

Risk factors for symptoms of childhood asthma, allergic rhinoconjunctivitis and eczema in the Pacific: an ISAAC Phase III study

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SUMMARY

BACKGROUND AND METHODS: Phase III of the International Study of Asthma and Allergies in Childhood (ISAAC) was conducted in eight Pacific countries, five of which (Samoa, Fiji, Tokelau, French Polynesia and New Caledonia) collected environmental questionnaire (EQ) data. We report the findings of the EQ analyses below.

RESULTS: The major factors associated with current wheeze were regular margarine consumption (prevalence odds ratio [POR] 1.19, 95%CI 1.01–1.40), paracetamol use (POR 1.35, 95%CI 1.11–1.64), electric cooking (POR 1.42, 95%CI 1.11–1.80), regular exercise (POR 1.44, 95%CI 1.18–1.75) and maternal smoking (POR 1.16, 95%CI 1.01–1.33). Protective factors included having older siblings (two or more POR 0.69, 95%CI 0.58–0.82; one POR 0.86, 95%CI 0.71–1.05), and being born in

the country of the survey (POR 0.74, 95%CI 0.63–0.87). Risk factors for rhinoconjunctivitis included regular consumption of meat, butter, margarine and nuts, regular exercise, regular television viewing, paracetamol use and passive smoking. Eczema was associated with regular meat, pasta and butter consumption, regular television viewing, paracetamol use and passive smoking.

CONCLUSIONS: Regular meat and margarine consumption, paracetamol use, electric cooking and passive smoking are risk factors for symptoms of asthma, rhinoconjunctivitis and eczema in the Pacific. However, most of these associations were weak, and account for only a small proportion of cases.

KEY WORDS: asthma; epidemiology; ISAAC study; Pacific; risk factors

THE INTERNATIONAL STUDY of Asthma and Allergies in Childhood (ISAAC) has provided valuable information regarding international prevalence patterns and potential risk factors in the development of asthma, allergic rhinoconjunctivitis and eczema.^{1,2} However, although Australia and New Zealand participated in Phase I of ISAAC, only a small number of Pacific children were included and no Pacific countries participated. The ISAAC Phase III study not only involved repeating the survey in centres that had participated in Phase I (Phase IIIA centres), but also included new centres that had not previously participated (Phase IIIB centres),³ including eight centres in the Pacific.⁴ We have previously reported the ISAAC Phase III Pacific findings on symptom prevalence.⁴ In the present study, we report on risk factors for the prevalence of these symptoms in the Pacific.

METHODS

The methods of the basic Phase III prevalence surveys have been described previously.^{3–6} Following clearance

by the respective national ethics committees or appropriate national authorities (some countries had no identified ethics committee), meetings were arranged and held with both government and non-government education authorities in each country. Letters to parents were distributed via schools where appropriate, and parents were requested to contact the school only if they did not wish their children to participate; no contact or action from the parents was taken as passive consent.

The Pacific countries that participated in ISAAC Phase III included Tonga, Fiji Islands, Samoa, Cook Islands, Tokelau Islands, Niue, French Polynesia and New Caledonia. Of these, Samoa ($n = 2988$), Fiji Islands ($n = 3093$) and Tokelau ($n = 66$) included the ISAAC Phase III environmental questionnaire (EQ). French Polynesia ($n = 4289$) and New Caledonia ($n = 7247$) were 'late Phase I' centres and the surveys were conducted before the ISAAC EQ was finalised. However, these two centres used their own EQs and many of the questions were identical or comparable to the ISAAC EQ questions. There were also some questions

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that were not used in Fiji, Samoa or Tokelau because there was no appropriate translation (e.g., the question on pasta consumption). For each question, we have included only data from centres that had relevant and comparable data.

In the data analyses, we followed the standard practice for ISAAC questionnaires and coded a missing response to a symptom question as 'no symptoms',^{1,2} whereas for the questions on environmental exposures, missing values were treated as 'missing'. To avoid too many study participants being excluded from the multivariate analysis because of missing values, the multivariate analysis was conducted separately for each exposure variable: in each instance, participants with missing values for the 'main' variable were excluded, whereas missing values for the potential confounders were represented by indicator variables.

The data were analysed using standard methods for asthma prevalence studies,⁷ i.e., using prevalence odds ratios (PORs), with adjustment for confounding using logistic regression.⁸ After conducting separate analyses for each participating country, it was found that the key findings were very similar across the centres, and the data sets were combined in the final analyses, which were adjusted for country as well as age and sex. In the final model, we also carried out tests for heterogeneity by country.

RESULTS

Table 1 shows the associations between potential risk and/or protective factors and symptoms for all countries combined, adjusted for age, sex and country. There were statistically significant associations between wheezing in the last 12 months and using margarine ≥ 1 times a week (POR 1.20), exercising ≥ 1 times a week (POR 1.37), electric cooking (POR 1.50), using paracetamol at least once a month in the previous year (POR 1.41) and maternal smoking (POR 1.22). There were protective effects for consumption of nuts ≥ 1 times a week (POR 0.81), having older siblings (two or more POR 0.66; one POR 0.84) and having been born in the country of the survey (POR 0.67).

There were also significant associations between having ever had asthma and several environmental variables. Among the dietary variables there were associations with having meat ≥ 3 times a week (POR 1.15), having pasta ≥ 1 /week (POR 1.28), having rice ≥ 1 times a week (POR 1.83), having margarine ≥ 1 times a week (POR 1.33), having milk ≥ 3 times a week (POR 1.17) and electric cooking (POR 1.65). Exercise ≥ 3 times a week also showed a weak but statistically significant association with 'asthma ever' (POR 1.17), as did watching television ≥ 3 h a day (POR 1.17). Maternal smoking was also associated with having ever had asthma (POR 1.14). In contrast with the findings for 'wheeze ever', there was little evi-

dence of a protective effect of having older siblings, but there was a protective effect of having been born in the country of the survey (POR 0.72).

For current symptoms of allergic rhinoconjunctivitis, the strongest associations were for regular consumption of meat (POR 1.22), fruit (POR 1.15), butter (POR 1.22), margarine (POR 1.14), nuts (POR 1.15), potatoes (POR 1.18) and fast food (POR 1.16), as well as regular exercise (POR 1.19), regular television viewing (POR 1.24), paracetamol use in the previous year (POR 1.16), regular truck traffic (POR 1.29), current cat (POR 1.33) or dog (POR 1.13) ownership and having two or more smokers in the house (POR 1.15).

For current eczema symptoms, the strongest associations were for regular consumption of meat (POR 1.30), seafood (POR 1.22), cereal (POR 1.37), pasta (POR 1.27), rice (POR 1.86), butter (POR 1.29) and nuts (POR 1.22), as well as for regular television viewing (POR 1.37), paracetamol use in the previous year (POR 1.47), current cat ownership (POR 1.20), maternal smoking (POR 1.23) and having two or more smokers in the house (POR 1.50). There was a protective effect of having been born in the country of the survey (POR 0.83).

Table 2 shows the findings of a multiple logistic regression analysis for all countries combined, adjusting for age, sex and country, and all other variables in the model. The analysis included those factors that were of a priori interest and/or which showed elevated risks in the univariate analyses for 'current wheeze' or 'asthma ever' (Table 1). The strongest associations with 'current wheeze' were for regular margarine consumption (POR 1.19), electric cooking (POR 1.42), paracetamol use in the previous year (POR 1.35) and maternal smoking (POR 1.16). Protective factors included having older siblings (two or more POR 0.69; one POR 0.86), and being born in the country of the survey (POR 0.74).

However, none of these risk factors had high population attributable risks (PAR). For example, the highest odds ratio (OR) (1.44) in the multiple regression analysis (Table 2) was for exercise ≥ 3 times a week; 27% of survey participants were in this exercise category, yielding a PAR of 11%. Other risk factors included paracetamol use at least once a month (PAR 6%), use of electricity for cooking (PAR 6%) and use of margarine one or more times a week (PAR 7%).

Type of cooking was the only variable in Table 2 that showed significant heterogeneity ($P = 0.01$) by country for wheeze in the last 12 months, with ORs for electric cooking of 1.21 (95% confidence interval [CI] 0.94–1.56) in Fiji, 2.10 (95%CI 1.53–2.88) in Samoa, 0.47 (95%CI 0.05–4.81) in Tokelau and 0.99 (95%CI 0.71–1.37) in New Caledonia (the French Polynesia survey did not collect data on this variable).

The findings for 'asthma ever' were generally similar (Table 2). Meat consumption was the only variable in

Table 1 Environmental risk factors for all countries, adjusted for age, sex and country

Variable, level	Patients with symptoms											
	Wheeze in last 12 months			Asthma ever			Allergic rhinoconjunctivitis			Eczema		
	%	OR	95%CI	%	OR	95%CI	%	OR	95%CI	%	OR	95%CI
Meat												
0 Never—once or twice/week	9.7	1.00		14.4	1.00		18.3	1.00		10.2	1.00	
1 ≥3 times/week	8.9	1.09	0.94–1.27	15.4	1.15	1.02–1.30	22.2	1.22	1.10–1.36	13.8	1.30	1.14–1.48
Seafood												
0 Never—occasional	9.3	1.00		15.2	1.00		18.6	1.00		9.7	1.00	
1 ≥1 times/week	9.5	1.00	0.84–1.19	14.8	0.96	0.84–1.11	19.9	1.03	0.90–1.18	11.8	1.22	1.03–1.45
Fruit												
0 Never—once or twice/week	9.0	1.00		15.1	1.00		18.4	1.00		11.9	1.00	
1 ≥3 times/week	9.8	1.07	0.93–1.24	14.7	0.99	0.88–1.12	20.1	1.15	1.03–1.28	11.1	0.97	0.85–1.11
Vegetables												
0 Never—once or twice/week	9.7	1.00		15.9	1.00		18.0	1.00		10.2	1.00	
1 ≥3 times/week	9.3	0.96	0.83–1.12	14.2	0.95	0.84–1.07	20.5	1.02	0.91–1.14	12.2	1.12	0.97–1.28
Pulses												
0 Never—occasional	8.1	1.00		14.7	1.00		21.9	1.00		13.5	1.00	
1 ≥1 times/week	8.3	0.93	0.74–1.16	14.0	1.01	0.85–1.21	22.4	0.98	0.85–1.14	13.3	1.00	0.84–1.20
Cereal												
0 Never—once or twice/week	9.2	1.00		14.0	1.00		21.7	1.00		11.1	1.00	
1 ≥3 times/week	7.7	0.90	0.75–1.09	14.1	1.04	0.89–1.22	22.6	1.06	0.94–1.21	14.7	1.37	1.16–1.61
Pasta												
0 Never—occasional	9.0	1.00		13.5	1.00		22.5	1.00		12.7	1.00	
1 ≥1 times/week	9.9	1.08	0.87–1.35	16.2	1.28	1.07–1.53	23.8	1.06	0.91–1.24	15.2	1.27	1.05–1.53
Rice												
0 Never—occasional	7.3	1.00		8.6	1.00		21.5	1.00		8.2	1.00	
1 ≥1 times/week	8.2	1.12	0.67–1.88	14.1	1.83	1.14–2.94	22.4	1.05	0.76–1.45	13.6	1.86	1.14–3.03
Butter												
0 Never—occasional	10.6	1.00		15.0	1.00		15.6	1.00		8.5	1.00	
1 ≥1 times/week	9.0	1.06	0.90–1.25	14.8	1.15	1.00–1.32	21.7	1.22	1.07–1.39	12.9	1.29	1.09–1.52
Margarine												
0 Never—occasional	9.8	1.00		14.3	1.00		17.2	1.00		10.0	1.00	
1 ≥1 times/week	9.4	1.20	1.02–1.42	15.7	1.33	1.16–1.52	22.8	1.14	1.01–1.28	13.3	1.10	0.96–1.28
Nuts												
0 Never—occasional	9.8	1.00		14.1	1.00		20.8	1.00		11.9	1.00	
1 ≥1 times/week	7.7	0.81	0.66–0.99	14.2	1.04	0.88–1.23	23.3	1.15	1.00–1.33	14.1	1.22	1.03–1.45
Potato												
0 Never—once or twice/week	8.0	1.00		13.8	1.00		21.3	1.00		13.1	1.00	
1 ≥3 times/week	8.5	1.05	0.87–1.27	14.2	1.04	0.90–1.21	24.3	1.18	1.04–1.33	14.1	1.11	0.95–1.29
Milk												
0 Never—once or twice/week	9.0	1.00		13.8	1.00		19.1	1.00		10.8	1.00	
1 ≥3 times/week	9.8	1.07	0.93–1.23	15.4	1.17	1.04–1.31	20.3	1.02	0.92–1.14	12.0	1.12	0.99–1.28
Eggs												
0 Never—occasional	7.5	1.00		14.0	1.00		20.0	1.00		14.2	1.00	
1 ≥1 times/week	8.4	1.18	0.89–1.57	14.1	1.05	0.84–1.30	22.6	1.17	0.97–1.40	13.2	0.94	0.76–1.16
Fast food												
0 Never—occasional	10.2	1.00		15.1	1.00		17.4	1.00		10.1	1.00	
1 ≥1 times/week	9.0	1.07	0.92–1.24	15.0	1.10	0.97–1.25	21.7	1.16	1.03–1.31	12.9	1.11	0.96–1.29
Exercise												
0 Never—once or twice/week	7.5	1.00		13.5	1.00		21.7	1.00		13.0	1.00	
1 ≥3 times/week	10.5	1.37	1.12–1.68	15.6	1.17	1.00–1.39	23.9	1.19	1.03–1.36	14.6	1.10	0.93–1.30
Television												
0 <3 h/day	7.7	1.00		13.1	1.00		20.0	1.00		11.5	1.00	
1 ≥3 h/day	8.7	1.01	0.84–1.23	14.8	1.17	1.01–1.36	24.0	1.24	1.09–1.41	14.7	1.37	1.17–1.60
Type of cooking												
0 Others	6.3			10.8			21.4			12.8		
1 Gas	8.3	1.19	0.96–1.48	13.3	1.48	1.24–1.76	16.1	0.86	0.75–0.99	8.9	0.91	0.77–1.08
2 Electricity	9.9	1.50	1.18–1.91	15.3	1.65	1.36–2.00	21.4	0.98	0.84–1.14	12.6	1.03	0.85–1.24
Paracetamol use in the past year												
0 Less than once/month	6.7	1.00		13.3			20.7	1.00		11.2	1.00	
1 At least once/month	9.6	1.41	1.16–1.71	14.8	1.16	1.00–1.35	23.8	1.16	1.02–1.31	15.2	1.47	1.26–1.71
Older siblings												
0 0	9.5	1.00		15.2	1.00		15.8	1.00		9.7	1.00	
1 1	8.1	0.84	0.68–1.03	14.2	0.94	0.79–1.11	15.6	1.00	0.85–1.17	9.0	0.93	0.76–1.13
2 ≥2	6.3	0.66	0.55–0.79	11.5	0.72	0.62–0.84	16.7	1.01	0.88–1.16	9.3	0.86	0.73–1.03

(continued)

Table 1 (continued)

Variable, level	Patients with symptoms											
	Wheeze in last 12 months			Asthma ever			Allergic rhinoconjunctivitis			Eczema		
	%	OR	95%CI	%	OR	95%CI	%	OR	95%CI	%	OR	95%CI
Younger siblings												
0 0	8.0	1.00		12.8	1.00		14.6	1.00		8.4	1.00	
1 1	8.8	1.12	0.90–1.38	14.8	1.20	1.01–1.42	14.4	1.01	0.85–1.19	8.3	1.02	0.83–1.27
2 ≥2	6.6	0.84	0.69–1.03	12.1	0.95	0.81–1.11	17.9	1.21	1.05–1.40	10.2	1.14	0.95–1.38
Born in country of survey												
0 No	11.9	1.00		18.0	1.00		16.5	1.00		9.8	1.00	
1 Yes	8.3	0.67	0.56–0.79	13.6	0.72	0.62–0.84	15.8	0.90	0.77–1.04	8.8	0.83	0.69–1.00
Years lived in country of survey												
0 <5	11.3	1.00		17.0	1.00		15.2	1.00		8.5	1.00	
1 5–10	13.4	1.29	0.98–1.70	17.3	1.07	0.84–1.37	16.7	1.18	0.92–1.51	9.0	1.06	0.76–1.46
2 >10	9.2	0.90	0.73–1.10	13.2	0.84	0.71–1.00	16.7	1.05	0.88–1.25	8.9	0.95	0.76–1.19
Trucks pass house												
0 Seldom	6.4	1.00		13.6	1.00		19.4	1.00		13.1	1.00	
1 Most of the day	9.2	1.14	0.90–1.44	14.3	1.11	0.94–1.32	23.9	1.29	1.12–1.50	13.4	1.08	0.91–1.29
House near a street with intensive road traffic												
0 No	11.0	1.00		15.7	1.00		15.3	1.00		8.2	1.00	
1 Yes	13.2	1.26	0.97–1.63	18.3	1.22	0.97–1.53	15.8	1.03	0.81–1.31	10.6	1.31	0.98–1.74
Cat now												
0 No	9.2	1.00		13.8	1.00		15.2	1.00		8.8	1.00	
1 Yes	8.7	0.99	0.89–1.10	13.9	1.00	0.91–1.10	18.6	1.33	1.23–1.46	10.5	1.20	1.08–1.34
Dog now												
0 No	9.5	1.00		13.8	1.00		15.8	1.00		9.1	1.00	
1 Yes	8.7	0.93	0.83–1.06	13.8	0.99	0.89–1.10	17.7	1.13	1.03–1.25	9.9	1.03	0.91–1.16
Mother smokes												
0 No	8.4	1.00		13.4	1.00		17.1	1.00		9.4	1.00	
1 Yes	10.6	1.22	1.09–1.36	15.3	1.14	1.04–1.26	17.2	1.08	0.99–1.18	10.5	1.23	1.10–1.37
Father smokes												
0 No	9.6	1.00		13.8	1.00		14.8	1.00		8.1		
1 Yes	9.3	0.95	0.84–1.09	13.8	0.98	0.87–1.09	14.1	0.97	0.86–1.08	7.3	0.93	0.81–1.08
Smokers in house												
0 0	8.6	1.00		13.8	1.00		17.0	1.00		8.2	1.00	
1 1	8.8	1.05	0.91–1.20	13.6	0.99	0.88–1.11	16.7	1.07	0.96–1.19	9.4	1.28	1.11–1.47
2 ≥2	9.4	1.15	1.01–1.31	14.2	1.05	0.94–1.17	17.6	1.15	1.04–1.27	10.7	1.50	1.31–1.71

OR = odds ratio; CI = confidence interval.

Table 2 that showed statistically significant heterogeneity by country for 'asthma ever', with ORs of 1.27 (95%CI 1.02–1.57) in Fiji, 1.25 (95%CI 1.01–1.55) in Samoa, 18.3 (95%CI 3.17–106) in Tokelau and 0.92 (95%CI 0.75–1.13) in French Polynesia (the New Caledonia survey did not collect data on this variable).

Environmental risk factors associated with rhinoconjunctivitis symptoms included: regular meat (OR = 1.19, 95%CI 1.07–1.33), butter (OR = 1.19, 95%CI 1.04–1.35) and margarine (OR = 1.13, 95%CI 1.00–1.26) consumption; regular exercise (OR = 1.22, 95%CI 1.06–1.40) and regular television viewing (OR = 1.23, 95%CI 1.07–1.41), paracetamol use (OR = 1.13, 95%CI 1.00–1.29) and having two or more smokers in the house (OR = 1.12, 95%CI 1.00–1.26). Maternal smoking was the only variable in Table 2 that showed statistically significant heterogeneity by country for allergic rhinoconjunctivitis symptoms, with ORs of 1.47 (95%CI 1.20–1.80) in Fiji, 1.19 (95%CI 0.97–1.46) in Samoa, 0.18 (95%CI 0.04–0.78) in Tokelau, 1.09 (95%CI 0.91–1.29) in

French Polynesia and 0.88 (95%CI 0.75–1.02) in New Caledonia.

Eczema was associated with regular meat (OR = 1.26, 95%CI 1.11–1.44), pasta (OR = 1.25, 95%CI 1.09–1.343) and butter (OR = 1.19, 95%CI 1.01–1.41) consumption; regular television viewing (OR = 1.27, 95%CI 1.09–1.49); paracetamol use (OR = 1.39, 95%CI 1.19–1.62) and having one (OR = 1.25, 95%CI 1.08–1.44) or more (OR = 1.43, 95%CI 1.23–1.66) smokers in the house. Four variables in Table 2 showed statistically significant heterogeneity by country for eczema symptoms: regular milk consumption (ORs of 1.11, 1.07, 13.43 and 1.18 for Fiji, Samoa, Tokelau and French Polynesia, respectively); exercise ≥3 times a week (ORs of 0.83, 1.43 and 3.32 for Fiji, Samoa and Tokelau respectively), type of cooking (ORs for electric cooking of 1.26, 1.14, 2.98 and 0.80 for Fiji, Samoa, Tokelau and New Caledonia, respectively) and maternal smoking (ORs of 1.56, 1.09, 0.17, 1.40 and 1.06 for Fiji, Samoa, Tokelau, New Caledonia and French Polynesia, respectively).

Table 2 Environmental risk factors for all countries: multivariate analysis adjusted for age, sex and country

Variable, level	Patients with symptoms											
	Wheeze in last 12 months			Asthma ever			Allergic rhinonjunctivitis			Eczema		
	%	OR	95%CI	%	OR	95%CI	%	OR	95%CI	%	OR	95%CI
Meat, ≥ 3 times/week	9.0	1.04	0.90–1.20	15.4	1.09	0.97–1.23	22.2	1.19	1.07–1.33	13.8	1.26	1.11–1.44
Pasta, ≥ 1 time/week	9.9	1.05	0.90–1.22	16.2	1.25	1.06–1.49	23.8	1.02	0.88–1.18	15.2	1.25	1.09–1.43
Rice, ≥ 1 time/week	8.2	1.17	0.72–1.91	14.1	1.45	0.97–2.17	22.4	0.91	0.68–1.21	13.6	1.34	0.89–2.01
Butter, ≥ 1 time/week	9.0	1.05	0.89–1.24	14.8	1.11	0.97–1.28	21.7	1.19	1.04–1.35	12.9	1.19	1.01–1.41
Margarine, ≥ 1 time/week	9.4	1.19	1.01–1.40	15.7	1.25	1.09–1.43	22.8	1.13	1.00–1.26	13.3	1.04	0.90–1.20
Nuts, ≥ 1 time/week	7.7	0.80	0.66–0.98	14.2	1.03	0.87–1.22	23.3	1.16	1.01–1.34	14.1	1.18	0.99–1.40
Milk, ≥ 3 times/week	9.8	1.02	0.89–1.17	15.4	1.08	0.96–1.21	20.3	0.99	0.89–1.09	12.0	1.04	0.91–1.18
Exercise, ≥ 3 times/week	10.5	1.44	1.18–1.75	15.7	1.07	0.91–1.25	23.9	1.22	1.06–1.40	14.6	1.16	0.98–1.37
Television, ≥ 3 h/day	8.9	0.91	0.75–1.10	14.8	1.09	0.94–1.27	24.0	1.23	1.07–1.41	14.7	1.27	1.09–1.49
Type of cooking												
Gas	8.3	1.17	0.95–1.45	13.3	1.37	1.16–1.62	16.1	0.86	0.75–0.98	9.0	0.93	0.79–1.10
Electricity	9.9	1.42	1.11–1.80	15.3	1.46	1.20–1.77	21.4	0.95	0.81–1.11	12.7	1.00	0.82–1.21
Paracetamol past year, at least once/month	9.6	1.35	1.11–1.64	14.8	1.14	0.98–1.32	23.8	1.13	1.00–1.29	15.2	1.39	1.19–1.62
Older siblings												
One	8.1	0.86	0.71–1.05	14.2	0.94	0.80–1.10	15.6	1.04	0.89–1.21	9.0	0.96	0.79–1.16
≥ 2	6.3	0.69	0.58–0.82	11.5	0.74	0.64–0.85	16.7	1.03	0.91–1.17	9.3	0.87	0.74–1.03
Born in country of survey, yes	8.3	0.74	0.63–0.87	13.6	0.83	0.73–0.95	15.8	0.96	0.84–1.10	8.9	0.85	0.72–1.01
Mother smokes, yes	10.6	1.16	1.01–1.33	15.3	1.11	0.99–1.24	17.3	1.00	0.90–1.11	10.5	1.03	0.90–1.17
Smokers in house												
One	8.8	1.06	0.92–1.22	13.6	1.00	0.89–1.13	16.7	1.06	0.95–1.18	9.4	1.25	1.08–1.44
≥ 2	9.4	1.13	0.97–1.33	14.2	1.04	0.92–1.18	17.6	1.12	1.00–1.26	10.7	1.43	1.23–1.66

OR = odds ratio; CI = confidence interval.

DISCUSSION

In this cross-sectional study, we identified a number of risk factors for symptoms of asthma, rhinoconjunctivitis and eczema in Pacific children. Before discussing the findings, their limitations should first be considered.

First, information on environmental exposures was obtained retrospectively and could be subject to recall bias. However, this would only occur if the recall of particular exposures was different in children with asthma symptoms than in children without asthma symptoms. This is unlikely to be the case for those risk factors that we have identified as being significant.

Second, 30 potential risk factors were investigated. Thus, for each symptom, one would expect one or two findings to be statistically significant by chance alone. However, one would expect less than one finding per analysis to be significantly positive by chance alone, and all of the analyses had more than one finding that was statistically significant.

A third limitation is that asthma symptom prevalence was ascertained by questionnaire. Although there may be particular concern about recall for questions on lifetime asthma risk (asthma ever), the focus of the ISAAC studies, and the current analyses, is on asthma symptoms in the last year, a question that has generally validated well,^{3,9} and any misclassification of asthma symptoms would only produce bias if the rate of misclassification also differed according to ex-

posure status, which is unlikely. With regard to the EQ, validated questions were sought in an extensive literature review and used where available, but validated questions were not available for all factors or for all possible environments.³ The EQ was piloted in New Zealand, Latin America, French-speaking Africa and the Asia-Pacific regions, and appropriate modifications were made.³

A fourth limitation is that response rates may vary according to asthma symptom status. However, this would only create a bias if response rates were associated with both disease status and exposure status. Furthermore, the response rates were relatively high.

With regard to dietary factors, there were statistically significant associations of current wheeze, 'asthma ever' and rhinoconjunctivitis symptoms with regular margarine consumption. This finding has been observed in several studies in Western countries, including the studies of Weiland et al.¹⁰ and Bolte et al.,¹¹ whereas Woods et al.,¹² Wijga et al.¹³ and Ellison-Loschmann¹⁴ found no such association. We also found a marginally significant association between regular meat consumption and ever having had asthma, and significant associations with symptoms of rhinoconjunctivitis and eczema. Increased consumption of meat and fast food have been suggested to be risk factors for asthma,¹⁵ and a similar analysis among ISAAC Māori and non-Māori ISAAC Phase III participants in Wellington, New Zealand, showed a strong association between

'current wheeze' and regular meat consumption.¹⁴ The ISAAC Phase II study in Hastings, New Zealand, also showed a dose-dependent association between frequent consumption of hamburgers with asthma symptoms, as well as a similar association between consumption of takeaway food and airway hyperresponsiveness.¹⁵ A study among Indian schoolchildren (aged 6–7 and 13–14 years) also identified fast food or meat once or more per week as a risk factor for current wheeze or asthma.¹⁶ Decreased consumption of fruit and vegetables has been suggested to be associated with increased asthma prevalence.¹⁷ Other dietary studies found that eating at fast food outlets and lower intakes of milk, vegetables, fibre, vitamin E, magnesium, calcium, sodium and potassium were significantly related to asthma.¹⁸ However, we found no significant associations between vegetable intake and asthma symptoms in the current study. It is likely that regular margarine and meat consumption is associated with overweight and obesity, which may explain the increased risk for asthma symptoms, rhinoconjunctivitis and eczema. However, Wickens et al. found a positive association between hamburger consumption and asthma even after controlling for body mass index.¹⁵ Margarine and frequent meat consumption are also markers of a more Western lifestyle, which could be another explanation for the positive associations with respiratory symptoms.

Participating in exercise ≥ 3 times a week was associated with an increased risk of 'current wheeze' and rhinoconjunctivitis symptoms. This is consistent with a study in Indian schoolchildren.¹⁶ The incidence of new diagnoses of asthma has been reported to be associated with heavy exercise in communities with high concentrations of ozone; thus, air pollution and outdoor exercise could contribute to the development of asthma in children. The current study did not specifically collect information on ozone or climate, but air pollution levels are relatively low in the Pacific. On the other hand, symptoms of rhinoconjunctivitis and eczema were associated with watching television ≥ 3 h per day, a marker for lack of exercise.

There were also associations of using paracetamol (acetaminophen) at least once a month in the past year with both 'current wheeze' and 'asthma ever' as well as symptoms of rhinoconjunctivitis and eczema. A recent study in New Zealand has reported a similar association between paracetamol use and asthma symptoms.¹⁹ Several other studies have also linked frequent paracetamol use and asthma both from the prenatal stage to childhood asthma.^{20–23} These associations may be due to aspirin avoidance, reverse causation or other bias. However, in the light of results of other studies a causal role may also be possible. In particular, a study in Ethiopia showed dose-related associations between acetaminophen use and self-reported allergic symptoms which were highly unlikely to be due to aspirin avoidance or reverse causation.²⁴ Another study showed that paracetamol use in late pregnancy

was positively associated with wheeze and asthma in offspring at 69–81 months.²¹ There is also evidence from randomised clinical trials that paracetamol may increase morbidity in children with asthma (reviewed by Kanabar et al.²⁵). Thus, although the possibility of confounding or reverse-causation cannot be excluded, it is certainly possible that paracetamol may be causally related to asthma morbidity.

The potential mechanisms through which this may be mediated are not clear, but several options have been proposed. First, paracetamol has been found to reduce glutathione levels in the airways. Glutathione is an antioxidant, and paracetamol may therefore increase the susceptibility to oxidative stress, resulting in airway inflammation and bronchospasm.²⁶ Second, paracetamol may, through a lack of inhibition of COX-2, promote prostaglandin E₂ synthesis and a subsequent increased atopic T-helper cell type 2 (TH2) response.²⁶ Finally, paracetamol may itself act as an antigenic agent.²⁷

We found that having older siblings protected against both 'current wheeze' and 'asthma ever'. These findings are of interest, as most previous studies of family size and asthma risk have been conducted in Western countries where childhood infection rates are relatively low; these findings have now been reproduced in Pacific countries where infections rates are likely to be relatively high.

The ISAAC Pacific EQ data supports previous studies reporting the link between passive smoking and allergic conditions.^{28–31} Gas cooking was associated with 'asthma ever' but not with current wheeze, whereas electric cooking was associated with both outcome measures. The results of studies in other countries are inconsistent, with some finding an association of gas cooking with reduced lung function,^{32,33} while others showed no association.^{34,35} The finding of an association with electric cooking may reflect electric cooking being a marker of 'affluence' or degree of 'Westernisation'.

In conclusion, this is the first standardised study to examine risk factors for symptoms of asthma, rhinoconjunctivitis and eczema in children in the Pacific. Paracetamol use and passive smoking were significant risk factors for symptoms of all three conditions. Regular margarine consumption was a risk factor for asthma and rhinoconjunctivitis symptoms, and regular meat consumption for rhinoconjunctivitis symptoms and eczema symptoms. Electric cooking was a risk factor for asthma symptoms. Being born in the country where the survey was held was protective for asthma symptoms and eczema symptoms. Having older siblings was protective for asthma symptoms and non-significantly protective for eczema symptoms. However, most of the prevalence ORs were relatively weak, and these risk factors therefore, at least individually, would account for only a relatively small proportion of asthma cases. For example, as noted above, PAR for 'exercise ≥ 3 times a week' was only

11%, that for paracetamol use at least once a month was 6%, that for use of electricity for cooking was 6%, and the PAR for use of margarine ≥ 1 times a week was only 7%. Further studies are therefore required to identify other major risk and/or protective factors that will better explain the patterns in asthma, rhinoconjunctivitis and eczema prevalence within and between Pacific Island countries.

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R É S U M É

INTRODUCTION ET MÉTHODES : La Phase III de l'International Study of Asthma and Allergy in Childhood (ISAAC) a été conduite dans huit pays de l'Océan Pacifique, dont cinq (Samoa, Fiji, Tokelau, Polynésie Française et Nouvelle Calédonie) ont recueilli des données environnementales par le biais d'un questionnaire. Nous présentons ici les résultats de l'analyse de ces questionnaires.

RÉSULTATS : Les principaux facteurs associés aux sifflements respiratoires actuels ont été la consommation régulière de margarine (prevalence odds ratio [POR] = 1,19 ; 95%IC 1,01–1,40), la prise de paracétamol (POR = 1,35 ; 95%IC 1,11–1,64), la cuisinière électrique (POR = 1,42 ; 95%IC 1,11–1,80), la pratique régulière d'exercice (POR = 1,44 ; 95%IC 1,18–1,75) et le tabagisme maternel (POR = 1,16 ; 95%IC 1,01–1,33). Les facteurs de protection incluaient la présence de frères ou de soeurs plus âgés (deux ou plus POR = 0,69, 95%CI 0,58–0,82 ;

un POR = 0,86 ; 95%IC 0,71–1,05), et être né dans le pays de l'enquête (POR = 0,74 ; 95%IC 0,63–0,87). Les facteurs de risque pour la rhinoconjonctivite ont inclus la consommation régulière de viande, de beurre, de margarine et les noix, la pratique régulière d'exercice, le fait de regarder souvent la télévision, la prise de paracétamol et le tabagisme passif. L'eczéma était associé à la consommation régulière de viande, des pâtes et du beurre, le fait de regarder souvent la télévision, la prise de paracétamol et le tabagisme passif.

CONCLUSION : La consommation régulière de viande ou de margarine, la prise de paracétamol, l'utilisation d'une cuisinière électrique et le tabagisme passif sont des facteurs de risque des symptômes d'asthme, de rhinoconjonctivite et d'eczéma dans le Pacifique. Toutefois, la majorité des associations trouvées étaient faibles et n'intervenaient que dans une petite proportion des cas.

R E S U M E N

MARCO DE REFERENCIA Y MÉTODOS : Se llevó a cabo la Fase III del International Study of Asthma and Allergies in Childhood (ISAAC) en ocho países del Pacífico, cinco de los cuales (Samoa, Fiji, Tokelau, Polinesia francesa y Nueva Caledonia) recogieron datos de un cuestionario sobre el medioambiente. En el presente artículo se presentan los resultados del análisis de la encuesta medioambiental.

RESULTADOS : Los principales factores asociados con la presencia de sibilancias fueron el consumo regular de margarina (prevalence odds ratio [POR] 1,19 ; IC95% 1,01–1,40), el uso de paracetamol (POR 1,35 ; IC95% 1,11–1,64), el uso de cocinas eléctricas (POR 1,42 ; IC95% 1,11–1,80), la práctica asidua de ejercicio (POR 1,44 ; IC95% 1,18–1,75) y el tabaquismo materno (POR 1,16 ; IC95% 1,01–1,33). Fueron factores de protección el tener hermanos mayores (dos o más, POR 0,69 ;

IC95% 0,58–0,82 ; uno, POR 0,86 ; IC95% 0,71–1,05) y haber nacido en el país donde se realizó la encuesta (POR 0,74 ; IC95% 0,63–0,87). Los factores de riesgo de rinoconjuntivitis fueron consumo frecuente de carne, margarina y nueces, práctica asidua de ejercicio, observación frecuente de la televisión, uso de paracetamol y tabaquismo pasivo. El eccema se asoció con el consumo habitual de carne, pasta y mantequilla, observación frecuente de la televisión, uso de paracetamol y tabaquismo pasivo.

CONCLUSIONES : El consumo habitual de carne y margarina, el uso de paracetamol, las cocinas eléctricas y el tabaquismo pasivo son factores de riesgo de síntomas de asma, rinoconjuntivitis y eccema en el Pacífico. Sin embargo, la mayoría de estas correlaciones fue débil y explica solo una pequeña proporción de casos.