

# The prevalence of asthma and wheezing illnesses amongst 10-year-old schoolchildren

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**Abstract** Asthma and wheezing illnesses carry a significant burden of disease during childhood. Prevalence studies have the capacity to provide invaluable insights into the nature of these common conditions. As part of the Isle of Wight Whole Population Birth Cohort Study ( $n=1456$ ) we have examined wheezing and asthma development amongst 10-year-old children. At this age 1373 children completed ISAAC written questionnaires whilst 1043 children performed further testing including skin-prick testing, serum inhalant IgE antibody screening, spirometry and bronchial challenge. At 10-years, prevalence of current wheeze was 18.9%, current asthma (symptomatic bronchial hyper-responsiveness—BHR) 14.4% and currently diagnosed asthma (current wheeze and asthma ever—CDA) 13.0%. Both wheezing and asthma at 10 years were associated with average symptom onset at 3 years of age indicating an early life origin for such conditions. Current wheeze ( $P=0.011$ ) and CDA ( $P=0.008$ ) showed significant male predominance. Considerable disease morbidity was identified for these states that tended to be greatest amongst children defined asthmatic rather than simply current wheezers. Wheezing and asthma were significantly associated with both atopy ( $P<0.001$ ) and allergic co-morbidity. Children with these states, particularly current asthma, also demonstrated impaired lung function ( $FEV_1$ ,  $P<0.001$  and  $FEV_1/FVC$ ,  $P=0.010$ ) and increased BHR (inverse slope,  $P<0.001$ ). In conclusion, Asthma and wheezing showed substantial prevalence at 10 years of age. Strong associations to male gender, atopy, impaired lung function and BHR were seen for both wheeze and asthma. In regard to prevalence and morbidity characteristics, a questionnaire-based definition of currently diagnosed asthma gave similar results to the use of symptomatic BHR in defining current asthma. © 2002 Elsevier Science Ltd

doi:10.1053/rmed.2001.1236, available online at <http://www.idealibrary.com on> 

**Keywords** childhood asthma; wheezing; allergy; lung function; bronchial hyper-responsiveness.

## INTRODUCTION

During the latter decades of the 20th century, studies have consistently identified a high prevalence of wheezing illnesses and asthma during childhood (1–5). Worryingly, serial observations within the same geographical locations (6,7) have suggested a real increase in prevalence for childhood asthma over this period. A consistent trend for higher prevalence of wheezing and asthma in more affluent westernized societies has been shown repeatedly (8). Of these, the worst affected countries appear to have been New Zealand (9,10), Australia (2) and the U.K. (1,8,11–13).

A major difficulty in the past with interpretation of prevalence data for childhood wheezing and asthma has been the range of definitions used for these conditions in different studies. Thus comparison of data between stu-

dies has often been impossible. The inception of International Study of Asthma and Allergies in Childhood (ISAAC) (8), using standardized questionnaire material, has helped to reduce this problem. Another important shortcoming of many prevalence studies in this field has been the lack of objective data (12,13) such as skin-prick testing, IgE measurement, lung function testing and bronchial hyper-responsiveness assessment to corroborate questionnaire data.

In this paper we describe the prevalence of wheezing illnesses and asthma at 10 years of age from the Isle of Wight Whole Population Birth Cohort Study where both ISAAC questionnaire materials and objective assessments of asthma were employed.

## METHODS

A whole population birth cohort was established on the Isle of Wight, U.K., in 1989 to study the development of asthma and related allergic disorders. Approval for the study was obtained from the Local Research Ethics

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Committee. Of 1536 children born between 1 January 1989 and 28 February 1990, informed consent was obtained for 1456 subjects. Enrolment took place at birth and these children were subsequently seen at the ages of 1 ( $n=1167$ ), 2 ( $n=1174$ ) and 4 years ( $n=1218$ ). Results from these follow-ups have been reported previously (14–16).

At 10 years, information was updated during a visit to the Research Centre ( $n=1043$ ). Where this was not possible ( $n=330$ ), a telephone questionnaire was completed with a parent or a modified postal questionnaire sent for the parent to complete and return. Detailed interviewer-administered questionnaires were completed with the parents of each child regarding asthma and allergy development. ISAAC (8) written questionnaires were used assessing respiratory, nasal and dermatological symptoms. To minimize recall bias, responses concerning symptom onset were incorporated with data obtained earlier in the course of this prospective study. Additional information was obtained using a supplementary questionnaire consistent with those completed at prior follow-ups. Purely questionnaire-derived asthma-related definitions were current wheezing (wheezing in the last 12 months) and currently diagnosed asthma (CDA—a combination of both current wheeze and diagnosed asthma ever). A separate definition of current asthma incorporating objective assessment of bronchial hyper-responsiveness (BHR— $PC_{20} FEV_1 < 8 \text{ mg ml}^{-1}$  at bronchial challenge) with current wheeze was also used where bronchial challenge was performed. Other allergic states defined were current eczema (combination of eczema ever and current symptoms of chronic itchy rash), current hay fever (combination of hay fever ever and current nasal symptoms not associated with a cold) and current urticaria (urticarial symptoms within the last 12-months). Social class classification based on paternal occupation was made using the 'Standard Occupational Classification' (17).

At 10 years, skin-prick testing (SPT) was performed in all children who attended the Centre to a standard battery of common allergens (ALK, Hørsholm, Denmark). Positive (histamine dihydrochloride,  $10 \text{ mg ml}^{-1}$ ) and negative controls (physiological saline) were included. Inhalant allergens tested were house dust mite (*Dermatophagoides pteronyssinus*), cat, dog, *Alternaria alternata*, *Cladosporium herbarium*, grass pollen mix (timothy grass, rye, meadow, colts foot, june, false oat) and tree pollen mix (alder, silver birch, hazel). Food allergens tested were cows milk, soya, hens' egg, peanut and cod. Mean wheal diameter 3 mm greater than the negative control was regarded as a positive test for any given allergen. Presence of at least one such reaction defined the subject as atopic.

Baseline pulmonary function testing, forced expiratory volume in 1 sec ( $FEV_1$ ), forced vital capacity (FVC),

peak expiratory flow (PEF), was measured in all children attending the Research Centre using Koko spirometry software (Pds Instrumentation, Louisville, U.S.A.). All children with past or current wheezing were invited to perform a methacholine bronchial challenge to assess BHR using a Koko dosimeter (Pds Instrumentation, with compressed air source at  $8 \text{ l min}^{-1}$  and nebuliser output  $0.8 \text{ l min}^{-1}$ ). Initial inhalation of 0.9% Saline was followed 1 min later by spirometry recording to obtain a baseline value. Subsequently, incremental concentrations from  $0.0625 \text{ mg ml}^{-1}$  to  $16 \text{ mg ml}^{-1}$  of methacholine were serially administered using the methods of Chai *et al.* (18). The concentration causing a 20% fall in  $FEV_1$  from the post-saline value was interpolated and expressed as  $PC_{20} FEV_1$ . To perform this test, children were required to be free from respiratory infection for 14 days, not taking oral steroids, not taken a  $\beta_2$ -agonist for 6 h and abstained from caffeine intake for at least 4 h. A control group of 'non-wheezers' also underwent bronchial challenge using identical methodology.

Ten millilitres of whole blood was taken for measurement of total serum IgE and an inhalant screen (qualitative) for IgE antibody to common inhalant allergens (Phadiatop; Pharmacia, Uppsala, Sweden). The inhalant screen tested for house dust mite (*D. pteronyssinus* and *D. farinae*), cat dander, dog dander, horse dander, timothy grass, cladosporium, silver birch, olive, mugwort and nettle. Serum was stored at  $-40^\circ\text{C}$  until analysis.

## Analysis

Data was double entered onto SPSS version 10.0 (Chicago, IL, U.S.A.). Means for continuous variables were analysed (with transformation where necessary) using the independent samples *t*-test. Differences in proportions between groups were tested using chi-square analysis.

In our population, including non-wheezing children, many subjects might not be expected to possess a measurable  $PC_{20}$  at bronchial challenge. Therefore, a continuous measure of BHR (least-square dose-response slope) was also estimated by least-square regression of percentage change in  $FEV_1$  upon methacholine dose for each child (19). Inverse transformation,  $1/(10-\text{slope})$ , was used to satisfy normality and homoscedasticity. Thus, low values for  $1/(10-\text{slope})$  would infer high BHR.

## RESULTS

At 10 years, information was obtained from 1373 (94%) of the original 1456 children recruited into the study at birth. Of these 1043 (76.0%) visited the Research Centre to complete a questionnaire ( $n=1043$ ), SPT ( $n=1036$ ), total IgE measurement ( $n=953$ ), spirometry ( $n=981$ ) and methacholine bronchial challenge ( $n=784$ ). Only a questionnaire was updated in the remaining 330 children.

Children attending the Research Centre were more likely to have a personal or family history of allergy than those for whom only a questionnaire was obtained. Demographic and disease characteristics for these two groups of children at 10 years are given in Table 1.

Current wheeze at 10 years (as defined by the ISAAC questionnaire) was present in 18.9% (259) children. Current asthma (a combination of current wheeze and a  $PC_{20}$   $FEV_1 < 8 \text{ mg ml}^{-1}$ ) was present in 14.4% (113/784) children undergoing bronchial challenge testing. Furthermore, 13.0% (178 children) of the whole 10-year population had currently diagnosed asthma (CDA—a combination of asthma ever and current wheeze at 10 years). In total 55.7% (113/203) of current wheezers who performed a bronchial challenge met the criteria for having current asthma whilst 68.7% (178/259) of current wheezers fulfilled the definition of CDA. Amongst children with CDA who underwent bronchial challenge, 62.8% (86/137) also satisfied criteria for current asthma.

Male predominance was seen for all three wheezing categorizations. Significantly higher prevalence for current wheeze (21.5% vs. 16.1%,  $P=0.011$ ) and CDA (15.4% vs. 10.5%,  $P=0.008$ ) were found in boys than girls. A similar trend was found in current asthmatic children (boys 16.4% vs. girls 12.4%,  $P=0.111$ ), although this did not reach statistical significance.

Analysis of when children first experienced any wheezing episodes identified an early origin for wheezing at 10 years. The mean age of first symptom for current

wheeze was 3.0 years (SD 2.8), for current asthma was 3.1 years (SD 2.6) and CDA was 2.7 years (SD 2.5).

Morbidity indices for these three separate wheezing categorizations showed a trend for higher values in those with current asthma or CDA than those with current wheeze (Table 2). The only disease symptom to vary significantly by gender was exertional wheeze, which was significantly more frequent amongst boys (14.3% vs. 10.5%,  $P=0.031$ ). Current pharmacological treatment for wheezing was being used by 65.9% current wheezers, 75.2% current asthmatics and 77.7% CDA.

Atopy was significantly more common when each of current wheeze, current asthma or CDA were present than when these states were absent (Fig. 1). In each case, children with current wheeze (2.24 vs. 1.82,  $P<0.001$ ), CDA (2.32 vs. 1.84,  $P<0.001$ ) or who had current asthma (2.53 vs. 1.82,  $P<0.001$ ) all had significantly higher mean  $\log_{10}$  total IgE than those without that condition.

The whole population prevalence for current eczema was 13.7%, current rhinitis 15.1% and current urticaria 8.7%. These conditions were more common in the presence of wheezing or asthma at 10 years. Thus the prevalence of current eczema was 23.0% in those with current wheeze, 32.7% in current asthma, 24.4% in CDA and 11.5% in non-wheezers. Current rhinitis was found in 34.3% with current wheeze, 42.5% current asthma, 39.9% of CDA and 10.6% in non-wheezers. Current urticaria occurred in 13.8% with current wheeze, 16.1% current asthma, 8.2% of CDA and 7.5% in non-wheezers.

Varying evidence of lower baseline lung function was noted in each case for children with current wheeze, current asthma or who had CDA compared to when that particular condition was absent (Table 3). This tended to be statistically significant for indices associated with an obstructive pattern of spirometry ( $FEV_1$ ,  $FEV_1/FVC$  ratio). Analysis by gender for the whole population revealed, significantly lower baseline lung function for girls than boys (Table 4). This remained the case when children without current wheeze were considered separately. However, despite higher absolute values, an obstructive pattern (lower  $FEV_1/FVC$  ratio) was most prominent in boys, both within the whole population as well as in children without current wheeze. There was no significant variation by gender for lung function in those with current wheeze (Table 4).

BHR assessed by inverse slope analysis was significantly greater in the presence of both current wheeze and CDA than when that state was absent. Presence of  $PC_{20}$   $FEV_1 < 8.0 \text{ mg ml}^{-1}$  formed part of the definition of having current asthma and such children not surprisingly therefore possessed highly significant BHR judged by inverse slope analysis (Table 3). Inverse slope did not vary significantly by gender amongst either the whole population tested (male 0.05 vs. female 0.05,  $P=0.599$ ) or children with current wheeze (male 0.03 vs. female 0.03,  $P=0.692$ ).

**TABLE 1.** Characteristics of children seen at 10 years by participation

| Characteristic      | Visited Research Centre<br>( <i>n</i> =1043) | Questionnaire Only<br>( <i>n</i> =330) |
|---------------------|----------------------------------------------|----------------------------------------|
| % Male              | 49.6%                                        | 54.5%                                  |
| ( <i>n</i> )        | (517/1043)                                   | (180/330)                              |
| % Parental allergy  | 63.4%                                        | 54.3%                                  |
| ( <i>n</i> )        | (628/990)                                    | (178/328)                              |
| % Parental asthma   | 32.8%                                        | 23.5%                                  |
| ( <i>n</i> )        | (324/989)                                    | (77/328)                               |
| % Current wheeze    | 20.9%                                        | 12.4%                                  |
| ( <i>n</i> )        | (218/1043)                                   | (41/330)                               |
| % Asthma ever       | 21.7%                                        | 14.9%                                  |
| ( <i>n</i> )        | (226/1042)                                   | (49/328)                               |
| % High social class | 47.9%                                        | 55.8%                                  |
| ( <i>n</i> )        | (450/939)                                    | (154/276)                              |
| % Smoking at home   | 44.9%                                        | 49.7%                                  |
| ( <i>n</i> )        | (414/923)                                    | (147/296)                              |
| % Domestic cat      | 44.7%                                        | 44.7%                                  |
| ( <i>n</i> )        | (466/1043)                                   | (182/329)                              |
| % Domestic dog      | 40.2%                                        | 35.3%                                  |
| ( <i>n</i> )        | (419/1043)                                   | (116/329)                              |

**TABLE 2.** Morbidity measures for current wheeze, CDA status and current asthma

|                                       | Current wheeze | CDA   | Current asthma |
|---------------------------------------|----------------|-------|----------------|
| % 1–3 wheezing episodes in last year  | 59.0%          | 54.7% | 55.9%          |
| (n)                                   | (147)          | (93)  | (62)           |
| % 4–12 wheezing episodes in last year | 29.7%          | 32.4% | 28.8%          |
| (n)                                   | (74)           | (55)  | (32)           |
| % > 12 wheezing episodes in last year | 11.2%          | 12.9% | 15.3%          |
| (n)                                   | (28)           | (22)  | (17)           |
| % Sleep disturbance                   | 53.5%          | 60.9% | 60.7%          |
| (at least once in the last year) (n)  | (136)          | (106) | (68)           |
| % Speech limitation                   | 12.6%          | 17.3% | 18.9%          |
| (at least once in the last year) (n)  | (32)           | (30)  | (21)           |
| % Nocturnal cough                     | 50.8%          | 58.2% | 54.9%          |
| (at least once in the last year) (n)  | (258)          | (103) | (62)           |
| % Exercise symptoms                   | 65.6%          | 72.5% | 69.9%          |
| (at least once in the last year) (n)  | (170)          | (129) | (79)           |

Sleep disturbance refers to sleep disturbance by wheezing at least once in the last year.

Speech limitation refers to wheezing severe enough to limit speech to one or two words at a time in the last year.

Nocturnal cough refers to dry cough at night not associated with infection in the last year.

Exercise symptoms refer to exercise induced wheezing in the last year.

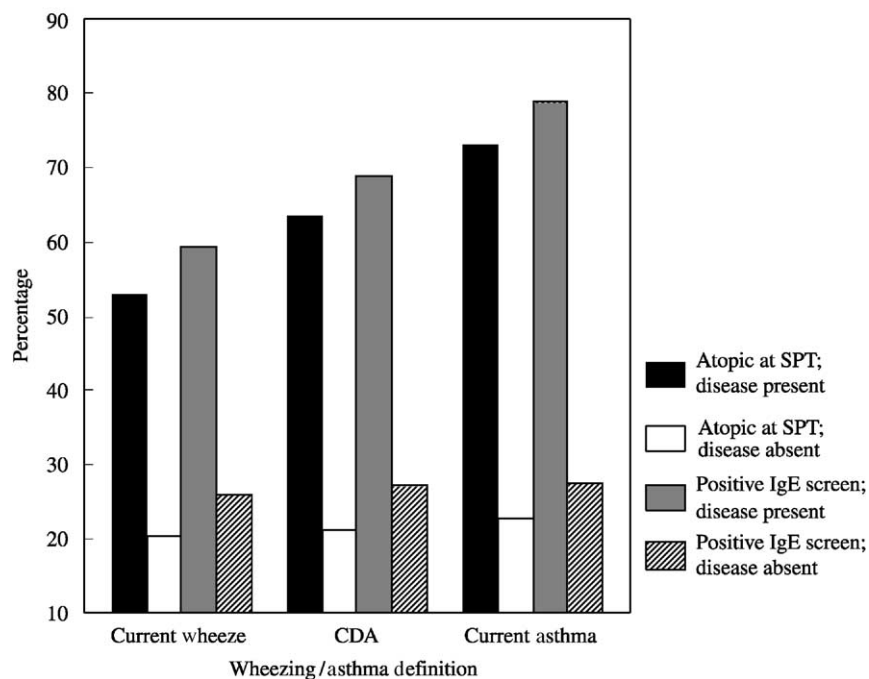


**FIG. 1.** The prevalence of atopy for current wheeze, CDA, current asthma at 10 years. Displayed are the proportions of children with and without each disease state who showed atopy at SPT (to common food and inhalant allergens) or a positive IgE inhalant screen.

## DISCUSSION

In this study we have identified a considerable prevalence for wheezing illnesses and asthma at 10 years of age for a U.K. whole population sample. Almost one-fifth (18.9%) of our population experienced a wheezing illness at this age. Furthermore, we found that 13.0% of children had

currently diagnosed asthma as defined by having both current wheeze at 10 years and asthma ever. This may represent a more accurate reflection of the extent of such states amongst 10-year-old children since not all wheezing in childhood is necessarily associated with true asthma (20). However, such a definition of asthma is reliant

**TABLE 3.** Baseline lung function and bronchial hyper-responsiveness (BHR; inverse slope) for children with and without current wheeze, CDA status and current asthma and at 10 years

| Spirometry                 | Wheezing condition at 10 years |             |             |             |                |             | Statistical significance * |
|----------------------------|--------------------------------|-------------|-------------|-------------|----------------|-------------|----------------------------|
|                            | Current wheeze                 |             | CDA         |             | Current Asthma |             |                            |
|                            | Present                        | Absent      | Present     | Absent      | Present        | Absent      |                            |
| FVC (l)                    | 2.29                           | 2.29        | 2.30        | 2.29        | 2.29           | 2.28        |                            |
| 95% CI                     | (2.25–2.34)                    | (2.27–2.32) | (2.24–2.35) | (2.27–2.31) | (2.24–2.34)    | (2.25–2.31) |                            |
| FEV <sub>1</sub> (l)       | 1.99                           | 2.04        | 1.99        | 2.03        | 1.94†          | 2.02        | *P=0.010                   |
| 95% CI                     | (1.95–2.03)                    | (2.02–2.06) | (1.94–2.04) | (2.01–2.05) | (1.90–1.99)    | (2.00–2.05) |                            |
| FEV <sub>1</sub> /FVC      | 0.87*                          | 0.89        | 0.87*       | 0.89        | 0.85*          | 0.89        | *P<0.001                   |
| 95% CI                     | (0.86–0.88)                    | (0.89–0.89) | (0.86–0.88) | (0.89–0.89) | (0.84–0.86)    | (0.89–0.89) |                            |
| PEF (l sec <sup>-1</sup> ) | 4.14                           | 4.15        | 4.21        | 4.13        | 4.13           | 4.11        |                            |
| 95% CI                     | (4.03–4.24)                    | (4.09–4.20) | (4.08–4.34) | (4.08–4.19) | (3.99–4.26)    | (4.05–4.17) |                            |
| Inverse slope (BHR)        | 0.03*                          | 0.06        | 0.03*       | 0.06        | 0.01*          | 0.06        | *P<0.001                   |
| 95% CI                     | (0.03–0.04)                    | (0.05–0.06) | (0.02–0.03) | (0.05–0.06) | (0.01–0.01)    | (0.06–0.06) |                            |

Values given are means with 95% confidence intervals for the means (95%CI).

\* Independent samples t-tests were used to compare lung function in the presence and absence of each wheezing condition.

**TABLE 4.** Baseline lung function by gender at 10 years

|                                | Spirometry (l)             | Male                | Female              | P-value |
|--------------------------------|----------------------------|---------------------|---------------------|---------|
| Whole population<br>(95% CI)   | FVC                        | 2.35<br>(2.32–2.38) | 2.23<br>(2.21–2.26) | <0.001* |
|                                | FEV <sub>1</sub>           | 2.06<br>(2.03–2.08) | 2.00<br>(1.97–2.02) | 0.001*  |
|                                | FEV <sub>1</sub> /FVC      | 0.88<br>(0.87–0.88) | 0.90<br>(0.89–0.90) | <0.001* |
|                                | PEF (l sec <sup>-1</sup> ) | 4.21<br>(4.14–4.27) | 4.08<br>(4.01–4.15) | 0.012*  |
| Not current wheeze<br>(95% CI) | FVC                        | 2.36<br>(2.33–2.40) | 2.23<br>(2.20–2.26) | <0.001* |
|                                | FEV <sub>1</sub>           | 2.08<br>(2.04–2.11) | 2.00<br>(1.97–2.03) | <0.001* |
|                                | FEV <sub>1</sub> /FVC      | 0.88<br>(0.87–0.89) | 0.90<br>(0.90–0.91) | <0.001* |
|                                | PEF (l sec <sup>-1</sup> ) | 4.21<br>(4.13–4.29) | 4.09<br>(4.01–4.17) | 0.027*  |
| Current wheeze<br>(95% CI)     | FVC                        | 2.32<br>(2.26–2.37) | 2.27<br>(2.20–2.34) | 0.267   |
|                                | FEV <sub>1</sub>           | 2.01<br>(1.95–2.06) | 1.98<br>(1.91–2.04) | 0.526   |
|                                | FEV <sub>1</sub> /FVC      | 0.87<br>(0.85–0.88) | 0.87<br>(0.86–0.89) | 0.447   |
|                                | PEF (l sec <sup>-1</sup> ) | 4.19<br>(4.06–4.32) | 4.06<br>(3.87–4.25) | 0.229   |

\* Statistically significant P-values

upon accurate diagnosis of asthma (asthma ever) and might underestimate the problem in some circumstances. Nevertheless, despite being a somewhat conservative definition, our figures for currently diagnosed asthma identify a substantial problem. By comparison,

previous U.K. studies have reported slightly lower current asthma prevalence of 9.3% at 7 years (11) and 9.5% at 11 years (1). An alternative classification of current asthma using a combination of current wheeze and bronchial hyper-responsiveness (BHR) at bronchial

challenge has become increasingly used as the gold standard (2,14) for asthma diagnosis in epidemiological surveys. Using this approach an element of objective measurement is introduced into the definition rather than simply relying upon questionnaire reporting. It is, though, worth reflecting that evidence of BHR is not always synonymous with presence of asthma. Thus, Lee (11) demonstrated BHR in one-third of asymptomatic 7-year-old children and showed that a similar proportion of such children with recurrent wheeze did not react to histamine. Furthermore, Sears (21) identified that 8.0% of 9-year-old children with no history of wheeze showed methacholine responsiveness, whilst 35.0% of symptomatic children failed to display BHR at challenge.

In our survey, methacholine bronchial challenge was performed in all children visiting the Research Centre who had a history of ever wheezing as well as a control group of 300 children who visited the Centre and had never wheezed. Financial and time constraints prevented us from testing more subjects. Using the definition of symptomatic BHR the prevalence of current asthma amongst the 784 children undergoing bronchial challenge was 14.4%. These are substantial figures bearing comparison to findings by Peat *et al.* (2) of current asthma ranging from 7.1% to 13.0% amongst 8–11-year-old Australian populations.

It is worth considering that in using a purely questionnaire-derived definition of currently diagnosed asthma we have shown broadly similar results for prevalence and morbidity to those obtained with an objective definition including BHR measurement. Children with current asthma showed a trend for greater BHR but by definition they must have had a  $PC_{20}$   $FEV_1$  less than  $8.0 \text{ mg ml}^{-1}$ . They also demonstrated trends for greater obstructive patterns of lung function than the other states considered in this study. In this context it was recently shown in the MAS-Study (22) that impaired baseline lung function could serve as a risk factor for BHR. Current asthmatics also showed a trend for higher atopic sensitization and prevalence of other allergic conditions possibly reflecting an association between such states and greater BHR. Therefore, the use of objective measurements within the definition of asthma, as occurs with incorporation of BHR, permits better identification of 'core asthmatics'. Nevertheless, where bronchial challenge testing is unavailable use of a composite questionnaire based definition such as currently diagnosed asthma may prove a valid research tool.

We identified early life origins for current wheeze, current asthma and currently diagnosed asthma at 10 years with an average age of onset at 2–3 years depending upon the precise definition used. This extends previous findings by Dodge (23) showing a typical onset for persistent asthma at 3–4 years. It is vital to realize that to have one of these states the child had to be wheezing at 10 years and therefore early life transient wheezers [to

use the phenotypic description coined by Martinez (5)] were by definition excluded. These transient wheezers might be expected to possess an earlier average wheezing onset than current wheezers/asthmatics at 10 years who would be drawn from both early life persistent wheezers and late onset wheezers.

We showed that current wheeze and currently diagnosed asthma were more common in boys at 10 years consistent with findings from other childhood studies (1,4,5,12,24). Indices of wheezing morbidity did not differ greatly by gender at 10 years, indicating that wheezing severity at this age may not be very different for boys and girls. BHR measurement also did not differ by gender. Baseline lung function, however, was significantly lower for girls both amongst the whole population as well as children who were not current wheezers. The relationship of spirometry to gender is complex, with factors such as height and growth rate being of importance. It is known that lower airway size to lung parenchyma ratio leads to lower airway calibre in boys during early life (25) and may influence an increased wheezing tendency in boys during infancy. It is possible that during growth boys show more pronounced changes in thoracic dimensions and hence better lung function than girls by 10 years. Despite better overall lung function, boys without current wheeze in our population displayed a significantly more obstructive pattern of lung function than their female counterparts. Thus, persisting male patterns of airways obstruction appear independent of symptom expression. It has previously been noted that an equalization of the male: female asthma ratio is reached by puberty (3), with peak prevalence for asthma occurring earlier in boys than girls (1). At 10 years of age our population may have been in a transition period with regard to gender ratio for asthma and baseline lung function.

Strong associations with atopy and other allergic disorders were identified in children with wheezing or asthma at 10 years. This was especially the case for the group we categorized as having current asthma by virtue of showing both wheeze and significant BHR at 10 years. Three quarters of this group were atopic at SPT. This is consistent with findings from the MAS-Study (22), suggesting that atopy, particularly in the form of sensitization to indoor allergens like house dust mite, is a crucial risk factor for BHR.

In summary, we have highlighted a substantial prevalence of current wheeze and asthma for 10-year-old children in the U.K. In doing so we used both an objective 'gold standard' definition of current asthma as well as an ISAAC-questionnaire-based definition of currently diagnosed asthmatic that may serve as an alternative where bronchial challenge testing is not feasible. It is clear that much of this condition appears to originate in early life. Furthermore strong associations to atopy and allergic states were observed for asthma at this age. Risk factors

for the presence of asthma at 10 years of age now need to be clearly identified.

## Acknowledgements

The authors gratefully acknowledge the co-operation of the children and parents who have participated in this study. The 10-year follow-up of this study was funded with the assistance of the National Asthma Campaign (U.K.). We are also grateful to Pharmacia, U.K., for providing kits for the measurement of total IgE and inhalant screen. We also thank Linda Waterhouse, Linda Terry, Gail Poulton, Heidi Savory, Tessa Booth, Andrew Gallini, Cathy Wilby and Rosemary Lisseter for their considerable assistance with many aspects of the 10-year follow-up of this study.

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