 translators and authors of the project identified differences in translations and created a combination of the 2 versions. In the third stage, 2 independent translators who were native English speakers translated the adjusted version of the Polish translation into the language of the original document. At the last stage, a commission composed of specialists in orthopedics, translators, a statistician and a psychologist reviewed all translations and drafted a final version of the questionnaire. In order to evaluate the psychometric properties of the questionnaire, 60 patients who fulfilled the inclusion criteria completed the Polish version of SRS-24.

We performed analysis of psychometric properties of the Polish SRS-24 for the whole study group and for analyzed

**Table 2.** Distribution of the SRS-24 results.

SRS-24 results	Mean	95% confidence intervals		Min.	Max.	SD
		From	To			
<b>Urban group</b>						
Pain	4.4	4.2	4.5	3.1	5.0	0.5
General self image	4.0	3.8	4.2	2.7	5.0	0.7
Self image after surgery	3.4	3.2	3.7	2.3	5.0	0.7
Function after surgery	3.0	2.6	3.4	1.0	5.0	1.3
General function	3.8	3.4	4.2	1.0	5.0	1.1
Function activity	4.2	3.9	4.5	1.3	5.0	1.0
Satisfaction with surgery	4.6	4.4	4.8	2.3	5.0	0.6
General result	4.0	3.9	4.2	2.8	4.8	0.5
<b>Rural group</b>						
Pain	4.3	4.0	4.5	2.6	4.9	0.5
General self image	4.3	4.1	4.6	3.3	5.0	0.6
Self image after surgery	3.8	3.5	4.2	3.0	4.7	0.7
Function after surgery	2.7	2.1	3.2	1.0	5.0	1.2
General function	3.9	3.4	4.4	1.0	5.0	1.2
Function activity	4.0	3.5	4.4	1.3	5.0	1.0
Satisfaction with surgery	4.7	4.5	4.9	3.7	5.0	0.5
General result	4.1	3.8	4.3	2.5	4.6	0.5
<b>All participants</b>						
Pain	4.3	4.2	4.5	2.6	5.0	0.5
General self image	4.1	3.9	4.3	2.7	5.0	0.7
Self image after surgery	3.6	3.4	3.7	2.3	5.0	0.7
Function after surgery	2.9	2.6	3.2	1.0	5.0	1.2
General function	3.8	3.5	4.1	1.0	5.0	1.1
Function activity	4.1	3.9	4.4	1.3	5.0	1.0
Satisfaction with surgery	4.6	4.5	4.8	2.3	5.0	0.6
General result	4.0	3.9	4.2	2.5	4.8	0.5

subgroups of patients from different environments. We analyzed mean, minimal and maximal values, standard deviations and 95% confidence intervals for the general results, and for 7 domains of the SRS-24. Additionally, we analyzed floor and ceiling effects (% of patients with the minimum score and % of patients with the maximum score, respectively). We used Cronbach's alpha to assess internal consistency and the following values were accepted:  $\geq 0.80$  as excellent, 0.70–0.79 as adequate, and  $< 0.70$  as poor [12]. Additionally, we performed analyses of the item-total correlation for the SRS-24 by means of Pearson's correlation coefficient ( $r$ ). Ceiling and floor effects were considered to be present if more than 15% of respondents achieved the lowest

or highest possible total score [13]. Moreover, the SRS-24 scores were further correlated with pertinent radiographic data in both study groups.

#### Statistics

For statistical quantitative features we calculated the mean, 95% confidence intervals, the range and standard deviations. As the majority of the considered features and results were not normally distributed, we used non-parametric tests to verify the hypothesis. To establish relationships between quantitative features we used Spearman's rank correlation (marked as  $r_s$ ) and the Mann-Whitney test was used to compare the

**Table 3.** Internal consistency of SRS-24.

SRS-24 results	Cronbach's alpha		
	All participants	Urban group	Rural group
Pain	0.63	0.58	0.73
General self image	0.78	0.81	0.67
Self image after surgery	0.67	0.73	0.52
Function after surgery	0.74	0.83	0.53
General function	0.55	0.51	0.61
Function activity	0.53	0.61	0.38
Satisfaction with surgery	0.65	0.66	0.61
General result	0.84	0.85	0.85

2 groups with respect to quantitative features. Linear regression analysis was used to investigate single variables that influence the SRS-24 general result. A  $p < 0.05$  indicated statistical significance. Statistical calculations were performed using Statistica software.

## RESULTS

### Distribution of the results in urban and rural sample

Mean scores and standard deviations, the minimum, maximum, and 95% confidence intervals were calculated for both patient populations and for the whole study group. The general result of the Polish SRS-24 equalled 4.1 (SD 0.5), 4.0 (SD 0.5) and 4.0 (SD 0.5) for the rural, urban and whole patient population, respectively (Table 2). The mean values of the individual domains for the rural, urban and whole patient population are shown in Table 2. Patients from both study groups and all study participants scored the best results in satisfaction in regards to treatment and pain domain. The worst scores were observed in regards to the functioning after surgery domain, for 3 analyzed patient populations (Table 2).

### Floor and ceiling effects in urban and rural populations

We analyzed floor and ceiling effects for the general results of the Polish SRS-24. We did not identify any patient with the minimum (24 points) or maximum (124 points) in any of the groups of patients. Therefore, both in the urban and rural groups of patients, floor or ceiling effects were not detected. Urban and rural groups do not differ in incidence in regards to floor or ceiling effects in the Polish version of SRS-24.

### Internal consistency

Table 3 presents the Cronbach's alpha values for the general results and the individual domains of the Polish version of SRS-24, both for the subgroups of patients and for

**Table 4.** Analyses of item-total correlation of Polish SRS-24.

SRS-24 individual items	Pearson's Correlation Coefficient (r)		
	All participants	Urban group	Rural group
Question 1	0.640	0.600	0.736
Question 2	0.603	0.592	0.633
Question 3	0.687	0.721	0.636
Question 4	0.524	0.557	0.522
Question 5	0.459	0.476	0.429
Question 6	0.536	0.506	0.594
Question 7	0.682	0.561	0.895
Question 8	0.305	0.298	0.317
Question 9	0.545	0.474	0.707
Question 10	0.627	0.665	0.546
Question 11	0.329	0.193	0.708
Question 12	0.671	0.640	0.742
Question 13	0.592	0.685	0.408
Question 14	0.496	0.545	0.409
Question 15	0.520	0.482	0.656
Question 16	0.603	0.649	0.570
Question 17	0.490	0.603	0.267
Question 18	0.155	0.217	0.049
Question 19	0.306	0.116	0.544
Question 20	0.292	0.310	0.250
Question 21	0.313	0.360	0.222
Question 22	0.542	0.658	0.286
Question 23	0.315	0.322	0.317
Question 24	0.375	0.429	0.262

all study participants. The Cronbach's alpha values are excellent for the general result of SRS-24 in urban and rural groups and for the whole group (0.85, 0.85 and 0.84, respectively). However, taking into account Cronbach's alpha values for the individual domains in both analyzed subgroups, the results for the rural group of patients were found to be better. In the urban group, 2 domains (general self-image and function after surgery) had excellent internal consistency, 1 domain (self-image after surgery) had moderate internal consistency, and the remaining 4 domains had Cronbach's alpha values below 0.7. In contrast, in the rural group only 1 domain (pain) had moderate internal consistency and the Cronbach's alpha of the remaining 6 domains were below 0.7.

The analyses of item-total correlation confirmed that SRS-24 is internally consistent (Table 4) in all analyzed groups of patients.



**Table 5.** Differences between urban and rural SRS-24 results (domains and general result).

SRS-24 results	p value
Pain	0.788
General self image	0.116
Self image after surgery	0.048
Function after surgery	0.468
General function	0.542
Function activity	0.135
Satisfaction with surgery	0.277
General result	0.583

#### Differences between patients from urban and rural areas

The differences between the general scores of the Polish SRS-24 achieved by the urban and rural groups of patients and the domains are shown in Table 5. The sub-groups only differ significantly in the self-image after surgery domain (Mann-Whitney test,  $p=0.048$ ). The scores on pain, general self-image, functioning after surgery, general functioning, functioning activity, and satisfaction with surgery domains were not significantly different between the 2 groups ( $p<0.05$ ).

Additionally we performed a detailed analysis of differences between the urban and rural groups of patients, taking into account individual items of the Polish SRS-24 scale. The urban group scored lower on item 21 (from the self-image after surgery domain) but higher on item 18 (from pain domain) (Table 4) when compared to the rural group. There were no significant differences between the scores of the 2 groups on the remaining items (Table 6).

An analysis of the relationship between age, pre- and post-operative radiographic data and the results of the Polish version of SRS-24, by means of the Spearman rank correlation coefficients (rS), were performed, and the differences between both analyzed groups of study participants were stated. In the urban population we identified correlations between preoperative Cobb angle in the thoracic spine and self-image ( $rS=-0.38$ ,  $p=0.016$ ), between the age at the time of the surgery and self image after the procedure ( $rS=0.36$ ,  $p=0.034$ ), between the preoperative Cobb angle in the proximal thoracic spine and self image after the surgery ( $rS=0.339$ ,  $p=0.032$ ), and between the postoperative T2-T12 kyphosis angle and satisfaction with the surgery ( $rS=-0.40$ ,  $p=-0.011$ ).

In the rural population we identified strong correlations between pain level and postoperative thoracic apical translation ( $rS=-0.45$ ,  $p=0.049$ ); between self-image and preoperative T2-T5 kyphosis angle ( $rS=-0.48$ ,  $p=0.031$ ), preoperative lordosis angle ( $rS=0.48$ ,  $p=0.031$ ), postoperative lordosis angle ( $rS=0.48$ ,  $p=0.013$ ), postoperative rib hump angle ( $rS=-0.66$ ,  $p=0.02$ ); between self-image after surgery and preoperative thoracic Cobb angle ( $rS=0.47$ ,  $p=0.037$ ), preoperative proximal thoracic Cobb angle ( $0.47$ ,  $p=0.034$ ), preoperative thoracic apical translation ( $rS=0.52$ ,  $p=0.019$ ), preoperative

**Table 6.** Differences between urban and rural SRS-24 results (individual items).

SRS-24 results	p value
Individual items	
Question 1	0.793
Question 2	0.614
Question 3	0.161
Question 4	0.344
Question 5	0.628
Question 6	0.368
Question 7	0.240
Question 8	0.178
Question 9	0.818
Question 10	0.382
Question 11	0.648
Question 12	0.993
Question 13	0.057
Question 14	0.140
Question 15	0.793
Question 16	0.218
Question 17	0.512
Question 18	0.028*
Question 19	0.149
Question 20	0.349
Question 21	0.017*
Question 22	0.559
Question 23	0.231
Question 24	0.434

\*  $p>0.05$ .

T5-T12 kyphosis angle ( $rS=0.47$ ,  $p=0.035$ ), postoperative thoracic Cobb angle ( $rS=0.45$ ,  $p=0.044$ ), postoperative upper thoracic Cobb angle ( $rS=0.45$ ,  $p=0.046$ ); functioning after the surgery and preoperative T5-T12 kyphosis angle ( $rS=0.47$ ,  $p=0.035$ ); general functioning and preoperative lordosis angle ( $rS=0.49$ ,  $p=0.030$ ); and between satisfaction with surgery and postoperative lordosis angle ( $rS=0.47$ ,  $p=0.036$ ).

We used logistic regression analysis to define the variable that affects patients' functioning most and satisfaction with treatment 2 years after surgery in both study groups. The total score of the SRS-24 was divided into 2 categories: good result (96 to 120 points) and poor result (from 24 to 28 points). We evaluated the potential influence of the following selected patient clinical and socio-demographic

characteristics on the probability of achieving a “good” result in the SRS-24 total score in regards to both analyzed patient groups: age at surgery, Cobb angle in the thoracic or lumbar spine, thoracic or lumbar apical translation, kyphosis angle, lordosis angle and rib hump angle. Calculations were performed taking into consideration preoperative and postoperative radiographic data.

The logistic regression model obtained as a result of the calculations revealed that age at surgery and the radiographic data do not have a statistically significant influence on the probability of achieving a good result in the SRS-24 in the urban or rural populations.

## DISCUSSION

We indicated that not only factors related to treatment methods may negatively affect patients’ condition and postoperative health-related quality of life (HRQL) of adolescents with idiopathic scoliosis. Factors such as degree of the deformity, culture, differences in geography, rural versus urban living environments, and social factors [2,5–7,18] can have similarly negative effects.

Considering possible differences in patients’ HRQL from different living areas, we should take into account the social, economic and political changes that took place in Polish society after the collapse of communism. We assumed that factors related to living environments can influence patients’ condition, as verified by the Polish version of SRS-24, in a developing country from the Western culture.

The Scoliosis Research Society Outcomes Instrument (SRS-24) was developed as a quality-of-life instrument to assess patient outcome after operative treatment of adolescent idiopathic scoliosis [6]. Haher et al. designed this questionnaire based on previously validated questionnaires and added questions to address a number of prior insufficiencies, especially patients’ concerns about self-image [6]. The 24 questions were divided into 7 domains as determined by factor analysis: pain, general self-image, postoperative self-image, general function, overall level of activity, postoperative function, and satisfaction. The instrument was found to be both reliable (Cronbach’s alpha coefficient <0.6 for each domain) and valid [6,9].

No report, to our knowledge, has addressed the validity of the SRS-24 instrument in patient populations from urban versus rural living environments. Our study confirmed excellent internal consistency of the Polish SRS-24, generally for both groups of patients and for the whole study group. Moreover, the analyses of item-total correlation confirmed that SRS-24 is internally consistent. However, taking into account Cronbach’s alpha values for the individual domains, we found better internal consistency in the urban rather than in the rural group of patients. Furthermore, our study confirmed that urban and rural study groups do not differ in incidence of floor (% of patients with the minimum score) or ceiling (% of patients with the maximum score) effects in the Polish version of SRS-24.

Watanabe et al. showed that the Cobb angle of the thoracic curve and the thoracic rotation angle may affect the postoperative score of the Scoliosis Research Society-24 (SRS-24)

scale in patients with idiopathic scoliosis. Specifically, family environment may also affect quality of life [14]. Kahanovitz and Weiser found that the quality of life of AIS patients in single-parent families was relatively lower, but the positive attitude of the mother towards the scoliosis could improve the quality of life for the patients [15]. In addition, cultural differences may also affect patients’ interpretation of the questions in any HRQOL questionnaire. Watanabe et al. studied the differences of the preoperative SRS-22 scale scores in patients with idiopathic scoliosis in the United States and Japan and found that the scores in all the domains and for most items were significantly different [16].

Wang et al. suggested that socio-demographic factors may play an especially important role in developing countries where the state of development may vary between urban and rural areas. He assumed that the region of residence (rural *vs.* urban environment) might impact postoperative SRS-22 results in adolescent scoliosis patients [7]. Wang et al. found that living environment influences postoperative results of SRS-22: the score on satisfaction of management domain in the urban group was significantly higher than that in the rural group, but the score on self-image/appearance in the urban group was significantly lower. However, there were no significant differences in functioning/activity, pain or mental health domains between the 2 analyzed groups [7]. In our study we assumed that factors related to living environment can influence patients’ SRS-24 scores and indicated that only results in the self-image after surgery domain differ significantly between urban and rural study samples, in favor of the rural group.

Wang et al. found that the scores on items 12, 15, and 18 in the functioning/activity domain, items 4, 6, and 10 in the self-image/appearance domain, and item 22 in the satisfaction of management domain were significantly different between the 2 analyzed groups. The urban group scored higher on items 4, 6, 10, and 18 than the rural group, but scored lower on items 12, 15, and 22 than the rural group. There were no significant differences between the scores of the 2 groups on items 5 and 9 in the functioning/activity domain, on the 5 items (1, 2, 8, 11, and 17) in the pain domain, on items 14 and 19 in the self image/appearance domain, on the 5 items (3, 7, 13, 16, and 20) in the mental health domain, or on item 21 in the satisfaction of management domain [7]. In contrast to these findings, our detailed analysis within each item indicated that groups differ significantly on item 21 in regards to the self-image after surgery domain and to question 18 (pain domain). Patients from the rural group scored higher in the self-image after surgery subscale but reported higher back pain intensity. There were no significant differences between the scores of the 2 groups on the remaining items.

Pennebaker’s Role of Attention Theory may be significant in understanding the relation between living environment and reported pain level [17]. He indicated that people who engage in non-stimulating tasks or living in socially isolated environments are more likely to focus their attention inward. Therefore, it seems likely that rural versus urban patient groups may be less distracted by external cues in their surrounding environment, leading them to become more attuned to pain signals [17]. Meanwhile, taking into account a higher score in the self image after surgery domain in the

rural group, we should take into consideration that living in small towns and rural areas may be associated with higher social stress due to visible spinal deformation. Therefore, improvement of body shape and higher self-esteem after surgical correction of scoliosis and rib hump resection may be more meaningful for this group of patients.

A similar study, conducted by Verma et al, evaluated the influence of variables related to socio-demographic factors on the Scoliosis Research Society (SRS)-22 results, and analyzed SRS-22 results in normal adolescents without scoliosis to establish a comparative baseline for adolescent idiopathic scoliosis. It was the first study to characterize the influence of demographic factors on the SRS-22 and provided the largest normative adolescent baseline for comparison to AIS [8]. The authors indicated that race, income, gender, and single- versus dual-parent households affected the SRS-22 results, with a significant clinical difference [8]. Specifically, Caucasians were associated with higher activity domain scores compared to Hispanic and "other" ethnicities. African American adolescents also tended to score higher than Hispanic adolescents on the pain domain. Increased household income had a positive effect on activity, image and mean SRS-22 score. However, incomes above \$125,000/yr did not have an added effect. Male adolescents tended to score higher on the mental health domain and overall SRS-22 when compared to female adolescents, while dual-parent adolescents tended to score higher on the activity domain and mean SRS-22 when compared to single-parent adolescents [8].

Several authors have investigated the association between radiographic measures and patient satisfaction with postoperative scoliosis correction. White et al, contrary to our study, found that postoperative SRS-24 scores did not correlate with preoperative or postoperative major curve magnitude or the percentage change in curve magnitude [3]. Similarly, Helenius et al. noted that there was no correlation between preoperative and postoperative radiologic parameters and SRS-24 scores in regards to the operative treatment of adolescent scoliosis [18]. In contrast, Haher et al. reported that the degree of curve correction, as indicated by preoperative to postoperative changes in Cobb angle, significantly correlated with patients' overall satisfaction with the surgical outcome, including perception of pain, improved self-image, and attractiveness [6]. Therefore, the association between radiographic parameters and satisfaction with surgery is controversial and remains unclear.

Results of our study show a clear relation between SRS-24 scores and the radiographic parameters in both rural and urban groups of patients. However, differences in the above-mentioned associations between both analyzed groups of study participants were observed. We noticed lower association between SRS-24 results and radiographic parameters in the urban than in the rural group. Correlations in the urban group were moderate, whereas each reported correlation between radiographic data and postoperative quality of life in rural patients was strong (from  $rs=0.45$  to  $rs=0.66$ ).

We believe that our attempt to analyze patients' self-image or postoperative function in terms of socio-demographic data could shed new light on factors determining patients' postoperative quality of life. Results regarding the differences

in the self-image domain between the 2 analyzed subgroups may have some practical implications for urban and rural scoliosis patient support programs.

There are some limitations to the current study that should be mentioned. Being cross-sectional, the current study did not address the question of causality; however, we found evidence for the presence of associations between quality of life of females with AIS and living environment. Further understanding of the characteristics and risk factors influencing the quality of life of scoliosis patients in rural and urban areas from developing countries in Eastern Europe are needed. Furthermore, we believe the longitudinal exploration of self-image in patients with scoliosis is of special importance, since it would support the positive influence of scoliosis correction on patients' quality of life. Future research should focus on changes in general self-image, function or function activity, in the course of surgical or conservative scoliosis treatment.

## CONCLUSIONS

In general we did not confirm many differences in postoperative quality of life between study participants from urban and rural regions. Patients from both study groups and all study participants scored the best in the satisfaction with treatment and pain domain. Urban and rural patients do not differ in incidence of floor or ceiling effects of Polish SRS-24 results.

However, patients from the rural group scored higher in the self-image after surgery domain, but reported higher pain level than urban patients. We found more associations between SRS-24 results and radiographic parameters in the rural group. Moreover, the correlations in the rural sample were strong, compared with moderate relations in the urban subgroup.

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