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Secular trend in the occurrence of asthma among children and young adults: critical appraisal of repeated cross sectional surveys [Paper]

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Abstract

Objectives: To review repeated surveys of the rising prevalence of obstructive lung disease among children and young adults and determine whether systematic biases may explain the observed trends.

Design: Review of published reports of repeated cross sectional surveys of asthma and wheezing among children and young adults. The repeated surveys used the same sampling frame, the same definition of outcome variables, and equivalent data collection methods.

Setting: Repeated surveys conducted anywhere in the world.

Subjects: All repeated surveys whose last set of results were published in 1983 or later.

Main outcome measures: Lifetime and current prevalences of asthma and current prevalence of wheezing. The absolute increase (yearly percentage) in the prevalences of asthma and wheezing was calculated and compared between studies.

Results: 16 repeated surveys fulfilled the inclusion criteria. 12 reported increases in the current prevalence of asthma (from 0.09% to 0.97% a year) and eight reported increases in the current prevalence of wheezing (from 0.14% to 1.24% a year). Changes in labelling are likely to have occurred for the reporting of asthma, and information biases may have occurred for the reporting of wheezing. Only one study reported an increase in an objective measurement.

Conclusions: The evidence for increased prevalences of asthma and wheezing is weak because the measures used are susceptible to systematic errors. Until repeated surveys incorporating more objective data are available no firm conclusions about increases in obstructive lung disease among children and young adults can be drawn.

Introduction

There is widespread belief that the prevalence of asthma is increasing in industrialised societies, particularly in children. This belief stems from results of epidemiological studies. Changes in diagnostic labelling and the presence of selection or information bias can lead to false interpretation of changes in repeated prevalence studies. We reviewed published studies on recent secular trends in asthma in the light of these potential sources of error. We limited the review to repeated cross sectional studies of asthma in children and young adults in which the last set of results was published in 1983 or later.

Materials and methods

Inclusion of studies

We included only repeated cross sectional studies that used the same methodology (definition of variables, wording of questions, and methods of data collection) on samples of children or young adults in the same geographic area. Furthermore, both the sampling frame and the sampling method had to be identical within studies. Surveys based on attendance at health care centres (for example, hospital admissions or consultations in general practice) were excluded because time trends for these data depend on the selection of subjects as well as on organisational efficiency, diagnostic

methods, and data registration practices over time. Because the mortality from asthma is low and mortality depends on both the incidence of asthma and the case fatality rate we did not include mortality studies.

We excluded some reports because of non-equivalent methods of data collection or content of information, non-equivalent sampling, or lack of specification of sample sizes. For instance, the NHANES studies changed the wording of the question on asthma from "Did a doctor ever tell you that you had asthma" to "Has [name of child] ever been treated for the following? Asthma (Yes, No)." [1] Peat et al changed questionnaires between surveys. [2] A study from Aberdeen reported changes between 1964 and 1989 but was excluded because the first data collection was by interview and the second by questionnaire, and the wording of questions was changed. [3] In addition, studies of Israeli [4] and Finnish conscripts [5] were excluded because sample sizes were not given. We also excluded studies in which the sampling frame was not equivalent on the two occasions. [6-8]

To identify studies for inclusion, abstracts of all studies referenced in Medline from January 1983 to April 1996 were extracted if they included "asthma" or "wheezing" combined with words such as "prevalence," "occurrence," "incidence," "increase," or "trend." Sixteen repeated cross sectional studies fulfilled the criteria for inclusion. [9-24] Six studies were from the United Kingdom, four from New Zealand or Australia, two from Israel, two from Scandinavia, one from Taiwan, and one from the United States (Table 1). Twelve studies concerned children and four were based on young adults.

Study	Country and time period	Population	Data collection method	Outcome measure	Operational definition
Wright (1982) ¹	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ²	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ³	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ⁴	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ⁵	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ⁶	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ⁷	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ⁸	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ⁹	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"
Wright et al (1982) ¹⁰	New Zealand 1982	12-15 year olds	Questionnaire	Asthma	"Has the child suffered from asthma?"

Table 1. Country, time period, population, data collection methods, outcome measures, and operational definitions used in repeated cross sectional studies of asthma and wheezing

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Variables

We extracted three measures of disease prevalence from the studies: lifetime occurrence (cumulative incidence) of asthma, current asthma, and current wheezing. For current wheezing, studies asked either for symptoms during a defined retrospective period (12 months or three years) or for the presence of symptoms recently or occasionally. Data collection methods for children were primarily based on questionnaires completed by parents whereas studies of young adults also relied on physical examination. Operational definitions of asthma and wheezing were usually not specified, and the implicit definitions (wording of questions) differed between studies.

[Table 1](#) briefly describes the data collection methods, outcome measures, and definitions of asthma and wheezing.

Statistical methods

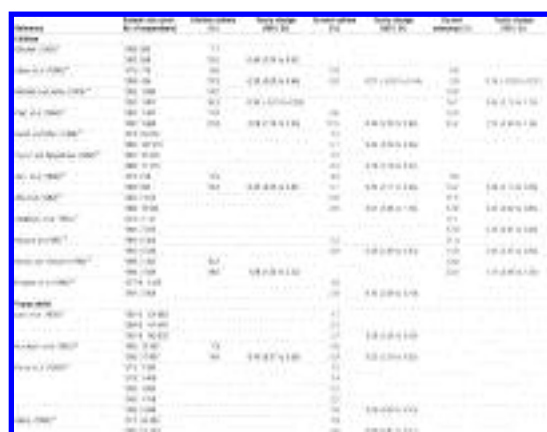
For each study the absolute changes in prevalence (percentage change yearly) were estimated from the published figures. The 95% confidence intervals for these estimates were based on weighted linear regression (if more than two years were studied) or on the Poisson distribution for calculating the standard error of the difference between two prevalences. The relative increase over time was studied by

the ratio of the prevalence rates at the first and last surveys (with 95% confidence intervals calculated by Taylor series) for both asthma and wheezing.

Results

Asthma

(Table 2) shows the absolute prevalences for each survey as well as the yearly increase in prevalence. The prevalence of lifetime occurrence of asthma ranged from 5.5% to 31.8% whereas the prevalence of current asthma showed less variability. For lifetime asthma the absolute increase in prevalence ranged from 0.35% to 2.08% yearly. For current asthma the increase ranged from 0.09% to 0.97%. All studies showed increasing prevalences. The increases were in general lower for young adults. Figure 1 shows the absolute yearly increases in the prevalence of current asthma by country and time period. The studies from the United Kingdom found very different degrees of increase. The two studies with the most recent start found the largest yearly increases.



Study	Year	Age group	Lifetime prevalence (%)	Current asthma prevalence (%)	Current wheezing prevalence (%)	Yearly absolute change in prevalence (%)
1	1974	15-64	11.1	5.5	10.0	0.35
2	1974	15-64	11.1	5.5	10.0	0.35
3	1974	15-64	11.1	5.5	10.0	0.35
4	1974	15-64	11.1	5.5	10.0	0.35
5	1974	15-64	11.1	5.5	10.0	0.35
6	1974	15-64	11.1	5.5	10.0	0.35
7	1974	15-64	11.1	5.5	10.0	0.35
8	1974	15-64	11.1	5.5	10.0	0.35
9	1974	15-64	11.1	5.5	10.0	0.35
10	1974	15-64	11.1	5.5	10.0	0.35
11	1974	15-64	11.1	5.5	10.0	0.35
12	1974	15-64	11.1	5.5	10.0	0.35
13	1974	15-64	11.1	5.5	10.0	0.35
14	1974	15-64	11.1	5.5	10.0	0.35
15	1974	15-64	11.1	5.5	10.0	0.35
16	1974	15-64	11.1	5.5	10.0	0.35

Table 2. Percentage prevalences of lifetime occurrence of asthma, current asthma, and current wheezing, with yearly absolute change in prevalence for 16 repeated cross sectional studies using same methodology

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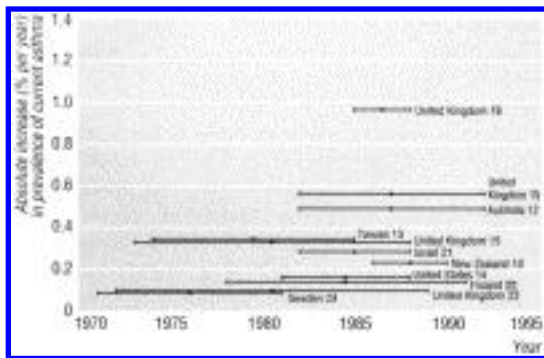


Figure 1. Absolute yearly increases in prevalence of current asthma in 12 repeated cross sectional studies by country and time period. Bars indicate first and last survey years of each study. Points are midyears

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Wheezing

Only studies in the United Kingdom, Australia, and New Zealand reported current wheeze. The prevalence of current wheezing varied from 4.6% to 25.4%. The absolute yearly increase in the prevalence of current wheezing ranged from 0.14% to 1.24%. Studies started after 1980 showed the largest absolute yearly increases in prevalence of wheezing (Figure 2).

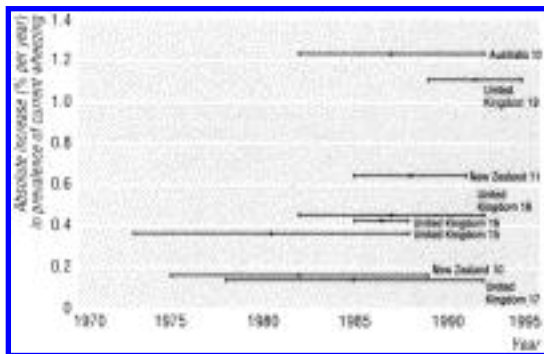


Figure 2. Absolute yearly increases in prevalence of current wheezing in eight repeated cross sectional studies by country and time period. Bars indicate first and last survey years of each study. Points are midyears

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The five studies that included both current asthma and current wheezing are listed in Table 3, which shows the relative increase in both measures. In the New Zealand study current asthma increased by 60% and current wheezing by 50%. In that study and the study from Australia asthma and wheezing increased proportionally. In contrast, all

three studies from the United Kingdom showed a larger increase in the prevalence of current asthma than in the prevalence of current wheezing.

Reference	Country	Prevalence ratio for asthma (95% CI)	Prevalence ratio for wheezing (95% CI)	Ratio of asthma to wheezing (95% CI)
1. Haines et al (1984) ¹¹	New Zealand	1.45 (1.33-1.58)	1.45 (1.33-1.58)	1.00
2. Haines et al (1984) ¹²	Australia	1.48 (1.34-1.62)	1.35 (1.21-1.50)	1.09
3. Haines et al (1984) ¹³	United Kingdom	1.15 (1.03-1.28)	0.85 (0.73-0.98)	1.35
4. Haines et al (1984) ¹⁴	United Kingdom	1.15 (1.03-1.28)	0.85 (0.73-0.98)	1.35
5. Haines et al (1984) ¹⁵	United Kingdom	1.15 (1.03-1.28)	0.85 (0.73-0.98)	1.35

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Table 3. Relative secular increase (prevalence at last survey over prevalence at first survey) for asthma and wheezing, and ratio between increase for asthma and wheezing

Discussion

Apparent increases in the prevalence of asthma and wheezing over time was found in all the reviewed studies. The degree of increase differed substantially between the studies, even those within the same country. In Australia and New Zealand the increases in asthma and wheezing were proportional whereas in the United Kingdom asthma increased comparatively more than wheezing. Before concluding that real increases in obstructive lung disease among children and young adults have been taking place in these populations we need to assess critically the informational content of the data.

Asthma

A main concern is whether the content of the asthma diagnosis is changing. In 1983 a study from Newcastle showed a substantial underdiagnosis of asthma. [26] The increase in parent reported asthma observed during the 1980s may be a consequence of changes among physicians in making use of the asthma diagnosis and giving better information to parents. [16] Better treatment options with a focus on early introduction of drugs and a change in the criteria for applying the diagnosis to children [27] may also have increased the prevalence. [28] Changing criteria for asthma may also have relevance for the studies of conscripts in Israel, [21,22] in which physicians examined

subjects with a wheezing history, and for the Taiwan study, [13] in which paediatricians revised the questionnaires. Physical examination for the determination of asthma adds a further layer of complexity, as the examination is subjective and the diagnosis of asthma may depend on the period in which the person is examined.

In addition to increased professional awareness, a public awareness bias may be present if allergies and asthma have been extensively discussed in public. After reviewing the many mechanisms that can influence an asthma diagnosis Anderson concluded that "the presence of a diagnosis of asthma is of little use epidemiologically." [29] On the basis of these considerations we cannot conclude from repeated studies that sought only the presence of asthma that asthma has increased.

Wheezing 🏠

If we cannot trust the asthma diagnosis for time trend studies we are left with the increase in wheezing (Table 2). The eight studies-from New Zealand, Australia, and the United Kingdom-showed variation in the yearly increase in prevalence of current wheezing from 0.14% in London [17] to 1.24% in two Australian towns. [12] A remaining question is whether the everyday meaning of the word wheezing has been constant over time. Do better educated parents more easily use this word for symptoms in their children? Is the tolerance of mild respiratory symptoms lower than it previously was? Have public health campaigns to increase the awareness of wheezing as a sign of asthma or media reports of increasing rates of asthma led to increased parental awareness of symptoms in their children? These questions cannot be answered from the studies reviewed. In the London study less disability in connection with wheezing was reported on the second occasion (1991). [17] This may be explained by an increase in the recognition and reporting of symptoms rather than

by effects of treatment, which presumably should reduce disability and symptoms to the same degree.

Lack of objective measures

Wheezing and other symptoms of obstruction are clinical expressions not easily captured by objective measurements in cross sectional studies. However, both bronchial hyperreactivity and positive skin prick test reactions are correlated with asthma, [\[13\]](#) though none of these measures provides a standard. But we should expect that the prevalence of these findings would increase in the general population of children if the prevalence of asthma really had increased.

Only two of the 16 studies included objective measurements on both occasions. In a study from Wales [\[15\]](#) peak expiratory flow rates were measured before (PEFR 1) and after (PEFR 2) six minutes of free running and the outcome analysed as $100 \times (\text{PEFR } 2 / \text{PEFR } 1)$. In both surveys (conducted in 1973 and 1988) the mean value was 96% (calculated from midpoint values in [Table 3](#)). The prevalence of airway hyperresponsiveness induced by exercise (more than 15% decrease) was 6.7% (SE 0.9%) in 1973 and 7.7% (0.9%) in 1988. In an Australian study comparing schoolchildren in 1982 and 1992 there was no change in skin prick test positivity to five allergens. [\[12\]](#) The proportion of children who had a positive bronchial response to histamine challenge was twice as high in 1992 as in 1982. The type of spirometer used differed between the two occasions. An unknown point is whether the increased use of drugs might increase the response to histamine.

Selection bias

Within each country the samples consisted of schoolchildren, students, or conscripts drawn from the general population. There is a lack of repeated cross sectional studies

of children below school age. Response rates are generally high. The important question is whether the repeated samples within studies are sufficiently comparable. We were careful to exclude studies that did not use the same geographic sampling frame (same schools or same regions). Nevertheless, the effects of selective migration between surveys cannot be controlled in detail and may influence some of the smaller studies based on samples of schoolchildren in cities. The studies based on conscripts [21,22,24] or on nationwide sampling [14,20] were more reliable in this respect. The studies were conducted in several countries representing large differences in geographic location and culture-namely, the United Kingdom, the United States, Australia and New Zealand, Taiwan, Sweden, Finland, and Israel. To complete the picture studies are needed from other countries, though it is unlikely that trends will be noticeably different. In our opinion, selection bias is unlikely to explain the observed trends.

Conclusion

The prevalence of asthma is difficult to follow over time owing to changes in diagnostic practice. The argument for an increase in obstructive lung disease among children rests on parental or self reports of symptoms in three countries (United Kingdom, New Zealand, and Australia) and finding an increased prevalence of bronchial hyperresponsiveness to a histamine challenge in one study. Information bias may explain the trends. It is encouraging that new epidemiological studies are under way with standardised questions on severity and objective measurements. [30] Until such studies have been performed on more than one occasion in the same population we believe that the evidence for an increasing trend in obstructive lung disease among children and young adults is weak.

Key messages📌

- There is an increase in the reporting of wheezing illness in children
- The increase may be due to information bias
- There is a lack of objective measurements in population based samples to support claims for an increase in asthma
- The changing informational content complicates following the epidemiology of asthma

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