Original article – Peer review

Follow-up study of asthma severity in Māori adolescents

Lis Ellison-Loschmann[1], Michelle Gray[1], Soo Cheng[1] and Neil Pearce[1]

[1]Centre for Public Health Research, Massey University, Wellington, New Zealand

E-mail: l.ellison-loschmann@massey.ac.nz

Māori experience disproportionate asthma severity compared to non-Māori in New Zealand. We studied factors associated with asthma severity in a sample of Māori adolescents who participated in the International Study of Asthma and Allergies in Childhood Phase Three survey in Wellington during 2001-2002.

Participants (n=88) completed a questionnaire on entry to the study, and after one year of follow-up, measuring asthma risk factors, health service usage, asthma morbidity and use of self-management tools. Half of the participants also kept monthly asthma symptom diaries for the follow-up period.

Risk factors for four or more attacks of wheezing during the one year of follow-up included experiencing four or more attacks of wheezing in the previous year 'prevalence odds ratio' (POR)=2.66, 95% confidence interval (CI) 0.85-8.27, previous problems of access (POR=2.45, 95% CI 0.69-8.71) and using paracetamol at least once a month (POR=2.18, 95% CI 0.68-6.98). Severe wheeze was associated with having experienced severe wheeze in the previous year (POR=3.05, 95% CI 0.86-10.79), problems of access (POR=3.13, 95% CI 0.59-16.66) and using paracetamol (POR=2.16, 95% CI 0.62-7.49).

Baseline asthma severity and frequency of wheeze were important determinants of subsequent morbidity in this population, although none of the findings were statistically significant because of the relatively small numbers involved. Access to care may be an important factor influencing asthma severity in Māori adolescents.

Introduction

Māori are the indigenous people of New Zealand and comprise approximately 15% of a total population of four million.[1] Previous studies have shown that asthma severity and hospitalisation rates are disproportionately greater among Māori than non-Māori.[2-4] A number of reasons for this increased severity have been proposed including exposure to environmental tobacco smoke[2], lack of appropriate management and medications[5,6] and inadequate information at a primary care level.[2,7] In a companion paper examining factors associated with asthma morbidity and access to care in Māori teenagers[8] we found that experiencing access problems in the year prior to the study was associated with access problems during the subsequent one-year follow-up period (prevalence odd ratio (POR) =5.06, 95% CI 1.48-17.37, p=0.01). Access to care may be an important mediating factor since regular asthma care and education have been shown to be associated with a reduced occurrence of hospital admissions.[7] Additionally, socio-economic factors have been shown to be related to health status and may be potentially modifiable environmental factors in relation to asthma severity and/or prolongation of asthma symptoms.[2] No New Zealand studies to date have specifically investigated risk factors for asthma severity in Māori. We therefore conducted a follow-up study to examine factors associated with asthma severity in Māori adolescents.

Materials and methods

Phase One of the International Study of Asthma and Allergies in Childhood (ISAAC) involved more than 700,000 children from two age groups (6-7 years and 13-14 years), in 56 countries[9,10] and ISAAC Phase Three involved a repeat of Phase One to assess trends over time.[11] ISAAC Phase Three was conducted in Wellington, New Zealand during March 2001 – March 2002. Recruitment methods for ISAAC Phase One and Phase Three have been previously described in detail elsewhere.[11-12] Briefly, in order to ensure comparability of information over time, ISAAC Phase Three in Wellington involved selecting schools from the same sampling frame as that which was used for ISAAC Phase One. The sampling frame was representative of the Wellington geographical area (Porirua, Lower Hutt and Wellington city), without selection by urban or rural residence or by socio-economic status. Each secondary school within the Wellington area (i.e. those with students in the 13-14 year age group), were allocated a number and the schools were selected using a table of random numbers. If a school refused participation it was replaced by the next randomly chosen school.

Additionally, in the current study, recruitment numbers were low and so participant numbers were supplemented by sampling more students, from the same 13-14 year age group, from three more schools (outside of the ISAAC sampling frame) during May-October 2002. Although, these additional schools were not part of the formal ISAAC Phase Three survey, we used the same approach as that for ISAAC Phase Three itself, including the use of the ISAAC Phase Three questionnaire.

An introductory letter, information sheet and consent form was sent to all students and their parents. Ethical approval for the study was obtained from the Wellington Ethics Committee (WGT/01/04/036) in New Zealand. All data were collected at either the student's home or their school.

The current study included those 13-14 year old students who self-identified as Māori, and who had completed the ISAAC Phase Three survey[9] and answered "*yes*" to the following two core questions as indicators of current asthma morbidity:[13] 1) "*Have you ever had asthma?*" and; 2) "*Have you had wheezing or whistling in the chest in the last 12 months*?" The asthma outcome measures were (in the previous 12 months) 4+ attacks of wheezing' (4+ versus 0-3 attacks of wheezing) and 'severe wheeze' (wheeze severe enough to limit speech to only one or two words at a time between breaths, yes versus no).

Participants completed a questionnaire (with assistance from the interviewer) relating to the previous twelve months on entry to the study and after one year of follow-up. Asthma morbidity was assessed using the standard questions from the ISAAC questionnaire[9] (*see Appendix 1*) relating to the following symptoms in the previous 12 months: number of attacks of wheezing; sleep disturbed due to wheezing; and wheezing severe enough to limit speech. Additional questions focused on symptom events[13] such as days lost from school due to asthma; use of asthma self-management tools (asthma action plans, peak flow meters); use of asthma medication (in the previous 12 months – taking asthma medication and/or running out of asthma medication) and; interaction with health services (routine visit to GP for asthma in previous 12 months) including number of emergency general practitioner visits and hospital admissions for asthma. All questions were based on those used in an earlier study of asthma morbidity in Māori adults.[7] The questionnaire also included the standard ISAAC Phase Three environmental questionnaire on risk factors.[11] Participants were also asked whether their family held a community services card (CSC) which entitles lower income families to a subsidy on general practitioner visits and prescription charges.[14] The completion and collection of monthly diaries involved a major effort from both the researchers and the participants. Thus, for logistical reasons, only one half of the students (those living in the Hutt Valley region of Wellington) were asked to complete monthly diaries on their asthma symptoms and management of their asthma during the follow-up period. The diaries were used to complement the other morbidity measures being undertaken in the study and provided additional information on what constituted 'usual' asthma care for the participant.

All data were entered using Microsoft Access 2000 for Windows and then manually checked against the original questionnaire. We used multivariable logistic regression to estimate period prevalence odds ratios (POR).[15] All variables relating to asthma severity, asthma management, medications and use of health services as well as variables of a *priori* interest (gender, siblings, cat ownership, smoking, parental smoking, paracetamol use) were included in the initial models. However, there were major problems of multi-collinearity and the regression coefficients had high standard errors. Even the findings for basic demographic variables such as gender were unstable because these were strongly related with smoking and other variables of interest. For the univariable analyses we therefore defined a summary

Table 1: Self-reported asthma severity at baseline and after one year of follow-up: findings for all participants who kept (or did not keep) an 'asthma diary'

		Total (n=88*)		Keeping a diary (n=41*)		Not keeping a diary (n=47*)	
Asthma severity	**Frequency**	**Baseline % (n)**	**One year follow-up % (n)**	**Baseline % (n)**	**One year follow-up % (n)**	**Baseline % (n)**	**One year follow-up % (n)**
Attacks of wheezing last 12 months	0 1-3 4-12 More than 12	14.0 (12) 58.1 (50) 20.9 (18) 7.0 (6)	21.2 (18) 48.2 (41) 22.4 (19) 8.2 (7)	22.5 (9) 52.5 (21) 17.5 (7) 7.5 (3)	25.0 (10) 32.5 (13) 27.5 (11) 15.0 (6)	6.5 (3) 63.0 (29) 23.9 (11) 6.5 (3)	17.8 (8) 62.2 (28) 17.8 (8) 2.2 (1)
Night waking last 12 months	Never < one night/week > one night /week	26.1 (23) 58.0 (51) 15.9 (14)	47.7 (42) 34.1 (30) 18.2 (16)	17.1 (7) 56.1 (23) 26.8 (11)	41.5 (17) 41.5 (17) 17.1 (7)	34.0 (16) 59.6 (28) 6.4 (3)	53.2 (25) 27.7 (13) 19.1 (9)
Severe wheeze last 12 months	Yes No	22.7 (20) 77.3 (68)	22.7 (20) 77.3 (68)	26.8 (11) 73.2 (30)	22.0 (9) 78.0 (32)	19.1 (9) 80.9 (38)	23.4 (11) 76.6 (36)
Exercise wheeze last 12 months	Yes No	83.9 (73) 16.1 (14)	79.5 (70) 20.5 (18)	92.5 (37) 7.5 (3)	75.6 (31) 24.4 (10)	76.6 (36) 23.4 (11)	83.0 (39) 17.0 (8)
Night cough last 12 months	Yes No	67.8 (59) 32.2 (28)	54.5 (48) 45.5 (40)	75.0 (30) 25.0 (10)	46.3 (19) 53.7 (22)	61.7 (29) 38.3 (18)	61.7 (29) 38.3 (18)
Days off school due to asthma/ wheezing in last 12 months	None 1-6 days 1-2 weeks 2-4 weeks More than 4 weeks	59.3 (51) 33.7 (29) 2.3 (2) 3.5 (3) 1.2 (1)	76.2 (64) 21.4 (18) 2.4 (2) 0.0 (0) 0.0 (0)	62.5 (25) 37.5 (15) 0.0 (0) 0.0 (0) 0.0 (0)	75.6 (31) 19.5 (8) 4.9 (2) 0.0 (0) 0.0 (0)	56.5 (26) 30.4 (14) 4.3 (2) 6.5 (3) 2.2 (1)	76.7 (33) 23.3 (10) 0.0 (0) 0.0 (0) 0.0 (0)

* Column numbers (n) may not always add up to total number (n) due to missing data

variable, 'problems of access', at baseline relating to any of the following events which might have occurred in the previous 12 months: (i) running out of medication or; (ii) requiring an emergency visit to the doctor or; (iii) requiring a hospital admission for asthma or; (iv) needing to see the doctor for asthma but being unable to. It is recognised that there is a complex interplay of issues that relate to accessing health care[2,7] which include key factors such as having medication[4,5,6] and use of health services[2,7,13] and the risk factors included in the 'problems of access' summary variable are both markers of problems of access and markers of asthma severity.

There were also problems with multi-collinearity in the multivariable analysis when we examined asthma morbidity during the one year follow-up. Thus, we ran a reduced model including the following variables: (i) a single measure of asthma severity at baseline (this differed according to which severity outcome variable was being considered); (ii) the summary variable 'problems of access' at baseline; (iii) having an asthma action plan at baseline (as a summary measure of having received asthma education); (iv) paracetamol at least once a month in the 12 months prior to baseline (a strong asthma risk factor in the univariable analyses); (v) currently smoking at baseline (a strong asthma risk factor in the univariable analyses); (vi) having a community services card (as a marker of socioeconomic status); and (vii) keeping a monthly asthma diary.

Results

From the ISAAC Phase Three survey responses, 144 students were initially selected to take part in the study. Of these, 20 (13.9%) were subsequently considered ineligible and excluded from the analyses (nine had not wheezed in the past 12 months, four were not Māori, two had not had a previous asthma diagnosis, and five had left school in the time between completing the ISAAC survey and being approached to take part in the current study), leaving 124 eligible students of which 68 (54.8%) consented to take part. From the additional sampling conducted in schools outside of the ISAAC sampling frame, a further 44 students were identified as eligible to take part in the current study of which 20 (45.5%) consented to participate. Thus, there were a total of 88 participants, giving an overall response rate of 52.4%.

We compared information for participants and non-participants using the responses from the ISAAC survey questionnaire. Among the participants, there were slightly more males (55.5% versus 48.0% of the non-participants), and participants were slightly younger compared to that of the non-participants (mean age 14.0 years versus 14.2 years respectively). The prevalence of asthma symptoms between participants and non-participants was similar with just over half of both the participants and non-participants experiencing waking at night with wheezing in the past 12 months (52.3% and 54.0% respectively). However participants did report a higher prevalence of night cough (65.9%) compared to non-participants (65.9% and 51.0% respectively, [p=0.05]).

Table 1 presents information on markers of asthma severity at baseline and at the one year follow-up for all participants together and separately for those who did and did not complete monthly asthma diaries during follow-up. At baseline, 27.9% of participants reported four or more attacks of asthma in the previous 12 months and 22.7% had experienced severe wheeze. The findings were generally similar at the one year follow-up although a non-significant reduction in the prevalence of some asthma symptoms (e.g. night cough, exercise wheeze) was evident. The proportion of students reporting four or more asthma attacks in the previous 12 months increased from 25.0% to 42.5% in those who kept diaries but decreased from 30.4% to 20.0% in those who did not keep diaries.

The unadjusted results for factors affecting asthma severity during the one year follow-up are shown in Table 2. The strongest risk factor for experiencing four or more attacks of wheezing during the one-year follow-up was having experienced four or more attacks of wheezing in the year prior to baseline, prevalence odds ratio (POR)=2.48, 95% CI 0.92-6.71. Having an asthma action plan was weakly negatively associated with the risk of having four or more attacks during the one-year follow-up period (POR=0.85, 95% CI 0.15-4.70). The strongest findings for severe asthma related to having experienced severe wheeze in the year prior to baseline (POR=4.24, 95% CI 1.42-12.6) and having had problems of access in the year prior to baseline (POR=4.02, 95% CI 0.86-18.9). Table 3 presents the adjusted PORs for factors associated with increased frequency of wheezing and increased asthma severity during the one year follow-up period.

Discussion

This follow-up study has examined factors associated with asthma severity in a sample of Māori adolescents. As expected, baseline asthma severity and frequency of wheeze were important determinants of subsequent severity. However, once baseline asthma severity was controlled for in the multivariable analysis, there were no other significant risk factors found for subsequent asthma severity. However, there were still relatively (but non-statistically significant) strong associations for several variables. In particular, risk factors for four or more attacks of wheezing during the one year of follow-up included experiencing four or more attacks of wheezing in the previous year (POR=2.66, 95% CI 0.85-8.27, previous problems of access (POR=2.45, 95% CI 0.69-8.71) and using paracetamol at least once a month (POR=2.18, 95% CI 0.68-6.98). Severe wheeze was associated with having experienced severe wheeze in the previous year (POR=3.05, 95% CI 0.86-10.79), problems of access (POR=3.13, 95% CI 0.59-16.66) and using paracetamol (POR=2.16, 95% CI 0.62-7.49).

Previous studies have consistently reported asthma prevalence to be similar between Māori and non-Māori children[16-18] while studies of asthma severity have found that Māori children experience excess asthma morbidity and higher hospital admission rates compared to non-Māori.[2-4] One study comparing asthma severity amongst indigenous and non-indigenous populations in Western Australia reported hospitalisation rates to be increased among the indigenous compared with non-indigenous peoples[19] although findings have not been consistent.[20]

Table 2: Factors affecting asthma severity during the one-year follow-up period (unadjusted prevalence odds ratios)

Baseline variables (at start of follow-up)		Asthma morbidity during one-year follow-up					
		4+ attacks of wheezing			Severe wheeze		
		%	POR†	95% CI	%	POR†	95% CI
Keeping a diary	No	20.0	1.00		23.4	1.00	
	Yes	42.5	2.96	1.13 – 7.74	22.0	0.92	0.34 – 2.51
Gender	Male	30.4	1.00		25.0	1.00	
	Female	30.8	1.02	0.40 – 2.56	20.0	0.75	0.27 – 2.07
Asthma severity							
4+ attacks of wheeze past 12 months	No	25.4	1.00		21.0	1.00	
	Yes	45.8	2.48	0.92 – 6.71	29.2	1.55	0.53 – 4.53
Waking at night past 12 months	No	26.8	1.00		23.0	1.00	
	Yes	50.0	2.74	0.85 – 8.83	21.4	0.91	0.23 – 3.66
Severe wheeze past 12 months	No	26.2	1.00		16.2	1.00	
	Yes	45.0	2.31	0.82 – 6.54	45.0	4.24	1.42 – 12.6
Days off school past 12 months due to asthma	No	28.6	1.00		17.6	1.00	
	Yes	35.3	1.36	0.53 – 3.48	31.4	2.14	0.78 – 5.89
Coughing at night past 12 months	No	25.9	1.00		21.4	1.00	
	Yes	33.3	1.43	0.51 – 3.97	23.7	1.14	0.39 – 3.37
Asthma management							
Has a peak flow meter	No	34.0	1.00		22.4	1.00	
	Yes	27.0	0.72	0.28 – 1.84	24.3	1.11	0.41 – 3.04
Has an asthma action plan	No	32.0	1.00		21.8	1.00	
	Yes	28.6	0.85	0.15 – 4.70	28.6	1.44	0.26 – 8.06
Asthma medications							
Taking asthma medication in the past 12 months	No	29.4	1.00		0.0	1.00	
	Yes	31.3	1.10	0.34 – 3.51	–	–	–
Run out of medication in the past 12 months	No	22.0	1.00		21.4	1.00	
	Yes	39.5	2.33	0.89 – 6.07	24.4	1.19	0.44 – 3.23
Use of health services							
Seen GP for asthma in past 12 months for routine visit	No	25.0	1.00		5.0	1.00	
	Yes	32.3	1.43	0.46 – 4.47	27.9	7.37	0.92 – 58.9
Seen GP for asthma in past 12 months as an emergency	No	25.0	1.00		11.1	1.00	
	Yes	36.6	1.73	0.68 – 4.40	34.9	4.29	1.40 – 13.2
Family has a Community Services Card	No	31.0	1.00		17.8	1.00	
	Yes	31.7	1.04	0.41 – 2.62	29.3	1.91	0.69 – 5.30
Needed to see GP in past 12 months but was unable to	No	31.3	1.00		20.0	1.00	
	Yes	29.4	0.91	0.29 – 2.92	35.3	2.18	0.69 – 6.92
Problems of access*	No	21.7	1.00		8.7	1.00	
	Yes	33.9	1.84	0.60 – 5.66	27.7	4.02	0.86 – 18.9
Risk factors							
Older siblings	0	41.2	1.00		22.2	1.00	
	1	27.3	0.54	0.14 – 2.06	30.4	1.53	0.37 – 6.35
	2+	30.6	0.63	0.19 – 2.08	16.7	0.70	0.17 – 2.88
Younger siblings	0	33.3	1.00		36.4	1.00	
	1	27.3	0.75	0.20 – 2.77	13.0	0.26	0.06 – 1.17
	2+	37.1	1.18	0.38 – 3.69	22.2	0.50	0.16 – 1.61
Cat now	No	40.9	1.00		21.7	1.00	
	Yes	28.3	0.57	0.21 – 1.58	22.6	1.05	0.33 – 3.34
Smoking ever	No	20.5	1.00		25.0	1.00	
	Yes	38.6	2.44	0.91 – 6.54	21.7	0.83	0.31 – 2.27
Current smoking	No	26.2	1.00		22.4	1.00	
	Yes	45.0	2.31	0.82 – 6.54	23.8	1.08	0.34 – 3.45
Mother smokes	No	35.7	1.00		27.3	1.00	
	Yes	27.5	0.68	0.27 – 1.75	19.5	0.65	0.23 – 1.79
Paracetamol in past 12 months	< once/month	19.4	1.00		18.2	1.00	
	> or = once/month	38.0	2.55	0.89 – 7.36	25.5	1.54	0.52 – 4.56

† POR, prevalence odds ratio
* Summary variable includes: (i) running out of medication or; (ii) requiring an emergency visit to the doctor or; (iii) requiring a hospital admission for asthma or; (iv) needing to see the doctor for asthma but being unable to.

The reasons for the difference between asthma prevalence and morbidity rates among Māori are unclear. Differences in asthma risk factors between Māori and non-Māori have been documented, for example, Māori are less likely than non-Māori to have preventive measures in place for their asthma including appropriate education materials,[2] action plans, peak flow meters[5] and medications[5-6] including prophylactic medication.[21] More generally "running out of medication" indicates that regular asthma care and asthma education is not being accessed and so may have a relatively direct causal association with asthma severity and the occurrence of asthma attacks. Under-treatment of asthma has been recognised as being more common among poor populations[22,23] and a recent study reporting on asthma hospitalisation risk in native and non-native Alaskans[24] reported a decrease in hospitalisation risk among urban Alaska natives concurrent with increased use of inhaled corticosteroids in this population. Shaw et al (1994)[21] reported cigarette smoking by the primary caregiver to be more common for Māori than Europeans in their study which examined asthma risk factors in 600 school-age children. However, when passive smoking was controlled for in the analysis, the relative risk for Māori of current severe wheeze fell only from 1.8 to 1.5 (95% CI 0.7-3.4). Thus, exposure to passive smoking could not entirely account for the differences in asthma severity seen in these children.

Having a community services card was negatively associated with severe wheeze in the current study. Previous New Zealand studies have found that financial burden is an important deterrent to care[26,27] and socio-economic factors such as income, employment, housing and education have all been shown to be strongly related to health status. Socio-economic status can be viewed as a potentially modifiable environmental factor, in relation to asthma, which could impact on the severity or prolongation of symptoms.[2,27]

Thus, appropriate access to care is vital for people with asthma both in terms of acute management and for the control of chronic asthma requiring ongoing assessment, treatment and health education. Markers of problems of access may also be common markers of asthma severity[28] with both having previously been found to be important determinants of access to care both internationally and in New Zealand.[2,29-31]

The current study found that both frequency of wheezing and increased asthma severity were non-significantly associated with use of paracetamol in this teenage population. Lesko et al[32] in a randomised trial of children with current asthma and a febrile illness found that short-term use of paracetamol (in comparison with ibuprofen) increased subsequent asthma severity, as measured by a higher frequency of out-patient visits in those from the paracetamol group. Another study in adults reported frequent paracetamol use to be associated with an approximately two-fold increased risk of asthma.[33] Possible underlying mechanisms involve increased oxidative stress due to the ability of paracetamol to reduce levels of the anti-oxidant glutathione in immune cells, thus depleting anti-oxidant defences and promoting TH2 allergic inflammation.[33] However another possibility is simply that health professionals encourage their asthmatic patients to take paracetamol rather than aspirin because the latter may worsen asthma severity or that children experiencing frequent upper respiratory infections, often an early symptom of asthma, may be more likely to be prescribed paracetamol.

Diaries can be a useful source of complementary information for use in studies of asthma morbidity.[13] However, previous studies have reported that collaboration in diary-keeping can be problematic.[34] In the current study, keeping a diary was associated with increased frequency of wheeze but not with severe asthma attacks during the one-year follow-up. It is possible that the diaries acted as a prompt for participants in recalling their symptoms more readily at the one-year follow-up interview, whereas the occurrence of a severe attack was recalled irrespective of whether the participant kept a diary.

The findings of this study must be treated with caution. Although there was no loss to follow-up over the one year period of the study, the low response rate and small participant numbers involved meant that very few findings were statistically significant despite the presence of relatively strong associations. At the time that students were being recruited to participate in the current study, there were major changes occurring with the implementation of a new education curriculum structure within New Zealand high schools. One consequence of this was strike action by teachers which occurred in many schools over the one year recruitment period of the current study. Hence there were sometimes prolonged delays between students completing the ISAAC questionnaire and being approached to take part in the current study as the initial contact with students relied on communication with the schools, and this may have affected participation rates for the study.

In summary, the findings from this study suggest that baseline asthma severity and frequency of wheeze were important determinants of subsequent morbidity in this population of Māori adolescents with asthma and having had previous problems of access to care was associated with increased asthma severity during the follow-up period. This is generally consistent with other evidence that problems of access do have an impact on asthma severity in Māori and emphasises the need for improved strategies to reduce barriers to health care services.

Acknowledgements

This study was funded by a Project Grant from the Health Research Council of New Zealand. Lis Ellison-Loschmann was funded by a training fellowship in Māori health research, and the Centre for Public Health Research is supported by a Core Programme Grant from the Health Research Council of New Zealand.

Table 3: Adjusted prevalence odds ratios for factors associated with increased frequency of wheezing and increased asthma severity during the one year follow-up period

Baseline variables (at start of follow-up)		Asthma morbidity during one-year follow-up			
		4+ attacks of wheezing		Severe wheeze	
		POR†	95% CI	POR†	95% CI
Severe wheeze	No			1.00	–
	Yes			3.05	0.86 – 10.79
4+ attacks	No	1.00	–		
	Yes	2.66	0.85 – 8.27		
Problems of access*	No	1.00	–	1.00	–
	Yes	2.45	0.69 – 8.71	3.13	0.59 – 16.66
Asthma action plan	No	1.00	–	1.00	–
	Yes	0.68	0.11 – 4.35	1.23	0.17 – 8.79
Paracetamol in past 12 months	No	1.00	–	1.00	–
	Yes	2.18	0.68 – 6.98	2.16	0.62 – 7.49
Current smoking	No	1.00	–	1.00	–
	Yes	1.35	0.44 – 4.15	0.77	0.23 – 2.61
Community services card	No	1.00	–	1.00	–
	Yes	1.27	0.43 – 3.73	1.33	0.41 – 4.32
Keeping a diary	No	1.00		1.00	
	Yes	2.80	0.89 – 8.82	1.03	0.31 – 3.42

† POR, prevalence odds ratio

* Summary variable which includes: (i) running out of medication or; (ii) requiring an emergency visit to the doctor or; (iii) requiring a hospital admission for asthma or; (iv) needing to see the doctor for asthma but being unable to.

Appendix 1: ISAAC standardised assessment of asthma symptoms

1. Have you had wheezing or whistling in the chest in the last 12 months?

❑ Yes

❑ No

2. If YES, how many attacks of wheezing have you had in the last 12 months?

❑ None

❑ 1-3

❑ 4-12

❑ more than 12

3. In the last 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

4. In the last 12 months, has wheezing ever been severe enough to limit your speech to only one or two words at a time between breaths?

❑ Yes

❑ No

References

1. **Statistics New Zealand. Demographic trends 2003.** Wellington: Statistics New Zealand, 2004.
2. **Pomare E, Tutengaehe H, Ramsden I, Hight M, Pearce N, et al.** He Mate Huango: Māori Asthma Review. Wellington: Huia Publications, 1991.
3. **Ellison-Loschmann L, Cheng S, Pearce N.** Time trends and seasonal patterns of asthma deaths and hospitalisations among Māori and non-Māori. NZ Med J 2002; 114: 4-9.
4. **Pattemore PK, Ellison-Loschmann L, Asher MI, Barry DM, Clayton TO, et al.** Asthma prevalence in European, Māori and Pacific children in New Zealand: ISAAC study. Paed Pulmonol 2004; 37: 433-442.
5. **Garrett JE, Mulder J, Wong-Toi H.** Reasons for racial differences in A&E attendance rates for asthma. NZ Med J 1989; 102:121-4.
6. **Mitchell EA.** Racial inequalities in childhood asthma. Soc Sci Med 1991; 32: 831-836.
7. **Ratima M, Fox C, Fox B, Te Karu H, Gemmell T, et al.** Long-term benefits for Māori of an asthma self-management program in a Māori community which takes a partnership approach. Aust NZ J Pub Health 1999; 23: 601-605.
8. **Ellison-Loschmann L, Gray M, Cheng S, Pearce N.** Asthma management and access to care in a random sample of Māori adolescents with asthma. Australasian Epidemiologist 2006; 13.1: 18-24.
9. **Asher MI, Keil U, Anderson HR, Beasley R, Crane J, et al.** International study of asthma and allergies in childhood (ISAAC): rationale and methods. Eur Resp J 1995; 8: 483-491.
10. **ISAAC Steering Committee (Writing Committee: Beasley R, Keil U, Von Mutius E, Pearce N).** Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema: ISAAC. Lancet 1998; 351: 1225-1232.
11. **Ellwood P, Asher MI, Beasley R, Clayton TO, Stewart AW and the ISAAC Steering Committee.** International Study of Asthma and Allergies in Childhood (ISAAC II): Phase III rationale and methods. Int J Tuberculosis Lung Dis 2005; 9: 10-16.
12. **Asher MI, Weiland SK, on behalf of the ISAAC Steering Committee.** The International Study of Asthma and Allergies in Childhood. Clin Exper Allergy 1998; 28(suppl 5): 52-66.
13. **Pearce N, Beasley R, Burgess C, Crane J.** Asthma epidemiology: principles and methods. New York: Oxford University Press, 1998.
14. **Ministry of Social Development.** Community Services Card (CSC). Accessed online 24/4/06. http://www.workandincome.govt.nz/get-assistance/csc/index.html
15. **Pearce N.** Effect measures in prevalence studies. Environ Health Perspect 2004; 112: 1047-1050.
16. **Robson B, Woodman K, Burgess C, Crane J, Pearce N, et al.** Prevalence of asthma symptoms among adolescents in the Wellington region, by area and ethnicity. NZ Med J 1993; 106: 239-241.
17. **Shaw R, Woodman K, Crane J, Moyes C, Kennedy J, et al.** Risk factors for asthma symptoms in Kawerau children. NZ Med J 1994; 107: 387-391.
18. **Barry DJM, Burr ML, Limb ES.** Prevalence of asthma among 12 year old children in New Zealand and New South Wales: a comparative survey. Thorax 1991; 46: 405-409.
19. **Williams P, Gracey M, Smith P.** Hospitalisation of Aboriginal and non-Aboriginal patients for respiratory tract diseases in Western Australia, 1988-1993. Int J Epidemiol 1997; 26: 797-805.
20. **Whybourne AM, Lesnikowski CL, Ruben AR, Walker AC.** Low rates of hospitalisation for asthma among Aboriginal children compared to non-Aboriginal children of the Top End of the Northern Territory. J Paediatr Child Health 1999: 35: 438441.
21. **Shaw R, Woodman K, Crane J, et al.** (1994). Risk factors for asthma in Kawerau children. NZ Med J; 107: 387-91.
22. **Bauman A, Young L, Peat JK, Hunt J, Larkin P.** Asthma under-recognition and under-treatment in an Australian community. Aust NZ J Med 1992; 22: 36-40.
23. **Gottlieb DJ, Beiser AS, O'Connor GT.** Poverty, race and medication use are correlates of asthma hospitalisation rates: a small area analysis in Boston. Chest 1995; 108: 28-35.
24. **Gessner BD, Neeno T.** Trends in asthma prevalence, hospitalisation risk, and inhaled corticosteroid use among alaska natives and nonnative Medicaid recipients younger than 20 years. Ann Allergy Asthma Immunol 2005; 94: 372-379.
25. **Barnett JP, Coyle P.** Social inequality and general practitioner utilisation: assessing the effects of financial barriers on the use of care by low income groups. NZ Med J 1998; 111: 66-70.
26. **Malcolm L.** Inequities in access to utilisation of primary medical care services for Māori and low income New Zealanders. NZ Med J 1996; 109: 356-358.
27. **Pomare E, Keefe-Ormsby V, Ormsby C, Pearce N, Reid P, et al. Hauora.** Māori Standards of Health III. A study of the years 1970-1991. Wellington: Eru Pomare Māori Health Research Centre, 1995.
28. **Ellison-Loschmann L, Gray M, Cheng S, Pearce N.** Asthma management and access to care in a random sample of Māori adolescents with asthma. Australasian Epidemiologist 2006; 13.1: 18-24.
29. **Shoen C, Doty MM.** Inequities in access to medical care in five countries: findings from the 2001 Commonwealth Fund International Policy Survey. *Health Pol* 2004; 67: 309-322.
30. **Garrett J, Williams S, Wong C, Holdaway D.** Application of asthma action plans to childhood asthma: a national survey. *NZ Med J* 1997;110:308-10.
31. **Holt S. Kljakovic M. Reid J.** Asthma morbidity, control and treatment in New Zealand: results of the Patient Outcomes Management Survey (POMS), 2001. *NZ Med J* 2003;116:U436, online. URL: http://www.nzma.org.nz/journal/116-1174/436/
32. **Lesko SM, Louik C, Vezina RM, Mitchell AA.** Asthma morbidity after the short-term use of ibuprofen in children. Paediatrics 2002; 109: 1-4.
33. **Shaheen SO, Sterne JA, Songhurst CE, Burney PG.** Frequent paracetamol use and asthma in adults. Thorax 2000; 55: 266-270.
34. T**urner S, Smedley J, Cherry N.** Estimating occupational health events in workers with asthma or diabetes: a comparison of diary and snapshot methods. Occup Med 2001; 51: 325-331.