Prevalence of asthma among 12 year old children in New Zealand and South Wales: a comparative survey

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Abstract

A survey of 12 year old schoolchildren was carried out in New Zealand and South Wales, the same questionnaire and exercise provocation test being used. The prevalence of a history of asthma at any time was higher in New Zealand (147/873, 17%) than in South Wales (116/965, 12%). The New Zealand children were also more likely than the Welsh children to have a history of "wheeze ever" (27% versus 22%), and wheeze brought on by running (15% versus 10·5%). The sex ratio of asthmatic and wheezy children was very similar in the two countries. A history of hospital admission for chest trouble was twice as common in New Zealand as in South Wales. An exercise test produced a fall in peak expiratory flow rate of 15% or more in more New Zealand children (12·2%) than Welsh children (7·7%). These results suggest that the prevalence of childhood asthma is higher in New Zealand than in South Wales.

There is continuing concern about the relatively high mortality from asthma among children and young adults in New Zealand.[1 2] Hospital admission rates have been rising in many countries, but the rise in New Zealand (10 fold over 15 years in children under 15 years old) has been disproportionately large (compared with six fold in England and Wales).[3] Use of drugs to treat asthma is higher in New Zealand than in Australia and the United Kingdom.[4] It is obviously important to know whether the prevalence of the disease is greater in New Zealand than elsewhere. A recent study[5] found that the prevalence of respiratory symptoms and bronchial hyperresponsiveness was similar in Auckland (New Zealand) and inland New South Wales (Australia) but lower among coastal New South Wales children than those from the other two sites. Few other surveys have been conducted in which the same methods have been used in different countries. A survey in Dunedin (New Zealand) showed higher prevalence rates of childhood asthma and wheezing than those reported in the United Kingdom,[6] and a survey in Christchurch (New Zealand) found a higher prevalence of childhood wheeze than that found in a somewhat similar survey in Croydon (England)[7]; in neither case, however, were the methods identical in the two countries. A survey was therefore conducted in New Zealand and South Wales, with the same questionnaire and exercise test, to see whether differences in prevalence could be found. Similar data from other countries are being collected and will be published in due course.

Methods

A defined population of children who reached 12 years of age during the year of testing was studied during the summer months in New Zealand and South Wales, a parental questionnaire and a running exercise test being used to identify the children.

The principals of schools with children qualifying for this study agreed to distribute a questionnaire and consent form to the children and to allow the investigators to check questionnaire returns with the school roll and to conduct exercise tests on a level floor in the school gymnasium or another suitable venue in the school grounds. Dry and wet bulb temperature readings were taken on a whirling hygrometer on each occasion, and relative humidity was calculated with the help of tables.

The New Zealand population was defined geographically by including all 12 year old children attending school in the City of Hastings and the Borough of Havelock North (approximate total population 50 000). The Welsh population was defined geographically in terms of the catchment areas of four high schools in North Cardiff and the Vale of Glamorgan, and included children living in those areas who attended Anglican, Roman Catholic, and Welsh language schools.

The questionnaire included questions about the personal and demographic details of the children, any history of asthma symptoms and atopic symptoms in the child and family, information about the diagnosis and medications given for asthma, and in the case of New Zealand children information about ethnicity. Information was also sought on pet ownership and hospital admissions for respiratory problems.

The questionnaire and consent form were first reviewed for completeness and the child's height was measured. Five peak expiratory flow (PEF) measurements were taken (with a Wright peak flow meter, Airmed Ltd). Each child then ran for exactly six minutes; heart rate was recorded immediately afterwards. Five minutes after the child stopped exercise

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Table 1 Proportions of New Zealand children of European and non-European origin with a history of symptoms

	European (%) n = 583	*Non-European (%) n = 290*
Asthma ever	(16·2)	(18·3)
Current asthma	(11·1)	(11·0)
Wheeze ever	(25·6)	(28·6)
Wheeze in past year	(17·2)	(19·3)
Breathless wheeze ever	(17·5)	(18·3)
Wheeze without cold ever	(15·8	(17·2)
Eczema ever	(17·0)	(13·8)
Hay fever/allergic rhinitis ever	(23·2)	(16·6)

five further measurements of peak expiratory flow were recorded, and on each occasion the mean of the three highest readings was taken as the true value. Further details of the exercise test have already been published.[8 9]

If peak expiratory flow fell by 15% or more no further testing was done; if necessary a beta$_2$ agonist was given by inhalation to the child. If PEF did not fall by 15% and the child had taken a bronchodilator or mast cell stabiliser within the preceding eight hours retesting after an interval without these medications was arranged for a later date.

Comparisons were made by means of Student's t test and 95% confidence limits calculated for the differences where appropriate.

Results

In the Hastings district of New Zealand 12 of the 13 principals in the study area agreed to participate in the study. The non-participating school had five children of the age group being studied. With these children included in the total number and the school rolls compared with the questionnaire returns in all other schools the response rate was 94%. In South Wales a questionnaire was completed for all the eligible children. Two per cent of the New Zealand children and 1% of the Welsh children completed the questionnaire themselves.

There were 873 New Zealand children and 965 Welsh children in the study. The ethnic distribution of the New Zealand children studied was: European origin 583 (67%), New Zealand Maori origin 226 (26%); Pacific Island origin 27 (3%), other groups or not specified 37 (4%).

The prevalence of reported symptoms in the New Zealand children of European and non-European origin is shown in table 1. "Current asthma" refers to children who were said to have had asthma at any time and to have wheezed during the past 12 months. The prevalence of all the respiratory symptoms was remarkably similar in the European and non-European children, so in subsequent tables these children are not distinguished from each other. Eczema and hay fever or allergic rhinitis were reported more commonly in children of European origin than in the others.

The prevalence of symptoms in New Zealand and South Wales is shown in table 2. For each respiratory symptom the prevalence was higher in New Zealand, the difference being statistically significant for "asthma ever", "wheeze ever", "breathless wheeze ever" (that is, wheeze occurring with breathlessness), and "wheeze brought on by running ever." A history of hay fever or allergic rhinitis was also significantly more frequent in New Zealand than in South Wales. The male : female sex ratio was remarkably similar in the two countries for the respiratory symptoms: for "asthma ever" it was 1·4 in both countries, for "current asthma" it was 1·3 in both countries, for "wheeze ever" it was 1·6 in New Zealand and 1·5 in South Wales, and for "wheeze in past year" it was 1·5 and 1·4 respectively.

Use of inhalers (including nebulisers) by the children is shown in table 3. A history of inhaler use was given more frequently by children in New Zealand than in South Wales, the excess being mainly associated with adrenergic drugs. Twice as many New Zealand as Welsh children had been admitted to hospital for chest trouble. Within New Zealand bronchodilator use was similar in the Europeans and non-Europeans, inhalers having been used at some time by 96 (16%) and 44 (15%) respectively, but hospital admission was much more commonly reported among the non-Europeans (38, 13%) than among the Europeans (36, 6%; p <0·001). At

Table 2 History of symptoms in New Zealand (NS) and Welsh children

	New Zealand children (%)			*Welsh children (%)*			
	Boys n=455	*Girls n=418*	*All n=873*	*Boys n=495*	*Girls n=470*	*All n=965*	*% difference: NZ—Welsh all children (95% of CL)*
Asthma ever	19·3	14·1	16·8	14·1	9·8	12·0	4·8* (1·6, 8·0)
Current asthma	12·5	9·6	11·1	10·3	7·9	9·1	2·0 (−0·8, 4·8)
Wheeze ever	32·3	20·3	26·6	26·7	17·7	22·3	4·3* (0·4, 8·2)
Wheeze in past year	21·3	14·1	17·9	17·8	12·6	15·2	2·7 (−0·7, 6·1)
Breathless wheeze ever	22·4	12·7	17·8	17·2	10·6	14·0	3·8* (0·4, 7·2)
Wheeze without cold ever	20·0	12·2	16·3	16·4	11·1	13·8	2·5 (−0·8, 5·8)
Wheeze brought on by running ever	15·8	13·9	14·9	11·9	8·9	10·5	4·4** (1·3, 7·5)
Eczema ever	14·3	17·7	15·9	16·0	15·7	15·9	0 (−3·3, 3·3)
Hay fever or allergic rhinitis ever	23·1	18·7	21·0	19·0	12·8	16·0	5·0** (1·4, 8·6)

*p < 0·05; **p < 0·01.

Table 3 Proportions of children with a history of inhaler use and hospital admission for chest illness

	New Zealand (NZ) children (%)	*Welsh children (%)*	*% difference NZ − Welsh (95% CL)*
Inhaler ever	16·0	12·3	3·7 (0·5, 6·9)
Inhaler in last year			
Adrenergic	12·4	8·6	3·8 (2·4, 5·2)
Anticholinergic	1·0	0	1·0 (0·3, 1·7)
Mast cell stabiliser	2·2	3·7	−1·5 (−3·0, 0·04)
Corticosteroid	3·6	2·5	1·1 (−0·5, 2·7)
Any of these	12·7	10·1	2·6 (−0·3, 5·5)
Hospital admission for chest trouble ever	8·5	4·2	4·3 (2·0, 6·6)

Table 4 Ownership of pets in New Zealand (NZ) and Welsh children

Pet	*% of children*		
	New Zealand n=873	*Welsh n=965*	*Difference: NZ–Welsh (95% CL)*
Dog	48·2	35·4	12·8 (8·3, 17·3)
Cat	63·2	28·5	34·7 (30·4, 39·0)
Other mammal	11·2	23·5	−12·3 (−15·7, −8·9)
Bird	17·3	11·2	6·1 (2·9, 9·3)
Any mammal or bird	80·0	65·9	14·2 (10·2, 18·2)

the time when the questionnaire was completed oral bronchodilators were being taken by seven New Zealand and four Welsh children, and oral corticosteroids by three New Zealand and no Welsh children.

The frequency of pet ownership in the two groups of children is shown in table 4. Owning a mammal or bird was more common in New Zealand than in South Wales; the New Zealanders were twice as likely to own a cat than were the Welsh children but only half as likely to own another mammal. There was, however, no obvious association between pet ownership and wheezing within either country. Thus cats were owned by 66% of children who had ever wheezed and 62% of those who had never wheezed in New Zealand, and by 3% of ever wheezers and 28% of never wheezers in South Wales, the corresponding percentages for any mammal or bird being 83% and 79% in New Zealand and 70% and 65% in South Wales.

The New Zealand and Welsh children were very similar in mean height within each sex (boys 1483 and 1489 mm, girls 1501 and 1508 mm). The PEF values, adjusted to a mean height of 1500 mm, are shown in table 5 for children classified as having current asthma, others who had ever wheezed, and non-wheezers. Mean values were very similar in the two countries. Three New Zealand children are omitted from this table; two did not perform a PEF measurement, and in one case the wheezing history was inadequate.

Table 5 Peak expiratory flow (PEF) adjusted for height, according to history of asthma and wheeze

	Peak expiratory flow (l/min)				
	New Zealand (NZ) children n	*Mean (SD)*	*Welsh children n*	*Mean (SD)*	*Difference: NZ–Welsh (95% CL)*
Current asthma					
Boys	56	350 (43)	51	337 (52)	13 (−5, 31)
Girls	40	334 (50)	37	333 (48)	1 (−21, 23)
Any history of wheeze					
Boys	89	347 (44)	81	350 (50)	−3 (−17, 11)
Girls	45	337 (55)	46	342 (41)	−5 (−25, 15)
No history of wheeze					
Boys	307	351 (46)	363	354 (41)	−3 (−10, 4)
Girls	333	354 (50)	387	348 (44)	6 (−1, 13)
All children					
Boys	452	350 (46)	495	351 (44)	−1 (−7, 5)
Girls	418	350 (51)	470	346 (44)	−4 (−10, 2)

Five children in each country did not perform the exercise test. The effect of exercise on PEF is shown in table 6 where the second PEF is expressed as a percentage of the first (100 × PEF2/PEF1). This percentage was virtually the same for the children with current asthma in the two countries, but significantly lower in New Zealand among the other wheezers and non-wheezers. The protocol specified a fall in PEF exceeding 15% as defining exercise induced asthma. This occurred in 47% of the children with current asthma in New Zealand and in 48% of those in South Wales, the percentages for other wheezers being 17% and 7% respectively, and for non-wheezers 6% and 3%. The cumulative percentage of all children with a value of 100 × PEF2/PEF1 below various levels is shown in table 7. A fall in PEF exceeding 15% occurred much more frequently in New Zealand than in South Wales ($p < 0·01$). Within New Zealand there was no difference between European and non-European children in this regard: a fall of more than 15% occurred in 12·4% of the former and 11·8% of the latter.

The mean (SD) atmospheric temperature was slightly higher in New Zealand (22°C, (2·9)) than in South Wales (20°C, (3·2)), and so was the mean relative humidity (61 (10·5) *v* 57 (10·6)). Regression analysis was carried out to see whether the change in PEF with exercise was related to either the dry bulb temperature or the relative humidity, but no relationships were found. Mean heart rate on cessation of exercise was 170 (18) beats/min in New Zealand and 167 (17) beats/min in South Wales.

Discussion

The results of this survey allow direct comparisons to be made between 12 year old children in New Zealand and in South Wales. The high response rates preclude any important degree of selective bias, and the simple exercise test gives some objective confirmation of the questionnaire findings.

There are obvious limitations in a study of this kind. Information obtained by questionnaire is susceptible to defects of memory, particularly for symptoms at any time in the past. There is no obvious reason, however, why symptoms should be recollected with different degrees of exactitude in the two countries. The relation between asthmatic symptoms induced by exercise challenge and clinical asthma is difficult to quantify as there is no gold standard for clinical diagnosis, but most asthmatic children show a response.[10–12] Free range running is more effective than treadmill or bicycle exercise[10 11] but is difficult to standardise. The similarity in heart rates suggests

Table 6 Effect of exercise on peak expiratory flow (PEF) according to history of asthma and wheeze

	100 × PEF2/PEF1					
	New Zealand children*			Welsh children*		
	n	Mean	(SD)	n	Mean	(SD)
Current asthma	97	80·5	(19·2)	87	79·9	(21·4)
Any history of wheeze	131	92·8	(10·8)**	125	96·2	(7·6)
No history of wheeze	639	96·9	(8·2)***	748	98·3	(6·5)

*Six New Zealand children and five Welsh children are omitted. **p < 0·01, ***p < 0·001: New Zealand *v* Welsh children.

that the degree of exercise was at least approximately similar in the two centres. We avoided exercising children who had undertaken physical education or sports during the previous lesson; we were unable to standardise further for previous exercise but have no reason to believe that important differences existed between the children in the two countries. There were slight differences in atmospheric temperature and relative humidity, but neither factor was related to the effect of exercise on PEF within the range of readings in this survey.

A history of asthma at any time was substantially more common in New Zealand than in South Wales among 12 year old children (16·8% compared with 12·0%). The difference is unlikely to be attributable to a greater readiness to diagnose asthma in New Zealand than in South Wales because the prevalence of a history of wheezing was also significantly higher in New Zealand (26·6% compared with 22·3%). Other symptom complexes suggestive of asthma (breathless wheeze, wheeze induced by running) also tended to occur more often in New Zealand than in South Wales. The percentages of New Zealand and Welsh children with symptoms in the previous year were closer than those relating to symptoms at any time, so the differences would presumably have been greater in a younger age group. The sex ratios for asthma and wheezing were remarkably similar in the two countries, suggesting that diagnostic criteria were not dissimilar. More children in New Zealand than in South Wales had used inhalers, and twice as many New Zealanders as Welsh children had been admitted to hospital at some time with chest trouble.

Table 7 Changes in peak expiratory flow (PEF) on exercise: cumulative percentages of children with 100 × PEF2/PEF1 below various levels

	NZ children*		Welsh children*	
100 × PEF2/PEF1	Cumulative %	(n)	Cumulative %	(n)
<25	0·1	(1)	0·2	(2)
<35	0·2	(2)	0·3	(3)
<45	0·7	(6)	0·8	(8)
<55	1·8	(16)	1·3	(12)
<65	2·9	(25)	2·3	(22)
<75	6·1	(53)	4·1	(39)
<85	12·2	(106)	7·7	(74)
<95	41·6	(361)	30·8	(296)
<105	91·7	(796)	89·0	(854)
<115	97·6	(847)	99·6	(956)
<125	99·9	(867)	99·9	(959)
<135	100·0	(868)	100·0	(960)

*Five New Zealand and five Welsh children are omitted.

The lung function tests confirmed the impression that the diagnosis of asthma is made on similar grounds in the two countries: resting PEF measurements and the effect of exercise on PEF were virtually identical in the asthmatic children of the two countries. The post-exercise PEF as a percentage of the initial value was lower in the New Zealand "other wheezers" than in the Welsh, suggesting a greater tendency to asthma among this group of children in New Zealand. The mean value for 100 × PEF2/PEF1 among the non-wheezers was also slightly lower in New Zealand. The overall distributions of 100 × PEF2/PEF1 show that New Zealand children have a higher prevalence of exercise induced bronchoconstriction than Welsh children.

The results of this study show that childhood asthma is more common in New Zealand than in South Wales. Within New Zealand the European and non-European children had similar prevalence rates of asthma and a similar response to exercise, in contrast to the results of a survey in Auckland, where European children had a lower prevalence of wheezing, a similar prevalence of diagnosed asthma, and a higher prevalence of bronchial hyperresponsiveness than non-Europeans.[13] The difference in prevalence between the two countries is insufficient to explain completely the higher mortality rates in New Zealand: differences of more than fourfold have been reported for people aged 5–34 years[1] and more than double for white people aged 15–64 years.[2] The higher admission rates in New Zealand do not seem to be attributable to a greater readiness of general practitioners to admit patients to hospital.[7] It has been suggested that asthma is more severe as well as more common in New Zealand.[2]

Reasons for the high prevalence and mortality of asthma in New Zealand are the subject of much speculation. Hay fever and allergic rhinitis are significantly more common in New Zealand than in South Wales, whereas eczema was reported in exactly the same proportion of children in the two countries. This suggests that the difference in asthma prevalence may be attributable to greater exposure to inhaled allergens or other provoking factors rather than to a greater liability to atopic disease in New Zealand. Ownership of pets (particularly cats) was very different in the two countries, but it was not associated with wheezing in either. This lack of association does not exclude the possibility of some causative role; the overall exposure to cats in New Zealand may be more important than individual ownership, especially as parents are unlikely to keep a cat if their child appears to be allergic to cats.

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1 Jackson RT, Beaglehole R, Rea HH, Sutherland DC. Mortality from asthma: a new epidemic in New Zealand.

BMJ 1982;**285**:771–4.
2 Sears MR, Rea HH, Rothwell RPG, *et al.* Asthma mortality: comparison between New Zealand and England. *BMJ* 1986;**293**:1342–5.
3 Mitchell EA. International trends in hospital admission rates for asthma. *Arch Dis Child* 1985;**60**:376–8.
4 Keating G, Mitchell EA, Jackson R, Beaglehole R, Rea H. Trends in sales of drugs for asthma in New Zealand, Australia, and the United Kingdom, 1975–81. *BHJ* 1984;**289**:348–51.
5 Asher MI, Pattemore PK, Harrison AC, *et al.* International comparison of the prevalence of asthma symptoms and bronchial hyperresponsiveness. *Am Rev Respir Dis* 1988; **138**:524–9.
6 Jones DT, Sears MR, Holdaway MD, *et al.* Childhood asthma in New Zealand. *Br J Dis Chest* 1987;**81**:332–40.
7 Mitchell EA, Anderson HR, Freeling P, White PT. Why are hospital admissions and mortality rates for childhood asthma higher in New Zealand than in the United Kingdom? *Thorax* 1990;**45**:176–82.
8 Burr ML, Eldridge BA, Borysiewicz LK. Peak expiratory flow rates before and after exercise in school children. *Arch Dis Child* 1974;**49**:923–6.
9 Burr ML, Butland BK, King S. Vaughan-Williams E. Changes in asthma prevalence: two surveys 15 years apart. *Arch Dis Child* 1989;**64**:1452–6.
10 Anderson SD, Silverman M, König P, Godfrey S. Exercise-induced asthma. *Br J Dis Chest* 1975;**69**:1–39.
11 Shapiro CG, Pierson WE, Furukawa CT, Bierman CW. A comparison of the effectiveness of free-running and treadmill exercise for assessing exercise-induced bronchospasm in clinical practice. *J Allergy Clin Immunol* 1979;**64**:609–11.
12 Tsanakas JN, Milner RDG, Bannister OM, Boon AW. Free running asthma screening test. *Arch Dis Child* 1988;**63**: 261–5.
13 Pattemore PK, Asher MI, Harrison AC, Mitchell EA, Rea HH, Stewart AW. Ethnic differences in prevalence of asthma symptoms and bronchial hyperresponsiveness in New Zealand schoolchildren. *Thorax* 1989;44:168–76.