

The prevalence of immediate positive skin tests in Nepalese children

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Summary

Two hundred and ninety-three normal schoolchildren between 5 and 15 years old living in the hills of Eastern Nepal were tested by the skin prick method for sensitivity to six allergens: *Dermatophagoides pteronyssinus*, *Aspergillus fumigatus*, *Cladosporium herbarum*, *Penicillium notatum*, mixed pollens and mixed threshings. These children were also questioned and examined for symptoms and signs relating to allergic disease.

Of the children, 20% were skin-prick positive to at least one of the allergens, and 20% had symptoms of allergic disease, but there was no relationship between the symptoms and the prick test results.

No relationship was found between the prick test results and any of the following: the length of time a child was breast-fed; the age of the child and his month of birth.

Of the boys, 19% admitted to smoking cigarettes, as did 11% of the girls.

Introduction

The skin prick test is a simple and safe method of detecting type I hypersensitivity. A positive result to the prick test has been shown to correlate well with the presence of specific IgE antibody (Stenius *et al.*, 1971) although because of the variability in the preparation of allergen extracts and the dependence of the skin reaction on the concentration of test material it remains unclear as to what should count as a positive reaction (Lesso *et al.*, 1980).

The production of specific IgE antibody to common allergens appears to be an important factor in the cause of asthma and other allergic diseases such as hay fever (Turner Warwick, 1971). A great deal of work has been done on the prevalence of prick test positivity amongst people with allergic diseases, but relatively little on the prevalence within a normal population.

We report here the results of skin prick tests using a number of allergens, and the results of a questionnaire relating to allergic disease, on a sample of 293 normal children living in hills of Eastern Nepal.

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Materials and methods

We did skin prick tests on 293 of the 301 children who form the sample in another paper (Bangham & Hope, 1981). These children were aged between 5 and 15 years and lived in villages between 500- and 2000-m altitude in the hills of Eastern Nepal. We saw twelve children each morning for 1 month and moved on to the next village each afternoon. About 80% of the village children attended for BCG vaccination and we selected twelve of these for our survey. Our selection was determined mainly by which children were keen to take part, but also by whether there was a parent or older sibling present who could help with answering questions about each child.

We tested each child with six allergen preparations and one control—the manufacturer's diluent (Bencard). The allergens were: *Dermatophagoides pteronyssinus*, *Aspergillus fumigatus*, *Cladosporium herbarum*, *Penicillium notatum*, mixed pollens and mixed threshings. These were chosen to cover a wide spectrum of likely allergens in the absence of any precise information on allergens in Nepal.

One drop of each of the seven allergen solutions was placed on the volar aspect of the forearm 3 cm apart and adjacent to a corresponding number written in ballpoint ink. A shallow prick which involved lifting the skin slightly without drawing blood was made through each drop using sterile lancets designed for obtaining finger prick blood drops. A new lancet was used for each drop and for each child. After pricking, the drops were blotted with tissue paper.

The responses to the prick tests were read 10 min later. A response '0' was recorded if there was no reaction. A response '+' if there was a red flare only or a red flare and weal less than 2 mm in diameter. For weals greater than or equal to 2 mm the size of the weal, measured using standard circles on a plastic transparent plate, was recorded to the nearest millimetre. For non-circular weals the mean of the longest and shortest diameters was recorded.

A response was considered to be positive if it was two or more grades larger than control. The grades were: 0, +, 2, 3, 4, 5 or 6 mm. Thus if the control was recorded as +, only weals of 3 mm or more were considered as positive. We chose this criterion because it recorded as positive all and only those reactions which were clearly greater than and not simply adjacent in size to the control. Unless otherwise stated this was the criterion used. We also present some results using other criteria in order to compare our results with other studies and with work correlating IgE measurements with skin prick test positivity.

A questionnaire based on the one used at the Brompton Hospital was filled in for each child. We were helped in this by two Nepali interpreters, Tanka and Suresh. The questionnaire (available on request) included the following items: age, month of birth, amount smoked per day, length of time breast fed; symptoms of cough, wheeze, runny nose, watery eye and itching skin, and family history of these symptoms.

We obtained dust samples from under mats or bedding in six houses each from a different village. These samples were kindly analysed for their mite content by Mr A.M. Cunningham. The method for analysis has been described elsewhere (Stenius & Cunningham, 1972).

Results

The sample of 293 children consisted of 201 boys and 92 girls. The distribution of the whole sample of 301 children with respect to age, height and weight are shown elsewhere (Bangham & Hope, 1981).

Table 1. The number of children prick test positive to each allergen

Substance	Children using our criteria		Children not related to each other using our criteria		Children with weal ≥ 3 mm		Children with weal ≥ 4 mm		Children with weal ≥ 5 mm	
	n	%	n	%	n	%	n	%	n	%
<i>Dermatophagoides pteronyssinus</i>	26	8.9	24	10	14	4.8	7	2.4	2	0.7
<i>Aspergillus fumigatus</i>	10	3.4	10	4.1	4	1.4	0	0	0	0
<i>Cladosporium herbarum</i>	8	2.7	8	3.3	3	1.0	0	0	0	0
<i>Pencillium notatum</i>	2	0.7	2	0.8	1	0.3	0	0	0	0
Mixed pollens	11	3.8	11	4.5	6	2.0	2	0.7	0	0
Mixed threshings	40	13.7	35	14.5	31	10.6	9	3.1	1	0.3
At least one	59	20.1	53	22	44	15	15	5.1	3	1.0

Table 1 shows the number and percentage of children positive to each allergen. The results are given for different criteria of prick-test positivity. In twenty-one children the control was scored as + and in five children as 2 mm. The control never gave a weal with a diameter greater than 2 mm. The largest weal was of 6 mm diameter in one child to *D. pteronyssinus*.

The percentage of children positive to at least one allergen was 20. Of those positive to at least one, 46% were positive to two or more.

Forty-nine children were positive to *D. pteronyssinus* or to mixed threshings or to both, and fifty-five children positive to at least one of *D. pteronyssinus*, mixed threshings and *C. herbarum*. In other words using those three allergens alone we would have picked up 93% of children who were positive to at least one of the six allergens used.

Ninety-four of the 301 children were siblings of at least one other child in the sample. Since there is a genetic component to the type I reaction we looked at our results including only those children ($n=242$) not related to anyone seen previously.

The results are shown in Table 1. The slightly higher proportion who were prick-test positive in this group is not significant.

The diagnosis of asthma and the prick test results in children diagnosed as asthmatic are discussed in another paper (Bangham & Hope, 1981).

In the hills of Nepal the people live in houses without chimneys and because the cooking and heating is by inside open fire the houses become very smoky. Furthermore skin infestations with scabies and lice are common, so the allergic symptoms in our questionnaire are met with frequently. By finding out what made the symptoms worse and by looking at the skin for marks of scabies we have classified the symptoms according to whether or not we judged them to be allergic in origin.

Sixty of the 293 children prick tested (20%) were thought by us to have symptoms of allergic disease. These symptoms are summarized in Table 2. With no single symptom nor with all taken together is there a significant difference in the frequency of prick-test positivity between those with symptoms and those without.

The symptom of itching skin has been divided into two groups. Three trees were

Table 2. The number of children with allergic symptoms

Symptom	Children		Precipitating factor	Number effected	Prick-test positive	
	<i>n</i>	%			<i>n</i>	%
Wheeze	18	6	Animals	2	6	33
			Plants	12		
			Others	4		
Watery eyes	6	2	Animals	3	1	17
			At night	1		
			Plants	2		
Runny nose	3	1	Animals	1	1	33
			At night	1		
			All the time	1		
Itching skin						
(a) from one of three 'itching' trees*	22	7			4	18
(b) others	28	9	Animals	7	7	25
			Touching meat	3		
			Eating meat	1		
			Plants	15		
			Others	2		

* Cilaune (*Schima wallichii*); Bhalayo (*Rhus wallichii*); Khirra.

responsible in almost half of the children with this symptom, and these trees were well known by our interpreters as causes of itching. Indeed the Nepali name for one of these means 'to itch' (cilaune). The cause of itching in these cases may have been due to a non-specific irritant. However, neither of us was affected by these trees which suggests that the response may be an allergic one in people previously sensitized.

In the other group a number of factors were responsible for the itching skin. It is interesting to note that three children gave a clear history of itching on touching meat.

Table 3 gives the number of children (total $n=229$) breast fed for each yearly interval.

Only three children were not fed at the breast. For one, her mother had no milk and the mother of one of the boys died. We did not find out why the second boy was never breast fed. The mean breast feeding time was 3.1 years for boys and 3.0 for girls.

Table 3. The length of time for which children were breast fed

	Not breast fed	Breast fed for (years)							
		1	1-<2	2-<3	3-<4	4-<5	5-<6	6-<7	>7
Males	2	3	20	53	40	13	9	1	3
Females	1	4	18	28	17	3	10	3	1

Combining the data for boys and girls there was no significant difference in the proportion of children prick-test positive in the group who were breast fed for more than 3 years compared to those breast fed for less than 3 years.

There was no significant difference in the proportion of children skin-test positive between those aged 11 or under and those of 12 and over.

We found no relationship between the month of birth and the results of the skin prick test.

Thirty-eight boys (19%) and 11 girls (11%) admitted on direct questioning to smoking cigarettes. Table 4 shows the number of boys and girls for each year of age who smoked and the mean number of cigarettes smoked per day. For a few children we were able to determine that they smoked but not how much. In working out the mean number of cigarettes smoked per day these children are not included. There was no

Table 4. The number of cigarettes smoked for each year of age

Age (years)	Boys				Girls			
	Number smoking	Total no.	%	Mean number of cigarettes smoked per day	Number smoking	Total no.	%	Mean number of cigarettes smoked per day
5	0	2	0	—	0	2	0	—
6	0	5	0	—	1	3	33	—
7	0	12	0	—	1	9	11	—
8	1	12	8	2	0	9	0	—
9	1	25	4	—	1	13	8	1-2
10	5	27	19	2.5	0	15	0	—
11	3	32	9	1	1	10	10	9
12	3	27	11	1	3	19	16	4-5
13	6	25	24	6	1	11	9	4
14	13	24	54	5	1	2	50	—
15	6	12	50	3	2	3	67	3

significant difference in the proportion of prick test positive children between those who smoked and those who did not.

D. pteronyssinus was present in five of the six samples of house dust although the numbers were small in all but one sample. *D. farinae* was not present in any sample. The other mites found in at least one sample were: *Euroglyphus maynei*; *Chortoglyphus arcuatus*; *Blomia tropicalis*; *Tyrophagus* sp.; *Glycyphagus* sp. and *Cheyletus* sp. *D. pteronyssinus* was, overall, the most abundant species and accounted for 60% of the total mite population.

Discussion

Table 5 summarizes much of the data on unselected populations and on populations which are the control group of studies primarily on asthmatics.

A major difficulty in comparing these data is the wide variety of criteria used for prick-test positivity between different authors. The problem of what is the correct criterion raises the question of correct for what? The size of the weal is positively

Table 5. A summary of various studies looking at the prevalence of prick-test positivity in unselected or non-asthmatic populations

Study	Locality	Population studied	Number of allergens	Criteria for positivity weal (mm)	Percentage positive
Anderson (1974)	New Guinea	122 Primary schoolchildren 122 Adults 91 High school students	11	≥ 3	14 Children 21 Adults 24 Students
McNichol & Williams (1973)	Melbourne	82 Children	6	—	4 7-year-olds 6 10-year-olds 10 14-year-olds
Bruce Pearson & Cunningham (1973)	Barbados	52 Adults	2	> 2	6 <i>D. pteronyssinus</i> 10 <i>D. farinae</i>
Carswell <i>et al.</i> (1977)	Tanzania	242 Primary schoolchildren	22	$>$ mean of controls (15)*	42 <i>D. pteronyssinus</i>
Godfrey (1975)	The Gambia	131 Rural and 60 urban children	2	—	1.5
Cookson & Makoni (1975)	Rhodesia	51 Non-allergic African patients	Many	> 5 above control	2
Warrell <i>et al.</i> (1975)	Nigeria	49 Non-allergic hospital patients and staff	19	≥ 2 above control (10-15)*	51 4 <i>D. pteronyssinus</i>
Godfrey & Griffiths (1976)	Southampton	303 Schoolchildren	2	≥ 3 above (10)*	33.7 26.4 <i>D. pteronyssinus</i>
Woolcock <i>et al.</i> (1978)	Australia & New Guinea	505 Adults	8	≥ 2	44 41 <i>D. pteronyssinus</i>
Barbee <i>et al.</i> (1976)	Arizona	3101 All ages	5	$>$ control (20)*	22 3-4-year-olds 35 5-9-year-olds 39 10-14-year-olds
Buchanan & Jones (1972)	Zambia	30 Africans	1	—	13 <i>D. farinae</i>
Wolstenholme (1979)	Southern Maldives	50 Non-allergic controls	11	≥ 3 (10-15)*	14 <i>D. pteronyssinus</i>
Macfarlane <i>et al.</i> (1979)	Nigeria	75 Non-allergic adults	12	> 2 above control	53

* Time read (minutes).

correlated with the concentration of specific IgE (Stenius *et al.*, 1971) but Lessof and his colleagues (1980) have concluded that for inhaled allergens it is not until the weal size is 4 mm or greater that it is a reliable indication that there are appreciable levels of specific IgE as measured by the radioallergosorbent test (RAST). However, most authors count as positive smaller weals than this.

The size of the weal depends also on the concentration of allergen used (Stenius *et al.*, 1971)—generally the more concentrated the allergen the larger the weal, although the reverse effect has been observed (Huggins & Brostoff, 1979). Thus the wide variety of allergen preparations which have been used confuse comparison.

In order to help comparison with other studies we have given the prevalence of prick test positivity to each allergen using a variety of criteria.

Godfrey (1975) found that only 1.5% of rural and urban school children in The Gambia were positive to one or other of house dust and *Dermatophagoides farinae*. Anderson (1974) found that 14% of primary school children in New Guinea reacted to at least one of eleven allergens with a weal size of 3 mm or more. This is very similar to our figure of 15% using the same criteria. Comparable data on English children show a prevalence of 33.7% (Godfrey & Griffiths, 1976).

The most extensive study of prick test response on a normal population is that of Barbee and his colleagues in Arizona (1976). They found that 35% of subjects aged between 5 and 9 years were positive and 39% aged between 10 and 14, to at least one of five allergens. Using their criteria, in which any reaction greater than the control is positive, our overall figure is 25%.

Godfrey & Griffiths (1976), like us, found no effect of age on prick-test positivity. Barbee and his colleagues (1976) however, in their extensive study found that the proportion of prick test positive subjects increased with age to a peak in the 20s and then gradually declined.

Several studies have shown a relationship between allergic disease and month of birth (Morrison Smith & Springett, 1979). These authors found that children positive to *Dermatophagoides* species were more frequently born in the period from May to October. All the children however in this large sample of 1286 were attending an asthma clinic. Both our results and those of Godfrey & Griffiths (1976) fail to show a relationship between month of birth and prick-test positivity.

All but three of the 229 children for whom we have information were fed at the breast. The mean breast feeding time is about 3 years and this is probably related to the average time when the next child is born and needs suckling. Potentially allergenic substances may pass from mother to infant in breast milk (Warner, 1980) and although such substances are likely to be related more to food allergy than to inhalants we analysed our results to see whether the length of time breast feeding affected the probability of being prick-test positive. We found no such relationship.

Of the 301 children in our sample, 299 told us whether or not they smoked. It is probable, in Western countries at least, that children admit, on direct questioning, to less than they really smoke, and an anonymous questionnaire may be better (Hanley & Robinson, 1976). It was our impression that there was very little embarrassment amongst the Nepalese children in admitting to smoking.

Cigarettes rolled locally by hand were readily available and cheap in the hill villages.

In an extensive Canadian study it was found that 20% of rural boys between 11 and 13 years old admitted to smoking and 46% of boys from 14 to 16 years old. The

corresponding figures for girls were 14% and 43% (Hanley & Robinson, 1976). In our study the results show: 14% of boys from 11 to 13 years, 53% from 14 to 15 years, 12.5% of girls from 11 to 13 and 60% (three out of five) girls aged from 14 to 15 years.

In our six samples of house dust, *D. pteronyssinus* accounted for 60% of the total mite population. Anderson & Cunnington (1974) found that *D. pteronyssinus* accounted for 73% of the mite population in samples from the Highlands of New Guinea, and in samples from the United Kingdom, Maunsell *et al.*, (1968) found that it accounted for 67%.

Most of the remaining were storage mites. Although *D. pteronyssinus* appears to be the most potent of the mite allergens, Wraith and his colleagues (1979) have shown that extracts from storage mites can cause immediate positive skin reactions.

In conclusion, the prevalence of prick-test positivity amongst Nepalese children is similar to that found in New Guinea (Anderson, 1974). It is however less than the prevalence found in a sample of children from Southampton (Godfrey & Griffiths, 1976).

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