

Agreement between Questionnaire Report of Allergy-related Outcomes in School-age Children and Objective Measures of Atopy: The Saskatchewan Rural Health Study

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Abstract:

Background and Objectives: In population-based studies, questionnaires remain the most efficient tool to assess the presence of allergy and atopic conditions, but the quality of the information obtained needs to be validated. We sought to evaluate the agreement and predictive values of a questionnaire to assess atopy in rural children, an understudied population with regard to atopy and allergic disease.

Methods: A total of 480 schoolchildren (Grades 1-8) from rural Saskatchewan completed a questionnaire report of allergy and atopic outcomes and participated in skin prick testing (SPT). SPT for 6 common allergens (local grasses, wheat dust, cat dander, house dust mite mixed, *Alternaria* and *Cladosporium*) was completed. Subjects with at least one positive SPT (≥ 3 mm) compared to the negative control were considered to be atopic. We considered percent concordance, Kappa, sensitivity,

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specificity, and the positive and negative predictive values (NPV, PPV) of reported allergies or allergic conditions in comparison to SPT as the gold standard.

Results: We found that 25.0% of children reported a history of any allergy and 19.4% were atopic based on SPT. The agreement between questionnaire report of allergic triggers and atopy measured by SPT was high (83.0%-89.5%). The agreement between atopy and report of allergic conditions ranged from 67.1% to 79.6%. Individual allergic conditions demonstrated high specificity but low sensitivity. The questionnaire report of any allergy had a low PPV in detecting atopy (47.3%) and high NPV (86.3%). The PPV of reported allergic conditions was low (24.8%- 43.9%), but the NPV was again high (82.0% - 82.9%).

Conclusions: We found that the standardized questionnaire report of allergy and atopic conditions was shown not to efficiently and reliably predict atopy. However, given the good specificity and the NPV, the questionnaire may be an efficient tool for epidemiological studies that involve the differential inclusion of subjects without atopy.

BACKGROUND

Atopy is defined as “the personal or familial tendency to produce IgE antibodies in response to low allergen doses, and to develop typical conditions such as asthma, rhinitis or eczema” (1). The prevalence of atopy varies internationally among children between 13% (2) and 49% (3), depending on the definition of atopy among different populations. The prevalence of atopy has been increased in recent years (4-6). In Canada, few studies were conducted to determine the prevalence of atopy. A cross-sectional study among 1,199 rural secondary school students aged 12 to 19 years in rural areas

surrounding Quebec City conducted by Ernst et al (7) found that the prevalence of atopy – defined as a positive reaction to any one of 24 common inhaled allergens was high and different between farm and non- farm populations (40.8% vs. 53.4%, respectively). Recently, Chu et al (8) found that the prevalence of atopy – defined as at least one reaction (skin test over 3 mm to any allergen) among 6 allergen used- in rural children in Saskatchewan was 19.4%.

Questionnaires are an efficient tool for assessing outcomes of interest in epidemiological studies. These are usually conducted using large population-based studies (9-11). A quick, simple and accurate questionnaire can be preferred to a more costly and involved objective measure of the same variable. In some circumstances, questionnaire report of allergy has been used instead of objective measures such as skin prick testing (SPT). In these situations, researchers must ensure that the questionnaire report of allergy accurately reflects the objective measure.

In the case of atopic diseases and allergy, in large-scale epidemiologic studies, researchers have commonly relied on reported allergic conditions or triggers reported by questionnaire (12-16) in order to assess the presence of these conditions. In order to clinically facilitate the diagnosis of allergic status or atopic conditions, objective measures such as skin-prick test positivity, elevated total IgE, and specific IgE are often used. The accuracy and agreement of questionnaire report compared to the results from objective measures are, therefore, of interest (9, 10, 17, 18) to maximize validity and practicality. Accordingly, there have been a number of studies assessing the relationship between clinical measures of atopy (e.g., skin-prick test positivity, specific IgE, total IgE) and questionnaire report to evaluate the discrepancy or concordance of information shown on questionnaire and clinical diagnosis (9, 10, 19-21). However, there have been few population-based studies (9, 15, 22) examining the sensitivity and

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specificity of questionnaire report of allergy and allergic conditions, and SPT of atopy, especially studies validating the questionnaire in relation to SPT from the International Study of Asthma and Allergies in childhood (ISAAC) study (10, 15, 23) prior to collecting data.

In Canada, to our knowledge, few studies have been carried out to examine the agreement between questionnaire report of allergy and results from SPT in population. There was one hospital-based study in children aged 1-17 years referred to the B.C's Children's Hospital in Vancouver due to their previous allergic symptoms (24). Recently, in Saskatchewan, Canada, a group of researchers conducted the Saskatchewan Rural Health Study (SRHS). It is a large, population-based study that retrieved detailed information on allergy and atopic outcomes as well as clinical measures of atopy (skin prick testing) both in adults and children (25). The objectives of the present analysis were: first, to examine the agreement between atopy measured by SPT and allergy (overall and specific to several allergens) measured by the questionnaire report; second, to examine the agreement between atopy measured by SPT and allergy related conditions (hay fever, current rhinitis, ever eczema, current eczema) measured by the questionnaire; and third, to evaluate the predictive values of the questionnaire to assess atopic outcomes.

METHODS

Study design and population

We compared the agreement between questionnaire report of allergy and allergic conditions to atopy measured from SPT in children. We used data from the baseline cross-sectional study of children from the Saskatchewan Rural Health Study (SRHS) (25). The SRHS is a longitudinal study (2010-2015)

examining the health outcomes of rural adults and children in the Canadian province of Saskatchewan with a focus on lung disease and related conditions. The methods of this study were described elsewhere (25). In brief, all Grade 1-12 children in selected 4 quadrants in rural Saskatchewan were sent a study package containing a questionnaire for their parent to complete. Of the 5667 children who were approached, 2383 children took part (response rate = 42%). Among those who took part, a subset of students in grades 1-8 attending 16 selected schools were invited to participate in the clinical assessments. The schools where clinical assessments were conducted were selected based on school participation numbers in the survey in order to maximize efficiencies and reduce costs. Also, we did not use the data of those who identified themselves as non-Caucasian in order to reduce potential confounding as there are differences in atopic outcomes prevalence by ethnic background (26, 27). A total of 1768 students from 16 schools were approached for clinical testing. Two groups resulted: a "Questionnaire Group Only" and a "Questionnaire and SPT group". Of the 1768 students approached, 584 of these schoolchildren agreed to participate in the clinical study. There were 30 non-Caucasian children from the "Questionnaire Group Only" and 104 non-Caucasian children from the "Questionnaire and SPT group" excluded. This resulted in 480 children with both adequate information on the questionnaire and SPT who were of Caucasian background. Information from these children was used in the current analysis. Those who completed only the questionnaire report, not participating in SPT and following the inclusion and exclusion criteria from above (i.e. not Caucasian) were defined as a "Questionnaire Group Only" (N=1154).

Ethical approval was obtained from the University of Saskatchewan Biomedical Research Ethics Board prior to data collection. Written consents from parents and written assents from children were completed prior to data collection of the clinical studies. Schools and school divisions approved the study.

Skin prick testing (SPT) and atopy definition

We used a panel of allergens that were most common in Saskatchewan including *Alternaria* (mold), *Cladosporium* (mold), cat dander, local grasses, wheat dust and mixed house dust mite (ALK-Abello Pharmaceuticals, Inc., Ontario, Canada). Histamine (10mg/ml) and saline solution (0.9%) were used as positive and negative controls, respectively. Skin prick testing for atopy was conducted according to international standards for testing (28, 29). The allergy skin prick testing was not completed if the child had a severe systemic reaction to an allergen previously or if the child had taken any cold preparations or antihistamine on the day of testing. Atopy was defined as a ≥ 3 mm wheal formed for any of the allergens compared to the negative control on SPT as recommended by the Global Allergy and Asthma European Network (GA²LEN) (28) and European standards (29).

Questionnaire report of allergy

Parents completed a self-administered health questionnaire about their socio-demographics, the respiratory and general health of the child, allergic disease, lifestyle, home environment, and early life exposures. The parent-completed cross-sectional questionnaire was based on questions from standardized questionnaires including: the American Thoracic Society's 1979 Children's Respiratory

Disease Questionnaire (30); the International Study of Asthma and Allergies in Childhood Study (ISAAC) questionnaire (31); and questionnaires used in recent studies in Saskatchewan (32-34).

History of allergy was defined by the question “Has the child ever had an allergy (hives, runny nose, swelling, itchiness and/or wheezing) to any of the following: house dust, grain dust/pollen, trees, grasses, mold or mildew, dog, cat, birds or feathers, farm animals, chemicals, foods). A positive answer to cat, grasses, wheat dust, house dust mite, and mold was included in the definition of **any allergy** due to the link to specific SPT allergens included in our study. Each of these specific allergens was also examined separately. The term “wheat dust” was from the questionnaire and the term “grain dust” was from the SPT allergens. For consistency, we used the term “wheat dust” throughout the manuscript.

Allergic triggers were defined as one of the allergens including cat, grasses, wheat dust, house dust mite, and mold. Each of these specific allergens was also examined separately. **Allergy-related conditions** included the conditions as defined below (hay fever, ever eczema, current rhinitis, and ever eczema symptoms). The specific definitions are as follows. The status of **hay fever** was defined according to the question: “Has this child ever had hay fever?” and the status of **ever eczema** was defined according to the question: “Has this child ever had eczema?” **Current rhinitis** was defined as a positive response to the question “In the past 12 months, has your child ever had a problem with sneezing, or a runny, or a blocked nose when he/she did not have a cold or the flu?” **Ever eczema symptoms** were defined as a positive response to the question “Has your child ever had an itchy rash which was coming and going for at least 6 months?”

Statistical analysis

Agreement between questionnaire report of allergy and objective measures of atopy were considered overall and between the specific allergens tested on SPT and those assessed on questionnaire (house dust mite, cat, grasses, mold, and wheat dust). The percent concordance (absolute agreement) and Kappa statistic were used to quantify the agreement between atopy assessed by SPT and allergic disease based on questionnaire reports. Cohen's Kappa coefficient is used in many studies to measure levels of agreement. The values of agreement are often interpreted as: >0.80 (very good agreement), 0.61-0.80 (good), 0.41-0.60 (moderate), 0.21-0.40 (fair), and <0.2 (poor) (35). We calculated the sensitivity, specificity, and positive and negative predictive values of each questionnaire variable and variable for atopy based on SPT. We assumed that SPT was the gold standard. SPSS® (the Statistical Package for the Social Sciences) version 21 statistical package was used for data analysis.

RESULTS

Table 1 shows the characteristics of Grades 1-8 children in the "Questionnaire and SPT group" (Validation group) in comparison with those in the "Questionnaire Group Only". These two groups were similar in the current residence, maternal and paternal educational attainment, maternal and paternal smoking status, and family history of allergies or asthma. However, children in the "Validation Study Group" were more likely to be male compared to those the "Questionnaire Group Only" (54.4% vs. 48.4%, $p=0.03$, respectively). Moreover, those in "Validation Study Group" were younger than those in the "Questionnaire Group Only" [9.60 years (± 2.17) vs 10.27 years (± 2.50); ($p<0.001$)]. **Table 1** also shows that they were similar in the prevalence of allergy and atopic conditions reported from the questionnaire between the two groups.

Prevalence of atopy and allergy related conditions

The prevalence for each outcome is given in **Figure 1**. The overall prevalence of atopy was 19.4% (95%CI: 18.3%-20.5%). Among atopic children (n=93), 56.9% were sensitized to one allergen, 22.6% were sensitized to 2 allergens, 14.0% were sensitized to 3 allergens, and 6.5% were sensitized to 4 allergens. Among children having at least one allergy-related condition (hay fever ever, current rhinitis, eczema ever, and ever eczema symptoms) (n=218), 54.1% had only one condition, 29.3% had 2 conditions, 13.3% had 3 conditions, and 3.3%.

When we divided our population into age groups (younger and older age groups), we found that the prevalence of any allergen from questionnaire of the younger age group (6-9 years old) and the older age group (10-14 years old) were 20.6% (50/243) and 29.5 % (70/237). In the younger age group, the sensitivity, specificity of the questionnaire variables of “any allergen from questionnaire” for atopy were 47.1% and 84.4%, respectively; the PPV and the NPV of “any allergy from questionnaire” were 36.0% and 89.6%, respectively. In the older age group, the sensitivity, specificity of the questionnaire variables of “any allergen from questionnaire” for atopy were 47.2% and 75.8%, respectively; the PPV of “any allergy from questionnaire” was 37.1%, and the NPV was 82.6%.”

Levels of agreement and diagnostic characteristics between results from SPT and questionnaire report of allergy

The percentage of agreement between results from skin prick testing and results from the questionnaire is shown in **Table 2**. The agreement of reported any atopy/allergy and the results from SPT was fair based on Kappa (Kappa=0.25, $p<0.001$) and the percentage of agreement was 74.0%. The

agreement between report of specific triggers and overall results based on SPT ranged from 77.1% to 80.2%. For instance, the agreement of reported allergy to grain dust and any SPT positivity was 77.3% with a Kappa=0.14 ($p<0.001$). When comparing between report of specific triggers and specific results from SPT, the agreement ranged from 83.0% to 89.5%. For example, according to **Table 2**, the agreement of reported allergy to cat and the result from SPT (cat dander) was fair based on Kappa (Kappa=0.34, $p<0.001$) and the percentage of agreement was 89.5%.

Levels of agreement and diagnostic characteristics between results from SPT and questionnaire report of allergic conditions

Table 3 shows the agreement between atopy and reported allergic conditions. There was agreement beyond chance between reported hay fever ever and atopy based on Kappa (Kappa=0.17, $p<0.001$) as well as current rhinitis symptoms (Kappa=0.09; $p=0.049$). The percentage of agreement ranged from 67.1% to 79.6%. **Table 4** summarizes the sensitivity, specificity and predictive values of the questionnaire variables for atopic outcomes. The sensitivity of the questionnaire variables of allergic conditions for atopy was generally low (19.3%-34.4%) (not including “any allergy from questionnaire”), while the specificity was higher (74.9%-94.0%). In general, the positive predictive value of allergic conditions (not including “any allergy from questionnaire”) was low (24.8% - 43.9%), but the negative predictive value was high (82.0% - 82.9%).

DISCUSSION

We found that 25.0% of children reported a history of allergic conditions by questionnaire and 19.4% were atopic detected by skin pick test. In our study, the agreement between questionnaire report of specific allergic triggers and atopy measured by SPT was higher (83.0% - 89.5%) for specific allergen

associations only. This result showed that the information from the questionnaire report was reliable to predict the actual manifestations shown by SPT.

The question of hay fever was very specific but not sensitive given the low percentage of sensitivity and high percentage of specificity. This finding was in agreement with one study among 2,120 Swiss school children visiting the school health service in the ISAAC study (10). Furthermore, the positive predictive value (PPV) of the questionnaire of hay fever in the earlier study was 70% (10) which was higher than in our study (43.9%). A consideration is that prevalence affects predictive values with increasing disease prevalence, the PPV increases, and with decreasing prevalence, the negative predictive value (NPV) increases (36). This lower PPV in our study might be due to the higher number of those who reported no hay fever on the questionnaire, but in fact SPT were positive [15.6% (=75/480)]. Furthermore, it is a possibility that using SPT as criteria of hay fever or allergic rhinitis may underestimate the sensitivity of the questions, because not all those sensitized have symptoms (37). The high NPV found for all allergic conditions in this study suggests that the questionnaire could be used as a diagnostic tool for primary screening that can rule out subjects with asymptomatic allergy. The low prevalence of hay fever (8.5%), will influence the NPV by increasing it.

We also found that the current rhinitis yielded a positive predictive value of 25.6%, which was lower than that of the ISAAC study in a population of Swiss school children (aged 5-15 years) (52.0%) (10). The prevalence of these symptoms in our study (25.1%) was quite similar to that of these Swiss school children (23.7%). The reason for our low PPV would be the high percentage of false positives at 13.1% (=63/480 in table 3). Moreover, the results of our study are aligned with another study conducted in British Columbia (B.C), Canada (24). In this study, children aged 1-17 years currently having allergic

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symptoms were referred to the B.C's Children's Hospital in Vancouver. Of these, 48% were found to have allergies based on SPT to inhalant allergens. The parents were then asked about their children's symptoms using a standardized questionnaire containing detailed questions about allergic status by trained interviewers. The results showed that the standardized questionnaires accurately predicted the history of allergies among these children. In general, the specificity was above 80% and sensitivity ranged from 11% to 56% (24).

It is challenging to compare results of our study to findings obtained from other studies in which different methods of measuring and defining the presence of atopy were used (serum and specific IgE) and the age of participants varied. One study among 2067 adults aged 20-60 years examining the predictive value of the questionnaire relative to atopy, defined by the presence of serum specific IgE found that the PPV of the questionnaire on hay fever was 41.8%, which was quite similar to our findings (43.9%) (38). The authors suggested that this low PPV may be due to the overall low prevalence of hay fever in this population (18.5%) (38). This result was similar to our findings where the overall low prevalence of hay fever was 8.7% which could lead to our low PPV. We therefore extend our findings from adults in the previous study to children in our study. Moreover, we observed that the hay fever ever prevalence was low (8.5%) compared to current rhinitis (25.1%). It is possible that parents tended to remember and recall the symptoms in the past 12 months (sneezing, or a runny, or a blocked nose when did not have a cold or the flu) rather than the label of "hay fever" if such a label was even applied.

There are limitations that should be considered. The main weakness was the modest participation rate (42%). However, we found that there were few differences between the "Validation Study Group" and the "Questionnaire Group Only" and no statistically significant differences in the

prevalence of reported allergy between those two mentioned groups. Therefore, the results of the analyses examining clinical measures may be generalized to the more accessible study population although some care should be taken when generalizing to the larger Canadian or rural population as a whole. Recall bias should be considered. It is possible that over time, when the children were no longer bothered by allergic conditions, their parents tended to forget a previous diagnosis that can lead to lack of predictive value of the questions. Moreover, we observed the discrepancy between SPT and questionnaire data of symptoms of allergic disease. However, research has been explained explicitly in many studies in the sense that a high proportion of children and adolescents with typical symptoms for these diseases are not sensitized.

There were strengths that should also be taken into account. In our study, we assumed that SPT was a gold standard. It is an objective measure with established methodology (29). Moreover, prior to the allergy skin testing, we excluded children if they had taken any cold preparations or antihistamine on the day of testing as this could prevent a reaction from occurring and biasing the study results. Almost all participants experienced a histamine response in the SPT (97.8%) confirming that if a participant was susceptible to a reaction, it would occur. Also, the questionnaire was completed prior to atopy assessment, thereby limiting reporting bias that may occur with knowledge of the child's atopic status from the SPT.

In summary, questionnaires remain important, efficient, and sometimes the only way to collect medical information in a large study sample. Increasing the precision of questionnaires will improve their utility; however, not all aspects of the allergy-atopy spectrum are well described using questionnaires. In our study, the standardized questionnaire report of allergy and atopic conditions was

shown not to efficiently and reliably predict atopy as a screening tool based on the low positive predictive value. However, given the good specificity and the negative predictive value, the questionnaire may be an efficient tool for risk-factor epidemiological studies that involve the differential inclusion of subjects without atopy. Although use of a questionnaire inevitably leads to some misclassification, it is a more rapid and cost-effective method than SPT or the use of other objective means of measuring allergic status in population-based studies. Researchers need to be aware of the limitations of all potential atopy measures, given the lack of concordance in many large population-based studies in order to verify the accuracy of the data.

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Table 1: Characteristics of children who completed the skin-prick testing (SPT) and Questionnaire Report

	Questionnaire and SPT group*	Questionnaire Group Only†	p-value
	N= 480 (%)	N=1154 (%)	
Sex			
Male	261 (54.4)	559 (48.4)	0.03
Female	219 (45.6)	595 (51.6)	
Mean age in years (SD)	9.60 (2.17)	10.27 (2.50)	<0.001
Home location on farm			
Farming	222 (46.5)	511 (44.7)	0.49
Non-farming	255 (53.5)	633 (55.3)	
Maternal education			
High school or less	173 (36.3)	415 (36.4)	0.97
Any postsecondary education	303 (63.7)	724 (63.6)	
Paternal education			
High school or less	246 (52.1)	599 (52.8)	0.79
Any postsecondary education	226 (47.9)	535 (47.2)	
Mother smoking			
Never smoke	291 (61.0)	651 (57.0)	0.13
Ever smoke	93 (19.5)	275 (24.1)	
Currently smokes	93 (19.5)	217 (19.0)	
Father smoking			

Never smoke	262 (55.2)	625 (54.9)	0.34
Ever smoke	87 (18.3)	240 (21.1)	
Currently smokes	126 (26.5)	273 (24.0)	
Family history of allergies/asthma			
Yes	265 (57.1)	626 (56.5)	0.83
No	199 (42.9)	481 (43.5)	
Hay fever (ever)			
Yes	41 (8.5)	103 (8.9)	0.80
No	439 (91.5)	1051 (91.1)	
Eczema (ever)			
Yes	129 (26.9)	324 (28.1)	0.62
No	351 (73.1)	830 (71.9)	
Current rhinitis			
Yes	117 (24.4)	269 (23.3)	0.64
No	363 (75.6)	885 (76.7)	
Ever eczema symptoms			
Yes	74 (15.4)	161 (14.0)	0.44
No	406 (84.6)	993 (86.0)	
Any allergy (questionnaire report)			
Allergic to any allergy			
Yes	120 (25.0)	296 (25.6)	0.78
No	360 (75.0)	858 (74.4)	
Allergic to grasses			
Yes	58 (12.1)	121 (10.5)	0.34

No	422 (87.9)	1033 (89.5)	
Allergic to mold/mildew			
Yes	57 (11.9)	126 (10.9)	0.57
No	423 (88.1)	1028 (89.1)	
Allergic to cat			
Yes	42 (8.8)	116 (10.1)	0.41
No	438 (91.3)	1038 (89.9)	
Allergic to house dust			
Yes	40 (8.3)	90 (7.8)	0.71
No	440 (91.7)	1064 (92.2)	
Allergic to grain dust			
Yes	56 (11.7)	142 (12.3)	0.71
No	424 (88.3)	1012 (87.7)	

* Grades 1-8 with SPT

† Grades 1-8 without SPT

Table 2: Measures of agreement between results from skin prick test and results from questionnaire
(any allergy/atopy and specific allergens)

Results based on SPT							
N=480							
		Positive (+) N=93 (%)	Negative (-) N=387 (%)	Kappa	% Agreement	% False negative	% False positive
Compared to any SPT positivity							
Any allergy	+	44 (47.3)	76 (19.6)	0.25*	74.0	15.8	10.2
	-	49 (52.7)	311 (80.4)				
House dust	+	13 (14.0)	27 (7.0)	0.09†	77.7	5.6	16.6
	-	80 (86.0)	360 (93.0)				
Grasses	+	26 (28.0)	32 (8.3)	0.23	79.4	6.6	13.9
	-	67 (72.0)	355 (91.7)				
Mold	+	20 (21.5)	37 (9.6)	0.14*	77.1	7.7	15.2
	-	73 (78.5)	350 (90.4)				
Cat	+	20 (21.5)	22 (5.7)	0.20	80.2	4.5	15.2
	-	73 (78.5)	365 (94.3)				
Grain dust	+	20 (21.5)	36 (9.3)	0.14*	77.3	7.5	15.2
	-	73 (78.5)	351 (90.7)				

Compared to specific allergen from SPT

House dust	+	3 (12.0)	37 (8.1)	0.03	87.7	7.7	4.5
	-	22 (88.0)	418 (91.9)				
Grasses	+	8 (20.0)	50 (11.4)	0.07	83.0	10.4	6.6
	-	32 (80.0)	390 (88.6)				
Mold	+	11 (36.7)	46 (10.2)	0.18*	86.5	9.5	3.9
	-	19 (83.3)	404 (89.8)				
Cat	+	17 (40.5)	25 (5.7)	0.34*	89.5	5.2	5.2
	-	25 (59.5)	413 (94.3)				
Grain dust	+	5 (25.0)	51 (11.1)	0.07	86.2	10.6	3.1
	-	15 (75.0)	409 (88.9)				

*p<0.001

†p<0.05

Table 3: Measures of agreement between SPT and questionnaire report of atopic diseases (N=480)

		Results based on SPT					
		N=480		Kappa	% Agreement	% False negative	% False positive
		Positive	Negative				
		(+)	(-)				
		N=93 (%)	N=387 (%)				
Hay fever ever	+	18 (19.4)	23 (5.9)	0.17*	79.6	4.8	15.6
	-	75 (80.6)	364 (94.1)				
Current rhinitis	+	30 (32.3)	87 (22.5)	0.09†	68.8	18.1	13.1
	-	63 (67.7)	300 (77.5)				
Eczema ever	+	32 (34.4)	97 (25.1)	0.08	67.1	20.2	12.7
	-	61 (65.6)	290 (74.9)				
Ever eczema symptoms	+	20 (21.5)	54 (14.0)	0.08	73.6	11.3	15.2
	-	73 (78.5)	333 (86.0)				

*p<0.001

†p<0.05

Table 4: Prevalence, Sensitivity, Specificity and Predictive values of questionnaire variables for atopic outcomes (N=480)

Questionnaire variables	% Prevalence (95%CI)	Sensitivity, %	Specificity, %	Predictive value, %	
				Positive	Negative
Any allergy from questionnaire	25.0 (21.0-28.0)	47.3	80.3	36.6	86.3
Hay fever ever	8.5 (6.1-10.8)	19.3	94.0	43.9	82.9
Eczema ever	26.9 (25.6-28.1)	34.4	74.9	24.8	82.6
Current rhinitis	25.1 (23.8-26.3)	32.2	77.5	25.6	82.6
Ever eczema symptoms	15.4 (12.2-18.5)	21.5	86.0	27.0	82.0

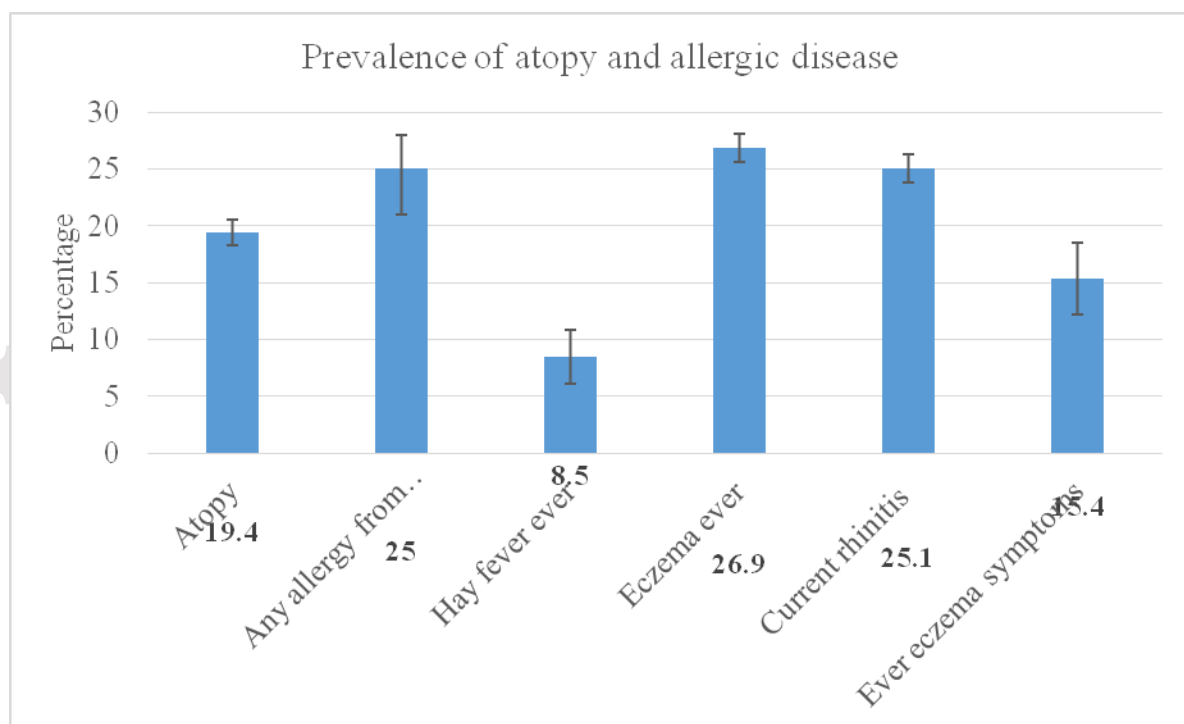


Figure 1: Prevalence of atopy and allergic disease