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Repeatability of the ISAAC video questionnaire and its accuracy against a clinical diagnosis of asthma

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The objective of the study was to evaluate the performance of the International Study of Asthma and Allergies in Childhood (ISAAC) video questionnaire in terms of repeatability and accuracy against a clinical diagnosis of asthma achieved according to the National Heart, Lung and Blood Institute (NHLBI) algorithm.

Two hundred and forty-one subjects, aged 13–14 years from two secondary schools in Rome, Italy, were enrolled. Video and written ISAAC questionnaires were completed twice, 3 months apart, by 194 and 190 adolescents, respectively. Two months later, 106 subjects were visited by two physicians blinded to the results of questionnaires.

Sixteen subjects were classified as having clinical asthma (CA) at the clinical visit, and eight of them as having clinical active asthma (CAA) on the basis of at least one positive outcome of the NHLBI algorithm. The repeatability of video questionnaire was similar to that of the written questionnaire for items on exercise wheeze and nocturnal cough and, to a lesser degree, for items concerning any wheeze in the past. The video questionnaire showed a worse performance than the written questionnaire for items on asthma attack: K-value (95% CL) = 0·59 (0·37–0·80) for video scene no. 5 and K-value (95% CL) = 0·86 (0·74–0·98) for written question no. 6. The overall accuracy of the video questionnaire, estimated as a positive answer to any video scene, was lower in terms of sensitivity than that of any written question when CA was used as a gold standard (0·50 *vs.* 0·81, $P = 0{\cdot}025$) and increased with respect to CAA (0·75 *vs.* 0·87, $P = 0{\cdot}317$). The specificity of any video scene was better than that of any written question, independently from the gold standard used.

In conclusion, the video questionnaire showed a fairly good accuracy, although slightly lower than that of the written questionnaire and provided sufficiently reliable results. However, samples of subjects from different geographic areas and cultures should be studied in order to conclusively define the performance of the ISAAC video questionnaire.

Key words: asthma; questionnaire; repeatability; accuracy.

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Introduction

The prevalence of childhood asthma is thought to have increased in the last 10 years, especially in industrialized countries. However, this trend has not yet been proved conclusively (1). Indeed, a reliable estimate of this phenomenon is lacking (2–7), owing in part to the methods used for measuring asthma prevalence. Several written questionnaires have been designed in the past decades to assess asthma prevalence (8–12), and the comparison of results obtained with such different instruments is difficult. Moreover, the use of the same written questionnaire can result in translation problems, and the comprehension of questions and the perception of symptoms may be different between countries and cultural groups. Thus, questions prompted by video scenes representing clinical aspects of asthma have been put forward in order to overcome these difficulties (13).

The International Study of Asthma and Allergies in Childhood (ISAAC) aimed to evaluate, by a standardized methodology, the prevalence of asthma and allergic diseases in children living in different geographical areas to provide a baseline reference for future aetiological research (14). Both written and video questionnaires have been developed for this study (15). The ISAAC written questionnaire has been validated in relation to bronchial hyper-reactivity (16) and doctor-diagnosed asthma (17). Until now, short-term repeatability of the ISAAC video questionnaire has never been tested. Moreover, the video questionnaire has been previously validated only against the results of a non-specific bronchial challenge test (16,18,19). However, the distribution of bronchial reactivity and asthma symptoms do not fully overlap, and bronchial hyper-responsiveness does not allow a diagnosis of asthma

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in the absence of subjective symptoms (20,21). Thus, a questionnaire proposed for diagnosing asthma should be validated against a standardized clinical diagnosis of the disease. At present, a standardized clinical diagnosis of asthma can be obtained following the diagnostic algorithm suggested by the National Heart, Lung and Blood Institute (NHLBI) (22).

The aim of this study was to evaluate the short-term repeatability of the ISAAC video questionnaire. In addition, the accuracy of the video questionnaire was assessed in a small sample of subjects against a clinical diagnosis of asthma obtained according to the NHLBI algorithm (22). Both repeatability and accuracy of the video questionnaire were compared with those of the written questionnaire proposed for the ISAAC study.

Methods

SUBJECTS AND STUDY DESIGN

In 1994, 241 adolescents, aged 13–14 years, from two secondary schools in Rome, were enrolled to evaluate the short-term repeatability of the Italian translation of the ISAAC written questionnaire and of the ISAAC video questionnaire (European version). Written and video questionnaires were completed twice, 3 months apart, by 190 and 194 subjects, respectively, following the ISAAC protocol. Both the methodology and the circumstances of the test sessions were the same on both occasions. In particular, no change was noted between the two occasions which may have altered either symptoms or bronchial reactivity, such as viral infection or allergen exposure.

Two months after the second administration of the questionnaires, 106 subjects (48 males and 58 females, mean age $13{\cdot}7 \pm 0{\cdot}75$ years), agreed to participate in a respiratory functional assessment performed using a computerized spirometer (Medgraphics 1070, Medical Graphics Corp, St. Paul, Minn, U.S.A.) and underwent a clinical visit by two respiratory physicians (L.F. and M.D.R.) blinded to the results of the questionnaires. The medical history was collected according to the list of items suggested by the NHLBI (22) and when both physicians were in agreement about the presence of asthma symptoms (especially wheeze, cough and chest tightness), the subject was suspected to have clinical asthma (CA). These subjects were further screened according to the NHLBI diagnostic algorithm (22) in order to evaluate the presence of clinical active asthma (CAA). In detail, if forced expiratory volume in 1 sec (FEV_1) fell to the lowest decile of the normal distribution derived from the equation of Quanjer *et al.* (23), a bronchial obstruction was diagnosed and its reversibility was defined as a FEV_1 increase of at least 10% 30 min after the inhalation of 200 μg of salbutamol. The presence of a reversible bronchial obstruction was considered diagnostic for CAA.

Non-obstructed subjects monitored their morning and evening peak expiratory flow rate (PEFR) during the following 2 weeks using a Mini-Wright peak flow meter (Clement Clarke International Ltd, U.K.). Three manoeuvres were performed each time, and the best value was recorded on a diary card. Daily variability was defined as follows:

[(high PEFR value $-$ low PEFR value)/high PEFR value] $\times$ 100.

A daily variability of 10% or more for at least a half of the monitoring days was considered diagnostic for CAA.

Subjects with a normal PEFR monitoring underwent a methacholine challenge test according to the method proposed by Ryan *et al.* (24), using a dosimeter giving a calibrated output of 9·0 μl per puff. After having inhaled an initial aerosol of diluent, subjects inhaled doubling concentrations (from 0·031 to 16 mg ml^{-1}) of methacholine. FEV_1 was measured 30 and 90 sec after each dose which was given at 5-min intervals. A fall in FEV_1 of at least 20% from baseline was considered diagnostic for CAA.

All other subjects were considered to be normal.

STATISTICAL ANALYSIS

Cohen's kappa (K) and its 95% confidence limits (95% CL) were used as a measure of the short-term repeatability of the answers to each video scene and written question. Five scenes of the second version of the ISAAC video questionnaire were evaluated:

no. 1: wheeze while at rest; no. 2: wheeze after exercise; no. 3: wakening with wheeze; no. 4: wakening with cough; no. 5: severe asthma attack.

The written questions were as follows:

no. 1: have you ever had wheezing at any time in the past?; no. 6: have you ever had asthma?; no. 7: in the last 12 months, has your chest sounded wheezy during or after exercise?; no. 8: in the last 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection?

Sensitivity, specificity and Youden's index (YI: sensitivity+specificity $-$ 1) (25) were calculated to assess the accuracy of the second set of video and written questions by using CA and CAA as alternative gold standards. The overall accuracy of each questionnaire was also evaluated when at least one positive answer to any video and written question was present. Sensitivity and specificity of these last two items were compared by using the Mc Nemar simmetry test in separate 2×2 tables for subjects affected and not affected by CA or CAA (26).

Results

The short-term repeatability of the questionnaires is shown in Table 1. The written questionnaire was more reliable than the video questionnaires for the items on wheezy sounds at any time in the past (written question no. 1 and video scene no. 1: K-values 0·59 and 0·47, respectively). However, the 95% CL of these two items largely overlapped, the lower limit of the written question falling inside the range of the video scene limits. The repeatability of the items on exercise-induced wheezing (video scene no. 2 and written question no. 7) was relatively low for both video and written questionnaires (K-values 0·47 and 0·41, respectively). The worst results were obtained by the items on nocturnal cough (video scene no. 4 and written question no. 8: K-values 0·28 and 0·29, respectively). On the contrary, the highest K-value among the video scenes was obtained for severe asthma attack (video scene no. 5, K = 0·59), whereas a larger K-value was found when the presence of asthma was asked in the written questionnaire (written question no. 6, K = 0·86). The 95% CL of these two last items were quite different with the written question showing a better repeatability.

Sixteen out of 106 subjects who underwent the clinical visit were classified as having CA. All were intermittent asthmatics and they used only short-acting inhaled β_2-agonists taken as needed. The anthropometric characteristics and the respiratory function data of these subjects are reported in Table 2. Lung function data were similar between normal and CA subjects and none of asthmatics had a significant bronchial obstruction. Eight out of the 16 CA subjects were identified as having also CAA: five of them had a positive PEFR monitoring and, according to the NHLBI algorithm, they did not perform the methacholine challenge test; three subjects with a normal PEFR monitoring had a positive methacholine challenge test.

Sensitivity, specificity, and YI of the video and written questionnaires with respect to the diagnosis of asthma based only on the medical history (CA), and with respect to the diagnosis of asthma based on the NHLBI algorithm (CAA), are reported in Tables 3 and 4, respectively. The written question no. 1 had the best performance with respect to both CA and CAA. When a positive answer to any video and written question was used to estimate the overall accuracy of the two formats, video and written questionnaire gave different results when CA was the gold standard (YI 0·38 and 0·59, respectively) but similar results

TABLE 1. Repeatability of video and written questionnaires (1st and 2nd administration)

Video questionnaire	1st Yes 2nd Yes	1st Yes 2nd No	1st No 2nd Yes	1st No 2nd No	Total	Concordance	K-value (95% CL)
Scene 1 (Any wheeze)	11	14	6	163	194	0·90	0·47(0·27–0·66)
Scene 2 (Exercise wheeze)	14	20	4	156	194	0·88	0·47(0·29–0·64)
Scene 3 (Nocturnal wheeze)	7	8	5	174	194	0·93	0·48(0·24–0·71)
Scene 4 (Nocturnal wheeze)	11	34	4	145	194	0·80	0·28(0·12–0·44)
Scene 5 (Severe asthma)	9	6	5	174	194	0·94	0·59(0·37–0·80)
Written questionnaire							
Question 1 (Any wheeze)	24	12	12	142	190	0·87	0·59(0·45–0·73)
Question 6 (Ever asthma)	21	5	1	163	190	0·97	0·86(0·74–0·98)
Question 7 (Exercise wheeze)	14	24	5	147	190	0·85	0·41(0·23–0·58)
Question 8 (Nocturnal cough)	13	32	8	137	190	0·80	0·29(0·13–0·45)

95% CL: 95% Confidence Limits.

TABLE 2. Characteristics and respiratory functional data (mean ± SD) of patients with Clinical Asthma in comparison with normal subjects

	Clinical Asthma	Normals	*P*-value (*)
Number	16	90	
Age (years)	13·4 ± 0·6	13·7 ± 0·7	0·126
Height (cm)	158·06 ± 4·93	162·06 ± 6·78	0·025
Weight (kg)	53·50 ± 6·95	56·02 ± 10·77	0·469
FVC (l)	3·61 ± 0·55	3·78 ± 0·67	0·655
FVC (% pred)	110·81 ± 12·67	109·12 ± 12·24	0·621
FEV_1 (l)	3·17 ± 0·41	3·37 ± 0·50	0·126
FEV_1 (% pred)	112·56 ± 14·84	111·83 ± 11·71	0·821
FEV_1/FVC (%)	88·44 ± 7·09	89·74 ± 5·23	0·606
$FEF_{25\cdot75}$ (l sec^{-1})	3·76 ± 0·79	4·11 ± 0·72	0·076
$FEF_{25\cdot75}$ (% pred)	114·19 ± 26·47	116·95 ± 21·15	0·649

(*)by *t*-test or Mann–Whitney test.
FVC: forced vital capacity; FEV_1: forced expiratory volume in 1 sec;
$FEF_{25\cdot75}$: forced mid-expiratory flow.

Table 3. Accuracy of video and written questionnaires with respect to clinical asthma

Video questionnaire	VQ Yes CA Yes	VQ Yes CA No	VQ No CA Yes	VQ No CA No	Total	Sensitivity	Specificity	YI
Scene 1 (Any wheeze)	6	4	10	86	106	0·37	0·96	0·33
Scene 2 (Exercise wheeze)	6	5	10	85	106	0·37	0·94	0·32
Scene 3 (Nocturnal wheeze)	5	1	11	89	106	0·31	0·99	0·34
Scene 4 (Nocturnal wheeze)	3	5	13	85	106	0·19	0·94	0·13
Scene 5 (Severe asthma)	6	3	10	87	106	0·37	0·97	0·34
Any video scene	8	11	8	79	106	0·50	0·88	0·38
Written questionnaire	**WQ Yes CA Yes**	**WQ Yes CA No**	**WQ No CA Yes**	**WQ No CA No**	**Total**	**Sensitivity**	**Specificity**	**YI**
Question 1 (Any wheeze)	12	11	4	79	106	0·75	0·88	0·63
Question 6 (Ever asthma)	9	4	7	86	106	0·56	0·96	0·52
Question 7 (Exercise wheeze)	7	7	9	83	106	0·44	0·92	0·36
Question 8 (Nocturnal cough)	2	8	14	82	106	0·12	0·91	0·04
Any written question	13	20	3	70	106	0·81	0·78	0·59

VQ: Video questionnaire; WQ: Written questionnaire; CA: Clinical asthma; YI: Youden's index.

Table 4. Accuracy of video and written questionnaires with respect to clinical active asthma

Video questionnaire	VQ Yes CAA Yes	VQ Yes CAA No	VQ No CAA Yes	VQ No CAA No	Total	Sensitivity	Specificity	YI
Scene 1 (Any wheeze)	5	5	3	93	106	0·62	0·95	0·57
Scene 2 (Exercise wheeze)	5	6	3	92	106	0·62	0·94	0·56
Scene 3 (Nocturnal wheeze)	4	2	4	96	106	0·50	0·98	0·48
Scene 4 (Nocturnal wheeze)	3	5	5	93	106	0·37	0·95	0·32
Scene 5 (Severe asthma)	5	4	3	94	106	0·62	0·96	0·58
Any video scene	6	13	2	85	106	0·75	0·87	0·62
Written questionnaire	**WQ Yes CAA Yes**	**WQ Yes CAA No**	**WQ No CAA Yes**	**WQ No CAA No**	**Total**	**Sensitivity**	**Specificity**	**YI**
Question 1 (Any wheeze)	7	16	1	82	106	0·87	0·84	0·71
Question 6 (Ever asthma)	6	7	2	91	106	0·75	0·93	0·68
Question 7 (Exercise wheeze)	5	9	3	89	106	0·62	0·91	0·53
Question 8 (Nocturnal cough)	1	9	7	89	106	0·12	0·91	0·03
Any written question	7	26	1	72	106	0·87	0·73	0·61

VQ: Video questionnaire; WQ: Written questionnaire; CAA: Clinical active asthma; YI: Youden's index.

when CAA was the gold standard (YI 0·62 and 0·61, respectively). Analysing the data in terms of sensitivity and specificity, the sensitivity of any video scene with respect to CA (0·50) was significantly lower than that of any written question (0·81), according to the Mc Nemar test ($P=0·025$); however, the specificity of any video scene (0·88) was better than that of any written question (0·78, $P=0·039$). On the other hand, when CAA was chosen as gold standard, the sensitivity of any video scene (0·75) was not significantly different from that of any written question (0·87, $P=0·317$), whereas the specificity of any video scene (0·87) confirmed to be significantly higher than that of any written question (0·73, $P=0·007$).

Discussion

This study showed that the repeatability of the video questionnaire was, in general, close to that of the written questionnaire, for most of items. The K-values of the written questions were, on average, higher than those of the video scenes. However, considering the 95% CL of the K-values, the repeatability of items about exercise wheeze and nocturnal cough was quite similar in both video and written questionnaire. The video scene and the written question on cough showed the worst repeatability, as already reported in literature (27). Moreover, the repeatability of items about any wheeze in the past were not significantly different between video and written questionnaire, at the 95% CL of K-values (Table 1).

The highest K-value among the video questionnaire was obtained by scene no. 5. This result indicates that only the scene showing a severe asthma attack was easily recognized by the subjects, whereas any other video scene could be erroneously interpreted with different conclusions between the two administrations of the video questionnaire. However, the repeatability of the video scene no. 5 was significantly lower than that of the written question no. 6, at the 95% CL of the K-values (Table 1). Indeed, question no. 6 (Have you ever had asthma?) was highly reliable. It is likely that the asthmatic subject well knows the meaning of the word 'asthma', from previous visits from their general practitioner for their condition.

The concordance of some matched items between video and written questionnaires (scene no. 1–question no. 1, scene no. 2–question no. 7, and scene no. 4–question no. 8) was also calculated during the first administration of the questionnaires. The K-values (0·42, 0·43, and 0·29, respectively) were very close to those obtained for the short-term repeatability of each questionnaire.

The accuracy of the video questionnaire was evaluated in this study, but only in a small sample of subjects. The previously reported better performance of the video questionnaire in comparison with the written questionnaire was obtained in validation study against the results of a bronchial challenge test (18). However, a bronchial challenge result might not be considered as an objective tool for a clinical diagnosis of asthma in absence of subjective symptoms (20,21). This conclusion has also been confirmed by two Italian studies performed in the same region as the present study (27,28). These papers reported an asthma prevalence in the schoolchildren of primary and secondary schools in Lazio region of 7%, whereas subjects with a positive methacholine challenge test were two-times more frequent in the same population. Thus, it seems more sensible to validate a questionnaire for measuring asthma prevalence against a clinical history investigating the presence of symptoms and/or against a standardized clinical protocol for diagnosing asthma (22).

No definitive conclusion can be drawn from our data because the sample size was too small and all the asthmatic subjects of our sample could be classified in the mild category of the disease. However, our results indicate that the accuracy of all scenes of the video questionnaire with respect to CA was relatively low, as reflected by the YI values (Table 3). Indeed, a quite high frequency of false negatives characterized the results of the video questionnaire when they were compared with CA and the sensitivity of any video scene was significantly lower than that of any written question (0·50 *vs.* 0·81, respectively; $P=0{\cdot}025$). However, the specificity of any video scene was significantly higher than that of any written question (0·88 *vs.* 0·78, respectively; $P=0{\cdot}039$). Moreover, the overall performance of the video questionnaire was better when CAA was used as gold standard, with an increase in sensitivity which resulted not significantly different from that of any written question (Table 4). When considering the individual items, scene no. 4 of the video questionnaire (Wakening with cough) was characterized by a very low accuracy with respect to both CA and CAA (Tables 3 and 4). It is possible that this scene is not sufficiently clear and it might be erroneously interpreted because cough is usually considered a non-specific symptom by subjects who know the diagnosis of their disease. On the contrary, all other video scenes are characterized by the presence of wheeze which is generally well known by the asthmatic subjects. The written questions no. 1 (Have you ever had wheezing at any time in the past?) and no. 6 (Have you ever had asthma?) had the best accuracy, no matter which gold standard was used. It seems worthwhile to underline the difference in sensitivity between the written question no. 1 (Have you ever had wheezing at any time in the past?) and the video scene no. 1 (Wheeze while at rest) for both CA and CAA diagnosis. We suggest that the video scene no. 1 might be confused with a normal resting situation. The written question no. 8 about cough in the night (In the last 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection?) had a poor accuracy, even worse than the corresponding video scene no. 4 (Wakening with cough). As already noted for the repeatability of items on cough, the currently available epidemiological instruments are probably not able to pick up the peculiar type of cough that has a clinical relevance for the diagnosis of asthma.

As reported above, we used the data collected during the second administration of the questionnaires to evaluate accuracy. However, as shown in Table 1, some learning effect could affect the second set of video and written questions. Indeed, the number of 'yes' answers was significantly higher in the first than the second administration for scenes no. 1, 2, and 4, and questions no. 7 and 8. These results suggest that the estimates of asthma prevalence derived from the ISAAC instruments could be affected by the general setting in which the instruments are used. The results of the first set of video and written questions, if used to develop the accuracy assessment, gave higher estimates for sensitivity and lower estimates for specificity, but this finding did not significantly affect the comparison between the relative performance of video and written questionnaire.

Some limitations of this study must be noted. First, the relatively small sample of subjects studied was not a representative random sample of the general population. However, the prevalence of asthma in this group of subjects (7·5%) was not far from the estimated prevalence of the disease for the same age range in the same Italian region (27,28) and the sample was derived from two schools included in our target population. Second, only asthmatic subjects suffering from mild asthma were studied. A more favourable estimate of accuracy could have been obtained by including more asthmatic subjects in the study group, possibly affected by a more severe disease. However, these results could not be extrapolated to the routine epidemiological application of the questionnaires in our country where the majority of asthmatic adolescents are affected only by mild asthma (29). Moreover, the asthmatics included in our group were equivalent in number to those reported in another validation study (19).

In conclusion, the repeatability of the ISAAC video questionnaire was slightly but not significantly lower than that of the written questionnaire. Its accuracy was as satisfactory as that of the written questionnaire when a clinical diagnosis of asthma based on a standardized protocol was used as gold standard. This study, despite the small number of diseased subjects studied, showed that the ISAAC video questionnaire may be considered an useful tool for measuring the asthma prevalence and, if used alone, provides sufficiently reliable results. Future research based on a larger sample of subjects is essential in order to confirm these results.

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