Eur Respir J 2001; 17: 881–886
Printed in UK – all rights reserved

European Respiratory Journal
ISSN 0903-1936

Is the increase in childhood asthma coming to an end? Findings from three surveys of schoolchildren in Rome, Italy

R. Ronchetti, M.P. Villa, M. Barreto, R. Rota, J. Pagani, S. Martella, C. Falasca, B. Paggi, F. Guglielmi, G. Ciofetta*

Is the increase in childhood asthma coming to an end? Findings from three surveys of schoolchildren in Rome, Italy. R. Ronchetti, M.P. Villa, M. Barreto, R. Rota, J. Pagani, S. Martella, C. Falasca, B. Paggi, F. Guglielmi, G. Ciofetta. ©ERS Journals Ltd 2001.

ABSTRACT: Time trends in the prevalence of asthma, family history of asthma and atopy in Roman schoolchildren were assessed. The study population consisted of all children (aged 6–14 yrs) attending two primary schools in Rome, situated in urban areas that differed markedly in socioeconomic conditions and environmental pollution. Three questionnaire-based surveys were conducted in 1974, 1992 and 1998 in 2,259, 1,229 and 1,139 children. The prevalence of asthma in males and females increased significantly during 1974–1992 and remained stable from 1992–1998. In age groups born in the subsequent 4-yr periods it increased almost linearly, for children born from 1962–1965 to 1982–1985 (4.4%–12.5%), and remained remarkably stable in children born after 1985. Because the prevalence of asthma had a steeper trend in males than in females (approximately 0.55%·yr^{-1} *versus* 0.25%·yr^{-1}), the male:female asthma ratio increased (1:38 in 1974; 1:84 in 1992 and 1:62 in 1998). No single environmental factor, including area of residence, seemed to influence the prevalence of asthma. Family history of asthma and atopy also increased steadily (0.72%·yr^{-1} and 0.30%·yr^{-1} respectively) more than doubling during the 24-yr study period. The strong relationship between asthma and a family history of atopy not only persisted but also strengthened over time (23.3% of asthmatic children belonged to families with atopic illnesses in 1974 but 44.2% in 1998). The environmental factors that might explain the almost three-fold rise in childhood asthma between 1974 and 1992 remain unknown but the genetic background of the disease has presumably remained unchanged since the early 1970s. The fact that the prevalence of asthma increased no further during the past 6 yrs suggests that the progressive induction of asthma symptoms in genetically predisposed subjects is a self-limiting process that has probably come to an end in the authors' study area.

Eur Respir J 2001; 17: 881–886.

Paediatric Clinic of the 2nd Faculty of Medicine, University of Rome "La Sapienza", Rome, Italy.

Correspondence: R. Ronchetti
Paediatric Clinic of the 2nd
Faculty of Medicine
Viale Regina Elena, 324
00161 Rome
Italy
Fax: 39 064462767

Keywords: Asthma increase
asthma prevalence
childhood asthma
family history of atopy

Received: April 27 2000
Accepted after revision December 6 2000

The prevalence of asthma in children and young persons has increased significantly in the last three decades all over the world [1–24]. Prevalence rates have risen not only for asthma but also for hay fever and eczema [4, 15, 22, 24–26]. Nonetheless, some recent papers indicate that the trend to an increase has slowed or ceased [22, 24].

To assess the prevalence of asthma and of several personal and family characteristics including a family history of atopy and cigarette consumption, a questionnaire-based cross-sectional study was conducted on 2,259 schoolchildren aged 6–13 yrs [27]. The study population came from two schools situated in urban areas of Rome who were chosen because they represented two extremes of socioeconomic conditions, traffic and environmental pollution. In 1992 and 1998 the study was repeated in the same schools, with the same field investigators using the same questionnaire and identical epidemiological procedures. In this study, designed to assess time trends in the prevalence of asthma and of family history of asthma and atopy in Roman schoolchildren, the results of the three surveys conducted over the 24-yr period 1974–1998 are reported.

Materials and methods

Sample selection

In the three studies (1974, 1992 and 1998), the study population consisted of all children (age range 6–14 yrs) attending two primary schools in Rome, chosen because they were situated in urban areas that differed markedly in socioeconomic conditions, intensity of traffic and environmental pollution (table 1). Area A has: 250,000 inhabitants·km^2, typically high buildings, heavy vehicular traffic, industrial pollution and few green areas. Area B has: about 100,000 inhabitants·km^2, low buildings which are further apart,

Table 1. – Demographic socioeconomic characteristics of the children studied in the three surveys according to urban area of residence

	Surveys					
	1974		1992		1998	
	Area A	Area B	Area A	Area B	Area A	Area B
Subjects n	2259		1229		1139	
Demography						
Sex M	1154 (51.1)		635 (51.7)		561 (49.2)	
F	1105 (48.9)		594 (48.3)		579 (50.8)	
Age yrs						
<9.9	1098 (48.6)		611 (49.7)		620 (54.4)	
>10	1161 (51.4)		618 (50.3)		518 (45.6)	
Socioeconomic characteristics						
Living in house with >4 rooms	5.8	31.7*	9.8	44.8*	10.3	45.1*
Father's nonmanual activity	5.6	30.0*	9.2	34.8*	9.6	37.7*
Habitually engaging in organized sport	32.6	57.7*	37.6	64.2*	39.6	61.4*
Household smoking (% of families consuming the given no. of cigarettes·day^{-1})						
0–19	76.2	77.4	65.5	67.7	65.4	72.8
20–39	17.7	16.7	26.1	24.4	26.7	20.3
>39	6.1	5.9	8.4	8.0	7.9	6.9

Data are presented as n (%) or %. Urban area A: intensive housing, high buildings, chemical industries, heavy traffic, scarce green areas (lower standard of living); Urban area B: lower and widely spaced buildings, no chemical industries, light traffic, wide green areas (higher standard of living). *: significant difference between urban areas, $p<0.05$, Chi-squared test.

light traffic and wide open green areas, including the surrounding course of the river Tiber.

The questionnaire

All pupils attending the schools received an identical self-administered questionnaire that the parents filled out and returned 3 days later. Pupils absent from school on the distribution day or who failed to return the completed questionnaire received a second copy to complete and were encouraged to return it within 3 days.

The questionnaire comprised 36 items seeking information on: family housing and socioeconomic status; smoking habits in household members; history of atopic illness in parents or siblings; and respiratory history including physician-diagnosed asthma, wheezy bronchitis and exercise-induced asthma in the child. This questionnaire was developed in the 1970s by participants in a special project of the Italian Research Council and validated by comparison with the European Coal and Steel Community questionnaire [28] and by respiratory function tests in populations including children [29].

In the 1974 survey carried out by the authors, all the children underwent standard spirometry and measurement of the anteroposterior thoracic diameter. Children classified as asthmatic more frequently belonged to the group with a forced expiratory volume in one second/forced vital capacity ratio in the lowest quartile ($p<0.001$ for goodness of fit) and to the group with an anteroposterior thoracic diameter in the upper quartile ($p<0.025$). They also had more school absenteism ($p<0.001$) and more medical visits ($p<0.001$) [26].

Definitions

To allow reliable comparisons, the following items were defined in the 1974 study and despite their shortcomings the definitions were maintained thereafter. The definition of asthma was based on the following questions: 1) Has your physician ever told you that your child has asthma or asthmatic bronchitis? 2) Has your child ever had asthmatic attacks (attacks characterized by shortness of breath with audible wheezing)? 3) When playing, does your child become breathless more easily than other children? Asthmatic children were defined as those whose parents gave an affirmative answer to question 1 or questions 2 and 3. A family history was considered positive for asthma or atopy if at least one parent or two siblings (brothers or sisters, or both) had physician-diagnosed asthma, allergic rhinitis or atopic eczema. The fathers' occupational status were classified as follows: professions requiring a university degree; qualified work (including all nonmanual and artisan activities); and manual or unqualified employment. The daily consumption of cigarettes in household members was calculated by summing the number of cigarettes smoked during the day by every household member. Poor housing conditions were defined as questionnaire replies reporting a lack of central heating or the presence of damp rooms.

Statistical analysis

In all three surveys, to determine the statistical significance in 2×2 contingency tables the Chi-squared test was used which corrected for continuity. To estimate the significance of the trend in the effect of

household smoking, the Chi-squared test was applied to a 2×3 contingency table. The 95% confidence intervals (CI) and odds ratios (OR) were calculated. P-values $\leqslant 0.05$ were considered statistically significant. All p-values are two-sided.

Results

In all three surveys a similar percentage of questionnaires were appropriately completed by the schoolchildrens' parents and returned (2,259/2,518 questionnaires, 89.7% in 1974; 1,229/1,435, 85.6% in 1992; and 1,139/1,309, 87% in 1998). In the 1998 survey, all questionnaires from the 1992 participants were excluded (207, mostly children in the eighth grade). Owing to the fall in the birth rate, the total number of subjects studied diminished remarkably ($>50\%$) over the 24-yr study period (table 1).

Socioeconomic conditions in all three surveys differed markedly in the two urban areas: as expected, schoolchildren in area A lived in smaller houses, their fathers more frequently did manual work and the children engaged less frequently in organized sports. Household cigarette consumption remained statistically unchanged over time, despite a slight trend to an increase in 1992 and 1998 (table 1).

The data for the three surveys showed that the prevalence of affirmative answers to asthma-related questions increased during 1974–1992 and stabilized thereafter (table 2). Similarly asthma itself increased significantly ($p<0.001$) in the total population and in males and females during 1974–1992 and remained stable from 1992–1998 (total population: 5.5, 12.2 and 12.0; males 6.3, 15.7 and 15.4; females: 4.7, 8.5 and 9.0). Unexpectedly, in the two earlier surveys, older children of both sexes had a lower life asthma prevalence than younger children. The prevalence of asthma for children born in the subsequent 4-yr periods increased almost linearly for children born during 1962–1985 (a mean increase of $0.4\%\cdot yr^{-1}$) (fig. 1) so that the total male and female asthma rates almost tripled. The prevalence of asthma had a steeper trend in males than in females ($\sim 0.55\%\cdot yr^{-1}$ *versus* $0.25\%\cdot yr^{-1}$) and the male:female asthma ratio increased from 1:34 in 1974 (OR for being asthmatic in males, 1.38; 95% CI, 0.94–1.97; p = NS) to 1:84 in children studied in the 1992 survey (OR, 1.99; 95% CI, 1.39–2.86; $p=0.001$). In children studied in 1998 and belonging to age groups born after 1985, asthma rates remained remarkably stable, with a male : female ratio of 1:62 (OR, 1.71; 95% CI, 1.14–2.56; $p=0.01$).

Other variables that increased steadily as a function of time over the three surveys (1974, 1992 and 1998) were the percentage of children with a family history of asthma (5.0, 9.1, and 12.3%) and of atopy (10.3, 23.2,

Table 2. – Prevalence of positive answers to questions concerning wheezing, dyspnoea and asthma

	Survey year		
	1974	1992	1998
Subjects n	2259	1229	1139
Q1 Physician diagnosis of asthma or asthmatic bronchitis	5.0***	11.6#	11.0
Q2 Dyspnoea on effort more easily than other children	0.9***	2.6#	4.1
Q3 Parent reported asthmatic attacks (attacks of breathlessness and audible wheezing)	3.6***	10.8#	9.4
Q4 Parent reported asthmatic attacks during the past year	1.6***	4.0#	3.7
Asthma*	5.5***	12.2#	12.0

Data are presented as per cent of total population. *: affirmative answer to question 1 or to question 2 and 3; ***: $p<0.0001$, Chi-squared test; #: p = NS.

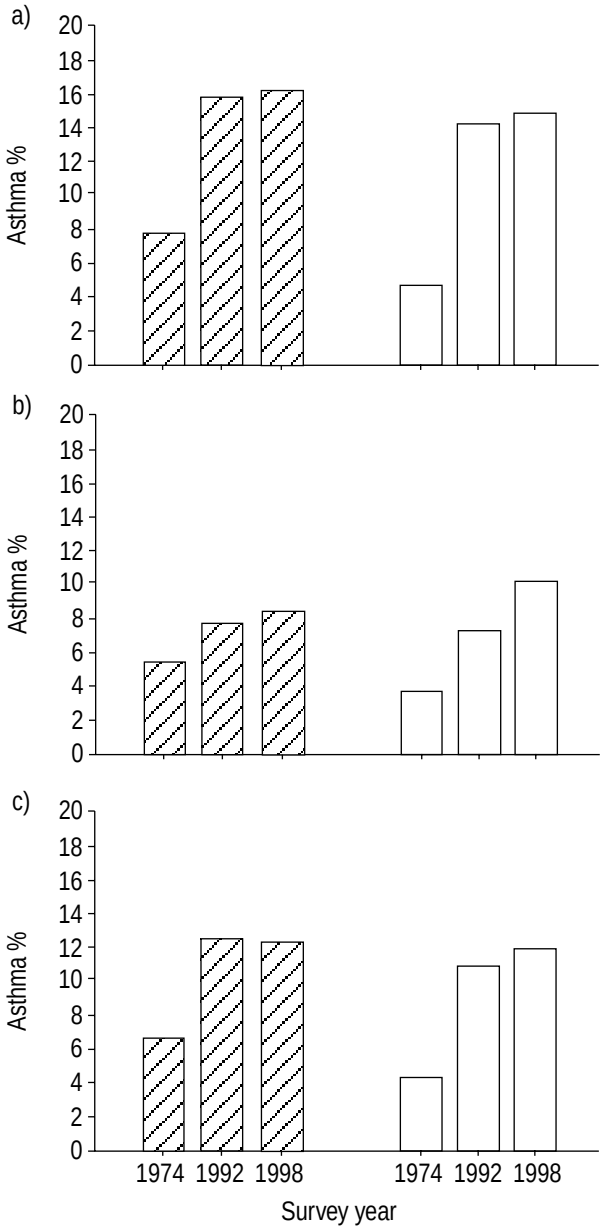

Fig. 1. – Time trends in the prevalence of asthma in the three surveys (1974, 1992 and 1998) in a) males, b) females and c) the total population by children's birth-yr. ▨: prevalence of asthma in younger children (6–9.9 yrs); □: prevalence of asthma in older children (10–13 yrs).

and 27.7%). Although the increase in family history of atopy yielded a steeper slope (an increase of 0.72%·yr^{-1} for a family history of atopy and 0.30%·yr^{-1} for asthma), both variables increased in proportion to their initial prevalence, more than doubling during the 24-yr study period.

The similar ORs for being asthmatic in the presence of a family history of atopy in the 1974, 1992 and 1998 surveys (2.65 *versus* 2.51 *versus* 2.27) showed that the effect of a family history of atopy on the prevalence of asthma remained unchanged over time. But in all surveys the family history of atopy had a far greater influence in males than in females (ORs males: 3.63 *versus* 2.65 *versus* 3.04; females 2.4 *versus* 2.81 *versus* 1.60).

Owing to the strong relationship between asthma and family history of atopy found in all three surveys, and the significant increase in both clinical conditions over the 24-yr study period, the prevalence of asthmatic children born in atopic families also steadily and significantly increased (from 23.3% in 1974, to 41.0% in 1992, and 44.2% in 1998; $p=0.001$ using the Chi-squared test).

With the exception of household smoking, a variable that significantly increased the prevalence of asthma in the 1974 survey, no single environmental factor studied (household smoking, father's occupational level, family size, housing conditions or area of residence) seemed to influence the prevalence of asthma (table 3).

Discussion

The first two cross-sectional surveys carried out by the authors, conducted 18 yrs apart (1974 and 1992), showed that in urban areas of Rome, the prevalence of childhood asthma increased steadily and significantly over time. The increase was more evident in males and was apparently independent of age at the time of the survey, socioeconomic conditions, environmental factors and quality of housing. Environmental tobacco smoke, a significant determinant of asthma in 1974, became unimportant thereafter. The 1998 survey (children born after 1985) showed no further increase in the prevalence of asthma.

The self-administered questionnaire elicited a family history of asthma and of atopy with increasing frequency in the ensuing surveys. Because the prevalence of asthma increased most prominently in children who had a family history of atopy, the percentage of asthmatic children with at least one parent or two siblings reporting an atopic disease almost doubled.

To minimize technical bias, all the studies were conducted in the same schools (situated in two urban areas of Rome that differed in environmental and socioeconomic conditions), and standardized procedures were also used for collecting and analysing the questionnaires. Hence, the 1974 respiratory questionnaire did not address some items which are considered to be customary nowadays (for example, hay fever and atopic eczema). They also did not take into account pets and carpets or other indoor environmental variables. In addition, in the 1992 and 1998 surveys, the school population diminished owing to the lower birth rate.

Several studies published during the last two to three decades have reported figures similar to the authors'

Table 3. – Prevalence of asthma by environmental factors

Environmental factor	Asthma prevalence %		
	1974	1992	1998
Household smoking habits no. cigarettes·day^{-1}			
0–19	5.1	11.3	11.6
20–39	7.0	14.1	10.3
>39	10.9*	16.3	13.8
Father's occupation level			
Requiring university degree	5.4	12.7	13.9
Qualified, nonmanual	5.8	11.6	12.7
Manual	5.4	10.7	10.3
Number of persons in the household			
⩾3	7.1	12.2	10.3
4–5	5.3	12.3	12.3
⩽6	6.5	13.3	17.4
Number of rooms in the house			
1–2	4.5	11.6	13.7
3–4	6.4	11.9	11.7
⩾5	6.0	13.4	10.8
Housing conditions			
Central heating no damp rooms	5.5	11.8	11.6
No central heating or damp rooms	6.8	13.3	19.7
No central heating and damp rooms	11.4	21.5	18.7
Area of residence			
A	5.1	11.6	12.7
B	6.1	11.9	12.1

Urban area A: intensive housing, highbuildings, chemical industries, heavy traffic, scarce green areas (lower standard of living); urban area B: lower and more widely spaced buildings, no chemical industries, light traffic, wide green areas (higher standard of living). *: significant difference, $p<0.05$, Chi-squared test.

[1–24]. Most have rejected the hypothesis that the reported increases in the prevalence of asthma arose solely from changes in the diagnostic labelling of symptoms. Although it cannot be said with all certainty whether or not these changes had any effect in this study, the authors believe it to be unlikely. The increase was more evident in certain types of families (those with atopy) and in male children. These findings support a true increase in the prevalence of asthma in children born during 1962–1985.

Being a lifetime prevalence, the prevalence of "asthma-ever" should have increased rather than diminished with increasing age. Yet unexpectedly, in older children it decreased (fig. 1). At first, it was believed to be a spurious memory effect (older children could have forgotten early asthma). But in the two surveys carried out first, asthma increased with the birth year, independently from the children′s age, suggesting a true cohort effect, as observed by others [18–19].

During the 24-yr period covered by the surveys (1974–1998) numerous other studies reported widely differing increases expressed in absolute terms. This wide variability can be substantially reduced by expressing the increase per year in a standardized form, as a percentage of the initial prevalence rate (prevalence increase per year/initial prevalence $\times 100$). Using this formula, the authors calculated the data from 24 studies that had reported an initial asthma prevalence rate, and in which several years later this was redetermined, in the same place, and using standardized epidemiological techniques. The recalculated data yielded an annual percentage increase (ranging 0–22.5%) of the initial prevalence rate. But when the studies were subdivided according to the years examined, it was found that there was an annual percentage increase of $<8\%$ in 11/13 studies centred on the years preceding 1976, while, with one exception, those centred on the years 1982–1988 all found an increase $>9\%$ but those after 1988 again reported increases $<4\%$. These figures tend to yield a bell-shaped distribution, the greatest increases taking place in the mid 1980s, with two reported studies [24, 30] and the authors′ study describing no change in asthma prevalence from 1992–1998.

The most important findings in the present study are that asthma rates rose predominantly in male children and in those belonging to atopic families, which were two key asthma features already evident in 1974 before the prevalence began to rise. As asthma rates rose in children, so did the number of families with a history of asthma or atopy. In all three surveys the major risk factor for asthma was (together with male sex) a family history of atopy. Because a family history of asthma in the present data almost exclusively (96%) depended on the presence of an affected parent, during the past three decades asthma and atopy rates have increased in adults as well as children. Indeed, the strong relationship between a family history of atopy and childhood asthma has not only persisted but has also strengthened over time; a calculation more simple than the OR which only takes into account asthmatic children shows that 23.3% of asthmatic children belonged to families with atopic illnesses in 1974, whereas in 1998 this had increased to 44.2%.

Two prerequisites are necessary to explain a multifactorial illness such as asthma and its increase. The first is one or more specific, though unknown, and certainly new environmental factors. The second is an individual susceptibility to become asthmatic. While the environmental factors increase, the predisposition necessary to become asthmatic diminishes, until all susceptible individuals have been recruited so that the prevalence of asthma stabilizes. Hence, the epidemiological increase in prevalence of asthma presumably arises from supervening environmental factor(s) while, according to the present data, the necessary genetic background seems closely linked to that of atopy.

The environmental factors that might explain the almost three-fold rise in childhood asthma rates from 1974–1992 remain difficult to pinpoint [31]. Yet in all three surveys, and despite possible changes that were not controlled for, in the resident populations, the two areas of Rome that always differed notably for traffic, industrial pollution and family socioeconomic background yielded similar asthma rates. No relationship was also found between the prevalence of asthma and the size of the family, a variable closely associated with the level of atopy [32] but probably scarcely responsible for the reported increase in asthma [33]. Although family cigarette consumption remained stable over the three surveys, only in the first survey did passive smoking noticeably influence the prevalence of asthma. Smoking and other recent influential yet unknown environmental factors therefore, seem to have similar interchangeable mechanisms of action in inducing asthma.

Whatever factors caused the prevalence of childhood asthma to rise, in line with reported trends, during the past six years no further increase was observed.

Because the reported increases predominantly affect Western countries, it is concluded that recent epidemiological studies of childhood asthma suggest that certain environmental factors, related to current lifestyle, will continue to induce symptoms of asthma in genetically predisposed children until this self-limiting process comes to an end.

Acknowledgements. The authors are grateful to E. Bonci for the statistical analysis and to G. Antognoni, F. Macri, L. Indinnimeo, G. Tancredi, G. De Castro, F. Midulla, A. M. Zicari, A. Villani and R. Cutrera for their field epidemiological work.

References

1. Gergen P, Mullally DL, Evans R. III National survey of prevalence of asthma among children in the United States 1976 to 1980. *Paediatrics* 1988; 81: 1–7.
2. Morrison Smith J. The prevalence of asthma and wheezing in children. *Br J Dis Chest* 1976; 70: 73–77.
3. Varonier HS, De Haller J, Schopfer C. Prévalence de l′allergie chez les enfants et les adolescents. *Helv Paediat Acta* 1984; 39: 129–136.
4. Fleming DM, Crombie DL. Prevalence of asthma and

hay fever in England and Wales. *BMJ* 1987; 294: 279–283.
5. Mitchell EA. Increasing prevalence of asthma in children. *N Z Med I* 1983; 96: 463–464.
6. Aberg N. Asthma and allergic rhinitis in Swedish conscripts. *Clin Exp Allergy* 1989; 19: 59–63.
7. Robertson CF, Heycock E, Bishop J, Nolan T, Olinsky A, Phelan PD. Prevalence of asthma in Melbourne schoolchildren: changes over 26 years. *BMJ* 1991; 302: 1116–1118.
8. Haahtela T, Lindholm H, Bjorksten F, Koskenvuo K, Laitinen L. Prevalence of asthma in Finnish young men. *BMJ* 1990; 301: 266–268.
9. Ninan TK, Russell G. Respiratory symptoms and atopy in Aberdeen schoolchildren: evidence from two surveys 25 years apart. *BMJ* 1992; 304: 873–875.
10. Burr ML, Butland BK, King S, Vaughan-Williams E. Changes in asthma prevalence: two surveys 15 years apart. *Arch Dis Child* 1989; 64: 1452–1456.
11. Shaw RA, Crane J, O'Donnell TV, Porteous LE, Coleman ED. Increasing asthma prevalence in a rural New Zealand adolescent population: 1975–89. *Arch Dis Child* 1990; 65: 1319–1323.
12. Manfreda J, Becher AB, Wang PZ, Roos LL, Anthonisen NR. Trends in physician-diagnosed asthma prevalence in Manitoba between 1980–1990. *Chest* 1993; 103: 151–157.
13. Dubois P, Degrave E, Vandenplas O. Asthma and airway hyperresponsiveness among Belgian conscripts, 1978–91. *Thorax* 1998; 53: 101–105.
14. Aberg N, Hesselmar B, Aberg B, Eriksson B. Increase of asthma, allergic rhinitis and eczema in Swedish schoolchildren between 1979 and 1991. *Clin Exp Allergy* 1995; 25: 815–819.
15. Peat JK, Haby M, Spijker J, Berry G, Woolcock AJ. Prevalence of asthma in adults in Busselton, Western Australia. *BMJ* 1992; 305: 1326–1329.
16. Hill R, Williams J, Tattersfield A, Britton J. Change in use of asthma as a diagnostic label for wheezing illness in schoolchildren. *BMJ* 1989; 299: 898.
17. Peat JK, Van den Berg RH, Green WF, Mellis CM, Leeder SR, Woolcock AJ. Changing prevalence of asthma in Australian children. *BMJ* 1994; 308: 1591–1596.
18. Skjonsberg OH, Clench-Aas J, Leegaard J, *et al.* Prevalence of bronchial asthma in schoolchildren in Oslo, Norway. Comparison of data obtained in 1993 and 1981. *Allergy* 1995; 50: 806–810.
19. Nystad W, Magnus P, Gulsvik A, Skarpaas IJK, Carlsen KH. Changing prevalence of asthma in school children: evidence for diagnostic changes in asthma in two surveys 13 yrs apart. *Eur Respir J* 1997; 10: 1046–1051.
20. Auerbach I, Springer C, Godfrey S. Total population survey of the frequency and severity of asthma in 17 years old boys in an urban area in Israel. *Thorax* 1993; 48: 139–141.
21. Omran M, Russell G. Continuing increase in respiratory symptoms and atopy in Aberdeen schoolchildren. *BMJ* 1996; 312: 34.
22. Ciprandi G, Vizzacaro A, Cirillo O, Crimi P, Canonica W. Increase of asthma and allergic rhinitis prevalence in Young Italian Men. *Int Arch Allergy Immunol* 1996; 111: 279–283.
23. Kronqvist M, Johansson E, Pershagen G, Johansson SGO, Van Hage-Hamsten M. Increasing prevalence of asthma over 12 years among dairy farmers on Gotland, Sweden: storage mites remain dominant allergens. *Clin Exp Allergy* 1999; 29: 35–41.
24. von Mutius E, Weiland SK, Fritzsch C, Duhme H, Keil U. Increasing prevalence of hay fever and atopy among children in Leipzig, East Germany. *Lancet* 1998; 351: 862–866.
25. Weitzman M, Gortmaker SL, Sobol AM, Perrin JM. Recent trends in the prevalence and severity of childhood asthma. *JAMA* 1992; 268: 2673–2677.
26. Butland BK, Strachan DP, Lewis S, Bynner J, Butler N, Britton J. Investigation into the increase in hay fever and eczema at age 16 observed between the 1958 and 1970 British birth cohorts. *BMJ* 1997; 315: 717–721.
27. Ronchetti R, Martinez F, Criscione S, *et al.* Influenza dei fattori familiari e ambientali sulla prevalenza della sindrome asmatica e della sindrome bronchitica del bambino. *Riv Ital Ped* 1982; 8: 755–765.
28. Fazzi P, Viegi G, Paoletti P, *et al.* Comparison between two standardized questionnaires and pulmonary function tests in a group of workers. *Eur J Resp Dis* 1982; 63: 168–169.
29. Paoletti P, Carmagnani G, Viegi G, *et al.* Prevalence of asthma symptoms in a general population sample of North Italy. *Eur Resp J* 1989; S6: 527s–531s.
30. Fleming DM, Sunderland R, Cross KW, Ross AM. Declining incidence of episodes of asthma: a study of trends in new episodes presenting to general practitioners in the period 1989–98. *Thorax* 2000; 55: 657–661.
31. Grant EN, Wagner R, Weiss KB. Observations on emerging patterns of asthma in our society. *J Allergy Clin Immunol* 1999; 104: S1–S9.
32. Matricardi PM, Franzinelli F, Franco A, *et al.* Sibship size, birth order, and atopy in 11.371 Italian young men. *J Allergy Clin Immunol* 1998; 101: 439–444.
33. Wickens K, Crane J, Pearce N, Beasley R. The magnitude of the effect of smaller family sizes on the increase in the prevalence of asthma and hay fever in the United Kingdom and New Zealand. *J Allergy Clin Immunol* 1999; 104: 554–558.