

# Cumulative incidence of asthma and allergy in north-Norwegian schoolchildren in 1985 and 1995

Selnes A, Bolle R, Holt J, Lund E. Cumulative incidence of asthma and allergy in north-Norwegian schoolchildren in 1985 and 1995.

*Pediatr Allergy Immunol* 2002; 13: 58–63. © 2002 Blackwell Munksgaard

The prevalence of asthma and allergy in children is increasing. In order to investigate time trends, follow-up studies conducted several years apart and with identical study designs are essential. We compared two identical, cross-sectional and questionnaire-based studies of asthma and allergy in north-Norwegian schoolchildren (7–13 years of age). The first study was conducted in 1985 (n=10,093) and the second in 1995 (n=8,676). The cumulative incidence was as follows: diagnosed asthma, 8.6% in 1995 vs. 5.1% in 1985, relative risk (RR)=1.71 (95% CI: 1.53–1.90); allergic rhinoconjunctivitis, 22.1% in 1995 vs. 16.4% in 1985, RR=1.39 (95% CI: 1.31–1.47); and atopic dermatitis, 19.7% in 1995 vs. 13.2% in 1985, RR=1.48 (95% CI: 1.39–1.58). The cumulative incidence of allergic rhinoconjunctivitis and atopic dermatitis was higher in children of Sami ethnicity than Norse ethnicity in the 1985 study. Furthermore, although not statistically significant, there was a trend towards a greater increase in the cumulative incidence of diagnosed asthma, symptoms of asthma, allergic rhinoconjunctivitis, and atopic dermatitis from 1985 to 1995 in children of Sami ethnicity than Norse ethnicity. We conclude that there has been a marked increase in the cumulative incidence of asthma and allergy prevalence among schoolchildren in northern Norway from 1985 to 1995.

**Anders Selnes<sup>1</sup>, Roald Bolle<sup>2</sup>,  
Jan Holt<sup>3</sup> and Eiliv Lund<sup>1</sup>**

<sup>1</sup>Institute of Community Medicine, University of Tromsø, Tromsø <sup>2</sup>, Norway, <sup>2</sup>University

Hospital of Tromsø, Tromsø<sup>3</sup>, Norway,

<sup>3</sup>Nordland Central Hospital, Bodø, Norway

**Key words:** asthma; allergic rhinoconjunctivitis; atopic dermatitis; children; cumulative incidence; time trend; ethnicity; Norway

Dr Anders Selnes, Gjøvik Department, Oppland Central Hospital, Kyrre Grepps gt. 11, N-2819 Gjøvik, Norway

Tel.: +47 61 13 70 00

Fax: +47 61 15 74 80

E-mail: andersse@start.no

Accepted 1 May 2001

Extensive epidemiological research has been carried out on asthma and allergies in children, and considerable geographical variations in the prevalence of these diseases have been observed (1,2). Only repeated measurements after periods of  $\geq 10$  years, in comparable populations with comparable instruments, allow a valid estimate of time trends for atopic diseases (3).

The cumulative incidence of asthma and allergy in north-Norwegian schoolchildren was studied in a questionnaire-based, cross-sectional study conducted in 1985 (4,5). In 1995, an identical study was carried out. The aim of this article was to compare the two studies by analysing the changes in the cumulative incidence of asthma, allergic rhinoconjunctivitis (AR), and atopic dermatitis (AD) in north-Norwegian schoolchildren over the 10-year period.

## Subjects and methods

### The questionnaire

In 1985, a written, four-page questionnaire was formulated to assess the frequency of asthma and allergy among schoolchildren in northern Norway (4,5). The questionnaire targeted childhood asthma, AR, and AD, and the symptoms associated with these conditions. A letter accompanying the questionnaire broadened the descriptions of symptoms and signs of the diseases under investigation. The questionnaire included questions concerning ethnicity, e.g. 'Did two or more of the child's grandparents have Sami as their native language?' All questionnaires were written in the Norwegian language.

### The 1985 study

In 1985, the questionnaire was distributed with the accompanying letter to schoolchildren (7–

13 years of age) in primary schools in northern Norway. The schools were randomly selected from within the three northernmost counties of Norway, i.e. Nordland, Troms, and Finnmark. The local school nurse was responsible for distributing the questionnaire to the pupils. The questionnaire was filled in at home by the parents. Before delivery, a teacher checked that all fields had been completed. There were 11,200 children included, and 10,093 responded (>90%). The gender distribution among the respondents was 51.2% boys and 48.8% girls.

#### The 1995 study

The 1995 study was designed as a 10-year follow-up to the study conducted in 1985 (6). Questions concerning symptoms and diseases in the last 12 months were added to the questionnaire described above, which otherwise was unchanged. The questionnaire was distributed with an accompanying letter to the pupils in randomly selected primary schools in the three northernmost counties of Norway. Overall, an identical procedure to that utilized in the 1985 study (and described above) was followed. There were 9,950 schoolchildren included and 8,676 responded (87.3%). The gender distribution among the respondents was 49.1% boys and 50.9% girls.

The children were grouped in the statistical analysis according to age and school class level; the youngest (7–8 years of age) in the first class level and the oldest (12–13 years of age) in the sixth class level. In both studies, the distribution of pupils in the first to the sixth class level ranged from 14.9% to 18.2%.

#### Ethnicity

Historians believe that ≈1,000–2,000 years bc, the population in Norway was divided into two separate ethnicities. The farmers in the south and west of Norway (white Caucasians), who immigrated from southern Sweden and Denmark, spoke an Indo-European language, which developed into modern Norwegian. In eastern and northern parts of Norway, hunters (influenced from northern Sweden, Finland, and Russia) spoke a language linguistically linked to today's Sami and Finnish language. It is believed that the latter people are the forefathers of the Sami (7). Stereotypically, the Sami has been associated with nomads who keep reindeer. However, the nomads constitute today only a small percentage of the Sami. Although cultural differences still exist, both ethnicities live a modern lifestyle. The most recent generations of Sami speak Norwegian fluently, making mis-

interpretation of the questionnaire owing to language, unlikely.

#### Definitions

Sami ethnicity, as opposed to Norse ethnicity, was a label used to distinguish children who had two or more grandparents with Sami as their native language (6).

A diagnosis of asthma was recorded in the cases of affirmative answers to the question, 'Has the child ever had asthma?'. Answering 'yes' to the question, 'Does the child get a wheeze, periods with cough or attacks with shortness of breath (asthma) caused by external factors', was considered to indicate asthma symptoms. AR was defined as episodic rhinorrhea associated with nasal stuffiness and sneezing in response to known or strongly suspected allergens and often accompanied with itching and lacrimation. AD was recorded in the event of an itchy eruption lasting for >4 weeks combined with lesions on the face, elbowflexures or kneeflexures, or a high degree of itching and lesions elsewhere. As information about symptoms in the previous 12 months (point prevalence) were available solely for the 1995 study, only the differences in cumulative incidence in 1985 and 1995 were analyzed. All responses compared in this report were to questions identical in the two surveys.

#### Validity of the questionnaire

The questionnaire was used to assess the prevalence of atopic diseases in schoolchildren in both Telemark county and the Sør-Varanger Community, Norway (8–10). Clinical follow-up studies in these regions showed that the sensitivity and the specificity of the questionnaire was high. It was concluded that the questionnaire was a useful epidemiological tool.

The questionnaire studies were conducted after obtaining informed consent from the parents of the children. The studies were approved by the Ethical Committee in north Norway and the Norwegian Data Inspectorate.

#### Statistical analysis

Cochran-Mantel-Haenszel statistics for 2×2 tables were used together with linear regression, and computed by using the SAS software package (11).

#### Results

During the 10-year period from 1985 to 1995, there was an increase in the cumulative incidence

Table 1. Cumulative incidence of diagnosed asthma, respiratory symptoms, allergic rhinoconjunctivitis, and atopic dermatitis in schoolchildren in 1985 vs. 1995; relative risk (RR) and corresponding 95% confidence interval (CI) values are shown

|                                                                                                                     | Cumulative incidence (%) |      |           |             | Cumulative incidence in boys (%) |      |           |             | Cumulative incidence in girls (%) |      |           |             |
|---------------------------------------------------------------------------------------------------------------------|--------------------------|------|-----------|-------------|----------------------------------|------|-----------|-------------|-----------------------------------|------|-----------|-------------|
|                                                                                                                     | Study                    |      | 1995/1985 |             | Study                            |      | 1995/1985 |             | Study                             |      | 1995/1985 |             |
|                                                                                                                     | 1985                     | 1995 | RR*       | 95% CI      | 1985                             | 1995 | RR†       | 95% CI      | 1985                              | 1995 | RR†       | 95% CI      |
| Diagnosed asthma                                                                                                    | 5.1                      | 8.6  | 1.71      | (1.53–1.90) | 6.6                              | 10.5 | 1.59      | (1.39–1.82) | 3.6                               | 6.8  | 1.93      | (1.61–2.31) |
| Wheeze, periods with cough or attacks with shortness of breath (asthma) caused by external factors?                 | 6.1                      | 10.6 | 1.76      | (1.59–1.94) | 7.6                              | 12.0 | 1.60      | (1.41–1.81) | 4.6                               | 9.2  | 2.03      | (1.74–2.37) |
| Periods with shortness of breath and wheezing and/or episodes with dyspnoe without this being recognized as asthma? | 12.7                     | 13.7 | 1.09      | (1.01–1.17) | 14.9                             | 15.7 | 1.05      | (0.96–1.16) | 10.4                              | 11.8 | 1.14      | (1.01–1.28) |
| Periods with cough without having a cold?                                                                           | 14.8                     | 20.7 | 1.40      | (1.31–1.49) | 16.2                             | 22.5 | 1.38      | (1.27–1.50) | 13.3                              | 18.9 | 1.42      | (1.29–1.56) |
| Episodes with shortness of breath?                                                                                  | 9.8                      | 12.4 | 1.28      | (1.18–1.39) | 12.4                             | 14.4 | 1.16      | (1.04–1.29) | 7.1                               | 10.5 | 1.49      | (1.30–1.70) |
| Wheeze or more dyspnoic compared to children of the same age during exercise or in raw, cold air?                   | 5.7                      | 8.6  | 1.54      | (1.39–1.71) | 6.5                              | 9.5  | 1.48      | (1.29–1.70) | 4.9                               | 7.8  | 1.62      | (1.38–1.90) |
| Allergic rhinoconjunctivitis                                                                                        | 16.4                     | 22.1 | 1.39      | (1.31–1.47) | 18.7                             | 25.5 | 1.38      | (1.28–1.49) | 13.8                              | 18.9 | 1.40      | (1.27–1.53) |
| Atopic dermatitis                                                                                                   | 13.2                     | 19.7 | 1.48      | (1.39–1.58) | 12.8                             | 16.6 | 1.29      | (1.17–1.43) | 13.6                              | 22.6 | 1.66      | (1.52–1.81) |

\*RR adjusted by age and gender.

†RR adjusted by age.

of diagnosed asthma, asthma symptoms, respiratory symptoms, AR, and AD in primary schoolchildren in northern Norway (Table 1). The greatest increase was found in diagnosed asthma and asthma symptoms. Moreover, the rise in cumulative incidence of asthma and allergy during the 10-year period was most prominent in girls. In Table 2, the cumulative incidence of diagnosed asthma, AR, and AD is shown according to school class level. The frequency of diagnosed asthma escalated from the first to the sixth class

level only in girls in the 1995 study. The frequency of AR increased with increasing class level for both genders in both studies. In contrast to the 1985 study, the frequency of AD decreased with increasing age in the 1995 study.

#### Ethnicity

In the 1985 study, 7.2% of the children had Sami ethnicity compared to 5.9% in the 1995 study ( $p < 0.001$ ). There was a greater, although not

Table 2. Cumulative incidence (%) of diagnosed asthma, allergic rhinoconjunctivitis and atopic dermatitis in schoolchildren in 1985 vs. 1995, according to class level; rate of increase per class level and corresponding 95% confidence interval (CI) and p-values are shown

|                              |      | Class level |      |      |      |      |      | Rate of increase | 95% CI     | p-value |
|------------------------------|------|-------------|------|------|------|------|------|------------------|------------|---------|
|                              |      | 1           | 2    | 3    | 4    | 5    | 6    |                  |            |         |
| Diagnosed asthma             |      |             |      |      |      |      |      |                  |            |         |
| Boys                         | 1985 | 5.0         | 6.4  | 7.1  | 6.8  | 7.5  | 6.8  | 0.3              | (−0.1–0.7) | 0.12    |
|                              | 1995 | 10.0        | 12.5 | 10.1 | 9.9  | 9.9  | 10.2 | −0.2             | (−0.8–0.3) | 0.46    |
| Girls                        | 1985 | 2.8         | 3.0  | 3.1  | 4.3  | 4.0  | 4.0  | 0.3              | (0.0–0.6)  | 0.07    |
|                              | 1995 | 5.1         | 6.7  | 5.8  | 8.4  | 6.9  | 8.1  | 0.5              | (0.1–1.0)  | 0.02    |
| Allergic rhinoconjunctivitis |      |             |      |      |      |      |      |                  |            |         |
| Boys                         | 1985 | 15.8        | 15.6 | 18.7 | 19.9 | 21.8 | 19.9 | 1.1              | (0.5–1.8)  | <0.001  |
|                              | 1995 | 23.5        | 21.1 | 25.4 | 26.2 | 28.1 | 29.9 | 1.5              | (0.7–2.3)  | <0.001  |
| Girls                        | 1985 | 8.3         | 11.1 | 14.4 | 14.7 | 17.2 | 16.1 | 1.6              | (1.0–2.2)  | <0.001  |
|                              | 1995 | 13.9        | 19.5 | 19.4 | 20.3 | 20.0 | 21.0 | 1.1              | (0.4–1.8)  | <0.01   |
| Atopic dermatitis            |      |             |      |      |      |      |      |                  |            |         |
| Boys                         | 1985 | 13.0        | 13.0 | 10.9 | 13.1 | 14.2 | 12.3 | 0.1              | (−0.5–0.6) | 0.84    |
|                              | 1995 | 17.1        | 18.8 | 17.9 | 15.6 | 16.1 | 13.1 | −0.8             | (−1.5–0.2) | 0.01    |
| Girls                        | 1985 | 13.6        | 13.7 | 13.0 | 12.4 | 14.2 | 14.6 | 0.2              | (−0.4–0.8) | 0.49    |
|                              | 1995 | 23.5        | 24.5 | 23.3 | 23.5 | 21.7 | 18.8 | −0.9             | (−1.6–0.2) | 0.02    |

Table 3. Cumulative incidence of diagnosed asthma, asthma symptoms, allergic rhinoconjunctivitis and atopic dermatitis in Sami and Norse schoolchildren in 1985 and 1995; relative risk (RR) in 1995/1985 and corresponding 95% confidence interval (CI) values are shown

|                                                                                                     | Cumulative incidence (%) |      |           |             | Cumulative incidence in boys (%) |      |           |             | Cumulative incidence in girls (%) |      |           |             |
|-----------------------------------------------------------------------------------------------------|--------------------------|------|-----------|-------------|----------------------------------|------|-----------|-------------|-----------------------------------|------|-----------|-------------|
|                                                                                                     | 1985                     | 1995 | 1995/1985 |             | 1985                             | 1995 | 1995/1985 |             | 1985                              | 1995 | 1995/1985 |             |
|                                                                                                     |                          |      | RR*       | 95% CI      |                                  |      | RR†       | 95% CI      |                                   |      | RR†       | 95% CI      |
| Diagnosed asthma                                                                                    |                          |      |           |             |                                  |      |           |             |                                   |      |           |             |
| Sami                                                                                                | 6.0                      | 13.6 | 2.32      | (1.62–3.32) | 8.0                              | 17.5 | 2.22      | (1.42–3.46) | 4.0                               | 9.8  | 2.51      | (1.36–4.64) |
| Norse                                                                                               | 5.1                      | 8.2  | 1.64      | (1.46–1.84) | 6.5                              | 9.8  | 1.51      | (1.31–1.75) | 3.6                               | 6.6  | 1.88      | (1.55–2.27) |
| Wheeze, periods with cough or attacks with shortness of breath (asthma) caused by external factors? |                          |      |           |             |                                  |      |           |             |                                   |      |           |             |
| Sami                                                                                                | 7.5                      | 16.1 | 2.16      | (1.56–3.01) | 10.6                             | 17.8 | 1.66      | (1.10–2.53) | 4.4                               | 14.4 | 3.35      | (1.94–5.81) |
| Norse                                                                                               | 6.0                      | 10.2 | 1.71      | (1.54–1.90) | 7.4                              | 11.7 | 1.59      | (1.39–1.82) | 4.6                               | 8.7  | 1.91      | (1.62–2.26) |
| Allergic rhinoconjunctivitis                                                                        |                          |      |           |             |                                  |      |           |             |                                   |      |           |             |
| Sami                                                                                                | 19.4                     | 32.6 | 1.71      | (1.40–2.09) | 21.7                             | 37.6 | 1.74      | (1.34–2.26) | 17.0                              | 27.8 | 1.67      | (1.22–2.28) |
| Norse                                                                                               | 16.1                     | 21.6 | 1.38      | (1.29–1.47) | 18.4                             | 24.9 | 1.37      | (1.26–1.49) | 13.7                              | 18.5 | 1.39      | (1.25–1.53) |
| Atopic dermatitis                                                                                   |                          |      |           |             |                                  |      |           |             |                                   |      |           |             |
| Sami                                                                                                | 16.7                     | 26.7 | 1.57      | (1.25–1.96) | 18.0                             | 22.6 | 1.24      | (0.89–1.73) | 15.8                              | 30.7 | 1.92      | (1.42–2.61) |
| Norse                                                                                               | 12.8                     | 19.2 | 1.49      | (1.39–1.60) | 12.2                             | 16.3 | 1.33      | (1.20–1.48) | 13.4                              | 22.1 | 1.64      | (1.49–1.80) |

\*RR adjusted by age and gender.

†RR adjusted by age.

statistically significant, increase in the cumulative incidence of diagnosed asthma, asthma symptoms, AR, and AD in Sami than in Norse children from 1985–95 (Table 3). The greatest difference was found in diagnosed asthma and asthma symptoms, the latter showing an increase of 10% in Sami girls between 1985 and 1995. In the 1985 study, the cumulative incidence of AR and AD was highest in Sami children (Table 4). In the same study, the frequency of asthma symptoms among boys was greater in Sami children.

## Discussion

In accordance with recent epidemiological research (2,3), results of our 10-year follow-up study

showed an increase in the cumulative incidence of asthma and allergy in north-Norwegian schoolchildren from 1985 to 1995. The greatest increase in cumulative incidence was found in girls with diagnosed asthma and asthma symptoms.

The cumulative incidence of diagnosed asthma increased at a higher rate from the first to the sixth class level in girls in the 1995 study than in the 1985 study. Again, this reflects a rising frequency of girls labeled as asthmatics in the year prior to the 1995 study. In contrast to the 1985 study, the prevalence of AD decreased by nearly 1% per school class level in the 1995 study. The peak incidence of AD occurs in children of preschool age, and cessation of symptoms before adolescence is common (12). We consequently interpret

Table 4. Cumulative incidence of diagnosed asthma, asthma symptoms, allergic rhinoconjunctivitis, and atopic dermatitis in Sami and Norse schoolchildren in 1985 and 1995; relative risk (RR) Sami/Norse and corresponding 95% confidence interval (CI) values are shown

|                                                                                                     | Cumulative incidence (%) |       |            |             | Cumulative incidence in boys (%) |       |            |             | Cumulative incidence in girls (%) |       |            |             |
|-----------------------------------------------------------------------------------------------------|--------------------------|-------|------------|-------------|----------------------------------|-------|------------|-------------|-----------------------------------|-------|------------|-------------|
|                                                                                                     | Sami                     | Norse | Sami/Norse |             | Sami                             | Norse | Sami/Norse |             | Sami                              | Norse | Sami/Norse |             |
|                                                                                                     |                          |       | RR†        | 95% CI      |                                  |       | RR†        | 95% CI      |                                   |       | RR†        | 95% CI      |
| Diagnosed asthma                                                                                    |                          |       |            |             |                                  |       |            |             |                                   |       |            |             |
| 1985                                                                                                | 6.0                      | 5.1   | 1.21       | (0.88–1.65) | 8.0                              | 6.5   | 1.24       | (0.85–1.82) | 4.0                               | 3.6   | 1.14       | (0.67–1.95) |
| 1995                                                                                                | 13.6                     | 8.2   | 1.69       | (1.33–2.15) | 17.5                             | 9.8   | 1.81       | (1.34–2.43) | 9.8                               | 6.6   | 1.53       | (1.02–2.28) |
| Wheeze, periods with cough or attacks with shortness of breath (asthma) caused by external factors? |                          |       |            |             |                                  |       |            |             |                                   |       |            |             |
| 1985                                                                                                | 7.5                      | 6.0   | 1.27       | (0.96–1.68) | 10.6                             | 7.4   | 1.44       | (1.03–2.01) | 4.4                               | 4.6   | 0.99       | (0.59–1.65) |
| 1995                                                                                                | 16.1                     | 10.2  | 1.61       | (1.29–2.01) | 17.8                             | 11.7  | 1.54       | (1.14–2.07) | 14.4                              | 8.7   | 1.70       | (1.22–2.37) |
| Allergic rhinoconjunctivitis                                                                        |                          |       |            |             |                                  |       |            |             |                                   |       |            |             |
| 1985                                                                                                | 19.4                     | 16.1  | 1.22       | (1.04–1.44) | 21.7                             | 18.4  | 1.18       | (0.95–1.46) | 17.0                              | 13.7  | 1.27       | (0.99–1.64) |
| 1995                                                                                                | 32.6                     | 21.6  | 1.52       | (1.32–1.76) | 37.6                             | 24.9  | 1.51       | (1.25–1.82) | 27.8                              | 18.5  | 1.54       | (1.23–1.93) |
| Atopic dermatitis                                                                                   |                          |       |            |             |                                  |       |            |             |                                   |       |            |             |
| 1985                                                                                                | 16.7                     | 12.8  | 1.32       | (1.10–1.57) | 18.0                             | 12.2  | 1.48       | (1.16–1.89) | 15.8                              | 13.4  | 1.17       | (0.91–1.52) |
| 1995                                                                                                | 26.7                     | 19.2  | 1.39       | (1.18–1.63) | 22.6                             | 16.3  | 1.39       | (1.07–1.79) | 30.7                              | 22.1  | 1.38       | (1.13–1.70) |

\*RR adjusted by age and gender.

†RR adjusted by age.

this finding as an expression of increasing cumulative incidence in the 6 years prior to the study.

The prevalence of skin-test-positive allergic rhinitis in 15–41-year-old Danish adults increased between two cross-sectional surveys, conducted 8 years apart (1990/1998) (13). It was concluded that a genuine increase in respiratory allergy had occurred. Two cross-sectional studies of schoolchildren in Oslo, Norway, conducted 13 years apart (1980/1993), revealed an increase in asthma prevalence from 3.4% to 9.3% (14). Trends in hospital admissions for childhood asthma was studied in Oslo, Norway, from 1980 to 1995. The study revealed an increasing first admission rate, as well as an increasing overall admission rate, for acute asthma in children <4 years of age, reflecting an increasing prevalence of childhood asthma (15). Annual Health Interview Surveys in the United States show an increase in the prevalence of self-reported asthma for children 5–14 years of age, from 4.3% in 1980 to 7.4% in 1993–94, an increase of 74% (16). In 1992/93, Dotterud et al. studied the prevalence of AD among schoolchildren in Sør-Varanger Community, northern Norway, a study area which was also included in our two cross-sectional studies. The study incorporated a clinical examination of the subjects together with objective measurements (skin-prick test, serum immunoglobulin E [IgE]). Definite atopy accounted for 36% of the study participants, i.e. AD was present in 23% and mucous membrane atopy in 18% (9,10).

The cumulative incidence of AR and AD was higher in Sami children than in Norse children in 1985. This was also the case concerning asthma symptoms in boys. Furthermore, there was a trend towards a greater increase of asthma and allergy in children of Sami than Norse ethnicity during the 10-year study period. In the study conducted in 1995, marked differences in the frequency of asthma and allergy were found between children of Sami and Norse ethnicity (6). These findings indicate that attention should be paid to the development of asthma and allergy in children of Sami ethnicity. Above all, we speculate that these children are more vulnerable when confronting a modern, western lifestyle.

Because the questionnaires in the two studies were identical, a valid estimate of the time trend is allowed (3). However, owing to the lack of objective data, the increasing cumulative incidences in our repeated cross-sectional study, should be interpreted with caution (17). In the previous few decades, asthma and allergy have been increasingly focused upon, both by medical science and

by the public. Consequently, the higher awareness of these diseases in general may partly explain the increasing frequencies in studies based on self-reported questionnaires. Nevertheless, awareness by the public and the medical profession cannot alone explain an increase of the magnitude found in our study. We therefore conclude that, in line with the findings of epidemiological research in the western world, the frequency of asthma and allergy in north-Norwegian schoolchildren is rising.

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