

Feasibility of the Allergy Questionnaire for Athletes (AQUA[®]) in pediatric age

To the Editor,

A burden of respiratory and allergic symptoms up to almost 60% has been observed in young and adult athletes, influencing physical performances.¹ The Allergy Questionnaire for Athletes (AQUA[®]) is a validated screening tool for the prediction of the atopic status in adult athletes²; it was recently tested in Belgian young elite athletes (12-14 years old),³ but its actual feasibility and suitability for children and adolescents were not evaluated. Indeed, there is evidence that children are prone to employ "satisficing" response strategies, answering every question positively/negatively, or simply not answering.⁴ Therefore, the present cross-sectional survey was carried out to assess feasibility of a linguistically simplified version of AQUA[®] in children and adolescents, stratifying by sport practice and focusing on the core items (12 questions, 5 to 14 and 16 to 17) related to allergy. The study was approved by the Local Institutional Ethics Committee (Palermo 1, Italy, Approval Number: 07/2017) and registered on the central registration system, ClinicalTrials.gov (ID: NCT03286894).

Each subject was classified as child if his or her age was <11 years, as adolescent if his or her age was ≥11 years; indeed, meaningful improvement in questionnaire feasibility was observed since the age of 11 years.⁵ About 650 children and 700 adolescents, aged 7 to 15 years, were invited to participate in the survey. They were recruited from nine randomly selected schools and three sport associations, located in the city and the province of Palermo.

A linguistically simplified version of AQUA[®] was developed by a panel of expert physicians (MB, SDG, GF, SLG) and a psychologist (IB). The final questionnaire was composed of 25 items (see Data S1). Questionnaires were distributed at school by four investigators, to whom both oral and written instructions were given on how to introduce the questionnaire to the participants. In particular, they clarified that the survey results were confidential and provided the definition of competitive sport activity, that is, any regular sport activity played in extracurricular time, in some sport association, society, or federation. Teachers also helped to explain the usefulness of the survey. Although teachers and distributors were present, the participants filled the questionnaire autonomously, and they were invited to skip the questions if they did not understand them. The questionnaire was considered completed if at least the personal information part was filled.

The primary outcome was the percentage of non-response for each of the 12 core items, as a possible proxy of their difficulty or low motivation to answer. Secondary outcomes were the presence/absence of suspect patterns of response, that is, "one or more core items skipped" and "all core items answered negatively." Based on

previous surveys on the prevalence of allergies in adolescents aged 13-14, the expected non-response percentage was about 7%,^{6,7} so that a sample size of 118 participants per group would have ensured 95% confidence intervals with a desired width of 10 percentage points. The actual sample sizes for both children and adolescents were much larger and allowed to account for potentially higher non-response percentages, especially in younger children. Non-response percentages and their 95% confidence intervals (CIs) were calculated for each core item, stratifying by age (proxy of cognitive development) and sport practice (proxy of motivation), and group differences were evaluated through Fisher's exact tests. Predictors of the suspect patterns of response (present/absent) were assessed through multiple logistic regression models.

About 8% of invited children and 4% of invited adolescents refused to participate in the survey (they did not even complete the personal information part). On the contrary, the questionnaire was completed by 593 children and 671 adolescents. Mean completion time was approximately 15 minutes for children and 10 minutes for adolescents. Table 1 reports some descriptive statistics. About 45% of the participants were males. The percentage of respondents who declared to practice competitive sports was higher in adolescents than in children (77.0% vs 70.7%, $P = 0.013$), while the other respondents were sedentary or amateur sport players.

Table 2 shows the frequency distribution of the missing answers for the 12 core items by age-group and sport practice. Overall, the non-response percentage was smaller than 10%, with somewhat higher non-response percentages associated with item 6 ("Do you think to be allergic or have you ever seen a doctor for allergy?"). For several items, age and sport practice were significantly associated with the non-response percentages. In particular, children were more likely to skip items 5, 6, 9, 11, and 14 than adolescents. Moreover, athletes were less likely to skip core items than others, both in the subgroup of children (items 6, 7, 14, and 16) and in adolescents (items 5 and 14).

Figure 1 depicts the results of the multiple logistic regression models for the suspect patterns of response. Tendency to skip one or more core items (19.61% of the whole sample) was significantly higher in children than in adolescents (OR = 1.49, [1.07-2.08]), while it was lower in females than in males (OR = 0.66, [0.48-0.92]) and in athletes than in others (OR = 0.65, [0.46-0.93]) (Figure 1A). Similarly, tendency to answer all core items negatively (13.23% of the whole sample) was significantly higher in children than in adolescents (OR = 1.94, [1.46-2.60]), while it was lower in females than in males (OR = 0.73, [0.55-0.97]) and in athletes than in others (OR = 0.42, [0.31-0.57]) (Figure 1B).

TABLE 1 Participant characteristics and sport habits by age-group

	Overall n = 1264 (100%)	Children n = 593 (47%)	Adolescents n = 671 (53%)	P-value [*]
Gender				
Males	576 (45.6%)	261 (44.0%)	315 (46.9%)	0.322
Females	688 (54.4%)	332 (56.0%)	356 (53.1%)	
Sport practice				
Athletes	933 (74%)	417 (70.7%)	516 (77.0%)	0.013
Others	327 (26%)	173 (29.3%)	154 (23.0%)	
Missing	4 (0.3%)	3 (0.5%)	1 (0.2%)	
^a Sport duration				
<5 years	481 (54.3%)	285 (73.5%)	196 (39.4%)	<0.001
≥5 years	405 (45.7%)	103 (26.5%)	302 (60.6%)	
Missing	47 (5.0%)	29 (7.0%)	18 (3.5%)	
^a Training frequency				
Up to 3 times per week	663 (73.0%)	320 (79.2%)	343 (68.1%)	<0.001
More than 3 times per week	245 (27.0%)	84 (20.8%)	161 (31.9%)	
Missing	25 (2.7%)	13 (3.1%)	12 (2.3%)	
^a Training session duration				
1-2 hours	606 (66.3%)	306 (75.1%)	300 (59.2%)	<0.001
2-3 hours	261 (28.6%)	80 (19.7%)	181 (35.7%)	
More than 3 hours	47 (5.1%)	21 (5.2%)	26 (5.1%)	
Missing	19 (2.0%)	10 (2.4%)	9 (1.7%)	
^a Sport setting				
Indoor	313 (36.3%)	125 (34.7%)	188 (37.4%)	0.454
Outdoor	549 (63.7%)	235 (65.3%)	314 (62.6%)	
Missing	71 (7.6%)	57 (13.7%)	14 (2.7%)	

^aSubsample of athletes. Observed answers are reported as n (% of participants answering in the subsample). Missing answers are reported as n (% of all participants in the subsample).

^{*}Chi-square test. Significant P-values are in bold.

The reported percentages of missing answers, mostly lower than 10%, are comparable with the reports from previous survey on the prevalence of self-reported allergy symptoms in adolescents⁶ and in surveys on more general topics (reading attitude, perceived competence, environmental behavior, and others) including self-reports in children from 8 years of age.⁷ In general, an amount of missing data lower than 10% can be considered as acceptable.⁸ Only a small number of children (about 8%) and adolescents (about 4%) refused to participate in the survey; in fact, children and adolescents may have perceived the survey as a routine school activity, and felt encouraged to fill the questionnaire.

The frequency of missing answers for specific items was significantly higher in younger children, possibly due to lower cognitive ability or difficulties to stay focused. Concerning the lower percentages of non-response observed in athletes, it should be noted that AQUA[®] was initially thought for athletes (even if adults), so that sedentary or amateur sport players may have been less motivated to ask questions that were

not strictly related to their own activities and contexts.⁹ In particular, this would explain the higher percentage of sedentary or amateur sport players skipping item 14 related to exercise ("Have you ever had shortness of breath, cough or itching of the throat during exercise?"). Similarly, multiple logistic regression models highlighted a higher tendency to skip one or more core items or to answer all core items negatively in younger children and in sedentary or amateur sport players, probably due to the same mechanisms described for the missing responses to specific items. In addition, lower frequencies of suspect patterns of response were found in females, which is in line with earlier studies.¹⁰

To conclude, the present study demonstrates a high feasibility of a self-administered, linguistically simplified version of AQUA[®] in children and adolescents, and especially in athletes. However, the main limitation is the lack of assessment of the predictive ability of AQUA[®] with respect to the allergic sensitization of children and adolescents. A further validation process is therefore needed before using AQUA[®] in real life.

TABLE 2 Frequency distribution of missing answers (12 core items) by age-group and sport practice

Whole sample	Children (n = 593)		Adolescents (n = 671)		P-value*
	n (%)	95% CI	n (%)	95% CI	
Item 5	20 (3.4%)	[2.4%, 4.4%]	6 (0.9%)	[0.4%, 1.4%]	0.002
Item 6	42 (7.1%)	[5.7%, 8.5%]	27 (4.0%)	[2.9%, 5.1%]	0.018
Item 7	21 (3.5%)	[2.5%, 4.6%]	17 (2.5%)	[1.7%, 3.4%]	0.325
Item 8	11 (1.8%)	[1.1%, 2.6%]	4 (0.6%)	[0.2%, 1.0%]	0.065
Item 9	25 (4.2%)	[3.1%, 5.3%]	11 (1.6%)	[0.9%, 2.3%]	0.007
Item 10	11 (1.9%)	[1.1%, 2.6%]	7 (1.0%)	[0.5%, 1.6%]	0.243
Item 11	9 (1.5%)	[0.9%, 2.2%]	2 (0.3%)	[0.0%, 0.6%]	0.030
Item 12	10 (1.7%)	[1.0%, 2.4%]	10 (1.5%)	[0.8%, 2.2%]	0.824
Item 13	18 (3.0%)	[2.1%, 4.0%]	11 (1.6%)	[0.9%, 2.3%]	0.131
Item 14	27 (4.6%)	[3.4%, 5.7%]	9 (1.3%)	[0.7%, 2.0%]	0.001
Item 16	12 (2.0%)	[1.3%, 2.8%]	7 (1.0%)	[0.5%, 1.6%]	0.170
Item 17	13 (2.2%)	[1.4%, 3.0%]	12 (1.8%)	[1.1%, 2.5%]	0.687
	Athletes (n = 417)		Others (n = 173)		P-value*
Children	n (%)	95% CI	n (%)	95% CI	
Item 5	11 (2.6%)	[1.8%, 3.5%]	9 (5.2%)	[4.0%, 6.4%]	0.135
Item 6	21 (5.0%)	[3.8%, 6.2%]	21 (12.1%)	[10.3%, 13.9%]	0.004
Item 7	10 (2.4%)	[1.6%, 3.2%]	11 (6.4%)	[5.0%, 7.7%]	0.026
Item 8	6 (1.4%)	[0.8%, 2.1%]	5 (2.9%)	[2.0%, 3.8%]	0.314
Item 9	15 (3.6%)	[2.6%, 4.6%]	10 (5.8%)	[4.5%, 7.1%]	0.262
Item 10	6 (1.4%)	[0.8%, 2.1%]	5 (2.9%)	[2.0%, 3.8%]	0.314
Item 11	5 (1.2%)	[0.6%, 1.8%]	4 (2.3%)	[1.5%, 3.1%]	0.460
Item 12	5 (1.2%)	[0.6%, 1.8%]	5 (2.9%)	[2.0%, 3.8%]	0.167
Item 13	10 (2.4%)	[1.6%, 3.2%]	8 (4.6%)	[3.5%, 5.8%]	0.187
Item 14	5 (1.2%)	[0.6%, 1.8%]	21 (12.1%)	[10.3%, 13.9%]	<0.001
Item 16	5 (1.2%)	[0.6%, 1.8%]	7 (4.1%)	[3.0%, 5.1%]	0.048
Item 17	7 (1.7%)	[1.0%, 2.4%]	6 (3.5%)	[2.5%, 4.5%]	0.217
	Athletes (n = 516)		Others (n = 154)		P-value*
Adolescents	n (%)	95% CI	n (%)	95% CI	
Item 5	2 (0.4%)	[0.1%, 0.7%]	4 (2.6%)	[1.7%, 3.5%]	0.027
Item 6	20 (3.9%)	[2.8%, 4.9%]	7 (4.6%)	[3.4%, 5.7%]	0.648
Item 7	11 (2.1%)	[1.3%, 2.9%]	6 (3.9%)	[2.8%, 5.0%]	0.243
Item 8	3 (0.6%)	[0.2%, 1.0%]	1 (0.7%)	[0.2%, 1.1%]	1.000
Item 9	6 (1.2%)	[0.6%, 1.8%]	5 (3.3%)	[2.3%, 4.2%]	0.138
Item 10	4 (0.8%)	[0.3%, 1.3%]	3 (2.0%)	[1.2%, 2.7%]	0.202
Item 11	0 (0.0%)	[0.0%, 0.0%]	2 (1.3%)	[0.7%, 1.9%]	0.053
Item 12	7 (1.4%)	[0.7%, 2.0%]	3 (2.0%)	[1.2%, 2.7%]	0.704
Item 13	9 (1.7%)	[1.0%, 2.5%]	2 (1.3%)	[0.7%, 1.9%]	1.000
Item 14	4 (0.8%)	[0.3%, 1.3%]	5 (3.3%)	[2.3%, 4.2%]	0.034
Item 16	5 (1.0%)	[0.4%, 1.5%]	2 (1.3%)	[0.7%, 1.9%]	0.664
Item 17	8 (1.6%)	[0.9%, 2.2%]	4 (2.6%)	[1.7%, 3.5%]	0.486

Data are reported as number of missing answers (% of the subsample).

*Fisher's exact test. Significant P-values are in bold.

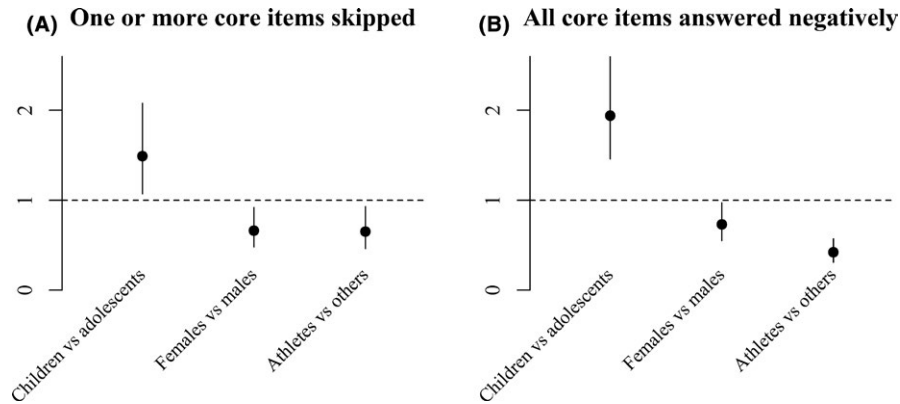


FIGURE 1 Multiple logistic regression models for the two suspect patterns of response: odds ratios and 95% confidence intervals

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.