







An exploratory study on the validity and reliability of the Greek translation of Juniper's Asthma Control Questionnaire in pediatric patients in Greece

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Abstract

Aim: Evaluation of asthma control is the first step in the management of pediatric patient symptoms. The aim of this study was to a) validate the accuracy of the Greek version of the Asthma Control Questionnaire (ACQ) in quantifying asthma status in Greek pediatric patients; b) compare the 6-item with the 7-item ACQ; and c) explore the discriminatory power of the ACQ in relation to medication use.

Methods: Cross-sectional analysis of pulmonary data from 64 primary school children with mild asthma (51% boys). At baseline and 6 months, pulmonary function was recorded using spirometry and asthma control using the Greek version of the ACQ. Validity was assessed using Cronbach's alpha.

Results: Cronbach's alpha showed good internal consistency for both the 7-item and 6-item ACQ (alpha = 0.67, 0.74 respectively). No differences in scores were observed in the presence/or absence of medication therapy.

Conclusions: The findings of this study showed good precision and internal consistency of the 6-item ACQ in measuring recent asthma control in Greek children of the mild-asthma phenotype, independent of forced expiratory volume in 1 second (FEV₁) and medication use. This suggests that the 6-item questionnaire alone is potentially a robust tool in assessing asthma symptom control in children when pulmonary function tests (PFTs) are not feasible.



Keywords

Asthma control, children, questionnaire, reliability, validation

Introduction

Asthma is a chronic heterogeneous inflammatory respiratory disease affecting 10% of European children [1], specifically 4.3% in Greece [2] of which only 25% have optimal asthma control as defined by Global Initiative for Asthma (GINA) guidelines [3, 4]. In Greece alone, the direct cost of asthma for the healthcare system is estimated at 727 million per year and €151 per patient. It is substantially higher in those with uncontrolled asthma and is experiencing exacerbations during the past year [5]. Achieving and maintaining optimal asthma control is essential in reducing the risk of future exacerbations, improving quality of life, and reducing the burden on the individual and their carers.

Asthma severity and control reflect the degree of impairment by frequency and intensity of symptoms (cough, wheeze, shortness of breath, and chest tightness), lung function variations, limitations of daily activities, disruption in sleep patterns, and future risk (likelihood of exacerbations, progressive loss of lung function, or adverse effects from medications) [6]. Markers of “well-controlled” asthma in children consist of the presence of symptoms or bronchodilator use ≤ 2 weekly, no night or early morning awakenings, no limitations on going to school or exercise, and normal or personal best measurements of spirometric indices peak expiratory flow (PEF)/forced expiratory volume in 1 second (FEV_1) $\geq 60/80\%$ of personal best predicted respectively [6]. In the clinical setting, evaluation of asthma in patients is based on history, physical examination, and pulmonary function tests (PFTs) spirometry, or PEF measurements which are necessary and practical but may not provide an adequate measure of asthma control sufficient to support physician or parent/patient self-management decisions. In a recent prospective study nearly 50% of children with normal PFTs presented with poor asthma control [7]. Thus, highlighting that children with normal lung function can be symptomatic. Given that physicians rely on the concept of control in monitoring patients with asthma, practical tools are urgently needed to assist the physician in decision-making. Spirometry is an important diagnostic tool for the epidemiology and clinical evaluation of respiratory diseases. Nevertheless, in routine practice, its utilization is not always feasible due to limited access to laboratories performing spirometry, equipment expenses, the need for technician training and expertise as well as patient cooperation [8]. Therefore, alternative tools that can be easily implemented for both patient and clinical use are of importance for control.

Juniper’s Asthma Control Questionnaire (ACQ) is a concise 7-item questionnaire developed for adults that are based on the presence of diurnal and nocturnal symptoms, limitation of daily activities as well as on the value of large airway caliber function as represented by the spirometric indices FEV_1 [9]. The ACQ has been well-validated in adults [10, 11] but less so in children [12, 13] and not in European pediatric populations. Given the cultural diversity of most populations and the need for translations of these questionnaires from English to various languages, translated versions must be validated for patient comprehensibility and to ensure that they measure the construct that they were developed for on symptoms alone, independent of medication use and PFT (based on FEV_1) providing further details on current asthma status. This is important because poor symptom control contributes to patient burden and is a risk factor for future exacerbations.

Therefore, the scope of this study was to test the accuracy, feasibility, and reliability of the Greek translation of the ACQ in assessing current asthma control in pediatric patients of the mild-asthma phenotype residing in Greece. A secondary objective investigated was the adequacy of the 6-item ACQ and discriminatory power in relation to children taking asthma medication.

Materials and methods

Study design

The present study was a cross-sectional analysis of data from the Mediterranean diet enriched with fatty fish cohort study in pediatric asthma which was a two-arm 6-month intervention that examined the effect of the traditional Greek Mediterranean diet supplemented with fatty fish in 72 Greek primary school children with asthma (intervention group) *versus* the control group [14]. Patients of the mild-asthma phenotype [15] aged 5–12 years were recruited from November to December 31st, 2016 from a pediatric outpatient clinic in the municipality of Athens, Greece. As defined in the GINA (2016) guidelines, mild asthma is “well-controlled asthma” with not more than twice weekly daytime symptoms and need for reliever medication (short-acting β -2 agonists), absence of nighttime symptoms, and limitations in daily activities due to asthma exacerbations [15]. The intervention group was instructed to consume 2 meals of fatty fish (≥ 150 cooked fillets/meal) as part of the traditional Greek Mediterranean diet for 6 months, and the control group, their habitual diet. The primary outcomes were spirometric indices [FEV_1 , forced vital capacity (FVC), FEV_1/FVC , PEF, forced expiratory flow at 25–75% of the pulmonary volume ($FEF_{25-75\%}$)], reported as percent predicted values pre-bronchodilator administration and bronchial inflammation biomarker, fractional exhaled nitric oxide (FeNO). In this manuscript the primary exposure of interest is FEV_1 . The design and study protocol have been described in detail previously [14].

In brief, G*Power analysis [16] was used to estimate sample size based on the spirometric index FEV_1 [17]. A sample of ≥ 52 patients was adequate to generate a power of 90% with a moderate effect size of 0.4 and to evaluate two-sided hypotheses regarding a difference in FEV_1 between the intervention *versus* control group setting $\alpha = 0.05$. Taking into account a 20% drop-out rate, generated a final sample of 64 patients.

Procedures/data collection

Patients were assessed at two scheduled visits at the pediatric asthma specialist clinic at baseline and 6 months. Information on socio-demographics and medication was collected at baseline. Complete data were available for 64 patients.

Anthropometry

Patients' weight and height were measured using calibrated electronic scales and stadiometer (SECA 813, 217, Hanover, MD) to the nearest 0.1 cm and 0.1 kg in light clothing and without shoes, followed by body mass index (BMI, kg/m^2) calculation.

PFT

Patients were instructed to abstain from bronchodilator use for at least 4 h before spirometry measurements. PFTs were performed by trained personnel following standard American Thoracic Society/European Respiratory Society (ATS/ERS) protocol [18] using a portable spirometer MIR Spirobank II (004488, Medical International Research Inc. New Berlin, USA). Normal pulmonary function in children was considered $FEV_1 \geq 80\%$ predicted [18].

Asthma control

A Greek translation of Juniper's ACQ for children and adolescents 6–16 years old was obtained from Professor Juniper (<https://www.qoltech.co.uk/acq.html>) and used to evaluate the degree of asthma control in children (Supplementary material) [13]. The ACQ was completed jointly by children and their parent(s)/or guardians. Parents were instructed to complete questionnaires with honesty. The 7-item ACQ comprises 6 questions that evaluated the presence of symptoms, night-time waking, activity limitation, shortness of breath, wheeze, and rescue medication use during the past 7 days on a 7-point scale ranging from 0 = totally controlled to 6 = extremely poorly controlled; and the final question 7 includes the spirometric measure of central airways caliber, % predicted FEV_1 . The overall ACQ score is the average value of the 7 items. A score of < 0.75 is considered “well-controlled” asthma and ≥ 1.5 “extremely poorly controlled”. The lower the

score, the better asthma is “controlled”. The minimal clinical important difference (MID) has been defined at 0.5 [13]. Similarly, the 6-item ACQ tool includes the same questions as the 7-item questionnaire excluding the spirometry measurement of %FEV₁.

Asthma therapy

Asthma medication use by patients was measured by the question “During the last month has your child been taking asthma medication?”. Possible responses were “Yes” or “No”.

Statistical analysis

Continuous variables were assessed if they complied with normality using the Shapiro-Wilks statistical test. Normally distributed variables are presented as means and standard deviation (SD), skewed variables as medians and percentiles (25th, 75th), and categorical by percentages and counts (*n*). Differences between the 7-item and 6-item ACQ scores at both time points were compared using the non-parametric Wilcoxon signed-rank test and group differences via the Mann-Whitney *U* test. Reliability and internal consistency of the ACQ items in measuring the characteristic of asthma control in children was assessed by estimating Cronbach’s alpha. This index is expressed as a number between 0 and 1 where alpha > 0.6 was considered acceptable and > 0.7 sufficiently internally consistent [19]. Statistical significance was set a priori at *P* < 0.05. Statistical Package for the Social Sciences (SPSS) version 27 was used for data analysis (IBM Corp, Armonk, NY, USA).

Results

The final sample comprised 64 children (51.6% boys, 48.4% girls), with a median age of 7 years (interquartile range 4 years old). The clinical characteristics of the population are displayed in Table 1. At both time-points children had normal lung function in central (FEV₁, FVC > 80%) and peripheral airways (FEF_{25–75%} > 65%) and “well-controlled” asthma. Most of the children (83%) were under asthma therapy which declined to about 55% at 6 months (*X*² test: *P* = 0.008).

Table 1. Clinical characteristics of the total population (*n* = 64) at baseline and 6 months

Parameters	Baseline	6 months
BMI (kg/m ²)	17.50 (15.40, 20.60)	17.90 (15.63, 21.28)
%FVC (L)*	95.48 ± 9.96	96.00 (90.50, 101.50)
%FEV ₁ (L)	98.19 ± 9.71	99.88 ± 9.07
%FEV ₁ /FVC (L)	103.00 (99.00, 106.50)	102.88 ± 4.72
%PEF(L)	91.00 (80.50, 101.50)	94.50 (87.50, 106.50)
%FEF _{25–75%} (L)	102.17 ± 19.71	102.67 ± 16.93
7-Item ACQ score	0.29 (0.14, 0.57)	0.14 (0.0, 0.29)
6-Item ACQ score	0.17 (0.00, 0.50)	0.00 (0.00, 0.17)
Asthma control level (%) <i>n</i> , well-controlled	89.10 (57/64)	98.40 (63/64)
Asthma therapy (%) <i>n</i> , yes	82.80 (53/64)	54.70 (35/64)

Data is shown as means ± SD, median (25th, 75th percentiles) or percentages and counts. * pre-bronchodilator administration

The accuracy and reliability of the 7-item and 6-item ACQ in measuring asthma control in Greek pediatric patients with mild asthma are presented in Table 2.

Table 2. Reliability and accuracy of the 7-item and 6-item ACQ in measuring asthma control in Greek children

Instrument	Baseline score mean (SD)	Difference in baseline scores mean (SD)	Change to follow-up mean (SD)	Difference in change mean (SD)	Baseline Cronbach alpha
7-Item ACQ	0.36 (0.36)	Ref	−0.14 (0.03)	Ref	0.67
6-Item ACQ (excluding FEV ₁ level)	0.32 (0.39)	0.04 (0.03) <i>P</i> = 0.08*	−0.13 (0.07)	−0.01 (0.10) <i>P</i> = 0.042*	0.75

* *P*-values estimated using Wilcoxon signed-rank test. Ref: reference group. *P* < 0.05 represents a significant difference in results

At baseline, the 7-item ACQ showed satisfactory accuracy in distinguishing “well-controlled” from “not-well controlled” asthma as reflected by a Cronbach’s alpha of 0.67, while an alpha of 0.75 indicated good internal consistency and reliability of the 6-item questionnaire in measuring asthma control in children, independent of FEV₁. There was no difference in the mean baseline score calculated by the 7-item and 6-item instruments ($P = 0.08$). A statistically significant difference was detected in the change to follow-up, however, the difference was far smaller than the MID of 0.50 ($-0.01, P = 0.042$) [13]. At both time-points, no differences in the 7-item and 6-item scores were observed between the intervention groups as well as in patients taking asthma therapy (yes/no, Table 3).

Table 3. ACQ scores for the 7-item and 6-item questionnaires per intervention group and medication use at both time-points

Time-points/ ACQ	Intervention group (n = 31)	Control group (n = 33)	<i>P</i> ^a	Group difference	<i>P</i> ^b	Medication use**				
						Yes (n = 53)	No (n = 11)	<i>P</i> ^a	Group difference	<i>P</i> ^b
Baseline										
7-Item ACQ	0.29 (0.43)	0.29 (0.29)	0.81	0.00 (0.14)	Ref	0.29 (0.43)	0.14 (0.57)	0.28	0.15 (−0.14)	Ref
6-Item ACQ*	0.17 (0.50)	0.17 (0.50)	0.86	0.00 (0.00)	0.89	0.17 (0.50)	0.17 (0.00)	0.51	0.00 (0.50)	0.69
6-Month follow-up										
7-Item ACQ	0.14 (0.29)	0.14 (0.29)	0.79	0.00 (0.00)	Ref	0.14 (0.29)	0.00 (0.14)	0.13	0.14 (0.15)	Ref
6-Item ACQ	0.00 (0.17)	0.00 (0.17)	0.96	0.00 (0.00)	0.98	0.00 (0.17)	0.00 (0.17)	0.49	0.00 (0.00)	0.44

Data is shown as median (interquartile range, IQR). Ref: reference group; ^a P -value derived by Mann-Whitney U Test; ^b P -value for the difference between the 7-item and 6-item ACQ score estimated by the Mann-Whitney U test; *: ACQ without spirometry measure % predicted FEV₁; **: medication using baseline data

Discussion

According to the current guidelines of the GINA, the long-term goal of asthma therapy is to achieve and maintain control of symptoms along with the reduction of risk for future exacerbations, airway damage, and medication side effects [4]. Furthermore, accurate reporting of patient symptoms is imperative for good asthma care. An underestimation of disease severity by physicians can lead to misclassification of asthma severity and inadequate treatment regimen, while overestimation by parents/or children can adversely influence management protocols [20].

Hence, measuring asthma control is a vital first step in the management of patient symptoms and in reflecting the actual asthma status in the “real situation”. The goal of patient-reported composite asthma control score instruments is to quantify and capture the multidimensional nature of asthma control in a single numerical value. The current study attempted to provide insight into the clinical utility of the Greek version of the ACQ in pediatric patients residing in Greece. Unique to this study was the evaluation of the 6-item ACQ in relation to recent asthma control in Greek pediatric patients. Based on the findings of this study, it was established that the Greek version of the ACQ has adequate sensitivity and internal consistency in detecting uncontrolled asthma from well-controlled pediatric patients and is a useful evaluative instrument for research and clinical practice in Greece. From the scarce data available, only two studies have conducted validation of the 7-item ACQ in children (6–17 years), one in the USA ($n = 305$) [12] and the other in the UK ($n = 35$) [13], reporting that this instrument is moderately reliable and valid (Cronbach’s alpha 0.74, 0.79 respectively) in assessing asthma control among children which coincides with the outcome of the present study.

Another significant finding demonstrated in this study was that Cronbach’s alpha verified the feasibility and accuracy of the 6-item ACQ in measuring current asthma control in Greek children of the mild-asthma phenotype, independent of FEV₁ and medication therapy. This is consistent and supports the findings of the original validation study of the shortened English version of the ACQ conducted by Juniper et al. [13] in 35 children (6–16 years) that documented good reliability and construct validity of symptoms alone as reflected by Cronbach’s alpha of 0.67. Hence, the Greek-translated questionnaire alone is potentially a robust tool in assessing asthma control in children based on symptoms alone and in the absence of spirometry measurements. Notably, the ACQ score has been strongly correlated to asthma symptoms as well as patients’ and physicians’ perceptions of asthma control [11]. This is important in research contexts where PFTs may

not be feasible due to the high cost of equipment and lack of trained personnel in performing PFTs. It is also valuable for capturing children of high risk for exacerbations that dwell in remote regions and do not have access to healthcare and routine consultations with pediatric pulmonologists. Regular monitoring and evaluation of current asthma status in these pediatric patients via the 6-item ACQ would allow for efficient and better care of asthma symptoms, medication adherence, and targeted therapies thereby mitigating the global burden of asthma in children. Alternatively, poor asthma control in patients as indicated by the 6-item ACQ could signify the need for further clinical assessment of lung function deterioration. This would be useful in countries with limited resources and reduce costs for the individual and healthcare system due to unnecessary PFT. So, in the clinical scenario, the implementation of the 6-item ACQ could be useful as a monitoring tool for asthma control and as an indication of patient adherence to medication therapy. The precision of this tool in measuring the degree of asthma control in the presence and absence of medication use is highly relevant in pediatric asthma management.

Strengths/limitations

To authors' knowledge, this is the first study to validate the precision and reliability of the Greek version of Juniper's ACQ in asthmatic children residing in Greece. Up to now, the utility of the Asthma Control Test has been validated for Greek adult patients [21] and the ACQ in English-speaking pediatric populations [12, 13]. Therefore, the present study is important in addressing the gap in the literature by providing new data, especially in countries where resources are limited and administering spirometry regularly is costly and difficult for patients residing in rural and remote areas. Here, the reliability and accuracy of the 6-item instrument in detecting the change in asthma control independent of FEV_1 and medication use, were validated. Hence this concise and simple questionnaire can capture features of asthma symptomology and may improve collaboration between physicians and parents, which in turn will ultimately lead to better patient compliance with pharmacotherapy. From a statistical point of view, in research, it is common practice to use Cronbach's alpha as an objective index of an instrument's validity and reliability [22]. Given that the ACQ uses a 6-item and 7-item single construct scale, which conforms with the assumption of unidimensionality, then Cronbach's alpha provides an acceptable lower bound of reliability and internal consistency that this test/or scale measures the same concept. One more source of potential bias might be that the present cohort was recruited in a different historical period and that differences in treatment strategies and standards compared to the current time could explain null findings in discriminating airway inflammation. Therefore, research on more recent cohorts is urgently needed.

A potential limitation of this study was the small sample size and the absence of subjects with severe asthma [23]. Future studies should consider possible differences in the sensitivity of the 6-item ACQ in predicting the risk of severe asthma in pediatric patients. However, the majority of Greek children suffer from mild asthma [24]. Generalizability is also limited since most of the patients had well-controlled asthma and were taking asthma medication which declined by 28% at 6 months. Furthermore, parents were used as surrogates to respond to questionnaires which are prone to overestimation of good asthma control by parents and underestimation by children due to recall/information bias and possibly misclassification of subjects [25].

In conclusion, evaluating asthma control is the first step in the management of symptoms in patients. The findings of this study showed good precision and internal consistency of the 6-item questionnaire in measuring recent asthma control in Greek schoolchildren of the mild-asthma phenotype, independent of FEV_1 and medication use. This suggests that the 6-item questionnaire alone is potentially a robust tool in assessing asthma symptom control in children when PFTs are not feasible. The ACQ has utility in clinical practice since it can provide practitioners in a matter of minutes with a complete picture of the child's level of asthma control and the need for step-up treatment. More longitudinal studies in children are warranted to assess the tool's ability to measure deterioration in asthma control over time and to predict future exacerbations.

Abbreviations

ACQ: Asthma Control Questionnaire

FEF_{25–75%}: forced expiratory flow at 25–75% of the pulmonary volume

FEV₁: forced expiratory volume in 1 second

FVC: forced vital capacity

GINA: Global Initiative for Asthma

PEF: peak expiratory flow

PFTs: pulmonary function tests

SD: standard deviation

Supplementary materials

The supplementary material for this article is available at: https://www.explorationpub.com/uploads/Article/file/10093_sup_1.pdf.

Declarations

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Author contributions

MMP: Conceptualization, Visualization, Investigation, Resources, Data curation, Writing—original draft. MMP, KAL, and BE: Formal analysis. BE, CI, and KAL: Supervision, Writing—review & editing. CK and DT equally contributed to: Data curation, Writing—review & editing. All authors read and approved the submitted version.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

This study was approved by La Trobe University Human Ethics Committee (Approval No.: HEC 16-035).

Consent to participate

Informed consent to participate in the study was obtained from all participants.

Consent to publication

Not applicable.

Availability of data and materials

All datasets for this study are included in the manuscript and the supplementary files.

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