

The epidemiology of childhood asthma

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Variability is the hallmark of childhood asthma. Conceptually defined as variable airflow obstruction, asthma affects individual children through a variety of clinical manifestations. Particular controversy surrounds the nature of wheezing in early infancy and its relationship to atopic asthma of later onset. Asthma prognosis is also highly variable and only to a limited extent predictable by clinical indicators in early childhood. Long-term follow-up studies suggest a complex pattern of remission and relapse as wheezy children are followed through adolescence into adult life. Similarly, the population burden of asthma is highly variable, both over time and between countries. The balance of evidence worldwide suggests a modest but sustained increase in the prevalence of asthma symptoms over the past three decades. Superimposed on this have been larger changes in diagnostic fashion and use of health services for childhood asthma in many countries. There is substantial international variation in the prevalence of asthma symptoms, and marked urban-rural differences have been reported from several African countries. These contrast with the more uniform distribution of the disease within industrialized countries, reflecting its ubiquity in affluent societies.

Variability in definition

Asthma is conceptually defined as variable airflow obstruction (1), but for epidemiological purposes a pragmatic definition is often required in order to make best use of the available data. Three measures of wheezing illness have been widely used in epidemiological research: diagnosed asthma, symptoms, and measurements of bronchial hyperreactivity.

A diagnosis of asthma is all that is available in most routine sources of data relating to health service utilization

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and mortality. However, many studies have confirmed that there is substantial variation between doctors, between areas, and over time in the degree to which the asthma label has been applied to wheezing illnesses (2). This limitation can be overcome to some extent by including a number of diagnostic labels in an attempt to cover all the major forms of wheezing illness. For instance, several studies from the 1960s and 1970s analysed the combination of asthma and wheezy bronchitis (2, 3).

Concern during the 1970s and 1980s about underdiagnosis and inadequate treatment of asthmatic symptoms in school-aged children (4) led to a clinical and epidemiological consensus that all wheezing should be considered as "asthma" (3). During the 1990s, this convention has been increasingly questioned, particularly for wheezing in pre-school children (5, 6).

Definition of asthma in terms of symptoms has the advantage that disease ascertainment is not sensitive to variations in doctors' preferences for specific diagnoses, but the reporting of symptoms by children or parents is difficult to standardize, and it must be recognized that spurious variations may arise from increased awareness of respiratory problems in certain groups or from changes in the perception of symptoms over time. International variations may also be affected by problems of translation.

Bronchoconstrictor challenge tests have the intuitive appeal of being objective and purport to measure the disease quantitatively on a single dimension. They are generally reserved for in-depth studies of selected groups of children, or for objective validation of differences in disease prevalence observed using simpler methods. Some investigators have proposed that objectively confirmed bronchial hyperresponsiveness should be incorporated into the definition of asthma (7). This may be effective in concentrating epidemiological enquiry on a group of children with relatively persistent airway abnormality, among whom risk factors may be easier to identify. However, it excludes a substantial proportion of children with asthmatic symptoms who need to be considered as part of the spectrum of wheezing illness in the community, and it has yet to be shown that the more restrictive disease definition yields greater returns in terms of discovering remediable causes of asthma.

Variability in presentation

An advantage of ascertaining symptoms rather than diagnostic labels is that the full range of manifestations can be

explored. It is evident that asthma displays a wide spectrum of severity, and no one dimension can adequately describe all aspects. Thus wheezing may be considered to be "severe" because mild attacks occur frequently, or because potentially life-threatening attacks occur rarely, or because the child is persistently troubled by bronchospasm (particularly at night) without having any clearly defined attacks. These dimensions of severity have been incorporated into questionnaires developed for recent international comparisons of asthma prevalence (8).

There has also been concern that some children without overt wheezing may have asthma presenting with other symptoms, particularly regular nocturnal cough, and may benefit from inhaler therapy (9). Although this presentation undoubtedly accounts for some individual cases, in the general population the differences between children with wheeze and cough are more striking than the similarities (10), suggesting that the prevalence of this syndrome is probably low.

Variability in natural history

The incidence of wheezing is greatest in the first few years of life (11), but there is considerable debate about the nature of this early wheezing and its relationship to asthma of later onset. Prospective studies in Tucson, Arizona (12, 13) have been particularly influential in developing concepts of multiple phenotypes of wheezing illness in early childhood. Associations with ventilatory function, bronchial responsiveness, serum IgE, and positive skin prick tests in infancy and at ages 6 and 11 years suggest at least two distinct syndromes: "transient wheezers" with early onset but no symptoms at school age, associated with poor neonatal lung function and therefore, arguably, a disease of impaired intrauterine lung development; and later onset "allergic asthma", more closely related to atopy.

Longer-term follow-up studies show that transient early wheezers are less likely to wheeze as young adults than those with symptoms at age 7 or of later onset (14). However, among children of school age, the triggers of wheezing also predict adult prognosis, independent of atopy (15). This suggests that wheezing triggered only by infection ("wheezy bronchitis") may be a third distinct syndrome with a more benign outlook than "allergic asthma" in which attacks may be triggered by other factors. The situation is complex because it is likely that the two phenotypes may coexist, either concurrently or sequentially, in the same individual,

and also because infection is a common provoking factor for wheezing even in atopic subjects (16).

Simple statements about the prognosis of childhood wheezing conceal the considerable variability in the time course of asthmatic symptoms in individual subjects. The pattern of prognosis from childhood to adult life has been studied in a national British sample who developed asthma or wheezy bronchitis before 7 years of age (14). Some children who had apparently outgrown their wheezing tendency at age 7 later developed further wheezing episodes, particularly at age 33. In another long-term follow-up study in Melbourne, Australia, there was a similar tendency for symptoms to recur in adulthood after a period of remission in the late teens (17). Thus, although a high proportion of early wheezers become symptom-free in later childhood, a significant minority later develop wheezing again, either because of relapse of the original wheezing tendency or the development of a new form of "adult-onset asthma".

Variability in prevalence: time trends

The burden of asthma at a population level is also highly variable, both over time and between countries. Over the past 30 years, rates of hospital admission for asthma in children have risen dramatically in several English-speaking countries, particularly in younger children (18). Changes in use of hospital services during acute attacks of asthma may have contributed to the rise in admissions in the UK (19). On the other hand, there has been an increase by about 50% in relative terms in the prevalence of wheezing among schoolchildren in Britain (20) and Australia (21) over the past 30 years, with larger increases reported from other countries, notably a sixfold increase in Taiwan (22). Thus, there is evidence of an increase in morbidity, although this may have been exaggerated in routine statistics by changes in diagnosis and medical care. Unfortunately, little is known directly about time trends in symptom prevalence in pre-school children, among whom hospital admission rates have increased most rapidly.

Concurrently with the increase in asthma prevalence, several studies suggest an increase in prevalence of hay fever and eczema, although the few studies of trends in allergic sensitization are inconsistent (23). If all forms of allergic disease are increasing simultaneously, it is perhaps more likely that there has been an increase in host susceptibility, rather than a change in allergic or bronchial responsiveness to any single environmental agent. A wide range of hypotheses have been advanced to explain these changes

(24, 25), but only two studies have assessed changes in prevalence in relation to time trends in personal exposure to known or suspected perinatal (26) and indoor environmental (27) factors. Neither was able to explain any substantial part of the rise in asthma prevalence. This suggests that hitherto unsuspected causes of asthma or allergy may underlie these trends, and these probably include environmental exposures or lifestyles which have changed dramatically over the past two to three decades (23).

Variability in prevalence: geographical comparisons

International comparisons may provide clues to factors which may explain the rise of asthma prevalence worldwide. Until recently, there were few studies which compared the prevalence or severity of asthma symptoms in different countries, independent of diagnostic label. Comparisons were generally limited to English-speaking countries (28, 29). The International Study of Asthma and Allergies in Childhood (8) has provided a framework for global comparisons using standardized written and videotaped questionnaires enquiring about asthma symptoms and diagnosis. The results of worldwide comparisons have recently been published, based on over half a million children aged 6–7 years and 13–14 years from 155 centres in 56 countries (30, 31). These provide for the first time a truly global map of the prevalence of childhood asthma, at least in children of school age.

Substantial variations were observed between countries, with the prevalence of wheeze in the past year varying from 2% to 33% in the older age group and from 6% to 32% in the younger children. In general, the prevalence was highest in affluent English-speaking countries, intermediate in Western Europe, Latin America, Africa, and Southeast Asia; and lowest in parts of India, China, Eastern Europe, and the former Soviet Union. The global patterns of prevalence derived from videotaped and written questionnaires were broadly similar, suggesting that artefacts of translation are not the sole explanation for the variability in response to the written questionnaires.

The proportion of wheezy children with more troublesome symptoms changed little with the prevalence of wheeze in the past year, suggesting that the relative severity of asthma is independent of the proportion of children with a wheezing tendency. Every country had some children who reported having "asthma" at some time in their life, but, as might be expected, the relationship between asthma

prevalence and wheeze prevalence varied between countries, reflecting international differences in diagnosis and labelling of respiratory illness.

Differences between centres within countries were generally less marked than the international variations, although in several countries with multiple centres, such as India, Italy, and Spain, there was a threefold or greater variation between centres. Much attention has focused on the possible link with urbanization and air pollution, but there is remarkably little urban–rural variation within the UK (32), and globally the pattern of asthma prevalence is, if anything, inversely related to levels of the commonly measured air pollutants (30). Indeed, perhaps the most striking feature of the epidemiology of childhood asthma in developed countries is its relative uniformity across urban and rural areas and socio-economic groups (33). This suggests that the factors responsible for international variations in disease prevalence, and perhaps also time trends, are widely distributed in affluent societies.

Intriguing and contrasting observations come from Africa, where three studies suggest a virtual absence of exercise-

induced bronchospasm in rural children, whereas bronchial hyperreactivity appeared to be common in urban children (34–36). More detailed study of these and other areas with exceedingly low asthma prevalence may shed more light on the causes of the disease than comparisons within Western populations.

Conclusion

Asthma is defined clinically in terms of variability of airflow obstruction, but it is itself highly variable in clinical presentation and natural history. Asthma prevalence varies a great deal between countries and has been rising to a variable extent in many parts of the world over the past 20–30 years. The explanations for these phenomena remain elusive, but known risk factors do not account to any substantial extent for these geographical differences and time trends. The case for a broad perspective in asthma research is as strong nowadays as it was a decade ago (37).

References

1. Sears MR. The definition of asthma. *Allergy* 1993;**48**:12–16.
2. Anderson HR. Is asthma really increasing? *Paediatr Respir Med* 1993;**1**:6–10.
3. Williams H, McNicol KN. Prevalence, natural history and relationship of wheezy bronchitis and asthma in children. An epidemiological study. *BMJ* 1969;**iv**:321–325.
4. Speight ANP, Lee DA, Hey EN. Underdiagnosis and undertreatment of asthma in childhood. *BMJ* 1983;**286**:1253–1256.
5. Silverman M. Out of the mouths of babes and sucklings. Lessons from early childhood asthma. *Thorax* 1993;**48**:1200–1204.
6. Wilson NM. The significance of early wheezing. *Clin Exp Allergy* 1994;**24**:522–529.
7. Toelle BG, Peat JK, Salome CM, Mellis CM, Woolcock A. Toward a definition of asthma for epidemiology. *Am Rev Respir Dis* 1992;**146**:633–637.
8. Asher MI, Keil U, Anderson HR, et al. International study of asthma and allergies in childhood (ISAAC): rationale and methods. *Eur Respir J* 1995;**8**:483–491.
9. Strachan DP. Epidemiology. In: Silverman M, editor. *Childhood asthma and other wheezing disorders*. London: Chapman & Hall, 1995:7–31.
10. Clough JB, Williams JD, Holgate ST. The natural history of symptoms, peak expiratory flow and bronchial responsiveness in 7 and 8 year old children with cough and wheeze: a 12 month longitudinal study. *Am Rev Respir Dis* 1991;**143**:755–760.
11. Strachan DP. The prevalence and natural history of wheezing in early childhood. *J R Coll Gen Pract* 1985;**35**:182–184.
12. Martinez FD, Wright AL, Taussig LM, Holberg C, Halonen M, Morgan WJ. Group Health Medical Associates. Asthma and wheezing in the first six years of life. *N Engl J Med* 1995;**332**:133–138.
13. Stein R, Holberg CJ, Morgan WJ, et al. Peak flow variability, methacholine responsiveness and atopy as markers for detecting different wheezing phenotypes in childhood. *Thorax* 1997;**52**:946–972.
14. Strachan DP, Butland BK, Anderson HR. The incidence and prognosis of asthma and wheezing illness from early childhood to age 33 in a national British cohort. *BMJ* 1996;**312**:1195–1199.
15. Ross S, Godden DJ, Abdalla M, McMurray D, Douglas A, Oldman D. Outcome of wheeze in childhood: the influence of atopy. *Eur Respir J* 1995;**8**:2081–2087.
16. Johnston SL, Pattemore PK, Sanderson G, et al. Community study of the role of viral infections in exacerbations of asthma in 9–11 year-old children. *BMJ* 1995;**310**:1225–1229.
17. Kelly WJW, Hudson I, Phelan PD, Pain MCF, Olinsky A. Childhood asthma in adult life: a further study at 28 years of age. *BMJ* 1987;**294**:1059–1062.
18. Mitchell EA. International trends in hospital admission rates for asthma. *Arch Dis Child* 1985;**60**:376–378.
19. Strachan DP, Anderson HR. Trends in hospital admission rates for asthma in children. *BMJ* 1992;**304**:819–820.
20. Lenney W, Wells NEJ, O'Neill BA. The burden of paediatric asthma. *Eur Respir Rev* 1994;**4**:49–62.
21. Bauman A. Has the prevalence of asthma symptoms increased in Australian children? *J Paediatr Child Health* 1993;**29**:424–428.
22. Hsieh KH, Shen JJ. Prevalence of childhood asthma in Taipei, Taiwan and other Asian Pacific countries. *J Asthma* 1988;**25**:73–82.
23. Strachan DP. Time trends in asthma and allergy: ten questions, fewer answers. *Clin Exp Allergy* 1995;**25**:791–794.
24. Bousquet J, Burney PGJ. Evidence for an increase in atopic disease and possible causes. *Clin Exp Allergy* 1993;**23**:484–492.

25. Peat JK. The rising trend in allergic illness: which environmental factors are important? *Clin Exp Allergy* 1994;**24**:797–800.
26. Lewis S, Butland B, Strachan D, Bynner J, Britton J. Study of the aetiology of wheezing illness at age 16 in two national British birth cohorts. *Thorax* 1996;**51**:670–676.
27. Butland BK, Strachan DP, Anderson HR. The home environment and asthma symptoms in childhood: two population based case-control studies 13 years apart. *Thorax* 1997;**52**:618–624.
28. 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**:524–529.
29. Burr ML, Limb ES, Andrae S, Barry BMJ, Nagel F. Childhood asthma in four countries: a comparative study. *Int J Epidemiol* 1994;**23**:341–347.
30. The ISAAC Steering Committee. Worldwide variations in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema: the International Study of Asthma and Allergies in Childhood. *Lancet* 1998;**351**:1225–1232.
31. Asher MI, Anderson HR, Stewart AW, et al. Worldwide variations in prevalence of asthma symptoms: the International Study of Asthma and Allergies in Childhood (ISAAC). *Eur Respir J* 1998;**12**:315–335.
32. Kaur B, Anderson HR, Austin J, et al. Prevalence of asthma symptoms, diagnosis and treatment in 12–14-year-old children across Great Britain (International Study of Asthma and Allergies in Childhood, UK). *BMJ* 1998;**316**:118–124.
33. Strachan DP, Anderson HR, Limb ES, O'Neill A, Wells N. A national survey of asthma prevalence, severity and treatment in Great Britain. *Arch Dis Child* 1994;**70**:174–178.
34. van Niekerk CH, Weinberg EG, Shore SC, de Heese HV, van Schalkwyk DJ. Prevalence of asthma: a comparative study of urban and rural Xhosa children. *Clin Allergy* 1979;**9**:319–324.
35. Keeley DJ, Neill P, Gallivan S. Comparison of the prevalence of reversible airways obstruction in rural and urban Zimbabwean children. *Thorax* 1991;**46**:549–553.
36. Addo Yobo EOD, Custovic A, Taggart SCO, Asafo-Agyei AP, Woodcock A. Exercise-induced bronchospasm in Ghana: differences in prevalence between urban and rural schoolchildren. *Thorax* 1997;**52**:161–165.
37. Gregg I. Epidemiological research in asthma: the need for a broad perspective. *Clin Allergy* 1986;**16**:17–23.