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 ± standard deviation), with a male/female ratio of 1/1.03. The internal validity of the KBASQ was excellent (Cronbach’s α=0.922), and that of each of its subscales ranged from excellent to acceptable (Cronbach’s α=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...
31 items, is easily scored, and takes less time to complete. It is used widely for screening autonomic symptoms. 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, 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. 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.

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). 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). The degree of autonomic dysfunction was assessed using the Composite Autonomic Scoring Scale (CASS), which includes three subscales: cardiovagal, adrenergic, and sudomotor functions.

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. 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±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 α=0.709–0.952). The internal validity was poor only in the subcategory for pupillomotor symptoms (Cronbach’s α=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).

**Table 1. Demographic and clinical characteristics of enrolled subjects**

| Characteristic               | Total (n=225) |
|------------------------------|--------------|
| Age, years                   | 54.0±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)|

**Table 2. Cronbach’s α values of all subjects**

|                  | Cronbach’s α | p       |
|------------------|--------------|---------|
| 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.
Validation of the KBASQ


dizziness in the morning when arising from bed' was correlated with the cardiovagal function test results. 'Swallowing difficulty' and 'nausea' were correlated with the sudomotor function test results, and 'anorexia' was correlated with the cardiovagal 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 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.
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 reliability. 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.'

### Table 5. Correlation between the KBASQ and the KOGS

| Symptoms                  | KBASQ Frequency | KBASQ Severity | KOGS Frequency | KOGS Severity | Orthostatic stressor | Daily activity | Standing time |
|---------------------------|-----------------|----------------|----------------|---------------|----------------------|----------------|--------------|
| 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 stresses      |                 |                |                |               |                      |                |              |
| 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 (0.056) |
| 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.
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Supplementary Materials

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

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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.

Acknowledgements

Kyung Suk Lee from Seoul National University translated Boston Autonomic symptom questionnaire into Korean version.

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