

## Original article

# Trends in hospital admissions for childhood asthma in Oslo, Norway, 1980–95

**Background:** The prevalence of asthma and quality of asthma care both influence hospital admission rates for childhood asthma. Therefore, we aimed to assess possible changes in the hospital admission rate for acute asthma in Oslo, Norway, from 1980 to 1995, as well as evaluate the possible effect of changes in asthma treatment upon hospitalization for acute asthma in this period.

**Methods:** All pediatric patient records from the two municipal hospitals in Oslo from 1980 through 1995 with the discharge diagnoses (ICD-9) acute asthma, acute bronchitis/bronchiolitis, pneumonia, and/or atelectasis were thoroughly reviewed.

**Results:** Of the 3538 children admitted for acute asthma, 66% were boys and 75% were younger than 4 years, and the admittance rate increased significantly among children aged 0–3 years. First admissions increased throughout the study, whereas readmissions, as well as the mean duration of hospital stay, decreased significantly. Prophylactic treatment with inhaled steroids prior to admission increased over 1980–89, but stabilized thereafter. The use of a short course of systemic steroids during admission increased markedly from 1991.

**Conclusions:** The findings of increasing first admission rate as well as overall admission rate for acute asthma in children under 4 years of age, but decreasing readmissions as well as number of treatment days in hospital, probably reflect changes in the management of the disease, as well as an increasing prevalence of childhood asthma.

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The admission rate represents the net results of prevalence, disease severity, and quality of care given to the asthma patient in the community (1). Increased prevalence and severity tend to increase admission rates, whereas improved quality of care reduces the number of admissions and especially the readmission rate.

During the last three decades, increased hospital admissions for childhood asthma have been reported in different countries (1–10). This appears to be a worldwide trend (7), and it has been postulated that this may, at least in part, represent an increase in disease severity (2, 11) as well as asthma prevalence (8). Others have suggested that this trend may reflect changes in utilization of health services rather than a major change in morbidity (5, 12). Diagnostic changes (13) and readmission rate (i.e., the same patients being admitted more than once for the same disease) have been thought to affect the hospital admissions rate (14), but this was not the case in other studies (15, 16). Most studies of

admissions rates for asthma were limited by the fact that data were collected from hospital databases only, and not by a review of patient records.

A decline in admission rate for asthma during the last 10 years has been reported in schoolchildren, and to a lesser extent in younger children (17–19). It has been suggested that the increase in the use of inhaled steroids is the major reason for this decline (18).

A recent survey of 2577 schoolchildren in Oslo, Norway, demonstrated an increase in lifetime prevalence of physician-diagnosed asthma from 3.4% in 1981 to 9.3% in 1994, with a corresponding increase in the use of asthma medication from 1.1% to 4.7% (20). The reported increase in prevalence is likely to have had an impact on the hospital admission rate for asthma, whereas changes in the management of asthma possibly counteracted the expected increase in admission rate.

The main objective of the present study was to assess possible changes in hospital admission rate for child-

hood asthma from 1980 to 1995, as well as to investigate whether possible changes in asthma management might affect the rate of hospital admissions for childhood asthma.

## Material and methods

### Methods

Two municipal hospitals (Ullevål and Aker) receive all acute admissions of children in Oslo, which has approximately 500 000 inhabitants. The majority (>90%) of hospital admissions for acute asthma during childhood are at Ullevål Hospital. The annual hospital discharge data for lower respiratory disease in children aged 0–14 years were obtained for both hospitals from 1980 through 1995. The *International Classification of Diseases* (ICD) system was used, the 8th revision until 1987, and thereafter the 9th revision (ICD-9). Patient charts were reviewed in detail, emphasizing the history of obstructive airway disease in all children with any of the following discharge diagnoses; ICD-493 (bronchial asthma), ICD-466 (bronchitis and/or bronchiolitis), ICD-480–84 (pneumonia), and ICD-518 (atelectasis). Bronchiectasis was not included, as the main aim was to investigate asthma, and possible bronchial obstruction is difficult to distinguish as asthma in patients with other chronic lung diseases.

Patients admitted for acute bronchial obstruction (BO) (periods of wheeze, prolonged expiration with or without increased respiratory rate, with the use of bronchodilators), with a history of at least two previous episodes of BO, were diagnosed as having asthma and subsequently included in the analyses. The charts were scrutinized for the presence of signs of BO. Exclusion criteria were that the primary cause for admission was not BO (diagnosis of asthma used as a supplementary diagnosis) or that the patient was not a registered resident of Oslo.

Medical records were examined for age, sex, ethnic group, home address, admission date, days in hospital, and treatment prior to admission and in hospital, as well as the number of readmissions. Readmission was defined as two or more admissions for a patient, and the annual readmission rate was calculated by dividing the number of readmissions by all admissions the same calendar year, and given as a percentage. Data were registered for each calendar year for both hospitals involved in the study. Five physicians all involved in the hospital treatment of the subjects abstracted data from medical records.

Annual community-based demographic data for the population in Oslo were obtained from the Official Bureau of Statistics (Statistisk Sentralbyrå).

No major changes occurred in Oslo throughout the study period related to referral for evaluation or to the decision to admit or treat as an outpatient any child

with respiratory disease. The decision to admit to hospital or discharge a patient with acute asthma was based on clinical evaluation of the child. Medical expenses for hospital admission are covered by the Norwegian Social Security System, as is the cost of medication for treatment of asthma at home.

### Statistical analyses

Admission data are expressed as rates; number of admissions for each age group per 10 000 population in the age groups. Years were compared individually to analyze possible trends, and in 5- and 6-year periods, i.e., 1980–5, 1986–90, and 1991–5, to investigate possible shifts in admission rates. When years were compared individually, a time series analysis, accounting for time dependency, was performed by exponential smoothing with Holt's linear trend (21). This type of analysis was used for the age of admitted patients and for readmission rates.

When comparing the 5- and 6-year periods, a two-sample *t*-test was used. Rates per 10 000 were seen as a binomial event drawn from an infinite population; i.e., a Poisson sample. An exact confidence interval was calculated for the mean rate with the Poisson distribution. Results with *P* values below 0.05 were considered to be significant. Likewise, two disjointed 95% confidence intervals were considered to show a significant difference.

## Results

A total of 3538 admissions for acute asthma over the 16-year period were included in the present study.

### Admission rate – age/sex

An increase in admission rate occurred from 1980 to 1989 with the highest rate of 44.7/10 000 in 1989. A slight decline in admission rate was found thereafter, with an apparent stabilization during the last 5-year period, as shown in Fig. 1. Admission rates increased significantly throughout the study period for the youngest age group (0–3 years) ( $P=0.001$ ), whereas a slight overall decrease was found among children 4–7 years old, as well as among the 8–14-year-old children (Fig. 1). The mean age at admission decreased significantly ( $P=0.02$ ) throughout the study period, as well as when comparing the mean age in 1980–5 and 1990–5 ( $P=0.002$ ) (Table 1). Boys accounted for 65% of all admissions (Table 2). The admission rate was significantly higher among boys than girls aged 0–3 years, but this sex difference decreased with increasing age (Table 2).

In 1990, the number of admissions for bronchiolitis (with the respective ratio to asthma admissions in parenthesis) was 229 (1.01). The corresponding figures

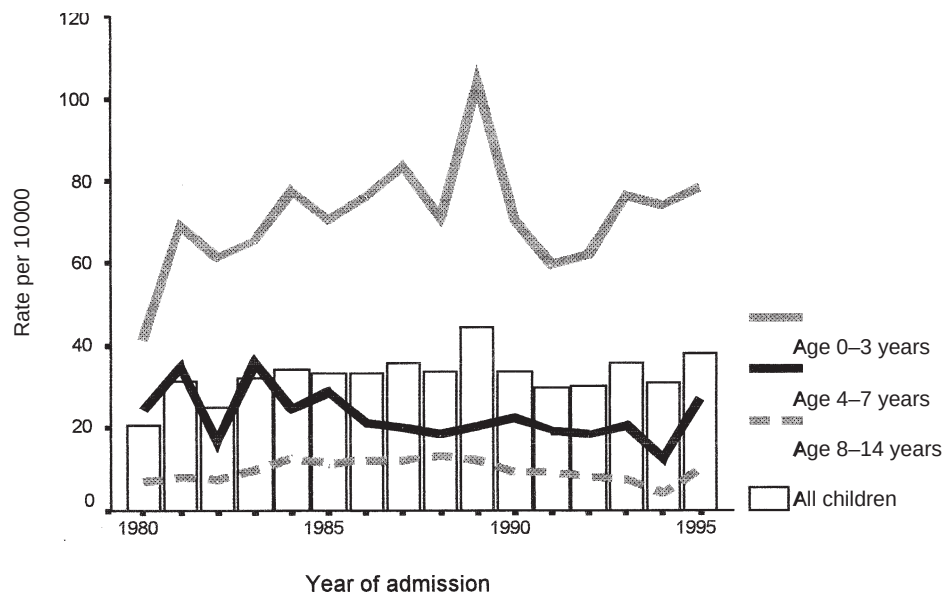


Figure 1. Changes in hospital admission rates/10 000 for different age groups of children admitted for acute asthma in Oslo, 1980–95. Bars represent all admissions for asthma, i.e., age group 0–14 years, and lines represent different age groups within this group.

for the next 5 years were as follows: 184 (0.90) in 1991, 278 (1.28) in 1992, 391 (1.47) in 1993, 245 (1.02) in 1994, and 321 (1.05) in 1995 (NS).

#### Rate of first admissions vs readmissions

The annual readmission rates were highest in 1984 and 1985 with 45.3% and 41.6%, respectively, but subsequently declined to the lowest values of 10.2% in 1993 and 11.2% in 1994. The readmission rate for the whole period decreased significantly ( $P=0.001$ ), and also showed a decrease ( $P<0.05$ ) when the 5- and 6-year periods were compared, as shown in Table 1.

The annual first admission rates as well as the readmission rates per 10 000 inhabitants for 1980–5 are shown in Fig. 2. For the 0–3-year-olds, the overall mean annual readmission rate per 10 000 children by age groups was 22.9, with the corresponding figures of 4.8 and 2.1 for the 4–7-year-old and 8–14-year-old children, respectively (Fig. 3). The mean male annual readmission rate was 27.9%, whereas the female read-

mission rate was 28.4% for the 16-year period. The mean readmission rate for boys/girls for the age group 0–3 years was 32.3%/31.1%; for the age group 4–7 years, it was 18.2%/22.2%; and for the age group 8–14 years, it was 16.34%/24.37%. No significant differences in readmission rates according to sex were found.

#### Duration of stay in hospital

The mean number of days per admission decreased significantly ( $P=0.001$ ) in the study period from a mean value in excess of 5 days during the first 6-year period to less than 3 days in the last 5-year period, as shown in Table 1. The overall annual total number of days of admission in hospital also decreased from 1990. No significant sex difference was found in the number of days spent in hospital.

#### Treatment

In the 1980s, the most commonly used treatment for acute BO was nebulized inhaled bronchodilators (racemic epinephrine and  $\beta_2$ -agonist) in combination with theophylline (59.4% in 1986) (Fig. 4). In the late

Table 1. Changes in hospital admission/readmission rate, age at admission, and length of stay in hospital for childhood asthma in Oslo, 1980–95

|                                | 1980–5<br>a | 1986–90<br>b | 1991–5<br>c | P value<br>a vs c |
|--------------------------------|-------------|--------------|-------------|-------------------|
| Admission rate/10 000          | 29.5        | 36.3         | 33.0        | NS                |
| Annual readmission rates (%)*  | 38.8        | 30.2         | 14.6        | <0.05             |
| Age at admission (years)       | 4.0         | 3.3          | 2.8         | 0.002             |
| Length of hospital stay (days) | 5.1         | 4.2          | 2.7         | 0.001             |

Results are given as mean values.

Asthma readmission was defined as two or more admissions for asthma.

\*Annual readmission rate was calculated by dividing number of readmissions per annum by all admission same year, and was given as percentages. NS: nonsignificant.

Table 2. Mean admission rates/10 000 for different age groups and sexes of children admitted for acute asthma in Oslo, 1980–95

| Age group | n    | Boys              | Girls            | P value |
|-----------|------|-------------------|------------------|---------|
| 0–3       | 2461 | 92.9 (78.6–109.4) | 47.1 (37.2–58.8) | <0.05   |
| 4–7       | 637  | 29.3 (21.6–38.4)  | 16.1 (10.8–23.1) | NS      |
| 8–14      | 440  | 11.2 (6.9–17.0)   | 8.3 (4.7–13.1)   | NS      |
| 0–14      | 3538 | 41.7 (32.8–53.2)  | 22.9 (15.7–30.2) | <0.05   |

Results are given as mean values with 95% confidence interval in parentheses. NS: nonsignificant.

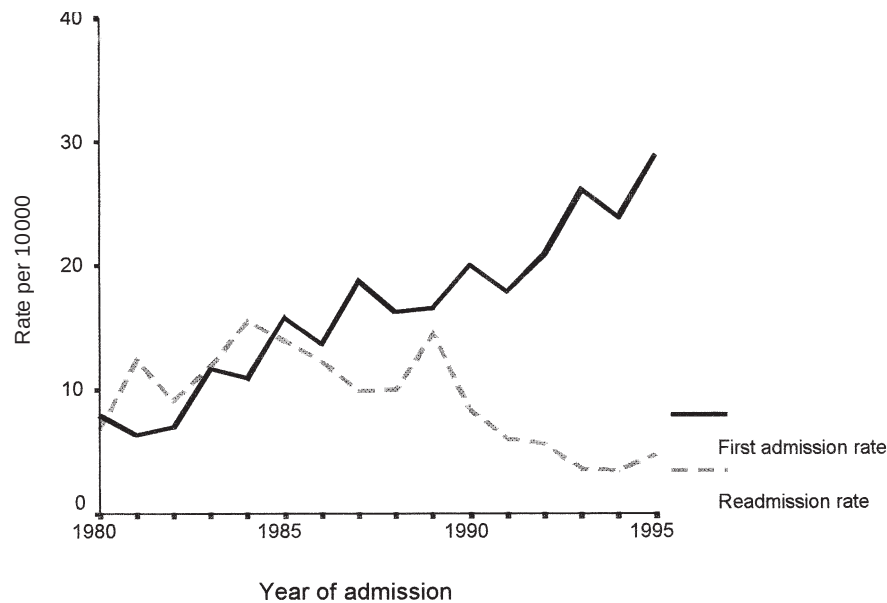


Figure 2. Rate per 10 000/population in Oslo, 1980–95, of annual first admissions and annual readmissions for acute asthma in children.

1980s and early 1990s, this treatment strategy was gradually replaced by nebulized bronchodilators as monotherapy, or with the increasingly used supplement of a short course of systemic steroids (63% of the admissions in 1995). Administration of intravenous treatment (fluids, theophylline, and/or steroids) was reduced from more than 35% in 1980 to less than 16% of all asthma admissions during the last 4 years of the study, as shown in Fig. 4.

Fig. 5 demonstrates changes in the reported regular treatment prior to admission from 1980 to 1995. In the 1980s, 30–50% of the admitted children received no

regular treatment for asthma prior to admission. More than 60% of children admitted for acute asthma in the 1990s did not receive any regular treatment for asthma. The percentage of admitted children who used prophylactic theophylline prior to admission was highest (42%) in 1981, but then declined to zero in 1990. Regular anti-inflammatory treatment with inhaled steroids prior to hospital admission increased from 4.8% of admitted children in 1981 to 25.1% in 1989 and 25.3% in 1995. Treatment with inhaled steroids in children who were readmitted ranged from 8.5% in 1981 to 52.6% in 1995. Regular use of sodium cromoglycate prior to admission

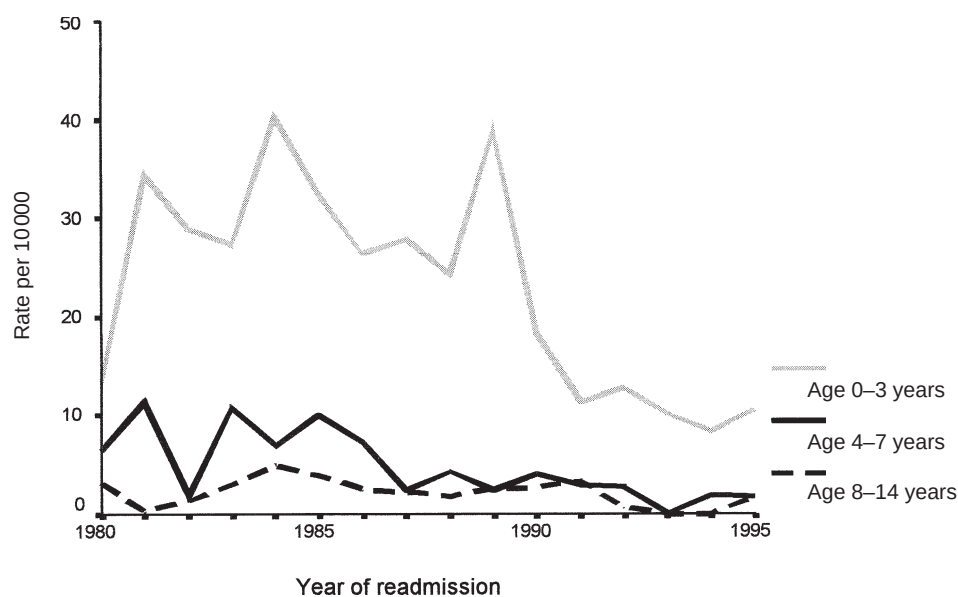


Figure 3. Changes in annual hospital readmission rate per 10 000 for three different age groups of children admitted for acute asthma in Oslo, 1980–95.

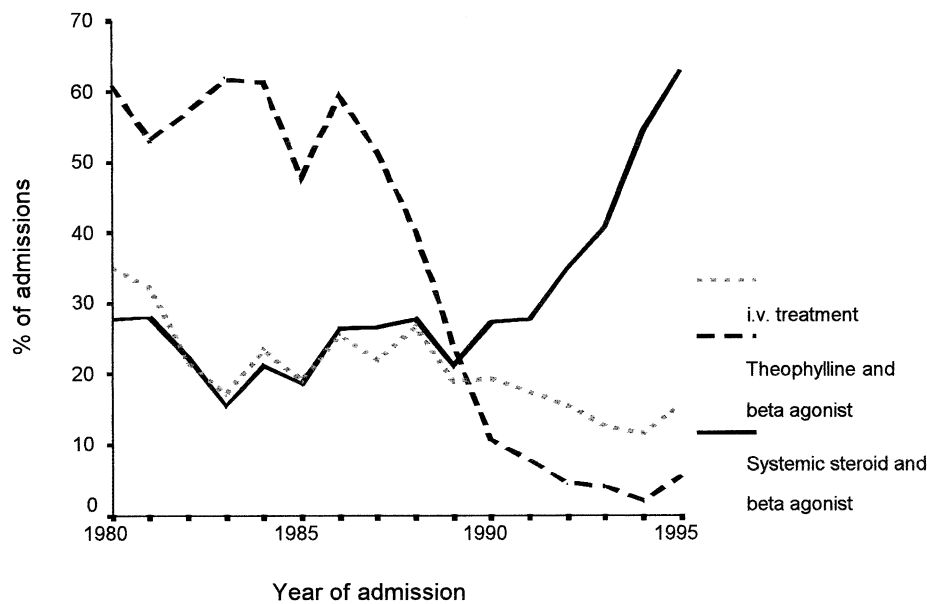


Figure 4. Changes in percentage of admitted children receiving i.v. treatment, theophylline, or short course of systemic steroids for asthma exacerbation, during admission, in Oslo, 1980–95.

was reported in less than 8% of admissions in the 1980s, increased to a maximum of 14% in 1990, and declined to less than 8% in 1995.

The percentage of admitted children with access to a nebulizer at home prior to admission increased from 35% in 1980 to 49% in 1989 and 1990, but then declined to 26% in the last year of the study.

## Discussion

Admission rates for acute asthma in children in Oslo increased from 1980 to 1989, but subsequently stabilized until 1995. The observed overall increase from 1980 to 1995 was due to a significant increase in acute asthma admissions in children aged 0–3 years. The most striking finding was a continuous increase in first admission rates with an accompanying decline in readmission rate. Changes in treatment strategies to increase use of glucocorticosteroids before as well as during hospital admissions were observed during the 16-year period.

### Diagnosis

A shift of diagnostic label from bronchiolitis to asthma, leading to the reported increases in asthma in this period, has been postulated (13). However, in the present study, a hospital admission was included only with documentation in the chart of signs of BO being the cause of the admission, as well as reports of at least two previous episodes of BO. Furthermore, there was no significant trend or differences in the number of hospital admissions due to acute bronchiolitis compared to acute asthma over the last 6 years. The admission rate for bronchiolitis were not recorded

before 1990, on its own account, although all charts were systematically scrutinized. However, as a computer system was used in the hospital from 1990, discharge data on bronchiolitis were added to detect any shift toward admissions labeled as bronchiolitis or asthma. A shift of diagnosis within the complex of obstructive airways disease among the youngest children is thus unlikely in the present study.

More subjects in the 1990s than in the first half of the 1980s received regular treatment prior to admission. It could be argued that the use of anti-inflammatory treatment reflects awareness of asthma diagnosis and consequently supports the possibility of diagnostic shift. On the other hand, regular anti-inflammatory treatment was not commonly prescribed to children even with a diagnosis of asthma before the mid-1980s. Thus, it is unlikely that changes in observed treatment strategies could be a marker of changes in diagnostic label.

### Data collection

The data collected in this study are based on medical charts which have been reviewed in detail retrospectively. The quality of the data assessment inevitably affects the strength of the study. No admission was included unless there was a record of signs of BO, as has been stated earlier. However, the most commonly missing variable upon admission was respiratory rate. This was not essential for inclusion, but was a frequently noted omission. All variables, which were collected systematically, represent categorical data from the patient chart and are not subject to difference in interpretation between the data collectors. Data for the present study were collected over a 10-year period, and

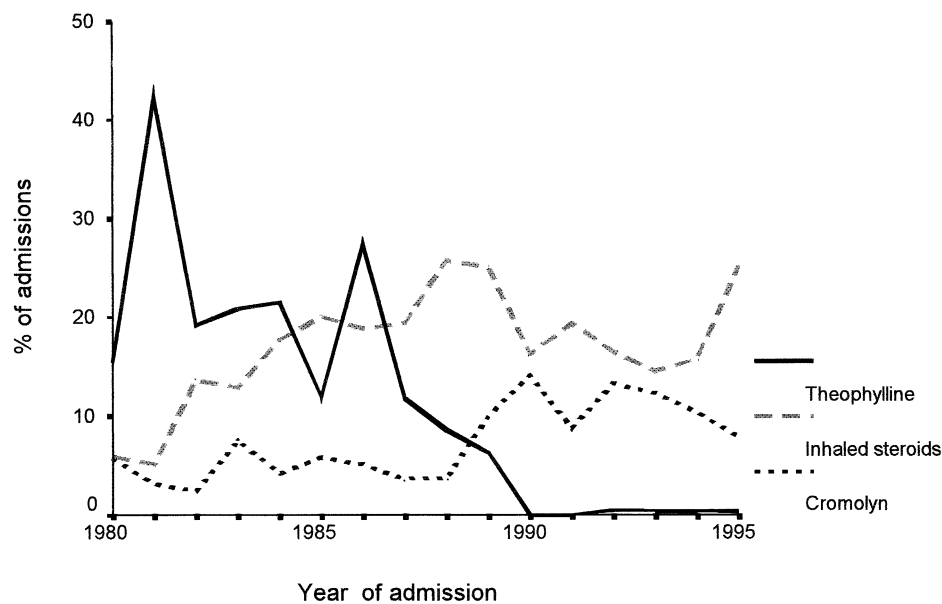


Figure 5. Changes in percentage of admitted children receiving theophylline, inhaled steroids, or cromolyn as daily prophylactic treatment prior to admission for asthma in Oslo, 1980–95.

the participating physicians were in most cases directly involved in the medical care of admitted patients and consequently interested in collecting relevant data for the study. On the second or third day of the hospital stay, the patient was examined by an asthma specialist, who made notes in the chart. It is probable that this strengthened the reliability of the medical charts.

#### Admission rates

Our finding of increasing admission rates throughout the 16-year period is in accordance with other studies (2, 14, 19). However, the increase was most pronounced from 1980 to 1989, with stabilization thereafter. Similar findings have been reported by some authors (14, 19), but not all (17). In the present study, there was no increase in hospital admission due to asthma among schoolchildren. This is interesting in view of the reported recent increase in prevalence of asthma in Oslo (20, 22). One explanation may be that increased prevalence results in more children with asthma of mild-to-moderate severity not requiring hospital admission. Another probable explanation is that the increased use of anti-inflammatory treatment is efficient in preventing severe exacerbation requiring hospital admission. The continuous increase in reported use of regular anti-inflammatory treatment in the present study supports this view.

The significant increase in acute asthma admissions in children younger than 4 years accounted for most of the observed overall increased admission rate, as has been observed in other studies (14). Since only those children with the most severe asthma are admitted to hospital throughout the study, it is likely that the

increasing hospitalization of very young children is an early reflection of the increased prevalence of asthma reported among schoolchildren (20, 22).

Our study, like others (6, 16), found a higher admission rate among boys than girls, probably reflecting the higher prevalence of bronchial asthma in boys among schoolchildren in Oslo (20, 22).

The present study excluded children admitted for acute asthma living outside Oslo, as well as children living in Oslo admitted to hospitals outside the city. Thus, the observed admission rates for acute asthma probably underestimate the total number of hospital admissions for asthma among Oslo children. Consequently, the present study does not enable us to draw any conclusions in relation to the prevalence of asthma.

Readmission rates in the present study declined from 1980 to 1995. This may, in part at least, be due to the increased use of anti-inflammatory drugs, especially inhaled steroids, as has been pointed out by other authors (18). It is also likely that increased focus on parental and patient education may be a contributing factor, as has been pointed out by others (17). The lack of significant differences in readmission rates for young boys and girls, as well as the similar number of days in hospital for both sexes, suggests that even if the prevalence of asthma is higher among young boys, disease severity is not significantly different. Senthilselvan reported similar findings regarding readmission rate for the younger age groups in Saskatchewan, Canada (16). Furthermore, as in our finding among the 8–14-year-olds of a higher mean readmission rate for girls (24.4%) than boys (16.3%), he also reported an increased readmission rate among 10–14-year-old girls.

## Hospital days

The number of days in hospital per admission, as well as the annual total number of days spent in hospital, decreased during the 1990s. Increased attention to the cost of overnight stay in hospital with increasing demands for early discharge is likely to affect the length of stay during an admission. However, premature discharge is likely to result in more patients being readmitted, a result which was not observed in the present study.

## Treatment strategies

The major shift in asthma treatment policy in the mid-1980s toward prophylactic treatment with inhaled steroids is reflected in the present study, with increasing use of inhaled steroids in admitted children from 34% in 1980 to 49% in 1989 ( $P < 0.05$ ). This is likely to reduce the frequency and severity of symptoms, and would thus influence the readmission rate, as shown by van Essen-Zandvliet et al. (23). Similar results have been shown in adults (24, 25). This can support the assumption that the readmission rate and possibly the admission rate could have been affected by a change in treatment policy at the time of the present study.

The increased use of a short course of systemic steroids during hospital admission in the early 1990s may have contributed to the observed reduction in the time spent in the hospital. This is supported by reports of oral prednisolone reducing the need for hospitalization among children treated in the emergency department for acute asthma, with measurable treatment effects within 4 h of its administration (26).

The use of intravenous treatment and the use of theophylline decreased from the late 1980s to the end of the study period; i.e., the same time that the use of a

short course of systemic steroids increased. In the early 1980s,  $\beta_2$ -agonists were used in combination with theophylline as the main bronchodilating therapy. Later, in the early 1990s, this was gradually replaced by  $\beta_2$ -agonists only, for some years, but, since 1993,  $\beta_2$ -agonists have mostly been used in combination with a short course of systemic steroids.

Home nebulizers have been customarily used to treat asthma in children in Norway, as demonstrated by the finding that 49% of admitted children in 1989 had a nebulizer at home. The use of home nebulizers has been reported to reduce the need for hospital admission among asthmatic children (27). During the 1990s, the presence of home nebulizers among admitted children decreased to only 26% of admitted children in 1995. This is possibly associated with the increasing availability of aerosol spacers for pre-school children, a treatment which also has been shown to improve asthma symptoms and reduce the number of exacerbations (28, 29).

In summary, the present study demonstrates that overall hospital admission for acute asthma among children in Oslo increased from 1980 to 1989, and then stabilized. However, first-time admissions increased throughout the study, mainly among children 0–3 years of age. The observed statistically significant decrease in readmission rates may be the result of the increasing use of anti-inflammatory treatment during the last years of the study, probably reducing the severity of disease among children with asthma.

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