



ORIGINAL ARTICLE

Time trends and risk factors for rhinoconjunctivitis in New Zealand children: An International Study of Asthma and Allergies in Childhood (ISAAC) survey

Chris D Moyes,¹ Tadd Clayton,² Neil Pearce,^{4*} M Innes Asher,² Philippa Ellwood,² Richard Mackay,^{6†} Ed Mitchell,² Philip Pattemore,⁷ Alistair W Stewart³ and Julian Crane⁵

¹Bay of Plenty District Health Board, Whakatane, ²Department of Paediatrics: Child and Youth Health, ³School of Population Health, The University of Auckland, Auckland, ⁴Centre for Public Health Research, Massey University Wellington Campus, ⁵Wellington Asthma Research Group, Wellington School of Medicine, University of Otago, Wellington, ⁶Nelson Hospital, Nelson and ⁷Department of Paediatrics, Christchurch School of Medicine, Christchurch, New Zealand

Aim: To investigate prevalence, time trends and factors associated with rhinitis and rhinoconjunctivitis not related to acute infections in New Zealand.

Methods: The International Study of Asthma and Allergies in Childhood (ISAAC) surveyed children aged 6–7 and 13–14 years for symptoms of these conditions. Five New Zealand centres were surveyed on two occasions (Phase One and Phase Three) 8–10 years apart. In Phase Three, questions were included on environmental factors, which might be associated with rhinoconjunctivitis. We report findings related to symptoms of rhinoconjunctivitis among 24 190 New Zealand children.

Results: Symptoms of rhinoconjunctivitis in the past year were reported in 11.4% of 6- to 7-year-old children and 18% of 13- to 14-year-old adolescents in Phase Three compared with 9.5 and 19.1%, respectively, in Phase One. Severe symptoms of rhinoconjunctivitis were reported in 0.5% of children and 0.8% of adolescents. Current symptoms were more common in males at 6–7 years and in females of 13–14 years, and Māori and Pacific Island ethnic groups had higher prevalence compared with those of European descent, especially in the older age group. For immigrant children, there was a very strong positive relationship between symptoms and length of time resident in New Zealand, supporting the probable importance of environmental factors. A positive association was found between symptoms and use of paracetamol in infancy or in the last year, and weaker associations were noted for antibiotic use, exercise, and regular pasta ingestion.

Conclusions: Further study of environmental factors is recommended.

Key words: adolescents; children; hay fever; rhinitis; New Zealand.

What is already known on this topic

- 1 Rhinoconjunctivitis is a common chronic disease, which has significant morbidity and costs for children and their families.
- 2 Phase One of the International Study of Asthma and Allergies in Childhood showed that rhinoconjunctivitis is prevalent throughout New Zealand.
- 3 Little is known regarding whether prevalence is changing over time, ethnic differences in prevalence or risk factors for rhinoconjunctivitis in New Zealand children and adolescents.

What this paper adds

- 1 Māori and Pacific children and adolescents experience symptoms of rhinoconjunctivitis and symptoms of severe rhinoconjunctivitis more frequently than European/Pakeha children and adolescents.
- 2 There was little change in prevalence of rhinoconjunctivitis between Phase One (1993) and Phase Three (2001–2003) although use of the label 'hay fever' became more common.
- 3 Symptoms of rhinoconjunctivitis are associated with a variety of environmental factors including exercise, birth in New Zealand, exposure to truck traffic, exposure to environmental tobacco smoke and consumption of paracetamol.

Correspondence: Mr Tadd Clayton, Department of Paediatrics: Child and Youth Health, The University of Auckland, Private Bag 92019, Auckland 1142, New Zealand. Fax: +64 9373 7602; email: t.clayton@auckland.ac.nz

*Current address: Department of Medical Statistics, London School of Hygiene and Tropical Medicine, London, United Kingdom.

†Current address: Canterbury Health Laboratories, Christchurch, New Zealand.

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Introduction

Rhinoconjunctivitis not related to acute infection is a common chronic disease that has significant morbidity for both adults and children.^{1,2} Families of children with rhinoconjunctivitis experience significant direct medical costs, significant indirect costs and significantly impaired quality of life.^{1–4}

The International Study of Asthma and Allergies in childhood (ISAAC) surveyed children of 6–7 and 13–14 years of age

for symptoms of rhinitis and rhinoconjunctivitis not related to acute infection.⁵ Six New Zealand centres participated in Phase One in 1992–1993 (Auckland, Wellington, Christchurch, Bay of Plenty, Hawke's Bay and Nelson) and all except Hawke's Bay repeated the survey in Phase Three in 2001–2003 (at intervals of between 8 and 10 years). The second survey included an environmental questionnaire which recorded information on a number of factors that are considered to be potentially associated with symptoms of rhinoconjunctivitis.

In this paper, we report the findings for symptoms of rhinitis and rhinoconjunctivitis in the five New Zealand Phase Three centres, including time trends and associations with environmental factors. The analysis focuses primarily on the combination of nasal and eye symptoms (rhinoconjunctivitis), which has been shown to most closely fit with objective indicators of allergic rhinitis.⁶

Materials and Methods

Participants were surveyed as part of ISAAC Phase One and Phase Three. Details of the methodology have been described previously.^{5,7} In each participating centre, schools were selected by sequential random sampling or by using all schools in the sampling frame so that 3000 6- to 7-year-olds and 3000 13- to 14-year-olds were surveyed. For those schools that agreed to participate, an information letter was sent home to all carers of both age groups. Questionnaires were completed at home by the carers of the 6- to 7-year-olds and self-completed at school by the 13- to 14-year-old children. The questionnaire included two main components: a core questionnaire which included questions about symptoms of asthma, rhinoconjunctivitis and eczema, and an environmental questionnaire which included questions about a variety of potential protective and risk factors. The questions in the environmental questionnaire concerned weight, height, a range of dietary factors, physical exercise, cooking and heating fuels in the home, paracetamol use, antibiotic use, number of siblings, birth in New Zealand, years lived in New Zealand, maternal education, truck traffic in street of residence, birthweight, breastfeeding, exposure to pets and farm animals, and exposure to environmental tobacco smoke at home (<http://isaac.auckland.ac.nz/phases/phasethree/environmentalquestionnaire/environmentalquestionnaire.html>). Several questions concerning early life exposures in the environmental questionnaire for the 6- to 7-year age group were omitted from the 13- to 14-year age group questionnaire as adolescents in this age group could not be expected to provide valid responses.

In this paper, symptoms of rhinitis and rhinoconjunctivitis only were examined using the questions specified in Table 1. The main outcome measures of interest were current symptoms of rhinoconjunctivitis (those participants who answered 'Yes' to question 2 and to question 3) and current symptoms of severe rhinoconjunctivitis (those participants with current symptoms of rhinoconjunctivitis who also answered 'A lot' to question 4). Selected results are also presented for question 5 (hay fever ever) to provide information concerning how use of the label 'hay fever' varied between centres and between Phases.

Confidence intervals for the prevalence estimates included an adjustment for the cluster sampling methodology. The odds

Table 1 ISAAC questions concerning symptoms of rhinitis, rhinoconjunctivitis and hay fever

1. Have you (Has your child) ever had a problem with sneezing or a runny or blocked nose when you (he or she) DID NOT have a cold or flu? (Yes/No)
2. In the past twelve months, have you (has your child) had a problem with sneezing or a runny or blocked nose when you (he or she) DID NOT have a cold or flu? (Yes/No)
3. In the past twelve months, has this nose problem been accompanied by itchy-watery eyes? (Yes/No)
4. In the past twelve months how much did this nose problem interfere with your (child's) daily activities? (Not at all/A little/A moderate amount/A lot)
5. Have you (Has your child) ever had hay fever? (Yes/No)

ratios (ORs) for the associations between the main outcome measures and environmental factors were estimated using logistic regression, adjusting for centre, gender, ethnicity, school decile, month of study, and the cluster sampling methodology. Maternal education and current maternal smoking were also included as potential confounders for associations with other environmental factors.

Ethics Committee approval was obtained for each centre (passive consent was the approved method of consent⁸), and centres obtained their own funding. All analyses were carried out using SAS version 9.2 (SAS Institute Inc, Cary, NC, USA).

Results

Participation

Wellington had a low response rate (47.2%) for the 6- to 7-year age group and was thus excluded from the analysis. All other centres and age groups had responses greater than 80% with 85.2% overall for the 6- to 7-year age group and 89.2% for the 13- to 14-year age group.

Prevalence

Table 2 presents the Phase One and Phase Three results with the change per year and 95% confidence interval by centre. Tables 3 and 4 show the prevalence by ethnicity and gender.

Geography

In Phase Three, the prevalence of current symptoms of rhinoconjunctivitis varied between the centres from 9.3 to 12.9% for the 6- to 7-year age group and from 15.3 to 23.2% for the 13- to 14-year age group (Table 2). Nelson had a comparatively low prevalence for the 6- to 7-year age group and Wellington had a comparatively high prevalence for the 13- to 14-year age group.

For prevalence of current symptoms of severe rhinoconjunctivitis there was also variation between centres in Phase Three, with values of 0.2 to 0.6% for the 6- to 7-year age group and 0.5

Table 2 Phase One and Three prevalence, and change per year from Phase One (95% confidence intervals) by centre

Centre	Phase One		Phase Three		Current symptoms of rhinoconjunctivitis		Current symptoms of severe rhinoconjunctivitis		Hay fever ever	
	One, <i>n</i>	Phase One, <i>n</i>	Three, <i>n</i>	Phase Three, %	Change per year, % (95% CI)	Phase One, %	Phase Three, %	Change Per Year, % (95% CI)	Phase One, %	Phase Three, %
6- to 7-year age group										
Auckland	3 526	3 541	3 541	9.8	11.0	0.14 (-0.03, 0.31)	1.1	0.5	12.4	14.8
Bay of Plenty	2 681	2 150	2 150	8.7	11.3	0.30 (0.10, 0.50†)	0.4	0.6	11.6	15.9
Nelson	1 868	1 867	1 867	7.5	9.3	0.18 (-0.04, 0.39)	0.2	0.2	10.2	17.2
Christchurch	3 318	3 315	3 315	11.2	12.9	0.17 (-0.01, 0.35)	0.3	0.5	14.6	20.4
Total	11 393	10 873	10 873	9.5	11.4	0.19 (0.09, 0.29†)	0.6	0.5	12.5	17.2
13- to 14-year age group										
Auckland	3 206	2 870	2 870	18.9	18.8	-0.01 (-0.48, 0.45)	0.9	1.3	33.7	33.3
Bay of Plenty	2 813	1 976	1 976	18.7	15.3	-0.38 (-0.67, -0.09†)	1.1	0.8	32.6	35.3
Wellington	4 417	3 050	3 050	19.8	23.2	0.43 (0.08, 0.77†)	1.1	0.9	37.4	40.6
Nelson	1 838	2 305	2 305	17.4	15.3	-0.21 (-0.78, 0.36)	0.3	0.5	36.1	43.1
Christchurch	3 186	3 116	3 116	19.4	15.9	-0.36 (-0.70, -0.01†)	0.9	0.5	40.5	45.3
Total	15 460	13 317	13 317	19.1	18.0	-0.13 (-0.33, 0.07)	0.9	0.8	36.2	39.8

†95% confidence interval (CI) does not include 0% change per year.

Table 3 Phase One and Three prevalence, and change per year from Phase One (95% confidence intervals) by ethnicity

Ethnic group	Phase One		Phase Three		Current symptoms of rhinoconjunctivitis		Current symptoms of severe rhinoconjunctivitis		Hay fever ever	
	One, <i>n</i> †	Phase One, <i>n</i> †	Three, <i>n</i> †	Phase Three, %	Change per year, % (95% CI)	Phase One, %	Phase Three, %	Change per year, % (95% CI)	Phase One, %	Phase Three, %
6- to 7-year age group										
European/Pakeha	7 552	6 118	6 118	9.4	11.3	0.21 (0.08, 0.33§)	0.3	0.2	13.3	18.3
Māori	2 245	2 578	2 578	9.5	12.1	0.29 (0.08, 0.49§)	0.6	0.6	9.5	15.2
Pacific Islander	891	818	818	11.7	11.6	-0.01 (-0.35, 0.34)	2.6	1.3	12.7	12.7
Other	624	1 307	1 307	8.5	10.4	0.21 (-0.10, 0.52)	0.8	1.1	13.5	18.7
13- to 14-year age group										
European/Pakeha	10 033	7 450	7 450	19.0	16.7	-0.25 (-0.47, -0.04§)	0.7	0.5	38.9	43.5
Māori	2 937	2 501	2 501	20.1	21.5	0.15 (-0.15, 0.46)	1.4	1.0	31.7	38.1
Pacific Islander	1 332	1 633	1 633	19.2	21.5	0.25 (-0.07, 0.58)	1.5	1.8	28.7	32.0
Other	1 076	1 634	1 634	16.1	15.1	-0.11 (-0.52, 0.29)	1.0	0.8	33.7	33.2

†A total of 81 6- to 7-year-olds and 82 13- to 14-year-olds did not provide ethnicity information for Phase One. ‡A total of 52 6- to 7-year-olds and 99 13- to 14-year-olds did not provide ethnicity information for Phase Three. §95% confidence interval (CI) does not include 0% change per year.

Table 4 Phase One and Three prevalence, and change per year from Phase One (95% confidence intervals) by gender

Gender	Phase		Current symptoms of rhinoconjunctivitis				Current symptoms of severe rhinoconjunctivitis				Hay fever ever	
	One, <i>n</i>	Phase Three, <i>n</i> [†]	Phase One, %	Phase Three, %	Change per year, % (95% CI)	Phase One, %	Phase Three, %	Change per year, % (95% CI)	Phase One, %	Phase Three, %	Phase One, %	Change per year, % (95% CI)
6- to 7-year age group	5 754	5 392	9.1	10.6	0.16 (0.01, 0.30) [‡]	0.5	0.4	-0.01 (-0.04, 0.02)	11.1	16.0		0.54 (0.37, 0.71) [‡]
	5 639	5 481	10.0	12.2	0.24 (0.11, 0.37) [‡]	0.6	0.6	-0.01 (-0.04, 0.03)	13.9	18.3		0.50 (0.32, 0.68) [‡]
13- to 14-year age group	8 289	6 940	22.4	20.7	-0.19 (-0.43, 0.05)	0.9	0.8	-0.01 (-0.06, 0.03)	38.4	43.2		0.53 (0.25, 0.82) [‡]
	7 171	6 372	15.2	15.1	-0.01 (-0.23, 0.20)	1.0	0.8	-0.02 (-0.06, 0.02)	33.7	36.0		0.25 (-0.06, 0.57)

[†]Five 13- to 14-year-olds did not provide gender information for Phase Three. [‡]95% confidence interval (CI) does not include 0% change per year.

to 1.3% for the 13- to 14-year age group (Table 2). For the 6- to 7-year age group, Nelson again showed the lowest value, while for the 13- to 14-year age group, Auckland showed the highest value. A different pattern was seen for 'hay fever ever' with Christchurch showing the highest prevalence for both age groups compared with the other centres (Table 2).

Ethnicity

Māori and Pacific children reported a high prevalence of current symptoms of rhinoconjunctivitis in Phase Three, especially in the older age group (Table 3). Māori and Pacific 13- to 14-year-old respondents also reported high prevalence of current symptoms of severe rhinoconjunctivitis (Table 3). However, a slightly different pattern was seen for current symptoms of severe rhinoconjunctivitis in the 6- to 7-year age group with high prevalence for Pacific children and children in the other ethnicities category (Table 3). These differences were not explained by exposure to tobacco smoke. For 'hay fever ever', there was a high prevalence for European/Pakeha and 'other' ethnicities category for the 6- to 7-year age group compared with Māori and Pacific children, and for European/Pakeha compared with Māori/Pacific for the 13- to 14-year age group (Table 3).

Gender

A consistent pattern of higher prevalence among males in the 6- to 7-year age group and among females in the 13- to 14-year age group was observed for both current symptoms of rhinoconjunctivitis and 'hay fever ever' (Table 4). This pattern was also present for the 6- to 7-year age group for current symptoms of severe rhinoconjunctivitis, but no difference was seen for the 13- to 14-year age group (Table 4).

Time trends

For overall New Zealand results, the most striking finding is an increase from Phase One to Phase Three in 'hay fever ever' for both age groups (Table 2). In contrast, there was a small increase in current symptoms of rhinoconjunctivitis of 0.19% per year for the 6- to 7-year age group, and a small decrease of 0.13% per year for 13- to 14-year age group (Table 2). There was little change in the prevalence of current symptoms of severe rhinoconjunctivitis between Phase One and Phase Three for either age group (Table 2) with generally similar patterns for most centres. European/Pakeha respondents reported increases between Phases One and Three in prevalence for current symptoms of rhinoconjunctivitis and 'hay fever ever' for the 6- to 7-year age group, and for 'hay fever ever' for the 13- to 14-year age group (Table 3). In contrast, there was a decrease in prevalence for current symptoms of rhinoconjunctivitis for European/Pakeha 13- to 14-year-olds (Table 3). Māori respondents reported a generally consistent pattern of increases in prevalence for current symptoms of rhinoconjunctivitis and 'hay fever ever' in both age groups (Table 3). Pacific Island and the other ethnicities category showed little change in prevalence between Phase One and Phase Three (Table 3). There was also little change in prevalence between Phase One and Phase Three for current symptoms of severe rhinoconjunctivitis for all ethnicities (Table 3).

Table 5 Associations between selected environmental variables for current symptoms of rhinoconjunctivitis and current symptoms of severe rhinoconjunctivitis, 6- to 7-year age group

Question	Response	Current symptoms of rhinoconjunctivitis		Current symptoms of severe rhinoconjunctivitis	
		Odds ratio†	P value‡	Odds ratio†	P value‡
Consumption of pasta	Once or twice per week	1.02 (0.86, 1.21)	0.871	0.76 (0.39, 1.51)	0.009
	Three or more times a week	0.97 (0.78, 1.22)		2.35§ (1.01, 5.49)	
Exercise	Once or twice per week	1.31§ (1.08, 1.60)	0.026	1.21 (0.55, 2.66)	0.795
	Three or more times a week	1.22§ (1.00, 1.50)		1.26 (0.64, 2.46)	
Heating fuel	Gas only	1.04 (0.86, 1.25)	<0.001	0.89 (0.34, 2.34)	
	Fire/wood only	0.86 (0.73, 1.02)		0.65 (0.29, 1.45)	
	Other fuel only	1.01 (0.49, 2.10)			
	Multiple fuels	1.32§ (1.13, 1.55)		2.05§ (1.07, 3.93)	
Paracetamol in first year of life	Yes	2.38§ (1.89, 2.99)	<0.001	9.61§ (1.24, 74.64)	0.031
Current paracetamol use	At least once a year	2.01§ (1.46, 2.76)	<0.001		
	At least once a month	4.17§ (3.02, 5.74)			
Antibiotics in first year of life	Yes	1.94§ (1.69, 2.24)	<0.001	1.89§ (1.04, 3.46)	0.038
Older siblings	1 sibling	0.87§ (0.75, 1.00)	0.025	1.27 (0.66, 2.45)	0.889
	2 siblings	0.82§ (0.69, 0.97)		1.28 (0.57, 2.90)	
	3 or more siblings	0.80§ (0.64, 0.99)		1.19 (0.48, 2.92)	
Birth in New Zealand	Yes	1.67§ (1.29, 2.15)	<0.001	4.73§ (1.64, 13.61)	0.004
Years lived in New Zealand	4–5 years	0.80§ (0.66, 0.98)	0.006		
	2–3 years	0.61§ (0.40, 0.92)		0.21 (0.03, 1.62)	
	0–1 years	0.48§ (0.27, 0.85)		0.28 (0.05, 1.56)	

†Adjusted for centre, gender, ethnicity, school decile, month of study, maternal education and current maternal smoking. ‡P value for the overall association of the explanatory variable with the outcome variable. §95% confidence interval does not include 1. Blank cells represent cases where an odds ratio or P value could not be calculated due to the absence of data.

There was little difference between males and females with respect to time trends. Both genders reported similar patterns to the national results (Table 4).

Environmental risk factors

Full results of the analyses of environmental factors are included in Appendices I and II. Selected results are presented in Tables 5 and 6.

For current symptoms of rhinoconjunctivitis, there were positive associations with consumption of pasta (13- to 14-year age group), exercise (both age groups), multiple fuels used for heating (both age groups), birth in New Zealand (both age groups), current exposure to truck traffic in the street of residence (13- to 14-year age group), current cats and dogs in the home (13- to 14-year age group), current maternal cigarette smoking (13- to 14-year age group) and two or more cigarette smokers in the home (13- to 14-year age group), as well as paracetamol use in the past 12 months (both age groups). A strong positive association was also seen for questions only used in the 6- to 7-year age group questionnaire for paracetamol use in the first year of life, and a weaker association was seen for use of antibiotics in the first year of life. There were negative (protective) associations for having one or more older siblings (6- to 7-year age group) and having lived fewer years in New Zealand (both age groups) (Tables 5 and 6; Appendices I and II).

For current symptoms of severe rhinoconjunctivitis, there were positive associations with consumption of pasta (both age groups), multiple fuels used for heating (both age groups) and birth in New Zealand (6- to 7-year age group). Positive associations were also seen for questions used only for the 6- to 7-year age group questionnaire for paracetamol use in the first year of life and use of antibiotics in the first year of life (Tables 5 and 6; Appendices I and II). There were no negative (protective) associations identified for current symptoms of severe rhinoconjunctivitis (Appendices I and II).

No statistically significant associations were observed for all other combinations of the symptoms and environmental factors (Appendices I and II).

Addition of maternal education and current maternal smoking to the model were not found to significantly alter any of these environmental associations, apart from creating a weak negative association for consumption of milk with current severe rhinoconjunctivitis in 13- to 14-year-olds which was not reflected in current symptoms or in the younger age group and was therefore likely to be a chance finding.

Discussion

The methodology of the ISAAC surveys has been previously described and validated.⁵ In this paper, we have concentrated on current and severe symptoms of rhinoconjunctivitis in order to

Table 6 Associations between selected environmental variables for current symptoms of rhinoconjunctivitis and current symptoms of severe rhinoconjunctivitis, 13- to 14-year age group

Question	Response	Current symptoms of rhinoconjunctivitis		Current symptoms of severe rhinoconjunctivitis	
		Odds ratio†	P value‡	Odds ratio†	P value‡
Consumption of pasta	Once or twice per week	1.20§ (1.07, 1.35)	0.004	1.95§ (1.10, 3.47)	<0.001
	Three or more times a week	1.28§ (1.08, 1.52)		3.56§ (2.01, 6.32)	
Exercise	Once or twice per week	1.13 (0.99, 1.30)	0.005	0.75 (0.44, 1.27)	0.009
	Three or more times a week	1.29§ (1.10, 1.50)		1.50 (0.88, 2.56)	
Heating fuel	Gas only	1.15§ (1.00, 1.32)	<0.001	1.09 (0.56, 2.12)	0.984
	Fire/wood only	0.98 (0.83, 1.16)		1.01 (0.65, 1.57)	
	Other fuel only	1.22 (0.87, 1.71)		0.77 (0.10, 6.16)	
	Multiple fuels	1.43§ (1.28, 1.59)		1.17 (0.64, 2.13)	
Current paracetamol use	At least once a year	1.30§ (1.09, 1.57)	<0.001	0.69 (0.34, 1.39)	0.008
	At least once a month	2.30§ (1.92, 2.75)		1.56 (0.77, 3.15)	
Older siblings	1 sibling	0.93 (0.83, 1.05)	0.135	1.57 (0.89, 2.77)	0.149
	2 siblings	0.86 (0.73, 1.00)		1.29 (0.71, 2.34)	
	3 or more siblings	1.03 (0.90, 1.18)		1.95§ (1.06, 3.57)	
Birth in New Zealand	Yes	1.35§ (1.12, 1.62)	0.002	1.44 (0.67, 3.10)	0.357
Years lived in New Zealand	6–8 years	1.02 (0.80, 1.29)	<0.001	0.58 (0.12, 2.81)	0.347
	3–5 years	0.72§ (0.55, 0.95)		0.17 (0.02, 1.26)	
	0–2 years	0.51§ (0.37, 0.71)		0.98 (0.40, 2.38)	
Truck traffic in street of residence	Seldom	1.09 (0.96, 1.23)	0.017	0.53§ (0.30, 0.93)	0.004
	Frequently through the day	1.16§ (1.02, 1.31)		0.96 (0.61, 1.53)	
	Almost the whole day	1.35§ (1.11, 1.64)		1.75 (0.93, 3.31)	
Cat in home now	Yes	1.22§ (1.10, 1.36)	<0.001	1.44 (0.99, 2.09)	0.059
Dog in home now	Yes	1.14§ (1.03, 1.26)	0.012	1.75§ (1.16, 2.63)	0.007
Current maternal smoking	Yes	1.20§ (1.09, 1.32)	<0.001	1.35 (0.89, 2.06)	0.157
Number of smokers in the home	1 smoker	0.99 (0.88, 1.12)	<0.001	0.53 (0.23, 1.23)	0.164
	2 smokers	1.30§ (1.12, 1.51)		0.71 (0.28, 1.78)	
	3 or more smokers	1.28§ (1.08, 1.51)		0.98 (0.39, 2.43)	

†Adjusted for centre, gender, ethnicity, school decile, month of study and maternal education. All variables except current maternal smoking and number of smokers in the home are also adjusted for current maternal smoking. ‡P value for the overall association of the explanatory variable with the outcome variable. §95% confidence interval does not include 1. Blank cells represent cases where an odds ratio or P value could not be calculated due to the absence of data.

reflect chronic atopic disease and to minimise confounding from reports of incidental viral infections. In Phase One, we found that reporting of symptoms was affected by the season in which the questionnaire was completed so the analyses were adjusted to allow for this.⁹

The methodologies of a parent-completed questionnaire for the 6- to 7-year age group and a self-reported questionnaire for the 13- to 14-year age group are clearly very different and the findings from the two age groups cannot be directly compared.

This study has notable strengths including the use of several geographically spread centres in New Zealand, and use of a standardised methodology which allows valid comparisons with other ISAAC centres worldwide and across time periods. We achieved high participation among children and schools, and completed rigorous data and methodology checks.

There are some limitations of the study which should be recognised. Prevalence has been examined at two time points only, and estimates of yearly changes between Phase One and

Phase Three cannot be interpreted with confidence as a consistent linear change. Data on climatic variation and pollen exposure could not be collected. There is the possibility of recall bias with questions related to memories of past events for both parents and adolescents, which may be worse for adolescents who are unable to recall events in early life. We were not able to exclude all possible confounders, which may particularly affect environmental associations. Cultural variation, for example, could only be crudely measured by ethnicity and maternal education, and the associations for antibiotics and paracetamol could not be adjusted for childhood infections. The environmental questionnaire included a significant number of questions (50 for the 6- to 7-year age group and 38 for the 13- to 14-year age group). Some statistically significant associations may thus have occurred by chance and it is therefore important to focus on patterns of associations that are consistent across age groups and outcome measures. The questions in the environmental questionnaire were intentionally simple in order to be used in a population survey throughout the world;

consequently, in-depth questioning concerning any of the associations was not possible.

The clear association between symptom prevalence and length of time in New Zealand suggests that local environmental factors are important. A similar highly significant association with symptoms of asthma has also been reported.¹⁰ In ISAAC Phase Three, the prevalence of symptoms of rhinoconjunctivitis varied considerably between countries, from 1.8 to 24.2% in the 6- to 7-year age group and 1.0 to 45.1% in the 13- to 14-year age group.¹¹ The New Zealand equivalent figures of 11.4 and 18.0% are therefore relatively high for 6- to 7-year-olds and moderate for 13- to 14-year-olds, respectively.

Symptoms of rhinoconjunctivitis showed a slight but significant increase of 0.19% per year (OR 0.1–0.28) in the 6- to 7-year age group but not in the adolescents. Worldwide, more centres showed an increase in prevalence of current symptoms of rhinoconjunctivitis between Phases One and Three than decreases (44 centres vs. 9 in younger and 48 vs. 26 in older children).¹² 'Hay fever ever' increased in both age groups which could reflect family perceptions or medical diagnostic fashion rather than any true change, and is particularly susceptible to recall bias.

The change from a male predominance in younger children to higher rates in adolescent females is striking and was also noted for asthma,¹³ which may possibly be a reflection of hormonal change. In contrast, females showed a higher prevalence of current symptoms of eczema for both age groups in the worldwide ISAAC Phase One and Phase Three studies.^{14,15}

Prevalence rates by ethnicity of current symptoms of rhinoconjunctivitis were similar for the 6- to 7-year age group but showed a lower rate for European/Pakeha compared with Māori and Pacific people for the 13- to 14-year age group, and this difference is not explained by passive smoking. Māori and Pacific people disproportionately experience lower socioeconomic situations, so this may relate to adverse home conditions such as low temperature and dampness.^{16,17} By contrast, 'hay fever ever' was higher in Europeans at both ages, which could possibly be a reflection of greater use of medical services or cultural bias in the interpretation of symptoms.

Small geographic differences were apparent, with Nelson lowest for both age groups for current symptoms of rhinoconjunctivitis and Wellington much higher in the 13- to 14-year age group. Nelson is also noted to have a relatively lower prevalence for asthma.¹³ A similar pattern of low prevalence in Nelson for the 6- to 7-year age group and high prevalence in Wellington for the 13- to 14-year age group was noted in Phase One.¹⁸

Among the environmental factors, the use of paracetamol in infancy and in the past year showed a strong association with rhinoconjunctivitis symptoms, as it also has for asthma and eczema.^{10,19} The relationship with rhinoconjunctivitis and asthma may of course be confounded by the use of both paracetamol and antibiotics for those with nasal or chest symptoms which could be due to atopy. However, the use of paracetamol in the first year of life is unlikely to confound current symptoms. This association has been shown consistently both in New Zealand¹⁰ and international data,²⁰ and a possible causative biological mechanism has been proposed.^{19,21}

Antibiotic exposure in the first year of life is associated with symptoms in the 6- to 7-year age group, but is weaker than the

association with paracetamol, which is commonly given at the same time and may be a confounder. This association has been noted both for individuals²² and populations.²³ Exercise appears associated with increased rates of symptoms and could be related to upper airway cooling as well as exposure to allergens such as pollen in the external environment. There were no associations with time spent viewing television, which is an indicator of a sedentary lifestyle.

There was a paucity of consistent associations of symptoms of rhinitis and rhinoconjunctivitis with dietary factors apart from a positive association with frequent pasta consumption in both age groups. However, no association was found with wheat in the form of cereals and bread. While the association with pasta consumption may therefore not be causative but reflect other differences in lifestyle, it is noted that it was also reported among children living in the Pacific Islands,²⁴ where rhinoconjunctivitis was associated with regular consumption of meat, pasta and butter. Pasta has also been described as a risk factor for eczema,²⁵ and wheat allergens have been identified²⁶ and need further consideration. The country level study by Ellwood *et al.*²⁷ showed decreases in symptoms of rhinoconjunctivitis, in countries that consumed more cereal, rice, starch and protein from vegetable sources, but pasta as a food group was not examined.

Analysis of heating methods showed increased symptoms in households using multiple heating methods and possibly could relate to exposure to irritating fumes but the questionnaire did not directly address this. However, specific exposures to gas and solid fuel heating methods did not show any association with prevalence of symptoms of rhinoconjunctivitis. A detailed study of the effect of heating fuels and use of flues to remove fumes is required to provide more information concerning this association.

In this study, breastfeeding or early exposure to farm animals did not show any significant association with symptoms of rhinoconjunctivitis in later years. Exposure to respiratory irritants such as smoke and truck fumes was significant in the older age group but not the younger, which may possibly indicate a greater susceptibility to these factors in the teenage years or just reflect the difference in sensitivity between the parental and personal questionnaire.

In conclusion, symptoms of rhinoconjunctivitis are very common in New Zealand children especially in Māori and Pacific Island groups, and local environmental and lifestyle factors are likely to be very important. Paracetamol ingestion may be a causative factor but will require clinical trials to elucidate the association further. Weaker associations were noted with exercise and pasta ingestion. The New Zealand home environment also warrants further study particularly in relation to temperature, humidity and heating fumes.

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Appendix I

Odds ratios for current symptoms of rhinoconjunctivitis and current symptoms of severe rhinoconjunctivitis, 6- to 7-year age group

Question	Response	Current symptoms of rhinoconjunctivitis			Current symptoms of severe rhinoconjunctivitis		
		Prevalence %	Odds ratio†	P value‡	Prevalence %	Odds ratio†	P value‡
Body mass index	Normal	11.5		0.598	0.4		0.606
	Overweight	12.5	1.09 (0.88, 1.34)		0.3	0.72 (0.20, 2.53)	
	Obese	10.7	0.92 (0.67, 1.25)		0.9	1.46 (0.53, 4.05)	
Consumption of meat	Never or occasionally	12.7		0.827	0.7		0.519
	Once or twice per week	11.4	0.91 (0.62, 1.35)		0.4	0.66 (0.14, 3.19)	
	Three or more times a week	11.3	0.90 (0.64, 1.28)		0.5	0.95 (0.21, 4.32)	
Consumption of seafood	Never or occasionally	11.5		0.718	0.5		0.665
	Once or twice per week	11.5	1.02 (0.90, 1.15)		0.5	0.99 (0.57, 1.73)	
	Three or more times a week	10.0	0.86 (0.58, 1.28)		0.3	0.40 (0.05, 2.96)	
Consumption of fruit	Never or occasionally	9.1		0.359	0.0		
	Once or twice per week	10.7	1.18 (0.74, 1.87)		0.6		
	Three or more times a week	11.5	1.29 (0.84, 1.98)		0.5		
Consumption of vegetables	Never or occasionally	12.4		0.639	0.6		0.895
	Once or twice per week	11.5	0.94 (0.71, 1.25)		0.7	1.22 (0.37, 4.00)	
	Three or more times a week	11.4	0.90 (0.69, 1.17)		0.4	1.06 (0.33, 3.40)	
Consumption of pulses	Never or occasionally	10.6		0.092	0.4		0.848
	Once or twice per week	12.0	1.16§ (1.02, 1.33)		0.5	1.22 (0.62, 2.40)	
	Three or more times a week	11.5	1.10 (0.93, 1.29)		0.4	1.16 (0.51, 2.67)	
Consumption of cereal	Never or occasionally	17.7		0.101	0.8		0.965
	Once or twice per week	10.7	0.55 (0.29, 1.02)		0.9	1.18 (0.13, 11.17)	
	Three or more times a week	11.4	0.56§ (0.33, 0.95)		0.4	1.03 (0.14, 7.65)	
Consumption of pasta	Never or occasionally	11.2		0.871	0.7		0.009
	Once or twice per week	11.6	1.02 (0.86, 1.21)		0.3	0.76 (0.39, 1.51)	
	Three or more times a week	11.4	0.97 (0.78, 1.22)		1.1	2.35§ (1.01, 5.49)	
Consumption of rice	Never or occasionally	10.4		0.140	0.6		0.213
	Once or twice per week	11.9	1.14 (0.96, 1.35)		0.3	0.57 (0.29, 1.10)	
	Three or more times a week	10.7	1.03 (0.83, 1.27)		0.8	0.54 (0.22, 1.31)	
Consumption of butter	Never or occasionally	12.4		0.018	0.3		0.336
	Once or twice per week	10.7	0.84§ (0.72, 0.98)		0.4	1.03 (0.44, 2.41)	
	Three or more times a week	10.8	0.84§ (0.74, 0.96)		0.6	1.50 (0.81, 2.80)	
Consumption of margarine	Never or occasionally	10.6		0.160	0.4		0.709
	Once or twice per week	12.1	1.17 (0.97, 1.42)		0.6	1.29 (0.50, 3.31)	
	Three or more times a week	11.8	1.14 (0.98, 1.32)		0.5	1.30 (0.69, 2.43)	
Consumption of nuts	Never or occasionally	11.7		0.542	0.4		0.479
	Once or twice per week	10.9	0.92 (0.80, 1.07)		0.6	1.28 (0.68, 2.44)	
	Three or more times a week	11.2	0.95 (0.69, 1.29)		0.9	1.88 (0.61, 5.78)	
Consumption of potato	Never or occasionally	10.5		0.608	0.7		0.417
	Once or twice per week	11.3	1.07 (0.78, 1.46)		0.4	0.73 (0.20, 2.65)	
	Three or more times a week	11.6	1.13 (0.82, 1.56)		0.5	1.08 (0.30, 3.90)	
Consumption of milk	Never or occasionally	14.7		0.011	0.4		0.997
	Once or twice per week	12.3	0.82 (0.60, 1.10)		0.5	0.99 (0.20, 5.02)	
	Three or more times a week	11.1	0.70§ (0.54, 0.91)		0.5	0.97 (0.25, 3.76)	
Consumption of eggs	Never or occasionally	12.2		0.188	0.5		0.740
	Once or twice per week	11.4	0.92 (0.80, 1.06)		0.4	0.82 (0.44, 1.53)	
	Three or more times a week	10.2	0.82 (0.66, 1.02)		0.6	0.71 (0.29, 1.77)	
Consumption of fast food	Never or occasionally	11.3		0.367	0.5		0.194
	Once or twice per week	11.4	1.00 (0.87, 1.16)		0.4	0.60 (0.35, 1.05)	
	Three or more times a week	14.0	1.26 (0.91, 1.73)		0.7	0.60 (0.12, 2.84)	
Exercise	Never or occasionally	9.5		0.026	0.6		0.795
	Once or twice per week	12.0	1.31§ (1.08, 1.60)		0.5	1.21 (0.55, 2.66)	
	Three or more times a week	11.6	1.22§ (1.00, 1.50)		0.4	1.26 (0.64, 2.46)	

Appendix I (Continued)

Question	Response	Current symptoms of rhinoconjunctivitis			Current symptoms of severe rhinoconjunctivitis		
		Prevalence %	Odds ratio†	P value‡	Prevalence %	Odds ratio†	P value‡
Television viewing	Less than 1 h	11.2		0.635	0.5		0.239
	1 h but less than 3 h	11.7	1.06 (0.89, 1.25)		0.3	0.58 (0.28, 1.21)	
	3 h but less than 5 h	10.7	0.97 (0.78, 1.21)		0.6	0.83 (0.34, 2.01)	
	5 h or more	12.3	1.11 (0.83, 1.47)		0.9	1.23 (0.46, 3.28)	
Cooking fuel	Electricity only	11.1		0.165	0.5		
	Gas only	12.0	1.05 (0.84, 1.32)		0.5	1.12 (0.43, 2.93)	
	Fire/wood only	19.1	1.92 (0.89, 4.13)		2.4	6.21 (0.73, 52.98)	
	Other fuel only	9.1	0.85 (0.11, 6.73)		0.0		
	Multiple fuels	13.0	1.18 (0.97, 1.43)		0.5	1.38 (0.47, 4.04)	
Heating fuel	Electricity only	11.3		<0.001	0.6		
	Gas only	11.4	1.04 (0.86, 1.25)		0.4	0.89 (0.34, 2.34)	
	Fire/wood only	9.5	0.86 (0.73, 1.02)		0.2	0.65 (0.29, 1.45)	
	Other fuel only	11.3	1.01 (0.49, 2.10)		0.0		
	Multiple fuels	14.3	1.32§ (1.13, 1.55)		0.7	2.05§ (1.07, 3.93)	
Paracetamol in first year of life	No	5.6		<0.001	0.1		0.031
	Yes	12.3	2.38§ (1.89, 2.99)		0.5	9.61§ (1.24, 74.64)	
Current paracetamol use	Never	5.2		<0.001	0.0		
	At least once a year	10.0	2.01§ (1.46, 2.76)		0.2		
	At least once a month	17.8	4.17§ (3.02, 5.74)		1.4		
Antibiotics in first year of life	No	7.5		<0.001	0.3		0.038
	Yes	13.8	1.94§ (1.69, 2.24)		0.6	1.89§ (1.04, 3.46)	
Older siblings	0 siblings	12.5		0.025	0.4		0.889
	1 sibling	11.0	0.87§ (0.75, 1.00)		0.5	1.27 (0.66, 2.45)	
	2 siblings	10.5	0.82§ (0.69, 0.97)		0.5	1.28 (0.57, 2.90)	
	3 or more siblings	10.3	0.80§ (0.64, 0.99)		0.6	1.19 (0.48, 2.92)	
Younger siblings	0 siblings	11.2		0.179	0.6		0.293
	1 sibling	11.9	1.08 (0.94, 1.24)		0.3	0.48 (0.22, 1.06)	
	2 siblings	9.7	0.86 (0.69, 1.07)		0.4	0.63 (0.23, 1.75)	
	3 or more siblings	13.6	1.20 (0.85, 1.70)		0.9	0.98 (0.30, 3.20)	
Birth in New Zealand	No	8.0		<0.001	0.2		0.004
	Yes	11.9	1.67§ (1.29, 2.15)		0.5	4.73§ (1.64, 13.61)	
Years lived in New Zealand	6 years or more	12.0		0.006	0.5		
	4–5 years	10.5	0.80§ (0.66, 0.98)		0.0		
	2–3 years	8.7	0.61§ (0.40, 0.92)		0.3	0.21 (0.03, 1.62)	
	0–1 years	6.9	0.48§ (0.27, 0.85)		0.4	0.28 (0.05, 1.56)	
Maternal education	Tertiary institution	12.0		0.085	0.4		0.929
	Secondary school	10.8	0.89§ (0.79, 1.00)		0.5	0.97 (0.55, 1.72)	
	Primary school	12.6	1.11 (0.85, 1.44)		0.8	1.24 (0.48, 3.24)	
	No response	8.5	0.76 (0.48, 1.20)		0.7	1.44 (0.31, 6.61)	
Truck traffic in street of residence	Never	10.9		0.032	0.5		0.097
	Seldom	10.8	0.97 (0.82, 1.16)		0.3	0.52 (0.22, 1.24)	
	Frequently through the day	12.5	1.18 (0.99, 1.41)		0.6	0.92 (0.38, 2.24)	
	Almost the whole day	12.9	1.22 (0.95, 1.56)		1.1	1.41 (0.48, 4.11)	
Birthweight	More than 4 kg	13.2		0.318	0.4		0.743
	3.5–4 kg	11.8	0.88 (0.72, 1.06)		0.4	1.28 (0.45, 3.65)	
	3–3.5 kg	11.0	0.83 (0.68, 1.01)		0.5	1.51 (0.59, 3.85)	
	2.5–3 kg	10.8	0.83 (0.66, 1.03)		0.5	1.32 (0.35, 4.98)	
	Less than 2.5 kg	12.8	0.96 (0.73, 1.25)		0.2	0.46 (0.05, 4.25)	
Breastfed	No	10.5		0.296	0.8		0.085
	Yes	11.6	1.09 (0.93, 1.28)		0.4	0.60 (0.33, 1.07)	
Cat in home in first year of life	No	11.0		0.126	0.6		0.593
	Yes	12.0	1.10 (0.97, 1.25)		0.4	1.18 (0.65, 2.13)	
Cat in home now	No	10.9		0.077	0.6		0.745
	Yes	11.8	1.11 (0.99, 1.25)		0.3	0.90 (0.48, 1.70)	

Appendix I (Continued)

Question	Response	Current symptoms of rhinoconjunctivitis			Current symptoms of severe rhinoconjunctivitis		
		Prevalence %	Odds ratio†	P value‡	Prevalence %	Odds ratio†	P value‡
Dog in home in first year of life	No	11.2		0.329	0.5		0.766
	Yes	11.8	1.07 (0.94, 1.21)		0.4	0.91 (0.51, 1.65)	
Dog in home now	No	11.4		0.904	0.5		0.441
	Yes	11.3	1.01 (0.89, 1.14)		0.5	1.28 (0.68, 2.41)	
Exposure to farm animals in first year of life	No	11.4		0.859	0.5		0.711
	Yes	11.3	1.02 (0.83, 1.25)		0.5	1.18 (0.50, 2.77)	
Maternal exposure to farm animals during pregnancy	No	11.2		0.101	0.5		0.700
	Yes	12.8	1.19 (0.97, 1.47)		0.3	0.79 (0.24, 2.60)	
Current maternal smoking	No	11.3		0.380	0.5		0.997
	Yes	11.7	1.07 (0.92, 1.24)		0.5	1.00 (0.55, 1.81)	
Number of cigarettes smoked by mother each day	No cigarettes	11.3		0.306	0.5		0.755
	Less than 10	13.2	1.21 (0.99, 1.49)		0.7	1.27 (0.58, 2.78)	
	10–19	11.1	1.01 (0.83, 1.23)		0.3	0.68 (0.22, 2.10)	
	20 or more	10.8	0.98 (0.71, 1.35)		0.3	0.56 (0.08, 4.00)	
Current paternal smoking	No	11.2		0.288	0.5		0.168
	Yes	11.8	1.09 (0.93, 1.27)		0.4	0.63 (0.33, 1.21)	
Number of cigarettes smoked by father each day	No cigarettes	11.2		0.928	0.5		0.096
	Less than 10	11.3	1.04 (0.80, 1.35)		0.1	0.17 (0.02, 1.35)	
	10–19	11.3	1.03 (0.83, 1.28)		0.2	0.29 (0.07, 1.16)	
	20 or more	11.7	1.08 (0.85, 1.39)		0.8	1.28 (0.48, 3.39)	
Maternal smoking in first year of life	No	11.3		0.811	0.5		0.607
	Yes	11.5	1.02 (0.85, 1.23)		0.5	0.78 (0.31, 1.99)	
Number of smokers in the home	No smokers	11.1		0.185	0.4		0.723
	1 smoker	12.5	1.24§ (1.02, 1.51)		0.6	0.93 (0.47, 1.86)	
	2 smokers	11.4	1.17 (0.90, 1.52)		0.5	0.65 (0.20, 2.05)	
	3 or more smokers	10.9	1.07 (0.72, 1.59)		0.3	0.37 (0.05, 2.74)	
Combined parental smoking	Neither smokes	11.0		0.145	0.5		0.309
	Father smokes	12.5	1.21§ (1.00, 1.46)		0.5	0.85 (0.38, 1.88)	
	Mother smokes	12.2	1.17 (0.96, 1.41)		0.8	1.44 (0.72, 2.87)	
	Both smoke	11.2	1.07 (0.88, 1.30)		0.3	0.58 (0.24, 1.44)	

†Adjusted for centre, gender, ethnicity, school decile and month of study. All variables except maternal education are also adjusted for maternal education. All variables except the cigarette smoking variables are also adjusted for current maternal smoking. ‡P value for the overall association of the explanatory variable with the outcome variable. §95% confidence interval does not include 1. Blank cells represent cases where an odds ratio or P value could not be calculated due to the absence of data.

Appendix II

Odds ratios for current symptoms of rhinoconjunctivitis and current symptoms of severe rhinoconjunctivitis, 13- to 14-year age group

Question	Response	Current symptoms of rhinoconjunctivitis			Current symptoms of severe rhinoconjunctivitis		
		Prevalence %	Odds ratio†	P value‡	Prevalence %	Odds ratio†	P value‡
Body mass index	Normal	17.2		0.426	0.4		0.256
	Overweight	16.1	0.91 (0.78, 1.05)		0.9	1.84 (0.85, 3.96)	
	Obese	17.8	0.96 (0.73, 1.27)		0.8	1.15 (0.37, 3.57)	
Consumption of meat	Never or occasionally	18.9		0.003	0.6		0.767
	Once or twice per week	16.9	0.92 (0.71, 1.19)		0.9	1.39 (0.49, 3.92)	
	Three or more times a week	18.8	1.08 (0.83, 1.40)		0.8	1.67 (0.45, 3.52)	
Consumption of seafood	Never or occasionally	17.6		0.009	0.6		0.230
	Once or twice per week	18.7	1.15§ (1.04, 1.27)		0.9	1.32 (0.93, 1.89)	
	Three or more times a week	18.6	1.15 (0.90, 1.46)		1.6	1.69 (0.79, 3.64)	
Consumption of fruit	Never or occasionally	20.7		0.077	0.7		0.403
	Once or twice per week	17.9	0.79§ (0.64, 0.98)		0.7	0.83 (0.26, 2.62)	
	Three or more times a week	18.0	0.78§ (0.63, 0.97)		0.9	1.13 (0.45, 2.89)	
Consumption of vegetables	Never or occasionally	19.5		0.781	1.1		0.318
	Once or twice per week	17.9	0.93 (0.73, 1.19)		0.8	0.79 (0.43, 1.43)	
	Three or more times a week	18.0	0.97 (0.78, 1.20)		0.8	1.07 (0.54, 2.12)	
Consumption of pulses	Never or occasionally	18.6		0.092	0.8		0.020
	Once or twice per week	17.3	0.98 (0.88, 1.08)		0.6	0.90 (0.57, 1.41)	
	Three or more times a week	18.7	1.09 (0.99, 1.19)		1.1	1.58 (0.97, 2.58)	
Consumption of cereal	Never or occasionally	19.2		0.704	1.4		0.007
	Once or twice per week	19.0	1.01 (0.85, 1.21)		1.1	0.74 (0.38, 1.46)	
	Three or more times a week	17.7	0.96 (0.80, 1.16)		0.7	0.50§ (0.29, 0.86)	
Consumption of pasta	Never or occasionally	16.7		0.004	0.5		<0.001
	Once or twice per week	18.4	1.20§ (1.07, 1.35)		0.8	1.95§ (1.10, 3.47)	
	Three or more times a week	19.8	1.28§ (1.08, 1.52)		1.6	3.56§ (2.01, 6.32)	
Consumption of rice	Never or occasionally	17.2		0.080	0.7		0.525
	Once or twice per week	18.2	1.10 (0.99, 1.22)		0.7	1.04 (0.60, 1.78)	
	Three or more times a week	19.1	1.18§ (1.02, 1.38)		1.2	1.43 (0.69, 2.98)	
Consumption of butter	Never or occasionally	18.4		0.213	0.7		0.612
	Once or twice per week	17.1	0.91 (0.81, 1.02)		0.7	0.83 (0.53, 1.32)	
	Three or more times a week	18.7	0.99 (0.89, 1.11)		0.9	0.99 (0.59, 1.67)	
Consumption of margarine	Never or occasionally	16.9		0.241	0.6		0.695
	Once or twice per week	18.5	1.11 (0.98, 1.26)		0.8	1.09 (0.62, 1.94)	
	Three or more times a week	18.4	1.07 (0.96, 1.21)		0.9	1.25 (0.72, 2.16)	
Consumption of nuts	Never or occasionally	18.0		0.207	0.8		<0.001
	Once or twice per week	17.9	1.05 (0.95, 1.16)		0.6	0.75 (0.43, 1.31)	
	Three or more times a week	19.5	1.19 (0.97, 1.46)		2.2	2.45§ (1.45, 4.15)	
Consumption of potato	Never or occasionally	18.1		0.007	0.8		0.360
	Once or twice per week	16.7	0.90 (0.76, 1.07)		0.7	0.93 (0.39, 2.19)	
	Three or more times a week	19.1	1.04 (0.88, 1.23)		0.9	1.26 (0.53, 3.02)	
Consumption of milk	Never or occasionally	19.0		0.545	0.8		0.043
	Once or twice per week	17.8	0.89 (0.72, 1.11)		0.5	0.61 (0.28, 1.31)	
	Three or more times a week	18.1	0.93 (0.75, 1.17)		0.9	1.09 (0.48, 2.50)	
Consumption of eggs	Never or occasionally	19.0		0.197	0.5		0.070
	Once or twice per week	17.4	0.92 (0.84, 1.01)		0.8	1.51 (0.92, 2.45)	
	Three or more times a week	18.7	0.97 (0.84, 1.12)		1.2	1.90§ (1.10, 3.26)	
Consumption of fast food	Never or occasionally	17.6		<0.001	0.7		0.002
	Once or twice per week	17.2	0.94 (0.83, 1.06)		0.6	0.76 (0.51, 1.14)	
	Three or more times a week	22.4	1.23§ (1.03, 1.48)		1.7	1.63§ (1.00, 2.64)	
Exercise	Never or occasionally	16.1		0.005	1.0		0.009
	Once or twice per week	17.9	1.13 (0.99, 1.30)		0.6	0.75 (0.44, 1.27)	
	Three or more times a week	18.7	1.29§ (1.10, 1.50)		1.0	1.50 (0.88, 2.56)	

Appendix II (Continued)

Question	Response	Current symptoms of rhinoconjunctivitis			Current symptoms of severe rhinoconjunctivitis		
		Prevalence %	Odds ratio†	P value‡	Prevalence %	Odds ratio†	P value‡
Television viewing	Less than 1 h	17.5		0.920	1.1		0.003
	1 h but less than 3 h	17.5	1.00 (0.86, 1.17)		0.4	0.41§ (0.23, 0.71)	
	3 h but less than 5 h	18.2	1.04 (0.89, 1.20)		0.8	0.66 (0.36, 1.21)	
	5 h or more	18.7	1.03 (0.86, 1.23)		1.3	0.93 (0.54, 1.60)	
Cooking fuel	Electricity only	17.8		0.092	0.8		<0.001
	Gas only	17.9	1.06 (0.90, 1.24)		0.4	0.58 (0.28, 1.19)	
	Fire/wood only	20.6	1.40 (0.71, 2.77)		3.2	4.16 (0.92, 18.90)	
	Other fuel only	26.7	1.76 (0.89, 3.48)		6.7	6.67§ (2.13, 20.92)	
	Multiple fuels	20.1	1.12 (0.92, 1.37)		1.3	1.79 (0.90, 3.56)	
Heating fuel	Electricity only	16.9		<0.001	0.8		0.984
	Gas only	18.6	1.15§ (1.00, 1.32)		0.8	1.09 (0.56, 2.12)	
	Fire/wood only	15.2	0.98 (0.83, 1.16)		0.7	1.01 (0.65, 1.57)	
	Other fuel only	19.3	1.22 (0.87, 1.71)		0.7	0.77 (0.10, 6.16)	
	Multiple fuels	22.1	1.43§ (1.28, 1.59)		0.8	1.17 (0.64, 2.13)	
Current paracetamol use	Never	10.5		<0.001	0.7		0.008
	At least once a year	13.9	1.30§ (1.09, 1.57)		0.5	0.69 (0.34, 1.39)	
	At least once a month	23.0	2.30§ (1.92, 2.75)		1.1	1.56 (0.77, 3.15)	
Older siblings	0 siblings	18.2		0.135	0.5		0.149
	1 sibling	17.2	0.93 (0.83, 1.05)		0.8	1.57 (0.89, 2.77)	
	2 siblings	16.4	0.86 (0.73, 1.00)		0.7	1.29 (0.71, 2.34)	
	3 or more siblings	20.0	1.03 (0.90, 1.18)		1.4	1.95§ (1.06, 3.57)	
Younger siblings	0 siblings	16.4		0.084	0.8		0.050
	1 sibling	18.6	1.14§ (1.03, 1.27)		0.6	0.75 (0.45, 1.26)	
	2 siblings	18.5	1.09 (0.99, 1.21)		0.6	0.63 (0.32, 1.22)	
	3 or more siblings	20.5	1.13 (0.95, 1.35)		1.6	1.44 (0.87, 2.37)	
Birth in New Zealand	No	14.6		0.002	0.7		0.357
	Yes	18.7	1.35§ (1.12, 1.62)		0.8	1.44 (0.67, 3.10)	
Years lived in New Zealand	9 years or more	18.6		<0.001	0.8		0.347
	6–8 years	19.0	1.02 (0.80, 1.29)		0.6	0.58 (0.12, 2.81)	
	3–5 years	14.4	0.72§ (0.55, 0.95)		0.2	0.17 (0.02, 1.26)	
	0–2 years	10.9	0.51§ (0.37, 0.71)		1.0	0.98 (0.40, 2.38)	
Maternal education	Tertiary Institution	17.5		0.186	0.8		0.367
	Secondary school	17.3	0.92 (0.82, 1.02)		0.8	0.85 (0.54, 1.35)	
	Primary school	15.9	0.79 (0.57, 1.10)		2.2	1.92 (0.75, 4.92)	
	No response	20.0	1.01 (0.88, 1.15)		0.8	0.83 (0.49, 1.41)	
Truck traffic in street of residence	Never	15.6		0.017	0.9		0.004
	Seldom	17.7	1.09 (0.96, 1.23)		0.5	0.53§ (0.30, 0.93)	
	Frequently through the day	19.0	1.16§ (1.02, 1.31)		1.0	0.96 (0.61, 1.53)	
	Almost the whole day	21.6	1.35§ (1.11, 1.64)		2.1	1.75 (0.93, 3.31)	
Cat in home now	No	16.5		<0.001	0.8		0.059
	Yes	18.9	1.22§ (1.10, 1.36)		0.8	1.44 (0.99, 2.09)	
Dog in home now	No	17.1		0.012	0.6		0.007
	Yes	19.0	1.14§ (1.03, 1.26)		1.0	1.75§ (1.16, 2.63)	
Current maternal smoking	No	16.9		<0.001	0.7		0.157
	Yes	20.8	1.20§ (1.09, 1.32)		1.1	1.35 (0.89, 2.06)	
Number of smokers in the home	No smokers	16.8		<0.001	0.7		0.164
	1 smoker	17.5	0.99 (0.88, 1.12)		0.6	0.53 (0.23, 1.23)	
	2 smokers	22.5	1.30§ (1.12, 1.51)		1.1	0.71 (0.28, 1.78)	
	3 or more smokers	22.9	1.28§ (1.08, 1.51)		1.6	0.98 (0.39, 2.43)	

†Adjusted for centre, gender, ethnicity, school decile and month of study. All variables except maternal education are also adjusted for maternal education. All variables except the cigarette smoking variables are also adjusted for current maternal smoking. ‡P value for the overall association of the explanatory variable with the outcome variable. §95% confidence interval does not include 1. Blank cells represent cases where an odds ratio or P value could not be calculated due to the absence of data.