Original Article

ISSN: 1735-0344 *Tanaffos 2015; 14(2): 121-127*

TANAFFOS

Reliability and Validity of the Iranian Version of Nijmegen Questionnaire in Iranians with Asthma

Majid Ravanbakhsh [1], Moslem Nargesi [2], Hanieh Raji [3], Maryam Haddadzadeh Shoushtari [3]

[1] Department of Physical Therapy, Musculoskeletal Rehabilitation Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, [2] Department of Physical Therapy, School of Rehabilitation, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, [3] Department of Pulmonology, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

Received: 10 January 2015
Accepted: 18 May 2015

Correspondence to: Nargesi M
Address: Department of Physical Therapy, School of Rehabilitation, Ahvaz Jundishapur University of Medical Sciences, Golestan Boulevard, Ahvaz, Iran.
Email address: nargessi.pt@gmail.com

Background: The aim of this study was to assess the validity and reliability of Nijmegen questionnaire (NQ) translated to Farsi for diagnosis of the hyperventilation syndrome (HVS) in patients with asthma.

Materials and Methods: The original version of NQ was translated to Farsi and then back-translated to English again to assess its agreement with the original version. To determine its cultural adaptation, a pilot study was carried out. The mean score of the questionnaire and the mean pressure of end tidal carbon dioxide ($PETCO_2$) were compared in 100 asthmatic patients to determine the validity of the questionnaire. For reliability, 52 out of 100 patients randomly filled out the questionnaire with an interval of 5 to 10 days. Internal consistency and content validity of the questionnaire were assessed by Cronbach's alpha coefficient and by calculating floor and ceiling effects respectively. The exploratory factor analysis was used to assess the factor structure.

Results: There was a significant inverse correlation between NQ scores and $PETCO_2$ (P=-0.783). Cronbach's alpha coefficient was greater than 0.7, indicating good internal consistency of the questionnaire (P=0.702). The questionnaire had a good stability in an interval of 5 to 10 days (P=0.826). The NQ had no floor and ceiling effect. and also factor analysis of 16 scales showed that this questionnaire has a five-factor structure, which can describe 55% of data variance.

Conclusion: The Iranian version of the Nijmegen questionnaire is a valid and reliable tool for detection of patients with HVS. In addition, the questionnaire can be used to evaluate the condition of respiratory function in people with asthma.

Key words: Questionnaires, Validity, Reliability, Capnography, Hyperventilation syndrome, Asthma

INTRODUCTION

Breathing is a vital function in the human body (1). The respiratory system delivers oxygen for metabolism and excretes the produced carbon dioxide. Any abnormality in breathing can lead to changes in the breathing pattern and cause breathing pattern disorders (BPD) (2,3). With a raise in respiratory rate, hyperventilation occurs, which can cause an increase in the speed of ventilation rather than tissue perfusion and finally the need for oxygen will increase for metabolic demands (4,5). Hyperventilation can also increase the excretion of carbon dioxide, which reduces the arterial pressure of carbon dioxide (P_aCO_2) from the normal value (35-45mmHg) and creates hypocapnia, which ultimately leads to respiratory alkalosis and increased blood pH (5,6). Evidence shows that changes in breathing patterns impact on the pH and cause respiratory alkalosis and negative effects on the

musculoskeletal system such as increased excitability of muscles, airways narrowing and nervous system disorders such as headache and dizziness (6-9).

Variability in symptoms and involvement of various systems in HVS and its high prevalence (1% to 5% of the general population, 30% of people with asthma and up to 83% of anxious people) indicate its significance (1). The prevalence of asthma symptoms is 13.14% in Iran, which is higher than the global mean value (10). Detection and diagnosis of this syndrome are important. Early detection reduces the treatment costs and saves time of the patient and the medical personnel.

Dysfunctional breathing would often occur in the form of hyperventilation with hypocapnia (2,3,11,12). Several studies show that hyperventilation is more common in people with asthma (2,11,13). This largely depends on the overlapping events and the side effects of these two disorders. There are various ways to diagnose HVS such as the followings:

Arterial blood gas (ABG) sample analysis that measures arterial carbon dioxide level. Difficulty of arterial blood gas sampling method, painfulness, invasiveness and the impact of moment changes of respiratory parameters regarding $PaCO_2$ are the main disadvantages of this method (6). The HVPT forces the patient to breathe too much for about 3 minutes. The low sensitivity of this test for the diagnosis of HVS is the reason that this method has not much validity (14). Capnography is a non-invasive method that measures pressure of the end tidal carbon dioxide ($PETCO_2$) by infrared light. Evidence shows that the $PETCO_2$ is correlated well with $PaCO_2$ (6,15,16). The NQ is another way to detect the HVS (17,18). This questionnaire would determine the signs and symptoms of HVS through symptomatology (19); NQ is a valid, non-invasive, rapid, inexpensive and easy tool to diagnose HVS and has a good sensitivity (91%) and specificity (95%). The NQ is a useful tool to assess the clinical and research interventions (11,18,20,21).

The NQ has been developed at the University of Nijmegen in Netherlands and has been translated into several languages, including Swedish, Danish, Spanish, Belgian and Taiwanese. This questionnaire has not been analyzed or translated in Iran; thus, our aim were to translate it into Farsi and evaluate the psychometric properties of the Iranian version of NQ.

MATERIALS AND METHODS

Instrument

The NQ consists of 16 items with a five-point Likert scale ranging from 0 to 4 for each item, based on severity (22). Total score is between zero to 64; zero shows an asymptomatic subject while 64 shows maximum symptoms (2,22,23). It has a three-factor structure. The first component is the "shortness of breath" and comprises seven out of sixteen items and includes questions 1, 2, 6, 7, 8, 11, 15. This second component is "peripheral tetany" comprising four items (questions 10, 12-14). The third component is "central tetany" comprising of five items (questions 1, 3, 4, 5, 9). In a non-asthma population if the total score of the questionnaire for a patient was 23 and above, the subject would be categorized as having HVS (14,18,22,24,25). Although no reports of validity of NQ in asthma have been published, it has been estimated to range from 20 to 66% for NQ score in asthmatic patients. Because of the lack of any report assessing the validity of this questionnaire in asthmatic patients, Grammatopoulou et al, in their recent paper examined the validity and reliability of the NQ in patients with mild to moderate asthma and showed that the NQ was a valid and reliable questionnaire for screening HVS in patients with mild to moderate asthma. They found a cut-off score of >17 with 92.73% sensitivity and 91.59% specificity to discriminate HVS cases among asthmatic patients (26). Capnography measures the end expiratory concentration of carbon dioxide in mmHg (6).A capnograph manufactured by ViaMed, England was used in this study. The subjects sat on the chair and nasal cannulas of the capnograph were

connected to the patient's nose; a few minutes after the patients were familiarized with the cannula, expiratory carbon dioxide levels were recorded for six minutes. It should be noted that the device was calibrated for each subject prior to data recording and the subjects were asked to breathe through the nose, and not to speak or move; they were given a text to read during data recording.

Procedure:

At the first step, the Iranian version of the NQ was evaluated for the guidelines suggested by the International Quality of Life Assessment (IQOLA) in terms of accordance with the Iranian culture in agreement with the original version. Two independent bilingual translators fluent in English, translated the questionnaire into Farsi separately and then the translated versions were reviewed by researchers (forward translation). Two other bilingual translators analyzed the forward Iranian version, in terms of clarity, not using jargon and conceptual equivalence and the preliminary Iranian version was prepared (forward translation). At the second step, this questionnaire was again translated by another bilingual native English translator into English to evaluate its conceptual consistency and similarity (backward translation). Finally, for demystification, in a pilot testing the preliminary Iranian version was filled randomly by 10 asthmatic patients, visited the lung hospitals and clinics in the Ahvaz city.

Simplicity and level of difficulty of questionnaires completed by patients were evaluated by the lung specialists and physiotherapists. Accordingly, modifications were made to the final version of the questionnaire. Subsequently, the final version was translated from Farsi into English. The study was approved by the Ethics Committee at Ahvaz Jundishapur University of Medical sciences. In this study, all subjects gave their informed consent before participation. A total of 100 asthmatic patients were entered into the study, selected by simple non-probability sampling. The diagnosis of asthma was based on clinical symptoms, patient history, physical examination and pulmonary function test results performed by a pulmonologist. The inclusion criteria were elementary education level, Iranian native speaker, living in Iran and the age range of 17-50 years. The exclusion criteria were smoking, having some other diseases with asthma, any change in pharmacotherapy, drug abuse and history of lung surgery.

A total of 100 stable asthmatic patients filled the Iranian version of the NQ and were then subjected to capnograph measurement of their end tidal carbon dioxide concentration. The correlation coefficient between these data showed the validity of the NQ. To evaluate the reliability of the questionnaire test-retest reliability was used; 52 out of 100 asthmatic patients, with an interval of 5 to 10 days, who did not have significant changes or new treatment plan, completed the NQ. Reliability was shown by comparing the scores of 52 patients at the first and second visits. Correlation coefficients and ICC were used to assess the reliability.

Ceiling and floor effect and Cronbach's alpha coefficient was also used to assess the content validity and internal consistency of the questionnaire, respectively. Exploratory Factor Analysis was used to evaluate the factor structure of the questionnaire and data were analyzed by SPSS software.

RESULTS

A total of 100 samples, diagnosed with stable mild to moderate asthma, with an average age of 40.90±11.04 years (59% males and 41% females), a body mass index mean of 27.06±4.98 (kg/m^2) and a mean duration of 7.88±9.68 years of asthma participated in this study. There was no change during the process of translating English to Farsi and vice versa (forward-backward) by the translators. In the pilot study, a little ambiguity was reported in the fifth question of the questionnaire regarding the "confusion or loss of touch with reality" which was modified as "confusion or not understanding the reality" by the translators.

Capnography was used in this study to assess the construct validity and the Pearson's correlation was used to describe associations between capnographic data ($PETCO_2$) and NQ scores. There was a high correlation between the score of NQ and $PETCO_2$ in 100 subjects (r_p=-0.783). The mean and standard deviation of the $PETCO_2$ and the total score of the questionnaire was 31.11±4.96 mmHg and 17.90±7.60, respectively.

In the first visit (n=100), the Cronbach's alpha coefficient was greater than 0.7, indicating good internal consistency of the questionnaire (α=0.702). Ceiling and floor effect should be less than 15% to comprises all criteria and indicates the changes over time; in this study no ceiling and floor effect was observed for NQ.

Test-retest reliability and internal consistency were examined to estimate the reproducibility of NQ scores. Pearson's correlation and ICC were used to evaluate the test-retest reliability and Cronbach's alpha coefficient was used to evaluate internal consistency of the questionnaire between the first and second visits of the subjects (n=52) (Table 1).

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test were used to confirm the assumptions of factor analysis. The KMO index value for given data was 0.651 and significance level in Bartlett's test was also smaller than 0.001, indicating assumptions' approval to perform the factor analysis. The questionnaire has five sub-groups that have particular values of more than 1 (the total variance explained by each factor shown in Table 2).

Five factors were identified as the main factors, according to the factor analysis performed on 16 studied variables. The effect of each variable on each factor was calculated in Table 3.

Table 1. Intraclass correlation coefficient and mean and SD of the NQ score

Scale	Test (n=52)	Retest (n=52)	Pearson's correlation	ICC (CI 95%)	Cronbach's alpha
NQ	17.03±6.72	16.90±6.65	0.826	0.819	0.819

Table 2. Total variance explained for each factor (variance greater than 1 has been bolded)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.243	20.272	20.272	3.243	20.272	20.272	**2.733**	17.082	17.082
2	1.561	9.758	30.030	1.561	9.758	30.030	**1.633**	10.205	27.287
3	1.461	9.129	39.159	1.461	9.129	39.159	**1.586**	9.913	37.200
4	1.345	8.404	47.563	1.345	8.404	47.563	**1.582**	9.889	47.088
5	1.140	7.128	54.691	1.140	7.128	54.691	**1.216**	7.602	54.691
6	.968	6.053	60.743						
7	.955	5.967	66.710						
8	.890	5.561	72.271						
9	.809	5.056	77.327						
10	.740	4.628	81.955						
11	.697	4.357	86.312						
12	.522	3.264	89.576						
13	.505	3.154	92.730						
14	.439	2.741	95.471						
15	.406	2.541	98.012						
16	.318	1.988	100.000						

Extraction Method: Principal Component Analysis.

Table 3. Numbers of factors and factor score coefficient matrix for each question

Rotated Component Matrix with Kaiser Normalization					
Question number	Component				
	1	2	3	4	5
Q1	0.298	**0.339**	0.050	-0.310	0.025
Q2	**0.625**	-0.297	0.198	-0.091	0.289
Q3	0.156	0.176	0.236	**0.683**	-0.085
Q4	**0.093**	0.732	0.125	0.180	0.010
Q5	0.048	**0.685**	-0.220	-0.113	0.290
Q6	**0.499**	0.275	0.153	0.151	-0.289
Q7	**0.656**	0.079	-0.050	0.379	-0.058
Q8	**0.795**	-0.016	0.051	-0.003	0.064
Q9	0.060	0.414	**0.428**	0.088	-0.153
Q10	0.140	-0.007	-0.082	**0.636**	0.103
Q11	**0.702**	0.228	-0.091	-0.045	-0.066
Q12	0-.133	-0.104	0.019	0.482	**0.565**
Q13	0.136	0.237	0.119	-0.020	**0.750**
Q14	0.046	0.037	**0.705**	0.255	0.144
Q15	**0.583**	0.111	0.214	0.180	0.085
Q16	0.117	-0.079	**0.801**	-0.233	0.046

DISCUSSION

The present study shows that the NQ has an acceptable validity and reliability. There was an acceptable correlation between the Iranian version of NQ scores and $PETCO_2$ in construct validity analysis (r_p=-0.783). It may be noted that patients with more dysfunctional breathing may have more clinical disorders, since they are in more hypocapnia conditions and as a result they acquire higher scores of NQ.

In line with our study, Grammatopoulou et al. showed a significant relationship between the $PETCO_2$ and the NQ score (r_p=-0.68) (26). In contrast, Courtney et al, in 2010 showed that there was no significant relationship between the $PETCO_2$ and the NQ score (r=-0.12, P=0.27). They emphasized that the lack of a significant relationship between the $PETCO_2$ and the NQ score, does not mean the lack of relationship between this two indexes. But there was a complex relationship between these two indexes, which may be influenced by other mediator factors such as anxiety (27).

This difference may be related to sample selection. Samples in the study of Courtney et al. (27) were either healthy or suffered from mild medical conditions including mild asthma but in the study by Grammatopoulou et al, as in our study, mild to moderate asthmatics were evaluated.

In addition, the sensitivity and specificity of this questionnaire to identify people with hyperventilation were adequate. In this study, there was no ceiling and floor effect for the NQ, which indicates good content validity of the questionnaire in the study population. Ceiling and floor effect was not calculated in other studies. Test-retest reliability of the Iranian version of NQ showed acceptable results as well (r_p=0.826). Cronbach's alpha coefficient was acceptable (α=0.702). This result shows that the questionnaire assessed the same concept (the breathing pattern disorder) and the obtained scores showed adequate reliability and stability, which indicate the accuracy of this questionnaire to detect HVS. In this study five factors out of 16 variables were identified as the main factors which had the particular values of greater than one (Table 4).

These five factors would explain approximately 55% of data variance. So that the first factor revealed 17.8%, the second factor 10.2%, the third factor 9.9%, the fourth factor 9.8% and the fifth factor 7.6% of explained variability. According to van Dixhoorn and Duivenvoorden, the structure of the NQ is based on three factors. The first factor is discussed in questions 1, 2, 6, 7, 8, 11, 15. The second factor is discussed in questions 10, 12-14 and the third factor is discussed in questions 1, 3, 4, 5, 9 (18). The identified factors in the study by van Dixhoorn and Duivenvoorden were different from those in the current study, but what is important is that the results showed several subscales of the NQ in both studies and each factor was different from the other to diagnose HVS.

Table 4. The correlations of the items with the components.

	Factor1	Factor2	Factor3	Factor4	Factor5
2.Feeling tense	0.625				
4.Dizziness	0.093				
6.Fast or deep breathing	0.499				
7.Shortness of breath	0.656				
8.Tightness across chest	0.795				
11.Difficulty in breathing or taking a deep breath	0.702				
15.Palpitations in the chest	0.583				
1.Chest pain		0.339			
5.Confusion or not understanding reality		0.685			
9.Bloated sensation in stomach			0.428		
14.Cold hands or feet			0.705		
16.Anxiety			0.801		
3.Blurred vision				0.683	
10.Tingling in fingers and hands				0.636	
12.Stiffness or cramps in fingers and hands					0.565
13.Tightness around the mouth					0.750
Percent of factor's invariances	17.8%	10.2%	9.9%	9.8%	7.6%

Limitations

The main limitation was the lack of generalization to the asthmatic population in Iran, since the samples in this study were selected only from Ahvaz city, which cannot be a good representative for all asthmatic patients. Collecting and recording data at rest, short duration of data collection, lack of other respiratory parameters such as spirometry and non-homogenous asthmatic patients due to lack of research grant were among other limitations of this study.

Conflict of interest

There is no conflict of interests to declare.

Acknowledgements

This study was supported by the Musculoskeletal Rehabilitation Research Center of Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. This research was part of a Masters' thesis (PHT-9206) by Moslem Nargesi. We would like to appreciate Mr. Reza Hassanzadeh, spirometry technician, at Imam Hospital of Ahvaz.

REFERENCES

1. Courtney R. The functions of breathing and its dysfunctions and their relationship to breathing therapy. ***International Journal of Osteopathic Medicine*** 2009; 12(3): 78- 85.
2. Stanton AE1, Vaughn P, Carter R, Bucknall CE. An observational investigation of dysfunctional breathing and breathing control therapy in a problem asthma clinic. ***J Asthma*** 2008; 45 (9): 758- 65.
3. Warburton CJ, Jack S. Can you diagnose hyperventilation? ***Chron Respir Dis*** 2006; 3 (3): 113- 5.
4. Bartley J. Breathing and temporomandibular joint disease. ***J Bodyw Mov Ther*** 2011; 15 (3): 291- 7.
5. Schleifer LM, Ley R, Spalding TW. A hyperventilation theory of job stress and musculoskeletal disorders. ***Am J Ind Med*** 2002; 41 (5): 420- 32.
6. McLaughlin L. Breathing evaluation and retraining in manual therapy. ***J Bodyw Mov Ther*** 2009; 13 (3): 276- 82.
7. Laffey JG, Kavanagh BP. Hypocapnia. ***N Engl J Med*** 2002; 347 (1): 43- 53.
8. Gardner WN. The pathophysiology of hyperventilation disorders. ***Chest*** 1996; 109 (2): 516- 34.

9. Leon Chaitow. Breathing pattern disorders, motor control, and low back pain. ***Journal of Osteopathic Medicine*** 2004; 7(1): 33 - 40.
10. Entezari A, Mehrabi Y, Varesvazirian M, Pourpak Z, Moin M. A systematic review of recent asthma symptom surveys in Iranian children. ***Chron Respir Dis*** 2009; 6 (2): 109- 14.
11. Thomas M, McKinley RK, Freeman E, Foy C. Prevalence of dysfunctional breathing in patients treated for asthma in primary care: cross sectional survey. ***BMJ*** 2001; 322 (7294): 1098- 100.
12. Osborne CA, O'Connor BJ, Lewis A, Kanabar V, Gardner WN. Hyperventilation and asymptomatic chronic asthma. ***Thorax*** 2000; 55 (12): 1016- 22.
13. Bruton A, Holgate ST. Hypocapnia and asthma: a mechanism for breathing retraining? ***Chest*** 2005; 127 (5): 1808- 11.
14. Hornsveld H, Garssen B. The low specificity of the Hyperventilation Provocation Test. ***J Psychosom Res*** 1996; 41 (5): 435- 49.
15. Miner JR, Heegaard W, Plummer D. End-tidal carbon dioxide monitoring during procedural sedation. ***Acad Emerg Med*** 2002; 9 (4): 275- 80.
16. Barton CW, Wang ES. Correlation of end-tidal CO2 measurements to arterial PaCO2 in nonintubated patients. ***Ann Emerg Med*** 1994; 23 (3): 560- 3.
17. Thomas M, McKinley RK, Freeman E, Foy C, Price D. The prevalence of dysfunctional breathing in adults in the community with and without asthma. ***Prim Care Respir J*** 2005; 14 (2): 78- 82.
18. van Dixhoorn J, Duivenvoorden HJ. Efficacy of Nijmegen Questionnaire in recognition of the hyperventilation syndrome. ***J Psychosom Res*** 1985; 29 (2): 199- 206.
19. Gilbert C. Better chemistry through breathing: the story of carbon dioxide and how it can go wrong. ***Biofeedback*** 2005; 33 (3): 100- 4.
20. Courtney R, Greenwood KM. Preliminary investigation of a measure of dysfunctional breathing symptoms: The Self Evaluation of Breathing Questionnaire (SEBQ). ***International Journal of Osteopathic Medicine*** 2009; 12 (4): 121- 7.
21. van Doorn P, Folgering H, Colla P. Control of the end-tidal PCO2 in the hyperventilation syndrome: effects of biofeedback and breathing instructions compared. ***Bull Eur Physiopathol Respir*** 1982; 18 (6): 829- 36.
22. Rowley J, Nicholls D. Development of the RoBE self-efficacy scale for people with breathing pattern disorders. ***New Zealand Journal of Physiotherapy*** 2006; 34 (3): 131- 41.
23. Courtney R, Cohen M, van Dixhoorn J. Relationship between dysfunctional breathing patterns and ability to achieve target heart rate variability with features of "coherence" during biofeedback. ***Altern Ther Health Med*** 2011; 17 (3): 38-44.
24. Thomas M, McKinley RK, Freeman E, Foy C, Prodger P, Price D. Breathing retraining for dysfunctional breathing in asthma: a randomised controlled trial. ***Thorax*** 2003; 58 (2): 110- 5.
25. Martínez-Moragón E, Perpiñá M, Belloch A, de Diego A. Prevalence of hyperventilation syndrome in patients treated for asthma in a pulmonology clinic. ***Arch Bronconeumol*** 2005; 41 (5): 267- 71.
26. Grammatopoulou EP, Skordilis EK, Georgoudis G, Haniotou A, Evangelodimou A, Fildissis G, et al. Hyperventilation in asthma: a validation study of the Nijmegen Questionnaire--NQ. ***J Asthma*** 2014; 51 (8): 839- 46.
27. Courtney R, Greenwood KM, Cohen M. Relationships between measures of dysfunctional breathing in a population with concerns about their breathing. ***J Bodyw Mov Ther*** 2011; 15 (1): 24- 34.