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Validity and Reliability of the Turkish Version of the Nuss Questionnaire Modified for Adults

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Background: Pectus excavatum (PE) is the most common chest wall deformity. The Nuss Questionnaire modified for Adults (NQmA) is a disease-specific health-related quality of life assessment tool for patients with pectus deformities. The aim of this study is to adapt the NQmA into Turkish. ***Methods:*** Two hundred and sixty-five patients with PE were participated, with an age range of 14 to 29 years. All patients underwent a physical examination and had not undergone corrective surgery. The Turkish version of the NQmA was completed by patients and their parents. ***Results:*** The content validity index based on expert opinions was 91% for the patient questionnaire and 96% for the parent questionnaire. The Cronbach's alpha value for the NQmA was found to be 0.805 for the patient questionnaire and 0.800 for the parent questionnaire. Exploratory factor analysis was used to assess construct validity. Two factors explained 51.1% of the total variance in the patient questionnaire (psychosocial: 31.145%, Cronbach's alpha=0.818; physical: 19.955%, Cronbach's alpha=0.862). In the parent questionnaire, two factors explained 51.422% of the total variance (psychosocial: 26.097%, Cronbach's alpha=0.743; physical: 25.325%, Cronbach's alpha=0.827). Construct validity was confirmed by confirmatory factor analysis. ***Conclusion:*** The Turkish version of the NQmA was found to be valid and reliable for the assessment of quality of life in patients with PE.

Key words: 1. Funnel chest
2. Quality of life
3. Psychometrics
4. Validation studies

INTRODUCTION

Pectus excavatum (PE), also known as funnel chest, is the most common chest wall deformity, characterized by inward displacement of the sternum and the costal cartilages. PE occurs in males three to five times more often than in females, with an incidence of one case in every 400 to 1,000 births [1,2]. Physical limitations and/or psychosocial distress can be observed in patients with PE and may result in a decreased quality of life [3]. The physical limitations caused by PE are mostly cardiopulmonary restrictions resulting in fatigue, exercise intolerance, shortness of breath, palpitations, and chest discomfort or pain [4]. The psychosocial problems associated with PE are mostly characterized by low self-esteem and avoidance of social and physical activities due to the appearance of the chest [5].

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Minimally invasive repair of PE, developed by Donald Nuss in 1987, is the current surgical approach for the correction of PE. Nuss et al. [6] published their 10-year experiences in 1998. Since that time, minimally invasive repair has mostly replaced the Ravitch procedure, because minimally invasive repair involves shorter operations and minimal surgical scarring [7]. However, Kang et al. [8] reported in 2012 that long-term satisfaction was not related to the operation type, but instead was related to the completeness of the correction and the absence of recurrence.

The primary aim of medical care is to increase the patient's quality of life, which includes physical and psychosocial well-being. The Nuss Questionnaire was first published and validated by Lawson et al. [9] in 2003 as a disease-specific tool for the evaluation of quality of life in pediatric patients with PE. Krasopoulos et al. [10] modified the questionnaire for adults. Improvements in physical and psychosocial well-being, with a better quality of life, have been reported after the minimally invasive repair of PE [5,9-13].

In the present study we aimed to evaluate the validity and the reliability of the Turkish version of the Nuss Questionnaire modified for Adults (NQmA).

METHODS

Patients with PE (age range, 14 to 29 years) were recruited from the Thoracic Surgery Clinic of Marmara University Hospital. Patients with any previous thoracic surgery history or complex deformities were excluded. This study was approved by the Clinical Research Ethics Committee of the Marmara University School of Medicine. Informed consent was obtained from each participant. All patients underwent a physical examination, and posteroanterior and lateral chest radiographs were obtained. The Turkish version of the NQmA was used to assess the patients' quality of life. Patients and their parents completed the questionnaires.

The two-step Nuss Questionnaire for pediatric patients and their parents is used to assess the disease-specific quality of life of patients with pectus deformities. Child and parent versions of the questionnaire were first published and validated by Lawson et al. [9]. The Nuss Questionnaire was modified for adult patients by Krasopoulos et al. [10], and the scoring of the first three questions was reversed.

The patient and parent questionnaires were translated into Turkish. Fourteen experts working with chest wall deformities and/or quality of life reviewed the parent and patient versions of the questionnaire for the suitability and comprehensibility of the items. The patient form of the NQmA included 12 items and the parent form included 13 items. Each item received a score between 1 and 4, with higher scores indicating a better quality of life (Tables 1, 2).

1) Statistical analysis

The AMOS ver. 6.0 (AMOS Development Co., SPSS Inc., Chicago, IL, USA) and SPSS ver. 15.0 (SPSS Inc., Chicago, IL, USA) software packages were used for statistical analysis. The content validity ratio and content validity index were used to examine the validity of the content based on the assessment of experts. Content validity means that the items in the test appropriately sample the content domain. The content validity ratio is used to determine whether specific test items should be retained or deleted. The content validity index is the mean of the content validity ratios of the remaining items in the test [14]. Cronbach's alpha was calculated to assess the reliability of the overall questionnaire, as well as to assess its physical and psychosocial components individually. Cronbach's alpha is a number between 0 and 1 [15] that measures internal consistency and reliability [16]. Internal consistency indicates the degree to which test items all measure the same concept [15]. In order to evaluate the contribution of each item to the questionnaire, item-total correlation coefficients and Cronbach's alpha values if item deleted were also calculated. Exploratory factor analysis (EFA) was used to assess construct validity. EFA is used to reduce the amount of data by grouping related items together [16]. The Kaiser-Meyer-Olkin measure of sampling adequacy is a number between 0 and 1 that measures the adequacy of the data in terms of the sample size. Bartlett's test of sphericity, which is a prerequisite for EFA, demonstrates whether the data have a multivariate distribution. Eigenvalues are used to decide the number of factors included in EFA [17], and each eigenvalue accounts for a certain percentage of the variance [18]. Confirmatory factor analysis (CFA) was used to confirm the construct validity. CFA is employed to determine whether the

Table 1. Patient form of the Nuss Questionnaire modified for Adults and the median and interquartile range results for each question stem

Question stem	Scoring	Median (interquartile range)
1. Looks in general	1: Very unhappy, 2: mostly unhappy, 3: mostly happy, 4: very happy	2 (2–3)
2. How chest looks without shirt	1: Very unhappy, 2: mostly unhappy, 3: mostly happy, 4: very happy	1 (1–2)
3. Spending rest of life as chest looks now	1: Very unhappy, 2: mostly unhappy, 3: mostly happy, 4: very happy	1 (1–2)
4. Others make fun of him/her because of chest	1: Very often, 2: often, 3: sometimes, 4: never	4 (3–4)
5. Avoids doing things	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–3)
6. Hides chest	1: Very often, 2: often, 3: sometimes, 4: never	3 (1–3)
7. Bothered because of the way chest looks	1: Very often, 2: often, 3: sometimes, 4: never	2 (1–3)
8. Feels shy/self-conscious because of chest	1: Very often, 2: often, 3: sometimes, 4: never	3 (2–4)
9. Feels bad about self	1: Very often, 2: often, 3: sometimes, 4: never	3 (2–3)
10. Has trouble exercising	1: Very often, 2: often, 3: sometimes, 4: never	3 (2–3)
11. Chest causes shortness of breath	1: Very often, 2: often, 3: sometimes, 4: never	3 (2–4)
12. Chest causes him/her to be tired	1: Very often, 2: often, 3: sometimes, 4: never	3 (2–3)

Table 2. Parent form of the Nuss Questionnaire modified for Adults and the median and interquartile range results for each question stem

Question stems	Scoring	Median (interquartile range)
1. Irritable	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–3)
2. Frustrated	1: Very often, 2: often, 3: sometimes, 4: never	3 (2.5–3)
3. Sad/depressed	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–3)
4. Restless	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–4)
5. Isolated	1: Very often, 2: often, 3: sometimes, 4: never	4 (3–4)
7. Reluctant to be in public while wearing bathing clothes that would show the chest	1: Very often, 2: often, 3: sometimes, 4: never	3 (1–4)
8. How often parent is concerned about effects of the deformity on patient's life	1: Very often, 2: often, 3: sometimes, 4: never	3 (1–3)
9. Have trouble exercising	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–4)
10. Have chest pain	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–4)
11. Have shortness of breath	1: Very often, 2: often, 3: sometimes, 4: never	3 (3–4)
12. Feel tired	1: Very often, 2: often, 3: sometimes, 4: never	3 (2–3)

factor structure indicated by EFA is represented in the data or not [18], and fit indices are used to confirm the CFA model [17]. The fit indices that we evaluated were the root mean square error of approximation, the goodness of fit index, the comparative fit index, the standardized root mean square error, and the chi-square/degrees of freedom test. Spearman correlation analysis was carried out to compare the physical and psychosocial component scores of the patient and the parent questionnaires. For all analyses, $p < 0.05$ was considered to indicate significance.

RESULTS

A total of 265 patients with PE participated to the study, of whom 233 (87.9%) were male and 32 (12.1%) were female. The mean age of the patients was 18.83±3.84 years (range, 14 to 29 years). Eighty-six (32.5%) of the patients had at least one associated disease or anomaly, and 21 patients (7.9%) had scoliosis. Symmetric deformities were observed in 176 (69%) of the patients, and the others had asymmetric deformities. A total of 265 patient and parent questionnaires were completed.

Table 3. Internal consistency of the patient questionnaire

Question stem	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Looks in general	27.97	31.321	0.413	0.794
2. How chest looks without shirt	28.74	31.822	0.497	0.789
3. Spending rest of life as chest looks now	28.88	32.993	0.398	0.796
4. Others make fun of him/her because of chest	26.81	33.192	0.278	0.804
5. Avoids doing things	27.35	31.349	0.463	0.790
6. Hides chest	27.75	28.637	0.550	0.781
7. Bothered because of the way chest looks	27.96	28.684	0.628	0.773
8. Feels shy/self-conscious because of chest	27.36	29.382	0.516	0.784
9. Feels bad about self	27.49	30.645	0.513	0.785
10. Has trouble exercising	27.56	30.634	0.390	0.798
11. Chest causes shortness of breath	27.38	31.259	0.382	0.798
12. Chest causes him/her to be tired	27.42	30.941	0.413	0.795

Table 4. Internal consistency of the parent questionnaire

Question stem	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Irritable	29.22	25.997	0.457	0.784
2. Frustrated	29.37	26.718	0.466	0.785
3. Sad/depressed	29.17	25.356	0.620	0.770
4. Restless	29.11	25.851	0.507	0.780
5. Isolated	28.89	26.086	0.388	0.792
7. Reluctant to be in public while wearing bathing clothes that would show the chest	29.46	25.265	0.322	0.807
8. How often parent is concerned about effects of the deformity on patient's life	29.80	25.223	0.413	0.790
9. Have trouble exercising	29.19	24.951	0.541	0.775
10. Have chest pain	28.78	26.692	0.471	0.784
11. Have shortness of breath	28.98	26.212	0.474	0.783
12. Feel tired	29.38	24.509	0.537	0.775

1) Expert opinions and content validity

We asked 14 experts for their opinions. The expected minimum content validity ratio for 14 experts was 51% [14]. Content validity ratios were provided for all items, and were between 57% and 100% in both of the questionnaires. The content validity index of the expert opinions was 91% for the patient questionnaire and 96% for the parent questionnaire. The content validity indices were 79% or higher for all of the items in both of the patient and the parent questionnaires [19].

2) Reliability and construct validity

(1) Patient questionnaire: The Cronbach's alpha value of the 12 items in the patient questionnaire was 0.805, indicating that it was reliable. The item-total correlation coefficients of items in the patient questionnaire were between 0.28 and 0.63 (Table 3). No increase in the Cronbach's alpha value was observed if any item was deleted.

(2) Parent questionnaire: Items were excluded from the questionnaire if they met the following criteria: (1) an item-total correlation coefficient <0.40, (2) a factor loading <0.40 [16], (3) if deleting the factor increased the Cronbach's alpha value, and (4) if an item did not load on the expected factor. The sixth and thirteenth items were deleted based on all the above criteria. These question stems were 'made fun of him/her' and 'have problems gaining

Table 5. Exploratory and confirmatory factor analysis for the patient questionnaire

Factors	Question stems	EFA factor loadings	CFA factor loadings	Cronbach's alpha
Psychosocial[a)]				0.818
	1. Looks in general	0.532	0.423	
	2. How chest looks without shirt	0.681	0.553	
	3. Spending rest of life as chest looks now	0.556	0.407	
	4. Others make fun of him/her because of chest	0.341	0.321	
	5. Avoids doing things	0.541	0.506	
	6. Hides chest	0.780	0.765	
	7. Bothered because of the way chest looks	0.800	0.803	
	8. Feels shy/self-conscious because of chest	0.714	0.691	
	9. Feels bad about self	0.697	0.618	
Physical[b)]				0.862
	10. Has trouble exercising	0.887	0.843	
	11. Chest causes shortness of breath	0.888	0.839	
	12. Chest causes him/her to be tired	0.858	0.788	

EFA, exploratory factor analysis; CFA, confirmatory factor analysis; AVE, average variance extracted.
[a)]Eigenvalues=3.962; EFA variance explained=31.145%; AVE for CFA=88.6%. [b)]Eigenvalues=2.170; EFA variance explained=19.955%; AVE for CFA=94.3%.

weight.' After two items deleted, the Cronbach's alpha value and item-total correlation coefficients were calculated and the factor structure was examined. The Cronbach's alpha value of the remaining 11 items in the parent questionnaire was 0.800. The item-total correlation coefficients of the questionnaire were between 0.32 and 0.62 (Table 4).

3) Exploratory factor analysis

(1) Patient questionnaire: EFA was conducted to assess the construct validity of the questionnaire, using the Varimax rotation method. In the EFA procedure, the parameters were grouped into two factors with eigenvalues >1. Two factors explained 51.1% of the total variance (Table 5). According to the Kaiser-Meyer-Olkin measure of sample adequacy, which was 0.812 (>0.80), the sample size was adequate. According to the Bartlett's test, the hypothesis was accepted that the correlation matrix was not an identity matrix (Bartlett's test, p=0.000 [<0.05]) [16]. Items 1–9 were included in the psychosocial component and items 10–12 were included in the physical component; factor loadings ranged from 0.341 to 0.888.

(2) Parent questionnaire: In the parent questionnaire, the parameters were similarly grouped into two factors with eigenvalues >1. Two factors explained 51.422% of the total variance (Kaiser-Meyer-Olkin measure=0.815 [>0.80], Bartlett's test p=0.000 [<0.05]) (Table 6). According to the EFA, items 1–8 were included in the psychosocial component and items 9–12 were included in the physical component; the factor loadings ranged from 0.436 to 0.856.

4) Confirmatory factor analysis

(1) Patient questionnaire: CFA was used to confirm the two-factor structure revealed in the EFA. According to CFA, the standardized regression weights ranged from 0.32 to 0.84 (Fig. 1), and the t-tests indicated statistical significance.

(2) Parent questionnaire: According to CFA, the standardized regression weights ranged from 0.46 to 0.86 (Fig. 2), and the t-tests indicated statistical significance. According to the fit indices for both the patient and the parent questionnaires, the two-factor (psychosocial and physical) model demonstrated good fit (Table 7). Modification indices between covariance errors >20 were allowed to correlate (Figs. 1, 2) [20]. As a result, the fit of the model improved for both questionnaires. CFA confirmed the construct validity of the factors that were obtained for both the patient and the parent questionnaires.

The physical and psychosocial components were correlated between the patient and the parent questionnaires (Table 8).

Table 6. Exploratory and confirmatory factor analysis for the parent questionnaire

Factors	Question stems	EFA factor loadings	CFA factor loadings	Cronbach's alpha
Psychosocial[a)]				0.743
	1. Irritable	0.656	0.469	
	2. Frustrated	0.681	0.492	
	3. Sad/depressed	0.706	0.788	
	4. Restless	0.698	0.650	
	5. Isolated	0.582	0.514	
	7. Reluctant to be in public while wearing bathing clothes that would show the chest	0.609	0.458	
	8. How often parent is concerned about effects of the deformity on patient's life	0.436	0.458	
Physical[b)]				0.827
	9. Have trouble exercising	0.856	0.856	
	10. Have chest pain	0.665	0.552	
	11. Have shortness of breath	0.827	0.721	
	12. Feel tired	0.830	0.827	

EFA, exploratory factor analysis; CFA, confirmatory factor analysis; AVE, average variance extracted.
[a)]Eigenvalues=3.908; EFA variance explained=26.097%; AVE for CFA=88.5%. [b)]Eigenvalues=1.749; EFA variance explained=25.325%; AVE for CFA=93.6%.

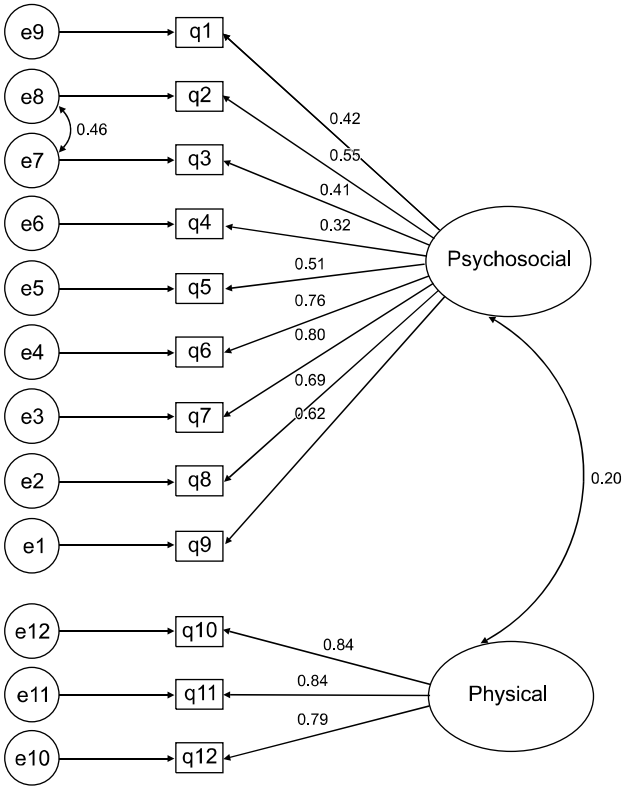

Fig. 1. Factor structure for the patient form.

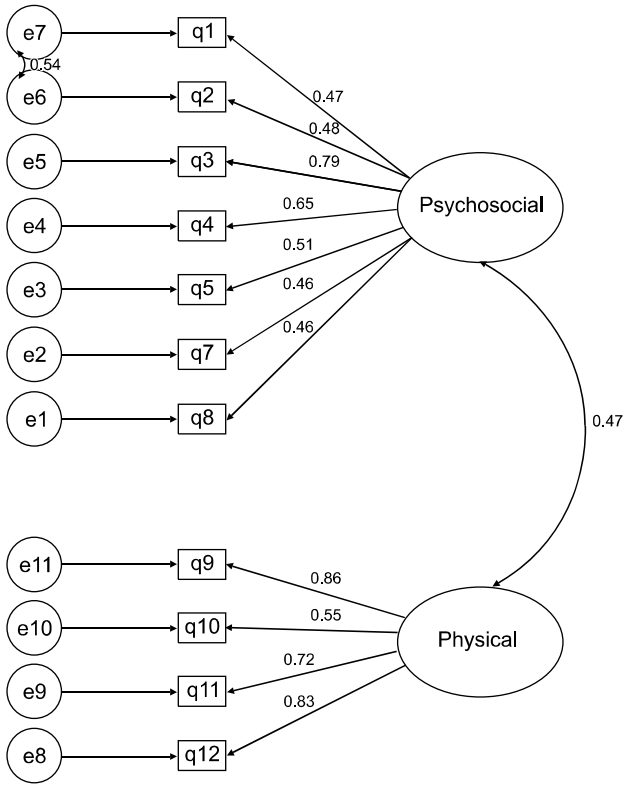

Fig. 2. Factor structure for the parent form.

Table 7. Goodness-of-fit results for the patient and the parent questionnaires

Goodness-of-fit indices	Value of each index indicative of good fit	Goodness-of-fit results for the patient questionnaire	Goodness-of-fit results for the parent questionnaire
Chi-square/degrees of freedom	<3	1.820	1.525
Root mean square error of approximation	≤ 0.080	0.056	0.045
Standardized root mean square error	≤ 0.080	0.053	0.053
Comparative fit index	>0.90	0.960	0.975
Goodness of fit index	>0.90	0.945	0.958

The two components were also correlated within the patient and the parent questionnaires, with a higher correlation between the patient and parent questionnaires observed for the physical component.

DISCUSSION

Recent studies have shown that the minimally invasive repair of PE generally results in improved self-esteem and quality of life [5,9-13]. In order to evaluate the effect of this surgical technique on the quality of life of our patients, we translated the questionnaire into Turkish and adapted it.

In the patient questionnaire, four of the question stems dealt with concerns about physical appearance: 'looks in general,' 'how chest looks without shirt,' 'spending rest of life as chest looks now,' and 'bothered because of the way chest looks.' These question stems had the lowest median scores, indicating unhappiness and anxiety related with appearance.

The correlation between the patient and the parent questionnaires was higher for the physical component. Physical complaints may be more observable than psychosocial problems. The question stems in the psychosocial component deal with internalizing symptoms, such as anxiety and depressive symptoms, and parents may not be fully aware of the internal states of adolescent or young adult patients with PE.

With regard to content validity, expert opinions demonstrated that the Turkish version of the NQmA was comprehensible. Our sample size was adequate. Cronbach's alpha values demonstrated good level of reliability for the Turkish version of the patient and the parent questionnaires [15,18]. As a result of the reliability analyses and EFA, there was no need to exclude any item from the patient questionnaire, although two items were excluded from the parent questionnaire. Reliability and construct validity were demonstrated for the remaining 11 items. EFA indicated that both the patient and the parent questionnaires were divided into physical and psychosocial components, which was confirmed by CFA results.

Table 8. The correlation of the components in the patient and the parent questionnaires

	Patient psychosocial	Patient physical	Parent psychosocial	Parent physical
Patient psychosocial				
r-value		0.195	0.439	0.114
p-value		0.001	0.000	0.065
Patient physical				
r-value			0.158	0.665
p-value			0.010	0.000
Parent psychosocial				
r-value				0.340
p-value				0.000

In conclusion, the adaptation of the NQmA into Turkish was successful, and it was found to be valid and reliable for the assessment of quality of life in Turkish patients with PE. The NQmA is easy for participants to complete and was found to be helpful for clinicians performing follow-up on their patients' quality of life [3,9,10].

CONFLICT OF INTEREST

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

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