Psychometric Properties of the Greek Version of the Gianaros Motion Sickness Assessment Questionnaire

Panagiotis Kousoulis; Athanasios Pantes; Georgios Alevetsovitis; Ourania Fydanaki

INTRODUCTION: The Motion Sickness Assessment Questionnaire (MSAQ) was developed in order to assess the multiple dimensions of the motion sickness syndrome (gastrointestinal, central nervous system, peripheral, and sopite-related symptoms). The aim of this study was to evaluate the psychometric properties of the Greek version of the MSAQ.

METHODS: The MSAQ was translated into Greek and then translated back into English. Minor differences between the two texts were corrected. The Greek version was then administered to male subjects before and after nauseogenic motion stimulation. With the use of a motor driven rotating chair, the subjects were exposed to Coriolis cross-coupling stimulation. A battery of statistical tests was used to evaluate the psychometric properties of the MSAQ.

RESULTS: There were 112 subjects who participated. Internal consistency, measured with Cronbach's alpha coefficient, was excellent for the total scale and subscales. The test-retest evaluation was done with Pearson's coefficient and Bland-Altman's plot for the total score and subscales and showed statistically significant results. Mean total MSAQ score was 19.04 before the exposure and 33.46 after the exposure, which was statistically significant.

CONCLUSION: Results suggest the Greek-MSAQ is a valid instrument with satisfactory internal consistency, reliability, reproducibility, validity, and responsiveness and can be used in future studies of motion sickness in Greek speaking populations.

KEYWORDS: validity, translation, motion sickness, questionnaire.

Kousoulis P, Pantes A, Alevetsovitis G, Fydanaki O. *Psychometric properties of the Greek version of the Gianaros Motion Sickness Assessment Questionaire.* Aerosp Med Hum Perform. 2016; 87(11):954–957.

Motion sickness is a syndrome resulting from exposure to a novel—real or apparent—motion environment. The main signs and symptoms are epigastric discomfort, nausea, vomiting, sweating, and pallor. However, not all individuals experience the effect of motion on their body in the same way. For most, the gastrointestinal symptoms prevail. Others report mainly anxiety, tension, and irritation, while some respond primarily with cold sweats or a feeling of warmth. A small percentage report fatigue and sleepiness, a cluster of symptoms termed the "sopite syndrome."[8]

Gianaros et al.[4] explored the multidimensionality of the motion sickness syndrome using the reports of several hundred subjects on their experience of motion sickness. With exploratory and confirmatory factor analysis, they devised the Motion Sickness Assessment Questionnaire (MSAQ). The MSAQ comprised 16 questions covering four clusters of symptoms: gastrointestinal, central nervous system, peripheral, and sopite-related. Each symptom was given a rating of 1 (not at all) to 9 (severe). The questionnaire was evaluated in practice and statistically validated. The major achievement of Gianaros is that he clarified, in a scientifically sound way, four distinguishable dimensions of the motion sickness syndrome and allowed scientists to grade the symptoms in a more precise and replicable way.

To our knowledge, no specific motion sickness questionnaire has been adapted in Greek so far. This causes a major problem in motion sickness research, since there is no validated way to measure motion sickness in a Greek speaking population. Therefore, the purpose of the present study was to translate and adapt the Greek version of Gianaros's MSAQ and to evaluate its psychometric properties.

From the 120 Flight Training Wing Medical Service, Hellenic Air Force, Kalamata, Greece; and the Department of Otorhinolaryngology and the Department of Gastroenterology, 251 General Air Force Hospital, Hellenic Air Force, Athens, Greece.

This manuscript was received for review in December 2015. It was accepted for publication in July 2016.

Address correspondence to: Panagiotis Kousoulis, Mpoumpoulinas 60A, Kalamata 24100, Greece; pkousoulis@gmail.com.

DOI: 10.3357/AMHP.4540.2016

METHODS

Subjects

During the years 2007 to 2008, male students from the Hellenic Air Force Academy were recruited to participate in the study. Participation was voluntary and was rewarded with 1 d off work. Each subject provided written informed consent before participating. Approval for the study was obtained from the Scientific/Bioethical Committee of the Air Force General Hospital. The study took place during the first year of their training, and prior to any flight training, in order to avoid the cross effect of flying with the subjects' tolerance of motion sickness. For the same reason, any trainee who had a previous history of flight training was excluded from the study. All subjects were healthy individuals who had successfully completed their annual medical tests in the Aviation Medical Center of the Hellenic Air Force. They had no known history of oculomotor, vestibular, cardiovascular, gastrointestinal or neurological disease. A clinical neuro-otological examination (Romberg, Dix Hallpike, Unterberger, Babinski-Weil, head thrust, spontaneous nystagmus, otoscopy, and tuning fork tests) was normal in all subjects prior to exposure to motion. Subjects who reported alcohol or medication use in the 2 d prior to the experiment were rescheduled. They were also advised to refrain from consuming caffeine, abstain from smoking, and fast for a minimum of 3 h prior to their participation.

Equipment and Procedure

The Gianaros Scale was translated from English to Greek by two independent native Greek translators. The Greek translation was translated back to English by two other native English translators, according to published guidelines.[2] The produced texts showed minor differences which were discussed between the group of translators and the principal investigator, and a final decision on the text was achieved.

The subjects were exposed to Coriolis cross-coupling stimulation with the use of a motor driven rotating chair, with angular velocity (yaw axis) of 15 RPM. The seat and head rest was adjusted for each subject so that the head was aligned with the rotation axis. Every 30 s, the subject performed head movements (right roll, front pitch, left roll, and back pitch), following recorded instructions. Specially devised black goggles prevented any light input, so that the subjects relied mainly on the vestibular system for orientation and, to a lesser extent, on proprioceptive cues. Coriolis cross-coupling stimulation has been shown in similar experiments to be extremely nauseogenic.[3]

The participants completed the questionnaire before, immediately after the motion exposure, and for a third time 10 min after the rotation ceased. In general, the severity of motion sickness symptoms rapidly decreases after the termination of motion stimulus. Therefore, in order to achieve comparable results, the participants were asked to report the highest score of each symptom that they experienced during the rotation and not how they felt at the time they completed the questionnaire, even when this was only a few minutes after the exposure ceased. Participants were asked to complete the questionnaire again for a fourth time 30 min later, when most of the symptoms would have subsided, reporting their actual symptoms at that time. If they demonstrated significant symptom reduction, they were discharged.

During the exposure to Coriolis stimulation and right after each head movement, the subjects were asked to rate the overall severity of motion sickness symptoms using a scale of 1–7 (1: no symptoms; 2: any symptoms, however slight; 3: mild symptoms, e.g., stomach awareness but no nausea; 4: mild nausea; 5: mild to moderate nausea; 6: moderate nausea but can continue; and 7: moderate nausea, want to stop). The purpose of this questionnaire was to provide an easy to use endpoint of exposure and was first used by Golding and Kerguelen.[5] Rotation would be stopped if the subject reached a severity of 6 in the Golding-Kerguelen scale, or after 20 min of rotation, or if the subject vomited, whichever came first. Immediately after the exposure, the principal investigator, who has the experience of treating numerous pilots suffering from motion sickness in the past, rated the subject's overall symptom severity on a Likert scale of 0–10 based on the signs of motion sickness that he could observe, like pallor, vomiting, retching, yawning, and sweating.

Statistical Analysis

Internal consistency of the questionnaire and of the different subscales was evaluated with Cronbach's alpha statistical measure. The minimum acceptable value was 0.7.[1] Stability or test-retest reliability was assessed using Pearson's test and the Bland-Altman plot, comparing the answers of the participants immediately after the exposure and 10 min later. Validity of the test was measured by correlating the total symptom score with the principal investigator's score using Pearson's correlation test. The responsiveness of the questionnaire was assessed by comparison of the symptom scores before vs. immediately after the exposure. Paired *t*-test was used for the statistical evaluation. Values of $P < 0.05$ were considered statistically significant.

RESULTS

There were 112 male student pilots who participated in the study. **Fig. 1** shows the Greek translation of Gianaros's MSAQ. All subjects included in the study completed the Greek version of the questionnaire without any need for assistance. The mean time required to complete the questionnaire was approximately 3 min (range, 2–4 min).

Cronbach's alpha was 0.927 for the total score and 0.948, 0.793, 0.832, and 0.731 for the gastrointestinal, the central nervous system, the peripheral symptoms, and the sopite-related symptoms subscales, respectively. All values show adequate internal consistency for all subscales and total scale.

Pearson's correlations for test and retest answers were 0.987 for the total score, 0.978 for the gastrointestinal symptoms score, 0.948 for the central nervous system symptoms, 0.984 for the peripheral symptoms, and 0.969 for the sopite symptoms

Ερωτηματολόγιο εκτίμησης της κινήτωσης **Motion Sickness Assessment Questionnaire**
1. Αισθάνομαι στομαχική δυσφορία (-I felt sick to my stomach)
2. Αισθάνομαι σαν να θέλω να λιποθυμήσω – (felt faint-like)
3. Αισθάνομαι εκνευρισμό – ένταση- (I felt annoyed/irritated)
4. Αισθάνομαι να είμαι ιδρωμένος – (I felt sweaty)
5. Αισθάνομαι αναγούλα – (I felt queasy)
6. Αισθάνομαι σαν να είναι άδειο το κεφάλι μου –(I felt lightheaded)
7. Αισθάνομαι υπνηλία –(I felt drowsy)
8. Αισθάνομαι κρύους ιδρώτες - (I felt clammy/cold sweat)
9. Αισθάνομαι αποπροσανατολισμένος, σαν να μην ξέρω που βρίσκομαι – (I felt disoriented)
10. Αισθάνομαι κουρασμένος – (I felt tired/fatigued)
11. Αισθάνομαι να έχω ναυτία –(I felt nauseated)
12. Αισθάνομαι ένα αίσθημα ζέστης –(I felt hot/warm)
13. Αισθάνομαι ζαλισμένος –(I felt dizzy)
14. Αισθάνομαι ίλιγγο (να γυρίζει ο κόσμος) –(I felt like I was spinning)
15. Αισθάνομαι σαν να θέλω να κάνω έμετο –(I felt as if I may vomit)
16. Αισθάνομαι ανησυχία –(I felt uneasy)

Fig. 1. The Greek version of the Motion Sickness Assessment Questionnaire.

subscale. All correlations were statistically significant at the level of $P < 0.01$ (2-tailed), implying excellent test-retest reliability.

The Bland Altman plot for the total score (**Fig. 2**) showed that the 95% limits of agreement ranged from −5.6157 to 6.0466, while almost all differences were located between the agreement thresholds for the total score. Similar plots were designed for all subscales, showing that the translated test is reliable and gives similar scores when administered in two different points in time. The analysis of the correlation between the total symptom score after the exposure with the principal investigator's score showed that the two values have a strong and statistically significant correlation with $P < 0.001$ (**Fig. 3**).

All subscale scores and the total symptom score showed statistically significant increases after the exposure. In particular, the subjects' mean symptoms on the gastrointestinal scale showed increase by 5.420 ($P < 0.001$, CI-99%: 4.027–6.812), on the central nervous system scale by 3.500 ($P < 0.001$, CI-99%: 2.552–4.448), on the peripheral symptoms scale by 4.723 ($P < 0.001$, CI-99%: 3.745–5.702), and on the sopite symptoms scale by 0.786 ($P = 0.009$, CI-99%: 0.201–1.371). Finally, the mean total symptom score was 19.04 before the exposure and 33.46 after the exposure, increasing by 14.429 ($P = 0.009$, CI-99%: 11.138–17.719).

DISCUSSION

The aim of this study was to evaluate the psychometric properties of the Greek version of the Gianaros Motion Sickness Assessment Questionnaire. Cronbach's alpha coefficient exceeded, in all scales, the 0.70 standard, indicating item homogeneity and internal consistency of the total scale and the subscales. The questionnaire showed responsiveness, with scores before and after the exposure to the nauseogenic stimulus showing statistically significant increases. The questionnaire was proved to be easy to complete and reliable.

In similar studies of transcultural questionnaire adaptation,[9] the validity of a translated questionnaire is measured against an already valid and evaluated questionnaire which is considered a "gold standard." Unfortunately, no other valid motion sickness questionnaires exist in Greek medical literature. The most accurate measurement of motion sickness that was available in this study was the overall motion sickness score given by the principal investigator, who acted as the "expert." A very high degree of correlation was found

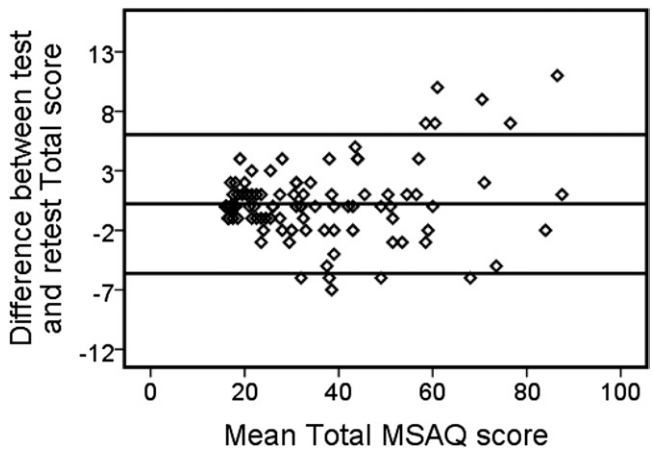

Fig. 2. Bland-Altman plot for the total score.

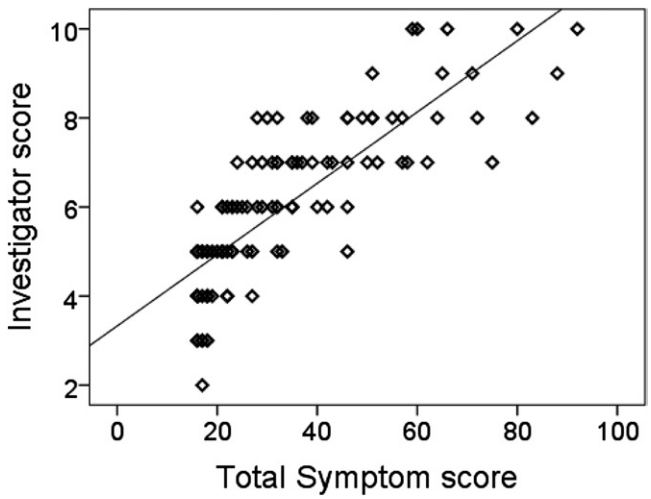

Fig. 3. Correlation between the total symptom score after the exposure and the principal investigator's score.

between the MSAQ score and the "expert" score, suggesting good validity.

One problem that the authors encountered was the evaluation of the test-retest reliability of the questionnaire. The difficulty lies in the characteristics of the motion sickness syndrome itself. Ideally, the same questionnaire should be given in two different periods of time. The time interval should be chosen so that symptoms are unlikely to have changed and respondents will not be able to remember their first responses.[1] In the case of motion sickness symptoms, which subside very soon after the exposure, these two requirements cannot be both met. Therefore, we chose to ask the participants to complete the questionnaire for the second time with an interval of 10 min, asking them to report on the severity of the symptoms that they experienced while they were rotating and not how they felt at the time of the questionnaire completion. In an attempt to minimize the memory effect, the order of the questions was changed.

One limitation of the present study is the administration of the questionnaire in a very specific population of student pilots, which consisted of male subjects ages 18–20 yr old. The age of the participants was similar to the ones used by Gianaros et al. (19 yr old), although they had both men and women in their sample. Therefore, one could argue that the Greek MSAQ might not be representative of the whole Greek population across all ages and both sexes. However, it is the future goal of the authors to use the translated MSAQ for motion sickness studies specifically in the student pilot community in Greece and the questionnaire was proven suitable for this kind of research.

It should be pointed out that the present study used a slightly different motion exposure methodology compared to the one used by Gianaros et al.[4] when they developed the initial questionnaire. The motion stimulus that Gianaros et al. used was apparent motion through an optokinetic drum, while we chose to use real motion through vestibular Coriolis cross coupling. Both motion stimuli can lead to the motion sickness syndrome, although there are subtle differences in the symptomatology and severity of sickness experienced between real and apparent motion exposure. For example, in visually induced motion, vomiting and retching are rare and can occur without accompanying prodromal symptoms.[6,7] The authors believe that, despite the difference in methodology, the questionnaire is still a valid instrument in measuring motion sickness symptoms.

In conclusion, our study demonstrates that the Greek version of the Gianaros MSAQ has satisfactory internal consistency, reliability, reproducibility, validity, and responsiveness. It is a valid and easy to use instrument for assessing all four dimensions of motion sickness in a Greek-speaking population and will be useful in future motion sickness research.

ACKNOWLEDGMENTS

The authors wish to thank George Karagiannakos, M.Sc. in Statistics, MBA - Columbia University, for his comments and support with the statistical analysis of the data. We also wish to thank Mrs. Aoife Waters, Specialty Registrar in Otolarygnology (North Cumbria University Hospitals NHS Trust), for her useful comments and linguistic support.

Authors and affiliations: Panagiotis Kousoulis, M.D., FEBORL-HNS, Georgios Alevetsovitis, M.D., and Ourania Fydanaki, M.D., 120 Flight Training Wing Medical Service, Hellenic Air Force, Kalamata, Greece; and Panagiotis Kousoulis, M.D., FEBORL-HNS, Department of Otorhinolaryngology, and Athanasios Pantes, M.D., Department of Gastroenterology, 251 General Air Force Hospital, Hellenic Air Force, Athens, Greece.

REFERENCES

1. Aday L. Designing and conducting health surveys: a comprehensive guide, 2nd ed. San Francisco: JosseyBass Publishers; 1996.
2. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine. 2000; 25(24):3186–3191.
3. Cheung B, Hofer K. Lack of gender difference in motion sickness induced by vestibular Coriolis cross-coupling. J Vestib Res. 2002; 12(4):191–200.
4. Gianaros PJ, Muth ER, Mordkoff JT, Levine ME, Stern RM. A questionnaire for the assessment of the multiple dimensions of motion sickness. Aviat Space Environ Med. 2001; 72(2):115–119.
5. Golding JF, Kerguelen M. A comparison of the nauseogenic potential of low-frequency vertical versus horizontal linear oscillation. Aviat Space Environ Med. 1992; 63(6):491–497.
6. Kennedy RS, Drexler J, Kennedy RC. Research in visually induced motion sickness. Appl Ergon. 2010; 41(4):494–503.
7. Kennedy RS, Lilienthal MG, Berbaum KS, Baltzley DR, McCauley ME. Simulator sickness in U.S. Navy flight simulators. Aviat Space Environ Med. 1989; 60(1):10–16.
8. Matsangas P, McCauley ME. Sopite syndrome: a revised definition. Aviat Space Environ Med. 2014; 85(6):672–673.
9. Tschan R, Wiltink J, Best C, Bense S, Dieterich M, et al. Validation of the German version of the Vertigo Symptom Scale (VSS) in patients with organic or somatoform dizziness and healthy controls. J Neurol. 2008; 255(8):1168–1175.