

Atopic diseases and related risk factors among Dutch adolescents

Monique O.M. Van De Ven¹, Regina J.J.M. Van Den Eijnden^{1,2},
Rutger C.M.E. Engels¹

Background: The aim of the present study was to gain insight into the prevalence of asthma, allergic rhinitis, and eczema among Dutch early adolescents, and to study the impact of several social demographic and individual risk factors. **Methods:** Cross-sectional survey study using the self-report questionnaires of the International Study of Asthma and Allergies in Childhood (ISAAC). In January 2003, 10 087 12- to 14-year-old students from 33 secondary schools in four regions of the Netherlands participated in this study. **Results:** Of all participants, 52.6% reported that they had an allergic disease at least once in their lifetime. The 12 months prevalence of wheezing, rhinitis, and itchy rash was 12.3%, 28.3%, and 13.5%, respectively. Several social demographic and individual factors (gender, age, education levels, ethnicity, body mass index, and residential area) were significantly associated with the atopic symptoms and diseases. **Conclusion:** This study showed that allergic conditions are common in the Netherlands. Several social demographic and individual risk factors were related to the atopic diseases and symptoms.

Keywords: adolescent, asthma, eczema, rhinitis

Worldwide, asthma and allergies are common among children and adolescents,^{1–4} and the prevalence of these atopic diseases appears to increase.^{5–8} Despite considerable research on the aetiology of atopic diseases, it is not well understood why the prevalence rates are rising. A comparison of prevalence figures in different regions and countries may help to gain insight into the factors contributing to this rising trend.

The International Study of Asthma and Allergies in Childhood (ISAAC) was developed to provide a standardized methodology and a standardized questionnaire to compare the prevalence of atopic diseases, both within and between countries, and across time.⁹ As one of the 281 centres (in 104 countries) participating in the third phase of ISAAC, we contribute to this international comparative study by determining the prevalence of atopic diseases among 12- to 14-year-old Dutch adolescents. The present study is the first Dutch study on the prevalence of atopic conditions among a nationwide and large sample of early adolescents. Having this large sample makes it possible to reliably measure the associations between several factors and atopic symptoms.

This article describes the prevalence figures of atopic diseases among Dutch early adolescents and the results will be compared with previous prevalence data of other Western European countries. Furthermore, associations between atopic symptoms and several possibly related individual and social demographic factors are also taken into consideration.

Methods

This study was approved by a medical ethics committee (CMO Arnhem-Nijmegen).

Sampling and data collection

Thirty-three secondary schools participated in this study. Schools in four regions of the Netherlands were randomly

selected and approached for participation. According to the ISAAC protocol,¹⁰ if a school refused participation, the school was replaced by another randomly selected school. A total of 22 schools refused participation. Head masters were asked why they did not want to participate and reasons not to participate always referred to involvement in other studies. The majority of head masters provided us with information about the nature of these studies and the schools were not selected for those other studies because of asthma-related problems (e.g. problems with indoor environment). However, for some schools we do not have information about the nature of these other studies, so there is a potential risk that some of these schools that did not participate in our study were selected for other studies because of health-related (and possibly asthma-related) problems. Therefore, a small selection bias on the school level cannot be ruled out.

In January 2003, all first-grade and second-grade students of the participating secondary schools filled out a written questionnaire during school hours, under supervision of a teacher. The first and second school years were selected because of the high proportion of children aged 12–14 years. All teachers received instructions about the procedure and how to handle questions from the students. Furthermore, they were asked to remind the students of the confidentiality and to note which students were absent and why. To increase motivation, the instruction for the students mentioned that CD gift vouchers would be raffled among students who had filled out their questionnaire seriously.

Of the 11 124 students on the participating schools, 10 147 (91.2%) filled out the questionnaire. Of the remaining 977 students, 440 students were absent during the measurement day, 15 students refused to fill out the questionnaire, 67 students had left school during the 3 months between contacting the schools and data collection, and from 455 students the reason for their non-response was unknown. Although attrition rates are low, a small selective attrition bias might have occurred. Because most teachers only wrote down that students were absent and did not note why, we cannot determine how many students were absent due to asthma or allergies. Furthermore, the data of 60 respondents were excluded from analyses because their questionnaires were incomplete or inconsistent. For this report, only the data of the respondents aged 12–14 years (i.e. 96% of the sample) were used, resulting in a sample

1 Radboud University Nijmegen, The Netherlands

2 IVO, Addiction Research Institute, The Netherlands

Correspondence: Monique Van De Ven, Behavioural Science Institute, Radboud University Nijmegen, PO Box 9104, 6500 HE Nijmegen, The Netherlands, tel: +31 24 3612140, fax: +31 24 3612776, e-mail: M.vandeVen@pwo.ru.nl

of 9713 respondents. Table 1 shows the characteristics of the early adolescents in this study.

Measures

A Dutch translation¹¹ of the validated ISAAC written self-report questionnaire for 13- to 14-year-olds was used in this study. The questionnaire contained standard questions about the prevalence and severity of asthma, rhinitis, and eczema. The optional video questionnaire is not used in the present study. A few studies have compared the results of the written questionnaire with the video questionnaire, and found that adolescents report lower prevalence rates of symptoms of asthma with the video questionnaire.^{12,13} Although the two types of questionnaires are highly correlated and the overall proportion of agreement is high, there is limited agreement as measured by the kappa coefficient between the two questionnaires. This disagreement shows variation between countries and centres, and cannot be explained by differences in language, culture, or literacy.^{12,13}

Additional questions on gender, age, education level, height, weight, and residential area were also included. Residential area was assessed with a single item: Which statement describes your neighbourhood best: (i) rural area, (ii) urban area, or (iii) (area close to an) industrial area. Educational level was also assessed with a single item (What educational level are you in?) on an 11-point scale ranging from (1) special education (LWOO) to (11) preparation for University (VWO). The respondents were divided into three groups: low (levels 1–3), middle (levels 4–7) and high (levels 8–11). The information on height and weight was used to calculate body mass index (BMI) (kg/m²). According to the international cut-off points for overweight,¹⁴ the respondents were divided in a group with overweight and a group without overweight. Respondents were also asked about their country of birth and that of their parents. A distinction was made between a group with a Dutch ethnic background (respondents who were born in the Netherlands and whose parents were born in the Netherlands) and a non-Dutch ethnic background. The four largest immigrant groups in the Netherlands comprise people from Turkey, Morocco, the Netherlands, Antilles, and Surinam. For the analyses, the adolescents with a non-Dutch background were subdivided into three groups 'Surinamese/Antillean', 'Turkish/Moroccan', or 'other country of origin'.

Statistical analysis

Data were analysed using the statistical package for the social sciences (SPSS) for Windows, version 11.0. Crude prevalence rates were calculated for the total group of respondents, as well as for different groups with regard to gender, age, educational level, ethnic background, BMI, and residential area. Multivariate logistic regression models were used to analyse the pure associations between those social demographic and individual factors and the prevalence of atopic diseases and symptoms.

Results

Slightly more than half of the adolescents, that is 52.6%, suffered from at least one atopic disease at some point in their lives. With regard to current symptoms, 38.3% suffered from atopic symptoms (wheezing, rhinitis, or itchy rash) in the past year. Of all respondents, 26.8% suffered from one of these symptoms, 9.4% reported two of those symptoms, and 2.2% reported that they had suffered from wheezing, rhinitis, and an itchy rash in the past year. The crude prevalence rates for asthma, hay fever, eczema, and their symptoms are shown in table 1. The results of the multivariate logistic regression analyses are given in tables 2–4 (odds ratios, *P*-values, and 95% confidence intervals).

Prevalence and covariates of symptoms and diagnosis of asthma

The reported lifetime prevalence of asthma was 12.9% (table 1). Table 2 presents the multivariate logistic regression models for lifetime asthma and symptoms of asthma. Boys reported more lifetime asthma and girls reported more symptoms of asthma in the past year. No significant differences were found for the three age groups. The group with low education level was more likely to report sleep disturbance and nocturnal cough, for the other symptoms, no significant differences between the education levels was found. When compared with Dutch adolescents, the youngsters with a Surinamese/Antillean background and an 'other' ethnic background were more likely to suffer from wheezing and nocturnal cough in the past year. The respondents with an 'other' ethnic background were also at higher risk of lifetime asthma. For adolescents with a Turkish/Moroccan background, the risks of lifetime asthma, lifetime wheeze, and past year exercise-induced wheeze was lower, the risk of past year nocturnal cough was higher, both in comparison to Dutch adolescents. Adolescents with overweight had an increased risk of lifetime asthma, lifetime wheezing, past year wheezing, and past year exercise-induced wheezing. With regard to residential area, adolescents living in an industrial area were more at risk of most symptoms of asthma than adolescents living in a rural area.

Prevalence and covariates of symptoms and diagnosis of hay fever

Lifetime hay fever was reported by 23.4% of the adolescents (table 1). Table 3 presents the multivariate logistic regression models for lifetime hay fever and nasal symptoms. Girls were at higher risk for all nasal symptoms. The oldest age group had a higher risk of lifetime hay fever, but did not differ from the youngest group with respect to nasal symptoms. Respondents in the high education group had a significantly lower risk of all nasal symptoms than the adolescents following low education. Adolescents with a Surinamese/Antillean background were almost twice more likely to report lifetime hay fever than Dutch adolescents, and the risk of all nasal symptoms is also higher for this group when compared with Dutch adolescents. The risk of nose problems to interfere with daily activities was higher for the group with an 'other' ethnic background than for the Dutch adolescents. Overweight was associated with higher risk for lifetime rhinitis. Adolescents living in or close to an industrial area had a higher risk of all nasal symptoms compared with the adolescents from the rural group.

Prevalence and covariates of symptoms and diagnosis of eczema

The reported lifetime prevalence of eczema was 37.1% (table 1). Table 4 presents the multivariate logistic regression models for lifetime eczema and symptoms of eczema. Again, girls were at higher risk for lifetime eczema and symptoms than boys. Age was associated with an itchy rash and a clearance of rash in the past year. Adolescents aged 14 years reported more of these symptoms. With regard to education level, adolescents following high education had a lower risk of sleep disturbance by rash than the adolescents following low education. The Surinamese/Antillean group is at higher risk than the group of Dutch adolescents, for both lifetime eczema and most symptoms of eczema. The respondents with a Turkish/Moroccan background had a lower risk of lifetime eczema and lifetime itchy rash than the Dutch adolescents. The risk of lifetime eczema was also lower for the 'other' background group in comparison to the Dutch group. Adolescents with overweight were at higher risk for lifetime eczema and lifetime itchy rash. Residential area was associated with clearance of rash in the past year: the adolescents living in an urban area were more at risk than those living in a rural area.

Table 1 Crude prevalence rates of symptoms and diagnosis of asthma, hay fever, and eczema

	<i>n</i> (%)	Asthma ever	Wheeze ever	Wheeze ^a ≥4 attacks of wheeze ^a	Sleep disturbance by wheeze ^a	Wheeze limiting speech ^a	Exercise-induced wheeze ^a	Nocturnal cough ^a	Hay fever ever	Rhinitis ever	Rhinitis ^a affecting daily activities ^a	Eczema ever	Itchy rash ever	Itchy rash ^a	Itchy flexural rash ^{a,b,c}	Clearance of rash ^a	Sleep disturbance by rash ^a			
Total	9713	12.9	22.6	12.3	4.0	4.5	2.2	14.4	24.8	23.4	38.3	28.3	9.3	16.7	37.1	21.0	13.5	8.9	9.1	4.1
Gender																				
Boys	4727 (48.8)	13.9	20.5	11.0	3.7	3.7	1.6	11.9	21.0	22.8	33.8	24.5	7.3	14.4	33.4	16.8	10.1	6.3	7.2	2.4
Girls	4969 (51.2)	12.0	24.6	13.5	4.4	5.2	2.8	16.8	28.4	23.8	42.6	31.9	11.1	19.0	40.6	24.9	16.8	11.3	11.0	5.7
Age																				
12	2846 (29.3)	12.6	21.9	11.9	3.8	4.2	2.5	15.1	23.7	22.5	38.8	28.1	8.4	16.6	38.9	21.0	13.6	9.0	9.0	4.4
13	4679 (48.2)	12.7	22.3	12.0	3.9	4.1	1.9	13.9	24.3	22.7	38.0	27.8	9.0	16.6	37.0	20.5	12.8	8.3	8.4	3.7
14	2188 (22.5)	13.7	24.2	13.4	4.7	5.6	2.5	14.7	27.2	26.0	38.5	29.5	10.9	17.3	35.1	22.1	14.9	9.9	10.9	4.6
Education																				
Low	3671 (38.7)	13.8	23.4	12.7	4.4	5.7	2.1	13.7	28.1	23.6	41.2	29.1	9.8	19.4	36.7	19.7	12.1	8.2	8.6	4.3
Middle	1927 (20.3)	12.7	23.6	12.9	3.7	4.4	2.4	15.1	25.6	24.7	40.3	30.6	10.5	18.1	36.4	21.9	14.6	9.7	10.1	4.6
High	3892 (41.0)	12.2	21.5	11.6	3.8	3.4	2.1	15.0	21.3	22.6	34.8	26.5	8.2	13.7	37.7	21.9	14.4	9.1	9.3	3.7
Ethnicity																				
Dutch	7665 (80.7)	12.9	22.7	12.0	4.0	4.4	2.2	14.6	23.9	22.6	38.1	28.1	9.1	16.3	38.4	21.1	13.5	8.8	9.3	4.0
Surinamese/Antillean	386 (4.1)	12.0	24.0	14.7	5.3	5.6	2.1	12.5	34.5	38.2	47.1	34.0	13.0	20.5	45.7	28.9	19.8	14.4	12.2	7.7
Turkish/Moroccan	424 (4.5)	10.6	17.5	10.3	3.2	4.9	1.5	9.4	31.1	20.4	37.7	26.9	8.7	17.8	21.7	15.9	9.7	7.3	6.5	4.1
Other	1023 (10.8)	15.1	24.4	15.3	4.8	5.7	2.4	16.0	26.2	25.5	38.0	28.5	10.0	18.9	30.6	20.0	12.7	8.1	8.4	4.2
BMI																				
No overweight	7924 (91.0)	12.3	22.2	12.1	3.9	4.4	2.1	14.4	24.7	23.7	38.0	28.0	9.3	16.6	37.0	20.9	13.7	8.9	9.1	4.2
Overweight	782 (9.0)	17.5	27.8	14.1	5.2	5.3	3.0	17.7	28.3	22.4	42.4	30.6	9.7	18.1	39.4	22.3	13.6	8.8	9.8	4.4
Residential area																				
Rural	4630 (50.5)	12.3	21.9	11.5	3.6	4.3	2.0	14.1	22.9	22.8	37.2	27.3	8.6	16.3	38.2	20.5	13.0	8.3	8.8	3.8
Urban	4065 (44.3)	13.4	22.7	12.3	4.2	4.3	2.3	14.3	26.0	23.6	38.4	28.7	9.8	16.5	35.9	21.6	14.4	9.7	9.9	4.6
Industry	475 (5.2)	14.3	26.6	16.1	5.8	7.1	2.8	16.3	29.1	24.7	43.0	31.9	11.9	22.5	36.6	21.6	11.8	8.1	6.2	4.5

All numbers (except for *n*) represent percentages

a: In the past 12 months

b: Rhinconjunctivitis = rhinitis accompanied by itchy, watery eyes

c: Flexural rash = rash affecting the folds of elbows or knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes

Table 2 Effects of multiple variables on the prevalence rates of symptoms and diagnosis of asthma

	Asthma ever			Wheeze ever			Wheeze ^a			≥4 attacks of wheeze ^a			Sleep disturbance by wheeze ^a			Wheeze limiting speech ^a			Exercise-induced wheeze ^a			Nocturnal cough ^a		
	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI
Gender																								
Boys	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
Girls	0.85	0.014 ^c	0.74–0.97	1.30	0.000 ^c	1.17–1.45	1.31	0.000 ^c	1.14–1.50	1.28	0.034 ^c	1.02–1.62	1.38	0.004 ^c	1.11–1.71	2.04	0.000 ^c	1.47–2.84	1.56	0.000 ^c	1.38–1.78	1.49	0.000 ^c	1.34–1.66
Age																								
12	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
13	0.98	0.825 ^c	0.84–1.15	1.03	0.629 ^c	0.91–1.17	1.04	0.668 ^c	0.88–1.22	1.13	0.402 ^c	0.85–1.49	0.94	0.663 ^c	0.73–1.22	0.84	0.329 ^c	0.59–1.20	0.98	0.735 ^c	0.84–1.13	1.05	0.466 ^c	0.93–1.19
14	0.99	0.931 ^c	0.82–1.20	1.11	0.197 ^c	0.95–1.29	1.12	0.269 ^c	0.92–1.36	1.34	0.076 ^c	0.97–1.85	1.25	0.131 ^c	0.94–1.68	1.01	0.974 ^c	0.66–1.54	1.05	0.569 ^c	0.88–1.26	1.13	0.107 ^c	0.97–1.31
Education																								
Low	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
Middle	0.99	0.951 ^c	0.83–1.20	1.02	0.783 ^c	0.88–1.18	1.02	0.832 ^c	0.85–1.23	0.91	0.577 ^c	0.66–1.26	0.81	0.143 ^c	0.60–1.08	1.19	0.417 ^c	0.78–1.80	1.14	0.140 ^c	0.96–1.37	0.80	0.002 ^c	0.69–0.92
High	0.91	0.216 ^c	0.78–1.06	0.93	0.244 ^c	0.82–1.05	0.89	0.166 ^c	0.76–1.05	0.93	0.576 ^c	0.71–1.21	0.64	0.000 ^c	0.49–0.82	0.95	0.791 ^c	0.66–1.37	1.13	0.100 ^c	0.98–1.31	0.68	0.000 ^c	0.60–0.76
Ethnicity																								
Dutch	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
Surinamese/ Antillean	0.91	0.618 ^c	0.63–1.32	1.15	0.319 ^c	0.87–1.52	1.44	0.031 ^c	1.03–2.00	1.37	0.243 ^c	0.81–2.34	1.43	0.177 ^c	0.85–2.40	0.96	0.915 ^c	0.44–2.10	0.94	0.704 ^c	0.67–1.31	1.61	0.000 ^c	1.24–2.08
Turkish/ Moroccan	0.61	0.013 ^c	0.41–0.90	0.65	0.005 ^c	0.48–0.88	0.70	0.073 ^c	0.47–1.03	0.64	0.198 ^c	0.32–1.26	0.83	0.534 ^c	0.47–1.48	0.51	0.190 ^c	0.19–1.40	0.51	0.001 ^c	0.34–0.76	1.38	0.010 ^c	1.08–1.76
Other	1.29	0.017 ^c	1.05–1.58	1.09	0.367 ^c	0.91–1.29	1.32	0.010 ^c	1.07–1.63	1.22	0.262 ^c	0.86–1.74	1.29	0.125 ^c	0.93–1.80	0.98	0.930 ^c	0.59–1.62	1.03	0.790 ^c	0.84–1.26	1.21	0.029 ^c	1.02–1.43
BMI																								
No overweight	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
Overweight	1.54	0.000 ^c	1.25–1.90	1.43	0.000 ^c	1.20–1.70	1.25	0.049 ^c	1.00–1.57	1.41	0.061 ^c	0.99–2.01	1.26	0.191 ^c	0.89–1.77	1.51	0.093 ^c	0.93–2.44	1.44	0.001 ^c	1.17–1.76	1.19	0.053 ^c	1.00–1.42
Residential area																								
Rural	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
Urban	1.12	0.108 ^c	0.98–1.29	1.05	0.369 ^c	0.94–1.18	1.03	0.717 ^c	0.89–1.19	1.16	0.226 ^c	0.91–1.49	0.95	0.687 ^c	0.76–1.20	1.18	0.313 ^c	0.85–1.64	0.97	0.698 ^c	0.85–1.11	1.13	0.035 ^c	1.01–1.26
Industry	1.15	0.360 ^c	0.85–1.54	1.34	0.013 ^c	1.06–1.69	1.50	0.005 ^c	1.13–1.98	1.69	0.022 ^c	1.08–2.65	1.62	0.019 ^c	1.08–2.43	1.62	0.128 ^c	0.87–3.02	1.27	0.093 ^c	0.96–1.67	1.46	0.001 ^c	1.17–1.78

OR = odds ratio, 95% CI = 95% confidence interval. 'Boys', 'Age 12', 'Education Low', 'Dutch', 'No overweight', and 'Rural' are reference groups

a: In the past 12 months

b: P-value for the factor

c: P-value for the individual odds ratios

Table 3 Effects of multiple variables on the prevalence rates of symptoms and diagnosis of hay fever

	Hay fever ever			Rhinitis ever			Rhinitis ^a			Rhinoconjunctivitis ^a			Rhinitis affecting daily activities ^a		
	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI
Gender		0.171 ^b			0.000 ^b			0.000 ^b			0.000 ^b			0.000 ^b	
Boys	1.00			1.00			1.00			1.00			1.00		
Girls	1.08	0.171 ^c	0.97–1.20	1.49	0.000 ^c	1.36–1.64	1.47	0.000 ^c	1.33–1.63	1.66	0.000 ^c	1.42–1.95	1.41	0.000 ^c	1.26–1.60
Age		0.013 ^b			0.527 ^b			0.900 ^b			0.075 ^b			0.607 ^b	
12	1.00			1.00			1.00			1.00			1.00		
13	1.02	0.779 ^c	0.90–1.15	0.95	0.368 ^c	0.85–1.06	0.99	0.863 ^c	0.88–1.11	1.12	0.248 ^c	0.93–1.34	0.98	0.769 ^c	0.85–1.13
14	1.22	0.009 ^c	1.05–1.42	0.93	0.290 ^c	0.82–1.06	1.02	0.786 ^c	0.89–1.18	1.29	0.023 ^c	1.04–1.60	0.92	0.335 ^c	0.76–1.07
Education		0.614 ^b			0.000 ^b			0.008 ^b			0.048 ^b			0.000 ^b	
Low	1.00			1.00			1.00			1.00			1.00		
Middle	1.04	0.616 ^c	0.90–1.20	0.92	0.183 ^c	0.81–1.04	1.04	0.540 ^c	0.91–1.20	1.03	0.771 ^c	0.84–1.27	0.89	0.153 ^c	0.74–1.02
High	0.97	0.594 ^c	0.86–1.09	0.74	0.000 ^c	0.66–0.82	0.87	0.015 ^c	0.77–0.97	0.83	0.038 ^c	0.69–0.99	0.65	0.000 ^c	0.56–0.74
Ethnicity		0.000 ^b			0.024 ^b			0.043 ^b			0.043 ^b			0.006 ^b	
Dutch	1.00			1.00			1.00			1.00			1.00		
Surinamese/Antillean	1.94	0.000 ^c	1.51–2.50	1.43	0.004 ^c	1.12–1.82	1.33	0.028 ^c	1.03–1.71	1.54	0.015 ^c	1.09–2.19	1.48	0.009 ^c	1.12–2.00
Turkish/Moroccan	0.80	0.114 ^c	0.60–1.06	0.91	0.419 ^c	0.72–1.15	0.80	0.096 ^c	0.62–1.04	0.79	0.261 ^c	0.52–1.19	0.92	0.583 ^c	0.67–1.23
Other	1.14	0.130 ^c	0.96–1.36	1.00	0.976 ^c	0.86–1.16	0.99	0.903 ^c	0.84–1.17	1.13	0.342 ^c	0.88–1.44	1.27	0.013 ^c	1.04–1.50
BMI		0.621 ^b			0.025 ^b			0.065 ^b			0.461 ^b			0.324 ^b	
No overweight	1.00			1.00			1.00			1.00			1.00		
Overweight	0.95	0.621 ^c	0.79–1.15	1.20	0.025 ^c	1.02–1.41	1.17	0.065 ^c	0.99–1.39	1.10	0.461 ^c	0.85–1.44	1.11	0.324 ^c	0.90–1.34
Residential area		0.891 ^b			0.014 ^b			0.042 ^b			0.038 ^b			0.010 ^b	
Rural	1.00			1.00			1.00			1.00			1.00		
Urban	1.00	0.927 ^c	0.89–1.11	1.05	0.318 ^c	0.95–1.16	1.04	0.420 ^c	0.94–1.16	1.09	0.284 ^c	0.93–1.29	0.98	0.718 ^c	0.85–1.10
Industry	1.06	0.659 ^c	0.83–1.34	1.36	0.004 ^c	1.10–1.67	1.32	0.012 ^c	1.06–1.65	1.50	0.012 ^c	1.09–2.06	1.43	0.005 ^c	1.14–1.85

OR = odds ratio, 95% CI = 95% confidence interval. 'Boys', 'Age 12', 'Education Low', 'Dutch', 'No overweight', and 'Rural' are reference groups

a: In the past 12 months

b: P-value for the factor

c: P-value for the individual odds ratios

Table 4 Effects of multiple variables on the prevalence rates of symptoms and diagnosis of eczema

	Eczema ever			Itchy rash ever			Itchy rash ^a			Itchy flexural rash ^a			Clearance of rash ^a			Sleep disturbance by rash ^a		
	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI
Gender		0.000 ^b			0.000 ^b			0.000 ^b			0.000 ^b			0.000 ^b			0.000 ^b	
Boys	1.00			1.00			1.00			1.00			1.00			1.00		
Girls	1.38	0.000 ^c	1.25–1.51	1.67	0.000 ^c	1.49–1.87	1.80	0.000 ^c	1.57–2.06	1.92	0.000 ^c	1.63–2.27	1.63	0.000 ^c	1.39–1.91	2.45	0.000 ^c	1.93–3.12
Age		0.674 ^b			0.072 ^b			0.033 ^b			0.137 ^b			0.001 ^b			0.149 ^b	
12	1.00			1.00			1.00			1.00			1.00			1.00		
13	0.96	0.424 ^c	0.86–1.07	1.04	0.553 ^c	0.91–1.18	1.01	0.933 ^c	0.86–1.18	0.95	0.578 ^c	0.79–1.14	1.01	0.965 ^c	0.83–1.21	0.81	0.104 ^c	0.63–1.05
14	0.95	0.455 ^c	0.83–1.09	1.19	0.028 ^c	1.02–1.39	1.23	0.025 ^c	1.03–1.48	1.16	0.184 ^c	0.93–1.44	1.41	0.002 ^c	1.14–1.75	1.01	0.929 ^c	0.75–1.37
Education		0.481 ^b			0.508 ^b			0.264 ^b			0.816 ^b			0.731 ^b			0.050 ^b	
Low	1.00			1.00			1.00			1.00			1.00			1.00		
Middle	0.93	0.278 ^c	0.81–1.06	1.09	0.284 ^c	0.93–1.27	1.13	0.176 ^c	0.95–1.36	1.07	0.541 ^c	0.86–1.33	1.09	0.431 ^c	0.88–1.35	0.90	0.482 ^c	0.67–1.21
High	1.00	1.000 ^c	0.90–1.11	1.06	0.371 ^c	0.93–1.20	1.12	0.149 ^c	0.96–1.30	1.01	0.903 ^c	0.84–1.22	1.03	0.771 ^c	0.86–1.23	0.73	0.016 ^c	0.56–0.94
Ethnicity		0.000 ^b			0.001 ^b			0.033 ^b			0.010 ^b			0.223 ^b			0.022 ^b	
Dutch	1.00			1.00			1.00			1.00			1.00			1.00		
Surinamese/Antillean	1.34	0.020 ^c	1.05–1.71	1.47	0.005 ^c	1.13–1.92	1.39	0.038 ^c	1.02–1.88	1.72	0.002 ^c	1.23–2.42	1.15	0.465 ^c	0.79–1.68	2.02	0.002 ^c	1.29–3.14
Turkish/Moroccan	0.49	0.000 ^c	0.37–0.64	0.69	0.014 ^c	0.51–0.93	0.70	0.057 ^c	0.49–1.01	0.80	0.304 ^c	0.53–1.22	0.69	0.088 ^c	0.45–1.06	1.02	0.948 ^c	0.59–1.75
Other	0.75	0.000 ^c	0.64–0.88	0.89	0.233 ^c	0.74–1.08	0.95	0.655 ^c	0.77–1.18	1.02	0.892 ^c	0.79–1.32	0.88	0.354 ^c	0.68–1.15	1.09	0.640 ^c	0.76–1.55
BMI		0.021 ^b			0.050 ^b			0.324 ^b			0.559 ^b			0.099 ^b			0.482 ^b	
No overweight	1.00			1.00			1.00			1.00			1.00			1.00		
Overweight	1.21	0.021 ^c	1.03–1.43	1.21	0.050 ^c	1.00–1.46	1.12	0.324 ^c	0.89–1.41	1.09	0.559 ^c	0.82–1.43	1.25	0.099 ^c	0.96–1.62	1.14	0.482 ^c	0.79–1.66
Residential area		0.422 ^b			0.362 ^b			0.106 ^b			0.074 ^b			0.007 ^b			0.198 ^b	
Rural	1.00			1.00			1.00			1.00			1.00			1.00		
Urban	0.94	0.226 ^c	0.85–1.04	1.08	0.190 ^c	0.96–1.21	1.14	0.056 ^c	1.00–1.31	1.20	0.030 ^c	1.02–1.42	1.21	0.021 ^c	1.03–1.42	1.23	0.078 ^c	0.98–1.56
Industry	0.92	0.459 ^c	0.74–1.14	1.11	0.409 ^c	0.87–1.43	0.92	0.610 ^c	0.67–1.27	0.95	0.800 ^c	0.65–1.40	0.69	0.086 ^c	0.45–1.05	1.21	0.448 ^c	0.74–1.98

OR = odds ratio, 95% CI = 95% confidence interval. 'Boys', 'Age 12', 'Education Low', 'Dutch', 'No overweight', and 'Rural' are reference groups

a: In the past 12 months

b: P-value for the factor

c: P-value for the individual odds ratios

Discussion

Prevalence rates of atopic diseases among Dutch adolescents were assessed using the ISAAC self-report questionnaires.⁹ As a consequence, the results are based on questionnaires rather than more objective measurements (e.g. skin prick test or IgE-test). However, the questionnaires of the ISAAC are designed for population-based research and have proven to be valid instruments for assessing the prevalence of atopic diseases.^{9,10,15,16} The results of the questionnaire have been compared with a physician's assessment of asthma status in the past year, and the ISAAC questionnaire showed to be sensitive and specific in measuring asthma and atopy.¹⁷ Another consequence of the ISAAC methodology is that information is given directly by the adolescent, rather than by the adolescent's parents. Especially during adolescence, parents may be unaware of the symptoms of their children. Self-reporting of atopic symptoms is seen as more reliable than parent-reporting.¹⁸ A third consequence of using the questionnaires of the ISAAC is that prevalence rates are based on symptoms rather than on diagnoses. This makes the results independent of regional or national differences in diagnostic processes and accessibility of medical assistance.

Using a standardized methodology with a standardized instrument allows for a comparison of the results of the present study with the prevalence data (of the first phase of ISAAC) of other Western European countries such as Austria, Belgium, France, Germany, Greece, Italy, Portugal, Ireland, Spain, and Great Britain.^{1,19} With regard to current as well as lifetime asthma, the Dutch prevalence rates are high in comparison to the other countries. Only adolescents from Ireland and Great Britain reported higher prevalence rates. The same holds for hay fever and nasal symptoms; only Irish and British adolescents reported higher prevalence rates than Dutch adolescents. However, when the Dutch prevalence rates of hay fever and nasal symptoms are compared with the prevalence rates of Belgium, France, Spain, Italy, and Germany, an unexpected pattern arises. Dutch adolescents reported lower or similar prevalence rates for current nasal symptoms than the adolescents from the countries mentioned above, but they report a higher prevalence of lifetime hay fever. The same pattern emerged for eczema and symptoms of eczema. Dutch adolescent reported lower prevalence rates for current symptoms of eczema than British, Irish, and French adolescents, but again the prevalence of lifetime eczema is higher among Dutch adolescents. This difference between the prevalence of symptoms in the past year and the lifetime prevalence of the allergic conditions may be explained by differences in diagnostic processes between the countries. However, it should be noted that we cannot rule out the possibility that the answers of the adolescents are based on the adolescent's own estimation whether or not they have an allergic condition, rather than being based on the diagnosis of a physician. In that case, the difference may be a result of a greater familiarity with the concepts of hay fever and eczema among Dutch adolescents, for example through commercials for hay fever products. These results might indicate that the ISAAC questionnaires are not totally independent of regional differences after all.

Boys reported more lifetime asthma and girls reported more symptoms of asthma in the past year. Several studies on gender differences in asthma have shown that during childhood, prevalence, and incidence rates of asthma are higher among boys.^{11,20,21} In puberty, a reversal in gender ratio takes place, and afterwards, asthma prevalence and incidence is greater in females.^{22–24} In the present study, the higher risk of current symptoms among girls suggests that this reversal takes place earlier in Dutch adolescents. Because of the higher prevalence during childhood, boys still report more lifetime asthma but already have a lower prevalence of current symptoms. With

regard to hay fever and eczema, as well as for the other atopic symptoms, girls report more lifetime hay fever and lifetime eczema than boys do. This is in line with other international studies on gender differences in the prevalence of atopic symptoms and diseases.^{11,25,26} Another explanation for the gender differences, however, may be a sociocultural difference in symptom perception and symptom reporting between males and females. A study by Kroenke and Spitzer²⁷ among adults has shown that most physical symptoms are reported at least 50% more often by women than by men, probably because of different social roles in society. Similar gender differences have been found for the reporting of symptoms during an asthma exacerbation: females reported more severe complaints than males.²⁸

Adolescents following higher education were at lower risk of atopic symptoms, especially with regard to nasal symptoms. This difference with respect to education level is probably due to differences in socioeconomic status (SES). The relation between SES and asthma and atopy has been studied many times earlier. With regard to asthma, conflicting results have been found. Some studies found no relationship,^{20,29} sometimes a positive association between asthma and SES was found,³⁰ and other studies demonstrated a negative relationship.^{31,32} The results for atopy are less conflicting; atopy is found to be more prevalent among high SES groups.^{33,34} Our finding that atopic symptoms are reported less among the highest SES groups is not in line with the above-mentioned studies. Further research should address why the results for SES and atopy are in contrast with the results found in the international literature. With regard to the higher prevalence of symptoms of asthma; this might be due to differences in passive smoking, since smoking is more prevalent in families with low SES. Research has consistently shown that when either one or both parents smoke, adolescents have an increased risk of lifetime asthma.³⁵

Adolescents with a Surinamese/Antillean background reported more allergic symptoms and diseases than Dutch adolescents, whereas adolescents with a Turkish/Moroccan background reported less symptoms and diseases. There is an ongoing discussion in the literature about differences between ethnic groups. These differences might be due to genetic differences, differences in environment, or both. The results of a study by Hjert *et al.*³⁶ among two generations of migrants in Sweden (the first generation born in Chile or Turkey, the second generation born in Sweden) point in the direction of heredity. Although the second generation is born and raised in Sweden, the risk of atopic disorders is more similar to their parents risk than to the risk of Swedish children. A study by Gruber and colleagues on the prevalence of atopic disorders among Turkish immigrant in Germany, however, points in the direction of environmental and cultural effects.³⁷ Results showed that when children of Turkish immigrants were raised with the German language, the prevalence of those children was similar to that of German children. In addition to an environmental or genetic explanation of differences in the prevalence rates between ethnic groups in this study, it is also possible that the found differences are due to differences in interpretation of the items between, for example, the Dutch and Surinamese/Antillean adolescents. Further research is needed to investigate this possible interpretation difference.

Although adolescents with overweight reported more lifetime rhinitis and lifetime eczema and itchy rash, overweight was predominantly associated with asthma. Adolescents with overweight reported more lifetime asthma and symptoms of asthma. This association is well documented in the literature.^{38–40} A few years ago, it was assumed that asthma preceded overweight, but recent longitudinal studies suggest that overweight is a risk factor for the development of asthma during adolescence.^{41,42}

The risk for asthma, symptoms of asthma, and nasal symptoms were higher among adolescents living close to an industrial area, when compared with adolescents from a rural environment. The risk for one symptom of eczema was higher for adolescents living in urban environments, also in comparison with adolescents from a rural environment. Previous studies have shown a positive association between traffic density and symptoms of asthma. This association has been found in survey studies^{26,43–46} as well as in studies with ‘objective measures’ of traffic density and lung function.⁴⁷ The association between residential area and hay fever and eczema has not been reported before. Further studies should be carried out to investigate why hay fever and nasal symptoms are positively associated with an industrial area and eczema is associated with an urban environment.

A limitation of our study is that there is a potential risk for spurious significant findings. First because a multitude of analyses was conducted. Although just one multivariate analysis is performed for each of the ISAAC questions (so there is no risk for spurious findings within each symptom), a total of 19 analyses have been conducted. Another reason for the potential risk for spurious significant findings is because no multilevel analyses have been conducted. Even though this is in line with most other ISAAC studies, and it will probably not affect the OR's, it could affect the *P*-values and the width of the confidence intervals. However, 41 of the 61 significant findings have a *P*-value of ≤ 0.01 , indicating strong differences. Furthermore, all the significant findings show a regular pattern within a condition (asthma symptoms, hay fever symptoms, and eczema symptoms). So even if some of the significant findings could be spurious, the direction of those possibly spurious findings is genuine.

Conclusion

This is the first study that investigates the prevalence of atopic diseases among Dutch early adolescents. The results demonstrate a rather high prevalence of atopic conditions. More than half of the adolescents had suffered from an atopic disorder at some point in their lives and almost 40% of the adolescents were bothered by atopic symptoms in the 12 months preceding the questionnaire. Several social demographic and individual factors were significantly associated with atopic symptoms and conditions among this group of Dutch early adolescents

Acknowledgements

This research was funded by a grant from the Dutch Asthma Foundation. The contribution of Rutger Engels was supported by the Netherlands Organization for Scientific Research. We would like to thank Dr J. Hendriks for his advice on biostatistical issues.

Key points

- Prevalence rates of atopic diseases are rising and prevalence studies may contribute to our knowledge about factors and mechanisms underlying this rising trend.
- Among Dutch early adolescents, the 12 months prevalence of self-reported wheezing, rhinitis, and itchy rash was 12.3%, 28.3%, and 13.5%, respectively.
- Girls and adolescents with lower education levels are at higher risk of self-reported atopic symptoms.
- Ethnic background, age, body mass index, and residential area are significantly associated with atopic symptoms and diseases.

References

- 1 The International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. *Lancet* 1998;351:1225–32.
- 2 The International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. Worldwide variations in the prevalence of asthma symptoms: the International Study of Asthma and Allergies in Childhood (ISAAC). *Eur Respir J* 1998;12:315–35.
- 3 Strachan D, Sibbald B, Weiland S, et al. Worldwide variations in prevalence of symptoms of allergic rhinoconjunctivitis in children: the International Study of Asthma and Allergies in Childhood (ISAAC). *Pediatr Allergy Immunol* 1997;8:161–76.
- 4 Williams H, Robertson C, Stewart A, et al. Worldwide variations in the prevalence of symptoms of atopic eczema in the International Study of Asthma and Allergies in Childhood. *J Allergy Clin Immunol* 1999;103:125–38.
- 5 European Allergy White Paper. *Allergic Diseases as a Public Health Problem*. Brussel: UCB Institute of Allergy, 1997.
- 6 Burney PG, Chinn S, Rona RJ. Has the prevalence of asthma increased in children? Evidence from the national study of health and growth 1973–86. *Br Med J* 1990;300:1306–10.
- 7 Burr ML, Butland BK, King S, Vaughan-Williams E. Changes in asthma prevalence: two surveys 15 years apart. *Arch Dis Child* 1989;64:1452–6.
- 8 Maziak W, Behrens T, Brasky TM, et al. Are asthma and allergies in children and adolescents increasing? Results from ISAAC phase I and phase III surveys in Munster, Germany. *Allergy* 2003;58:572–9.
- 9 Asher MI, Keil U, Anderson HR, et al. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J* 1995;8:483–91.
- 10 ISAAC Phase One Manual, 2nd edition., Auckland (New Zealand)/Münster (Germany), 1993.
- 11 Wieringa MH, Weyler JJ, Van Bever HP, et al. Gender differences in respiratory, nasal and skin symptoms: 6–7 versus 13–14-year-old children. *Acta Paediatr* 1999;88:147–9.
- 12 Crane J, Mallol J, Beasley R, et al. Agreement between written and video questions for comparing asthma symptoms in ISAAC. *Eur Respir J* 2003;21:455–61.
- 13 Pizzichini MM, Rennie D, Senthilvelan A, et al. Limited agreement between written and video asthma symptom questionnaires. *Pediatr Pulmonol* 2000;30:307–12.
- 14 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J* 2000;320:1240–3.
- 15 Shaw R, Woodman K, Ayson M, et al. Measuring the prevalence of bronchial hyper-responsiveness in children. *Int J Epidemiol* 1995;24:597–602.
- 16 Pearce N, Weiland S, Keil U, et al. Self-reported prevalence of asthma symptoms in children in Australia, England, Germany and New Zealand: an international comparison using the ISAAC protocol. *Eur Respir J* 1993;6:1455–61.
- 17 Jenkins MA, Clarke JR, Carlin JB, et al. Validation of questionnaire and bronchial hyperresponsiveness against respiratory physician assessment in the diagnosis of asthma. *Int J Epidemiol* 1996;25:609–16.
- 18 Renzoni E, Forastiere F, Biggeri A, et al. Differences in parental- and self-report of asthma, rhinitis and eczema among Italian adolescents. SIDRIA collaborative group. Studi Italiani sui Disordini Respiratori dell' Infanzia e l'Ambiente. *Eur Respir J* 1999;14:597–604.
- 19 ISAAC website (<http://isaac.auckland.ac.nz>).
- 20 SIDRIA (Italian Studies on Respiratory Disorders in Childhood and the Environment). Asthma and respiratory symptoms in 6–7 yr old Italian children: gender, latitude, urbanization and socioeconomic factors. *Eur Respir J* 1997;10:1780–6.
- 21 Sennhauser FH, Kuhni CE. Prevalence of respiratory symptoms in Swiss children: is bronchial asthma really more prevalent in boys? *Pediatr Pulmonol* 1995;19:161–6.
- 22 Anderson HR, Pottier AC, Strachan DP. Asthma from birth to age 23: incidence and relation to prior and concurrent atopic disease. *Thorax* 1992;47:537–42.
- 23 Nicolai T, Pereszlenyiova-Bliznakova I, Illi S, et al. Longitudinal follow-up of the changing gender ratio in asthma from childhood to adulthood: role of delayed manifestation in girls. *Pediatr Allergy Immunol* 2003;14:280–3.

- 24 Venn A, Lewis S, Cooper M, et al. Questionnaire study of effect of sex and age on the prevalence of wheeze and asthma in adolescence. *Br Med J* 1998;316:1945–6.
- 25 Fagan JK, Scheff PA, Hryhorczuk D, et al. Prevalence of asthma and other allergic diseases in an adolescent population: association with gender and race. *Ann Allergy Asthma Immunol* 2001;86:177–84.
- 26 Montefort S, Lenicker HM, Caruna S, Agius Muscat H. Asthma, rhinitis and eczema in Maltese 13–15-year-old school children—prevalence, severity and associated factors [ISAAC]. International Study of Asthma and Allergies in Childhood. *Clin Exp Allergy* 1998;28:1089–99.
- 27 Kroenke K, Spitzer RL. Gender differences in the reporting of physical and somatoform symptoms. *Psychosom Med* 1998;60:150–5.
- 28 Cydulka RK, Emerman CL, Rowe BH, et al. Differences between men and women in reporting of symptoms during an asthma exacerbation. *Ann Emerg Med* 2001;38:123–8.
- 29 Hancox RJ, Milne BJ, Taylor DR, et al. Relationship between socioeconomic status and asthma: a longitudinal cohort study. *Thorax* 2004;59:376–80.
- 30 Lewis S, Richards D, Bynner J, et al. Prospective study of risk factors for early and persistent wheezing in childhood. *Eur Respir J* 1995;8:349–56.
- 31 Ng Man Kwong G, Das C, Proctor AR, et al. Diagnostic and treatment behaviour in children with chronic respiratory symptoms: relationship with socioeconomic factors. *Thorax* 2002;57:701–4.
- 32 Duran-Tauleria E, Rona RJ. Geographical and socioeconomic variation in the prevalence of asthma symptoms in English and Scottish children. *Thorax* 1999;54:476–81.
- 33 Mercer MJ, Joubert G, Ehrlich RI, et al. Socioeconomic status and prevalence of allergic rhinitis and atopic eczema symptoms in young adolescents. *Pediatr Allergy Immunol* 2004;15:234–41.
- 34 Strachan DP. Family size, infection and atopy: the first decade of the “hygiene hypothesis”. *Thorax* 2000;55 (Suppl 1):S2–10.
- 35 Otten R, Engels RCME, van den Eijnden RJJM. Parental smoking and smoking behavior in asthmatic and nonasthmatic adolescents. *J Asthma* 2005;42:349–55.
- 36 Hjern A, Haglund B, Hedlin G. Ethnicity, childhood environment and atopic disorder. *Clin Exp Allergy* 2000;30:521–8.
- 37 Gruber C, Illi S, Plieth A, et al. Cultural adaptation is associated with atopy and wheezing among children of Turkish origin living in Germany. *Clin Exp Allergy* 2002;32:526–31.
- 38 von Mutius E, Schwartz J, Neas LM, et al. Relation of body mass index to asthma and atopy in children: the National Health and Nutrition Examination Study III. *Thorax* 2001;56:835–8.
- 39 Schachter LM, Peat JK, Salome CM. Asthma and atopy in overweight children. *Thorax* 2003;58:1031–5.
- 40 Gennuso J, Epstein LH, Paluch RA, Cerny F. The relationship between asthma and obesity in urban minority children and adolescents. *Arch Pediatr Adolesc Med* 1998;152:1197–200.
- 41 Gilliland FD, Berhane K, Islam T, et al. Obesity and the risk of newly diagnosed asthma in school-age children. *Am J Epidemiol* 2003;158:406–15.
- 42 Castro-Rodriguez JA, Holberg CJ, Morgan WJ, et al. Increased incidence of asthmatic symptoms in girls who become overweight or obese during the school years. *Am J Respir Crit Care Med* 2001;163:1344–9.
- 43 Duhme H, Weiland SK, Keil U, et al. The association between self-reported symptoms of asthma and allergic rhinitis and self-reported traffic density on street of residence in adolescents. *Epidemiology* 1996;7:578–82.
- 44 Duhme H, Weiland SK, Rudolph P, et al. Asthma and allergies among children in West and East Germany: a comparison between Munster and Greifswald using the ISAAC phase I protocol. International Study of Asthma and Allergies in Childhood. *Eur Respir J* 1998;11:840–7.
- 45 Keil U, Weiland SK, Duhme H, Chambless L. The International Study of Asthma and Allergies in Childhood (ISAAC): objectives and methods; results from German ISAAC centres concerning traffic density and wheezing and allergic rhinitis. *Toxicol Lett* 1996;86:99–103.
- 46 Weiland SK, Mundt KA, Ruckmann A, Keil U. Self-reported wheezing and allergic rhinitis in children and traffic density on street of residence. *Ann Epidemiol* 1994;4:243–7.
- 47 Brunekreef B, Janssen NA, de Hartog J, et al. Air pollution from truck traffic and lung function in children living near motorways. *Epidemiology* 1997;8:298–303.

Received 1 September 2004, accepted 19 January 2006

Appendix A: Original ISAAC questionnaire

Core questionnaire for asthma:

1. Have you ever had wheezing or whistling in the chest at any time in the past? Yes/No
2. Have you had wheezing or whistling in the chest in the past 12 months? Yes/No
3. How many attacks of wheezing have you had in the past 12 months? None/1–3/4–12/More than 12
4. In the past 12 months, how often, on average, has your sleep been disturbed due to wheezing? Never woken with wheezing/Less than one night per week/One or more nights per week
5. In the past 12 months, has wheezing ever been severe enough to limit your speech to only one or two words a time between breaths? Yes/No
6. Have you ever had asthma? Yes/No
7. In the past 12 months, has your chest sounded wheezy during or after exercise? Yes/No
8. In the past 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection? Yes/No

Core questionnaire for rhinitis:

1. Have you ever had a problem with sneezing, or a runny, or blocked nose when you did not have a cold or the flu? Yes/No
2. In the past 12 months, have you had a problem with sneezing, or a runny, or blocked nose when you did not have a cold or the flu? Yes/No
3. In the past 12 months, has this nose problem been accompanied by itchy, watery eyes? Yes/No
4. In which of the past 12 months did this nose problem occur? (not analysed in this paper)
5. In the past 12 months, how much did this nose problem interfere with your daily activities? Not at all/A little/A moderate amount/A lot
6. Have you ever had hay fever? Yes/No

Core questionnaire for eczema:

1. Have you ever had an itchy rash which was coming and going for at least 6 months? Yes/No
2. Have you had this itchy rash at any time in the past 12 months? Yes/No
3. Has this itchy rash at any time affected any of the following places: the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes? Yes/No
4. Has this rash cleared completely at any time during the past 12 months? Yes/No
5. In the past 12 months, how often, on average, have you been kept awake at night by this itchy rash? Never in the past 12 months/Less than one night per week/One or more nights per week
6. Have you ever had eczema? Yes/No

Appendix B: Dutch translation of the ISAAC questionnaire

Core questionnaire for asthma:

1. Heb je ooit piepen op de borst (een piepende ademhaling) gehad? Ja/Nee
2. Heb je in de laatste 12 maanden op de borst (een piepende ademhaling) gehad? Ja/Nee
3. Hoeveel aanvallen van piepen op de borst heb je in de laatste 12 maanden gehad? Geen/1–3/4–12/Meer dan 12

4. Hoe vaak gemiddeld werd je in je slaap in de laatste 12 maanden door piepen op de borst gestoord? Nooit/Minder dan 1 nacht per week/1 of meerdere nachten per week
5. Was het piepen op de borst in de laatste 12 maanden ooit zo erg dat je tussen twee ademhalingen hoogstens twee woorden na elkaar kon zeggen? Ja/Nee
6. Heb je ooit astma gehad? Ja/Nee
7. Heb je in de laatste 12 maanden tijdens of na inspanning piepen op de borst gehad (piepende ademhaling)? Ja/Nee
8. Heb je in de laatste 12 maanden's nachts een droge hoest gehad, zonder dat dit samenging met een verkoudheid of luchtweginfectie? Ja/Nee

Core questionnaire for rhinitis:

1. Heb je ooit last gehad van niesbuien of van een lopende of verstopte neus, wanneer je geen verkoudheid of griep had? Ja/Nee
2. Heb je in de laatste 12 maanden last gehad van niesbuien of van een lopende of verstopte neus, wanneer je geen verkoudheid of griep had? Ja/Nee
3. Gingen deze neusklachten in de laatste 12 maanden samen met jeukende of tranende ogen? Ja/Nee

4. In welke van de laatste 12 maanden traden deze neusklachten op? (not analysed in this paper)
5. Hoe ernstig belemmerde dit neusprobleem je dagelijkse activiteiten in de laatste 12 maanden? Geen belemmering/Een beetje/Redelijk veel/Veel
6. Heb je ooit wel eens hooikoorts gehad? Ja/Nee

Core questionnaire for eczema:

1. Heb je ooit een jeukende huiduitslag gehad die opkwam en weer wegging gedurende minstens 6 maanden? Ja/Nee
2. Heb je deze huiduitslag gehad in de laatste 12 maanden? Ja/Nee
3. Was deze jeukende uitslag ooit aanwezig op één van de volgende plaatsen: elleboogplooien, knieholten, vooraan op de enkels, onder het zitvlak, rond de hals, oren of ogen? t/Ja/Nee
4. Is deze uitslag ooit volledig weg geweest gedurende de laatste 12 maanden? Ja/Nee
5. Hoe vaak werd je's nachts gemiddeld uit je slaap gehouden door deze jeukende huiduitslag in de laatste 12 maanden? Niet/Minder dan 1 nacht per week/1 of meerdere nachten per week
6. Heb je ooit eczeem gehad? Ja/Nee