



Validation of the Korean version of the Boston Autonomic Symptom Questionnaire

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Background and Purpose The Boston Autonomic Symptom Questionnaire (BASQ) is a quantitative tool using a numeric rating scale to assess the symptoms of systemic dysautonomia, including cardiovascular, gastrointestinal, urinary, sudomotor, vasomotor, and sexual functions. The aim of this study was to validate the Korean version of the BASQ (KBASQ).

Methods Prospectively enrolled subjects who submitted to autonomic function tests, including tests for cardiovagal, adrenergic, and sudomotor functions, also completed the KBASQ and the Korean version of the Orthostatic Grading Scale (KOGS), a validated questionnaire for assessing orthostatic symptoms. Twenty-eight subjects completed the KBASQ twice to assess test-retest reliability. We classified the subjects to dysautonomia or normal control group according to dysautonomic symptoms and the results of autonomic function tests.

Results This study enrolled 225 subjects aged 54.0 ± 18.1 years (mean \pm standard deviation), with a male/female ratio of 1/1.03. The internal validity of the KBASQ was excellent (Cronbach's $\alpha=0.922$), and that of each of its subscales ranged from excellent to acceptable (Cronbach's $\alpha=0.709-0.952$). The test-retest reliability was good, with correlation coefficients ranging from 0.354 to 0.917. The subcategory scores for the KBASQ were significantly higher in the dysautonomia group than in the normal control group. There were significant correlations among the items in the KBASQ and KOGS. There was also a significant correlation between KBASQ scores and the results of the autonomic function tests.

Conclusions The internal validity and reliability of the KBASQ were good, indicating that it may be a useful screening tool for the systematic evaluation of autonomic symptoms in patients with dysautonomia.

Key Words autonomic nervous system, questionnaire, reliability and validity, validation study, symptoms

INTRODUCTION

The autonomic nervous system supplies the entire body, including the blood vessels, heart, stomach, intestines, liver, kidneys, bladder, sweat glands, pupils, and genitals. Symptoms of autonomic dysfunction vary depending on the involved region(s) of the autonomic nervous system. Therefore, a systematic autonomic symptom questionnaire is required to properly evaluate patients with autonomic dysfunction.

The Composite Autonomic Symptom Score (COMPASS) questionnaire is a representative and widely used tool for assessing autonomic symptoms.¹ The original version comprises 169 items, rendering its completion tedious and time-consuming for patients. Moreover, its scoring algorithm is complex and requires training to use accurately. The COMPASS questionnaire is thus not a convenient tool for rapid assessment of the severity of autonomic symptoms. COMPASS 31 is a refinement of the COMPASS questionnaire that comprises

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31 items, is easily scored, and takes less time to complete.² It is used widely for screening autonomic symptoms.³⁻⁵ The Korean version of COMPASS 31 has not yet been validated.

The Boston Autonomic Symptom Questionnaire (BASQ), developed by Freeman and colleagues at the Beth Israel Deaconess Medical Center,^{6,7} is used to assess cardiovascular, gastrointestinal, urinary, vasomotor, sudomotor, pupillomotor, and sexual functions. It also includes one item on hypoglycemia unawareness in patients with diabetes. Symptom severity is rated on a scale from 0 (symptom is never experienced) to 10 (symptom is always experienced). The BASQ is therefore intuitively useful for evaluating the severity of autonomic symptoms according to the subcategory of autonomic system involved.

The Orthostatic Grading Scale (OGS) is a five-item tool that addresses orthostatic symptoms and associated stressors and has been demonstrated to be a reliable and valid measure.⁸ However, since it is designed to evaluate only orthostatic symptoms, it cannot be used to assess other symptoms of autonomic dysfunction. The validity of the Korean version of this scale [Korean version of the Orthostatic Grading Scale (KOGS)] has been established.⁹

The aim of the present study was to determine the validity and reliability of the Korean version of BASQ (KBASQ) by comparing it with the KOGS. Furthermore, we aimed to determine the relationship between KBASQ scores and the results of autonomic function tests.

METHODS

Subjects

We prospectively enrolled subjects with orthostatic dizziness or underlying diseases that might cause autonomic dysfunction and who completed autonomic function tests between August 2017 and August 2018. We classified the subjects as dysautonomia group if they had underlying central nervous system (CNS) and/or peripheral nervous system (PNS) disorders that could cause autonomic dysfunction, and abnormality on autonomic function tests with dysautonomic symptoms. The normal control group included subjects with no dysautonomic symptoms and no abnormalities on neurologic examination, nerve conduction study, and autonomic function tests. Informed consent was obtained from all participants. Patients were excluded if they could not read Korean or if they did not provide informed consent for any reason. The Chungnam National University ethics committee approved this study (IRB No. 2017-07-062), and all procedures complied with the Declaration of Helsinki (1964) and its amendments.

Autonomic symptoms questionnaires

The BASQ has eight subcategories: 1) cardiovascular symptoms (seven questions), 2) orthostatic stressors related to the cardiovascular symptoms (five questions), 3) gastrointestinal symptoms (eight questions), 4) urinary symptoms (five questions), 5) sudomotor symptoms (four questions), 6) pupillomotor symptoms (two questions), 7) vasomotor symptoms (six questions), and 8) sexual symptoms (four questions). It also includes one question on hypoglycemia unawareness in diabetes (Supplementary Material 1 in the online-only Data Supplement). Each question is rated on a numeric scale from 0 (symptom is never experienced) to 10 (symptom is always experienced). The original BASQ was translated from English into Korean by one neurologist (AY Lee) and two nursing science specialists (MS Jung and KS Lee) and then translated back into English by the same neurologist (Supplementary Material 2 in the online-only Data Supplement).

The KOGS is a self-reported questionnaire that defines orthostatic symptoms. It comprises five questions regarding the frequency of the orthostatic symptoms, their severity, their relationship to orthostatic stressors, their disturbance of daily activities, and how long the patient can endure standing up. The response to each of these questions is rated on a numeric scale from 0 to 4.

All subjects completed the KBASQ and the KOGS consecutively at the same sitting, aiming to evaluate the reliability of cardiovascular symptoms as assessed by the KBASQ. In addition, 28 of the subjects completed the KBASQ twice, with a 2-week interval, to calculate the test-retest reliability. We compared the KBASQ scores for each subcategory between the normal control and dysautonomia groups.

Autonomic function tests

The autonomic function tests were performed using standard clinical diagnostic methods and equipment (WR Medical Electronics, Stillwater, MN, USA).^{10,11} Cardiovascular function was evaluated by measuring heart-rate variability during deep respiration and during the Valsalva maneuver. Adrenergic function was assessed by measuring the change in blood pressure during the Valsalva maneuver as well as changes in blood pressure and heart rate during the tilt-table test. Sudomotor function was explored using the Quantitative Sudomotor Axon Reflex Test (QSART).^{10,11} The degree of autonomic dysfunction was assessed using the Composite Autonomic Scoring Scale (CASS), which includes three subscales: cardiovascular, adrenergic, and sudomotor functions.¹² Possible responses to CASS items range from 0 (no deficit) to 10 (maximum deficit), with scores of ≤ 3 and ≥ 7 indicating mild and severe autonomic dysfunction, respectively.^{1,12} The blood pressure and heart rate were monitored continu-

ously using the Finapres system (Finapres Medical Systems, Enschede, the Netherlands), and QSART was performed using the QSWEAT device (WR Medical Electronics).

The autonomic function test results and KBASQ scores were compared only for subjects in the dysautonomia group.

Statistical analysis

The internal validity of the KBASQ and KOGS was assessed using Cronbach's α . A reliability test was performed to define the test-retest reliability of the KBASQ. An independent *t*-test was used to compare scores on the KBASQ between the normal control and dysautonomia groups. Spearman's rank correlation coefficient was used to assess the relationship between the scores of the KBASQ and the KOGS or the results of the autonomic function tests. All analyses were performed using SPSS Statistics for Windows (version 24.0, IBM Corp., Armonk, NY, USA).

RESULTS

Demographic and clinical characteristics of the subjects

This study prospectively enrolled 225 subjects aged 54.0 ± 18.1 years (mean \pm standard deviation). Of these, 64 (28.4%) had CNS disorders (e.g., cerebrovascular disorders, multi-system atrophy, and Parkinson's disease), 44 (19.6%) were diagnosed with PNS disorders (e.g., diabetic neuropathy, small-fiber neuropathy, and inflammatory neuropathy), 7 (3.1%) suffered from both CNS and PNS disorders (e.g., cerebrovascular diseases and diabetic neuropathy), 10 (4.4%) had a vestibular disorder (e.g., vestibulopathy), and 43 (19.1%) experienced syncope, and 28 (12.4%) subjects had no autonomic function abnormalities or symptoms and were assigned to the normal control group. The remaining 29 (12.9%) subjects were classified as undetermined because they experienced dysautonomic symptoms such as nonspecific dizziness, palpitation, excessive sweating, gastroparesis, or urinary frequency, without abnormalities on neurologic examination, brain imaging, nerve conduction studies, or autonomic function tests. Hypertension was diagnosed in 58 (25.8%) of the 225 subjects (Table 1).

Internal validity and reliability of the KBASQ

The internal validity of both the KBASQ and KOGS was excellent, with overall Cronbach's α values of 0.922 and 0.849, respectively. The internal validities of the cardiovascular, gastrointestinal, urinary, sudomotor, vasomotor, and sexual symptoms subcategories of the KBASQ ranged from excellent to acceptable (Cronbach's $\alpha=0.709$ – 0.952). The internal validity was poor only in the subcategory for pupillomotor

symptoms (Cronbach's $\alpha=0.554$) (Table 2).

The test-retest reliability of the KBASQ was good, with correlation coefficients ranging from 0.354 to 0.917 for its questions. Among these, pupillomotor symptoms in bright light and hypoglycemia unawareness in diabetes exhibited weak correlations (Table 3).

The scores on the KBASQ across all subcategories were significantly higher in the dysautonomia group than in the normal control group (Table 4).

Correlation of KBASQ scores with KOGS scores and autonomic function test results

Scores for the orthostatic symptoms subcategory in the KBASQ correlated significantly with those of the KOGS (Table 5). Scores for the cardiovascular, gastrointestinal, genitourinary, and vasomotor symptoms subcategories were significantly correlated with the results of the autonomic function tests. Among the cardiovascular symptoms, 'presyncopal

Table 1. Demographic and clinical characteristics of enrolled subjects

Characteristic	Total (n=225)
Age, years	54.0 \pm 18.1
Sex, male/female	111/114
Diagnosis	
CNS disorders	64/225 (28.4)
PNS disorders	44/225 (19.6)
CVD with DPN	7/225 (3.1)
Vestibular disorders	10/225 (4.4)
Syncope	43/225 (19.1)
Normal control	28/225 (12.4)
Undetermined	29/225 (12.9)
Hypertension	58/225 (25.8)

Data are mean \pm standard deviation or *n* (%) values.

CNS: central nervous system, CVD: cerebrovascular disorder, DPN: diabetic polyneuropathy, PNS: peripheral nervous system

Table 2. Cronbach's α values of all subjects

	Cronbach's α	<i>p</i>
KOGS	0.849	<0.001
KBASQ total	0.922	<0.001
Orthostatic symptoms	0.900	<0.001
Gastrointestinal symptoms	0.797	<0.001
Genitourinary symptoms	0.753	<0.001
Sudomotor		
Hypohidrosis	0.779	<0.001
Hyperhidrosis	0.735	<0.001
Pupillomotor symptoms	0.554	<0.001
Vasomotor symptoms	0.709	<0.001
Sexual symptoms	0.952	0.005

KBASQ: Korean version of the Boston Autonomic Symptom Questionnaire, KOGS: Korean version of the Orthostatic Grading Scale

Table 3. Test-retest reliability of the KBASQ

Questionnaire subcategory	r	p	Questionnaire subcategory	r	p
Cardiovascular symptoms			Urinary symptoms		
Lightheadedness	0.642	<0.001	Urinary urgency	0.681	<0.001
Dizziness	0.655	<0.001	Urinary hesitancy	0.575	<0.001
Presyncopal attack	0.795	<0.001	Loss of bladder control	0.811	<0.001
Syncope	0.535	<0.001	Sudomotor symptoms		
In the morning when arising from bed	0.594	<0.001	Hyperhidrosis	0.492	0.01
During or after a meal	0.589	<0.001	Hypohidrosis	0.451	0.02
When standing	0.631	<0.001	Anhidrosis	0.492	0.01
During exercise	0.460	0.01	Excessive sweating during a meal	0.491	0.01
While lying down	0.774	<0.001	Pupillomotor symptoms		
Rapid heart rate	0.705	<0.001	Seeing difficulty in bright light	0.429	0.62
Irregular heart beat or palpitation	0.707	<0.001	Seeing difficulty in dim light	0.712	<0.001
Difficulty breathing	0.710	<0.001	Vasomotor symptoms		
Gastrointestinal symptoms			Excessively cold hands/feet	0.818	<0.001
Difficulty swallowing	0.917	<0.001	Excessively warm hands/feet	0.538	<0.001
Nausea	0.875	<0.001	Color change of hands/feet	0.745	<0.001
Vomiting	0.768	<0.001	Red	0.712	<0.001
Diarrhea	0.354	0.06	Blue	0.893	<0.001
Constipation	0.695	<0.001	White	0.391	0.04
Loss of appetite	0.413	0.03	Sexual symptoms		
Getting full easily	0.605	<0.001	Decreased libido	0.765	<0.001
Loss of bowel control	0.755	<0.001	In males: morning erection	0.778	<0.001
Urinary symptoms			Masturbation	0.787	<0.001
Urinary frequency	0.608	<0.001	Sexual intercourse	0.758	<0.001
Nocturia	0.699	<0.001	Hypoglycemia unawareness	0.583	0.169

r: correlation coefficient; hypoglycemia unawareness, hypoglycemia unawareness in diabetes.
KBASQ: Korean version of the Boston Autonomic Symptom Questionnaire.

Table 4. Comparing the scores on the KBASQ between the normal control group and the dysautonomia group

Questionnaire subcategory	Control group	Dysautonomia group	p
Cardiovascular symptoms	6.8±4.8	20.6±19.3	<0.001
Gastrointestinal symptoms	5.1±5.7	14.2±11.5	<0.001
Urinary symptoms	4.3±4.9	13.7±10.7	<0.001
Sudomotor symptoms	4.9±4.0	10.3±7.1	<0.001
Pupillomotor symptoms	2.1±3.3	5.2±5.0	0.005
Vasomotor symptoms	5.6±4.5	10.1±8.3	0.005
Sexual symptoms	5.0±9.2	20.2±14.0	0.001

Data are mean±standard deviation.
KBASQ: Korean version of the Boston Autonomic Symptom Questionnaire

attack’ was correlated with the sudomotor function test results, ‘syncope’ was correlated with the results of the cardiovascular, adrenergic, and sudomotor function tests, and ‘dizziness in the morning when arising from bed’ was correlated with the cardiovascular function test results. ‘Swallowing difficulty’ and ‘nausea’ were correlated with the sudomotor function test results, and ‘anorexia’ was correlated with the cardiovascular function test results. ‘Frequency, hesitancy, and incontinence’ were correlated with the adrenergic function

test results, and ‘nocturia and urgency’ was correlated with the results of the adrenergic and sudomotor function tests. Finally, ‘color change of hands/feet’ and ‘change to red color’ were significantly correlated with the sudomotor function test results. Among the autonomic function tests, the strongest association with the KBASQ was found for the sudomotor function test results, and particularly with vasomotor symptoms (Table 6).

Table 5. Correlation between the KBASQ and the KOGS

KBASQ	KOGS				
	Frequency	Severity	Orthostatic stressor	Daily activity	Standing time
Symptoms					
Lightheadedness	0.540**	0.594**	0.512**	0.503**	0.293**
Dizziness	0.529**	0.581**	0.534**	0.462**	0.303**
Presyncopal attack	0.459**	0.522**	0.463**	0.436**	0.252**
Syncope	0.206**	0.274**	0.199**	0.209**	0.101
Orthostatic stressors					
Standing in the morning	0.532**	0.504**	0.483**	0.426**	0.239**
During or after a meal	0.338**	0.275**	0.270**	0.252**	0.162*
When standing	0.372**	0.364**	0.381**	0.375**	0.276**
During exercise	0.438**	0.413**	0.475**	0.411**	0.264**
While lying down	0.433**	0.401**	0.302**	0.295**	0.211**

Data are *r* values. *r*: correlation coefficient; hypoglycemia unawareness, hypoglycemia unawareness in diabetes.

p*<0.05, *p*<0.01.

KBASQ: Korean version of the Boston Autonomic Symptom Questionnaire, KOGS: Korean version of the Orthostatic Grading Scale

Table 6. Correlations between the KBASQ and autonomic function tests

	Cardiovascular	Adrenergic	Sudomotor	Total
CV				
Presyncope	-0.016 (0.877)	0.125 (0.213)	0.285 (0.041)*	0.284 (0.046)*
Syncope	0.207 (0.038)*	0.274 (0.006)*	0.778 (<0.001)**	0.779 (<0.001)**
Standing in the morning	0.257 (0.011)*	-0.006 (0.950)	-0.077 (0.588)	-0.076 (0.598)
GI				
Swallowing difficulty	0.167 (0.095)	0.100 (0.320)	0.450 (0.001)**	0.449 (0.001)**
Nausea	0.004 (0.966)	-0.077 (0.445)	0.275 (0.049)*	0.273 (0.055)
Anorexia	0.271 (0.006)**	0.123 (0.222)	-0.017 (0.905)	-0.012 (0.933)
GU				
Frequency	0.045 (0.654)	0.274 (0.006)**	0.055 (0.701)	0.061 (0.673)
Nocturia	-0.020 (0.843)	0.285 (0.004)**	0.288 (0.038)*	0.289 (0.041)*
Urgency	0.069 (0.495)	0.244 (0.014)*	0.341 (0.013)*	0.341 (0.015)*
Hesitancy	0.025 (0.806)	0.217 (0.030)*	-0.091 (0.520)	-0.096 (0.509)
Incontinence	0.143 (0.153)	0.213 (0.034)*	-0.062 (0.662)	-0.065 (0.656)
VS				
Color change	-0.074 (0.465)	0.164 (0.103)	0.524 (<0.001)**	0.535 (<0.001)**
Change to red	-0.081 (0.422)	-0.059 (0.558)	0.420 (0.002)**	0.422 (0.002)**

Data are *r* (*p*) values. *r*: correlation coefficient; hypoglycemia unawareness, hypoglycemia unawareness in diabetes.

p*<0.05, *p*<0.01.

CV: cardiovascular symptom, GI: gastrointestinal symptom, GU: genitourinary symptom, KBASQ: Korean version of the Boston Autonomic Symptom Questionnaire, VS: vasomotor symptom.

DISCUSSION

In this study we assessed the validity and reliability of the KBASQ by comparing it with the KOGS and the results of autonomic function tests. The scores on the KBASQ subcategories were significantly higher in the dysautonomia group than in the control group. To the best of our knowledge, this is the first study to investigate the internal validity and reliability of the KBASQ. The results show that this scale has excellent to acceptable internal validity and good reli-

ability. The subcategory of pupillomotor symptoms was the only one with poor internal validity; this may be attributable to the conflicting meanings of the two questions in that subcategory. Modification of the questions on pupillomotor symptoms could therefore help to improve the internal validity of the KBASQ.

The test-retest reliability of the KBASQ was good with the exception of two items that showed a weak correlation: 'seeing difficulty in bright light' in the pupillomotor symptoms subcategory and 'hypoglycemia unawareness in diabetes.'

Modifications to the items related to the pupillomotor symptoms subcategory is needed to enhance the test-retest reliability. It has been postulated that autonomic neuropathy could contribute directly to the development of hypoglycemia unawareness in patients with diabetes mellitus.¹³ However, recent evidence indicates that autonomic neuropathy is unlikely to be the primary underlying mechanism;¹⁴ other candidates of pathogenic mechanism include impaired CNS glucose sensing and changes in brain neurotransmitter signaling.^{15,16} Therefore, hypoglycemia unawareness cannot be considered a marker of autonomic neuropathy in patients with diabetes mellitus. Excluding this item from the KBASQ should be considered.

Each subcategory of the KBASQ was significantly correlated with the KOGS and with the results of the autonomic function tests. The cardiovascular symptoms subcategory of the KBASQ revealed an excellent correlation with the KOGS, confirming the reliability and validity of the KBASQ. However, the cardiovascular symptoms subcategory of the KBASQ showed a weak correlation with autonomic function test results. Furthermore, the question about standing up in the morning was only correlated with the results of the cardiovascular function tests. The COMPASS questionnaire has also demonstrated a strong correlation with sudomotor function test results in patients with small-fiber neuropathy, but not with the results of cardiovascular or adrenergic function tests.¹⁷ In addition, no clear association was reported between orthostatic symptoms and the degree of orthostatic hypotension during the tilt-table test in patients with either orthostatic hypotension or Parkinson's disease.^{18,19} Orthostatic symptoms should be interpreted with caution and objective tests must be performed to determine the correct status of patients. The finding in the present study of a strong correlation between the vasomotor symptoms subcategory of the KBASQ and the results of sudomotor function testing suggest that this subcategory is a reliable tool for evaluating sudomotor dysfunction.

The main strength of this study is the multiple comparisons performed between the KBASQ and other validated tests: the KOGS and the results of autonomic function tests. Based on these results, we were able to confirm the internal validity and reliability of the KBASQ in multiple ways. Another strength is the relatively large and heterogeneous cohort of subjects, who had various underlying diseases and autonomic dysfunctions, which allowed us to conclude that the KBASQ can be applied to various diseases and autonomic dysfunctions.

This study had two main limitations, both of which pertain to the normal control group. First, the criteria used to assign subjects to the normal control group may not have

been adequate. We enrolled subjects who complained of orthostatic dizziness or who had underlying disease that could cause autonomic dysfunction, and so it is possible that dysautonomic patients were included in the normal control group. However, the BASQ is a screening method, and additional specialized autonomic function tests are needed to accurately diagnose dysautonomia. To that end, we calculated a composite autonomic symptom score, a specialized autonomic function test to detect autonomic dysfunction, and assigned subjects to the normal control group only when neurologic examinations, nerve conduction studies, and autonomic function testing revealed no abnormalities. Several previous studies enrolled a diseased control group rather than a normal control group to validate the autonomic symptom questionnaire.^{12,17} Second, the normal control group was markedly smaller than the dysautonomia group, which might have reduced of the statistical strength of the analyses. Further studies with larger normal control groups are warranted.

In summary, the internal validity and reliability of the KBASQ were found to be good. The KBASQ could be a useful screening tool for systematically evaluating autonomic symptoms in patients with various autonomic dysfunctions.

Supplementary Materials

The online-only Data Supplement is available with this article at <https://doi.org/10.3988/jcn.2021.17.3.463>.

Author Contributions

Conceptualization: all authors. Data curation: Eun Hee Sohn, Sooyoung Kim. Formal analysis: Eun Hee Sohn, Sooyoung Kim. Methodology: all authors. Validation: all authors. Writing—original draft: Eun Hee Sohn. Writing—review & editing: all authors.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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