

# Asthma and airway hyperresponsiveness among Belgian conscripts, 1978-91

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## Abstract

**Background** - Although there is convincing evidence that the prevalence of asthma among children has increased over the last three decades, it remains uncertain whether such an upward trend has occurred in adults. The aim of this study was to assess whether the prevalence of asthma has changed in young Belgian adults in recent years.

**Methods** - A retrospective analysis was conducted of available statistics from the Belgian Armed Forces for the period 1978-91 because conscripts who reported a history of past or current asthma at call-up examination underwent standardised assessment of non-specific airway responsiveness by military chest physicians. Exemption from military service due to asthma was strictly based on the objective evidence of airway hyperresponsiveness.

**Results** - A mean of 48331 conscripts aged 17-31 years were examined annually from 1978 to 1991. The prevalence of reported asthma rose from 2.4% in 1978 to 7.2% in 1991, while the proportion of asthmatics with airway hyperresponsiveness remained little changed at 48.4% in 1978 and 51.4% in 1991.

**Conclusions** - The observed increase in prevalence of reported asthma was not accompanied by a decrease in the proportion of conscripts with objectively measured airway hyperresponsiveness. These observations provide supporting evidence that the increase in asthma symptoms was not simply due to reporting bias.

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Keywords: asthma, airway hyperresponsiveness.

There is accumulating evidence that the prevalence of asthma symptoms<sup>1-9</sup> and airway hyperresponsiveness<sup>3,7</sup> has increased in children during the last three decades in industrialised countries. At present it remains uncertain whether the prevalence of asthma is also increasing in adults. The prevalence of asthma reported by Swedish conscripts increased from 1.9% to 2.8% between 1971 and 1981.<sup>10</sup> In Finnish conscripts asthma increased steadily from 0.29% in 1966 to 1.79% in 1989, while the rate of exemption and discharge from military service for disabling asthma rose six-fold.<sup>11</sup> These studies, however, were not based on objective assessment of asthma. The prevalence of current asthma, defined by the use of anti-asthma medication and exercise-induced

bronchoconstriction, increased from 5.0% to 5.9% between 1986 and 1990 among conscripts from an urban area in Israel.<sup>12</sup> By contrast, serial surveys of an adult population in Busselton, West Australia conducted in 1981 and 1990 showed that the prevalence of airway hyperresponsiveness to histamine remained unchanged, although the reporting of both past and current asthma symptoms increased in young adults aged 18-40 years.<sup>13</sup>

The aim of this study was to assess whether changes in asthma prevalence have occurred in Belgian young adults. We analysed the prevalence of asthma in candidates for conscription because exemption from compulsory military service has been strictly based on objective tests of airway hyperresponsiveness.

## Methods

### SUBJECTS

In Belgium military service was a legal obligation for men until 1994. Conscriptio took place at the age of 17 but enrolment could be deferred to the end of higher education. At the time of enrolment all candidates for conscription underwent call-up examination to establish their fitness for military service. In 1971 asthma was established by law as a cause of exemption from service, whatever the severity of the disease at the time of examination, since it was considered that military training could lead to a worsening of asthma and a reappearance of symptoms in subjects with asthma in remission. Exemption because of asthma was, however, strictly based on objective functional tests demonstrating non-specific airway hyperresponsiveness (or variable airway obstruction).

### CALL-UP EXAMINATION

The call-up examination was performed in the central recruiting office of the Belgian Armed Forces. The conscripts completed a health questionnaire and underwent a thorough medical examination. Those who reported ever having had asthma or other respiratory disease were referred to the department of chest medicine of a military hospital for further investigation, including a detailed respiratory questionnaire and assessment of lung function and airway hyperresponsiveness.

Up to 1984 the investigation of asthma was carried out in four different military hospitals using various procedures for assessing airway responsiveness. Most of the assessments for asthma were, however, performed in the principal military hospital (Queen Astrid Military

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Table 1 Asthma history and airway hyperresponsiveness among Belgian conscripts, 1978–91

Year	No. of conscripts	Age (median)	History of asthma		Airway hyperresponsiveness		
			No.	% total conscripts	No.	% total conscripts	% conscripts with asthma
1978	51 107	18.5	1248	2.4	605	1.2	48.4
1979	47 445	18.6	1240	2.6	632	1.3	50.9
1980	51 696	18.5	1506	2.9	796	1.5	52.8
1981	52 347	18.5	1372	2.6	885	1.7	64.5
1982	49 826	18.5	1403	2.8	997	2.0	71.0
1983	50 149	18.6	1608	3.2	1149	2.3	71.4
1984	50 859	18.7	1557	3.1	1047	2.1	67.2
1985	44 233	19.1	1477	3.3	985	2.2	66.6
1986	50 393	19.1	1914	3.8	1311	2.6	68.4
1987	47 171	19.3	2445	5.2	1388	2.9	56.7
1988	46 536	19.4	2524	5.4	1283	2.8	50.8
1989	44 772	19.6	3144	7.0	1480	3.3	47.0
1990	45 609	19.7	3298	7.3	1645	3.6	48.8
1991	44 305	19.7	3209	7.2	1650	3.7	51.4

Hospital, Brussels) where the functional assessment of asthma was standardised and remained unchanged from 1978 to 1991. Since 1985 the investigation of asthma has been restricted to this principal military hospital.

#### ASSESSMENT OF AIRWAY HYPERRESPONSIVENESS

Baseline assessment included assessment of forced expiratory volumes by spirometric tests and airway resistance by body plethysmography. Conscripts who showed a forced expiratory volume in one second ( $FEV_1$ ) below 80% of the predicted value were given an inhaled bronchodilator. Those who showed a  $\geq 15\%$  improvement in  $FEV_1$  were considered as having objective evidence of asthma and they were exempted from military service. These conscripts are referred to as having airway hyperresponsiveness in this study because we could not discriminate between hyperresponsiveness to methacholine and variable airflow obstruction related to bronchodilators. Conscripts who had taken an inhaled bronchodilator on the day of examination were re-examined on the next day after withdrawal of the medication. Otherwise, non-specific airway responsiveness was investigated using an abbreviated procedure. The subjects inhaled, by tidal breathing, an aerosol of methacholine (10mg/ml) generated with a De Vilbiss 646 nebuliser driven by an air flow of 6 l/min (output 200  $\mu$ g/min) for three periods of 10 seconds. Airway resistance was measured after each period of methacholine inhalation. Spirometric tests were reassessed when airway resistance increased above 0.4 kPa/l/s or when the full inhalation protocol was completed. Airway hyperresponsiveness was considered to be present when  $FEV_1$  fell by more than 20% and airway resistance increased above 0.4 kPa/l/s in subjects who had a borderline fall in  $FEV_1$  of 15–19%.

The results of this abbreviated procedure have been compared with the provocative concentration of methacholine causing a 20% fall in  $FEV_1$  ( $PC_{20}$ ) obtained with the method described by Cockcroft *et al*<sup>14</sup> in 182 subjects. The abbreviated procedure showed a sensitivity of 95% and a specificity of 77% in detecting subjects with a  $PC_{20}$  value of  $\leq 16$  mg/ml (Dr T Pieters, unpublished data).

#### OUTCOME MEASURES

The material was derived from the computer records of the Belgian Armed Forces (Data Processing Center CTIDN/CVILV). The following information was collected for each year from 1978 to 1991: (1) the total number of conscripts who underwent call-up examination; (2) the number of conscripts who reported a history of past or current asthma and who were specifically assessed for this condition – that is, the prevalence of reported asthma; (3) the number of conscripts exempted from military service because of asthma, as evidenced by the presence of airway hyperresponsiveness – that is, the prevalence of confirmed asthma; (4) the number of conscripts exempted because of “bronchitis or other respiratory disease”; and (5) the number of conscripts exempted for non-respiratory health conditions. Available demographic characteristics included the age at the time of examination and the usual language (Flemish or French) of the conscripts. We were not able to discriminate between past and current asthma because the individual medical records containing the detailed results of the respiratory questionnaire and lung function assessment were unfortunately destroyed after discontinuation of compulsory conscription.

#### STATISTICAL ANALYSIS

Data were already cross-tabulated by year of conscription, age at call-up, and usual language of the conscripts. The changes in the total number of conscripts over the study period were assessed using linear regression analysis. To examine the trends in the lifetime prevalence of asthma and airway hyperresponsiveness during the study period, logistic regression analysis was performed using the year of conscription and the age of the conscripts as independent variables (SPSS software program). Further analysis of data was also conducted separately on the two linguistic communities. A *p* value of  $\leq 0.05$  was considered significant.

#### Results

The yearly number of conscripts ranged from 44 241 to 52 369 (table 1). The number of conscripts declined significantly over the period 1978–1991 with a mean annual decrease of 507 conscripts per year (95% confidence interval (CI) –234 to –780 per year). The age of the conscripts ranged from 17 to 31 years (table 1). The median age increased gradually from 18.5 years in 1978 to 19.7 years in 1991 ( $p < 0.001$ ), reflecting a rise in the school leaving age.

The prevalence of reported asthma rose from 2.4% in 1978 to 7.2% in 1991 while the proportion of confirmed asthma – that is, history of asthma plus airway hyperresponsiveness – among all conscripts increased from 1.2% to 3.7% (table 1, fig 1). The proportion of conscripts with airway hyperresponsiveness among those who reported a history of asthma increased from 48.4% in 1978 to 71.4% in 1983 and then gradually decreased to 51.4% in 1991 (table 1). Logistic regression analysis showed

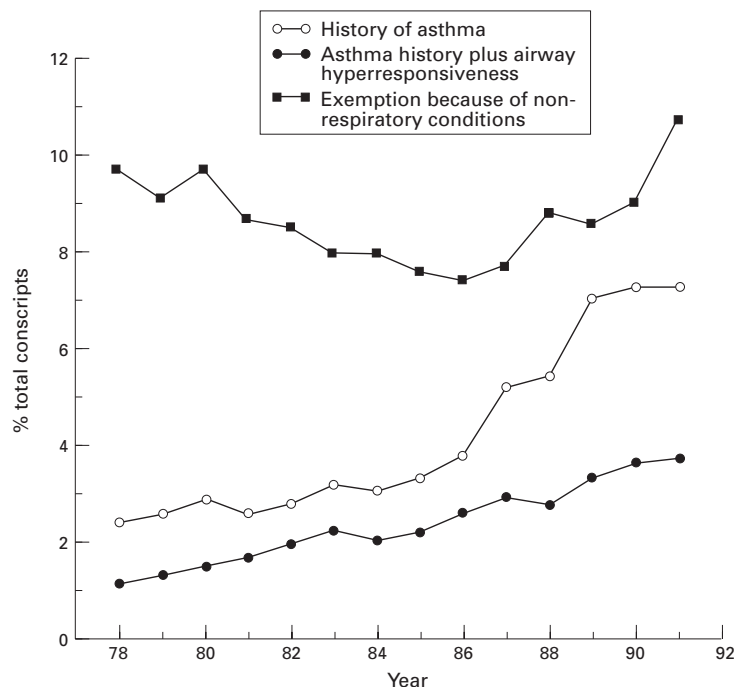


Figure 1 Prevalence of past or current history of asthma (○), exemption from service because of asthma based on the presence of airway hyperresponsiveness (●), and exemption because of other diseases (■) during the period 1978–91.

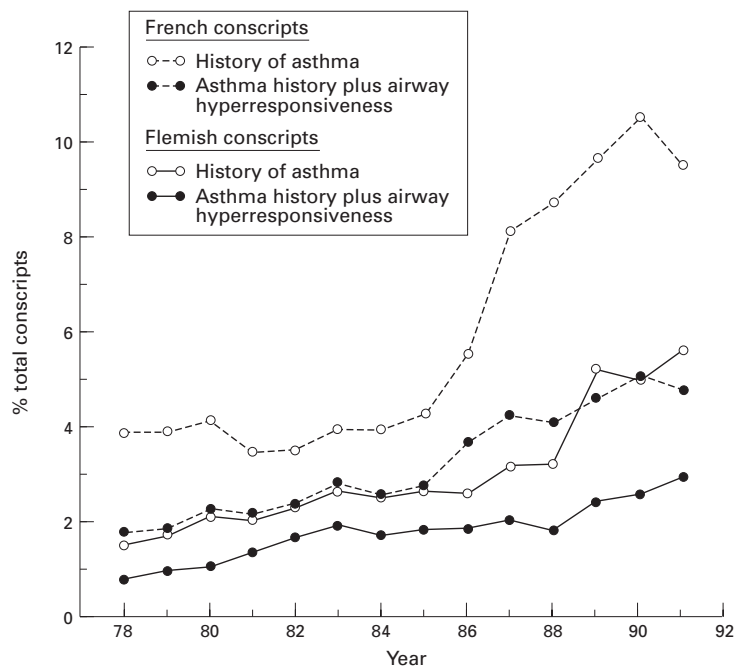


Figure 2 Prevalence of past or current history of asthma (○) and exemption from service because of asthma based on the presence of airway hyperresponsiveness (●) in Flemish speaking conscripts (solid lines) and French speaking conscripts (dotted lines) during the period 1978–91.

that increasing age of the conscripts at call-up examination was associated with an increase in both reported asthma (odds ratio (OR) per year of age 1.092 (95% CI 1.107 to 1.080)) and confirmed asthma (OR per year of age 1.069 (95% CI 1.087 to 1.055)). The age adjusted odds of reported asthma increased by 1.101 per year (95% CI 1.097 to 1.104) during

the study period and the odds of confirmed asthma increased by 1.083 per year (95% CI 1.078 to 1.087).

Exemption from military service because of "bronchitis or other respiratory disease" was uncommon, ranging from 0.02% to 0.12%, but tended to decrease over the study period (OR 0.966 per year (95% CI 0.939 to 0.993)). The proportion of conscripts exempted because of non-respiratory disease also decreased (OR 0.994 per year (95% CI 0.992 to 0.996)).

Since the medical and functional assessment of asthma was centralised to the principal military hospital in 1985, we compared the changes in reported asthma and confirmed asthma before and after this year. The trends were similar for the periods 1978–84 and 1985–91, with the exception of asthma reported in French speaking conscripts. In this population a steeper increase in reported asthma was recorded during the period 1985–91 (OR 1.103 per year (95% CI 1.090 to 1.117)) compared with that observed during 1978–84 (OR 1.005 per year (95% CI 0.994 to 1.016)).

As illustrated in fig 2, the prevalence of reported asthma and the proportion of confirmed asthma increased in both French speaking and Flemish speaking conscripts, although the figures remained consistently higher among French speaking conscripts. After adjustment for age, the odds ratio for the yearly trend in reported asthma was similar among French speaking (OR 1.104 per year (95% CI 1.099 to 1.109)) and Flemish speaking (OR 1.099 per year (95% CI 1.094 to 1.104)) conscripts. The odds ratio for the yearly trend in confirmed asthma was 1.079 per year (95% CI 1.073 to 1.086) in Flemish conscripts and 1.086 per year (95% CI 1.080 to 1.092) in French conscripts.

## Discussion

In this retrospective study of Belgian conscripts we found that the prevalence of reported asthma increased threefold between 1978 and 1991, although a number of factors could have biased the prevalence of asthma symptoms. Firstly, according to available data, the prevalence of asthma history was derived from the number of conscripts who were investigated for this condition by chest physicians. The tendency of physicians in charge of initial call-up examinations to refer conscripts with a past history of asthma for assessment of airway hyperresponsiveness might have been affected by the centralisation of this procedure in 1985. We found that the increased prevalence of asthma and airway hyperresponsiveness was already in evidence before 1985, with the notable exception of asthma reported in French speaking conscripts. Secondly, some of the apparent increase may reflect an increase in the use of asthma as a diagnostic label resulting from a greater awareness of the disease among medical and general communities.<sup>2</sup> The rate of exemption because of bronchitis or other respiratory diseases decreased during the study period. However, a diagnostic shift between asthma and other respiratory diseases cannot

explain the whole increase in asthma prevalence since the number of conscripts exempted because of non-asthmatic respiratory disease was low. Finally, the change in asthma prevalence may have been attributable, to an unknown extent, to a growing trend to report a history of asthma at call-up in order to avoid military service.

The observed increase in the prevalence of asthma plus airway hyperresponsiveness might result from the increasing number of conscripts who reported a history of asthma and who consequently underwent functional assessment. However, the proportion of conscripts with asthma history who demonstrated airway hyperresponsiveness did not decline during the study period. Such a decrease would have occurred if increasing numbers of conscripts with mild or doubtful asthma had been examined. These findings provide evidence that the observed increase in asthma was not due simply to reporting bias but they do not rigorously exclude the possibility of an increasing tendency to report asthma distributed equally across the mild and more severe types of the disease.

As the available data did not allow us to determine whether asthma symptoms were past or current at the time of call-up examination, the observed increase in reported asthma among young adults could result merely from an increase in asthma during childhood. However, we also found a threefold increase in the prevalence of asthmatic subjects with objectively measured airway hyperresponsiveness. Because non-specific airway responsiveness was assessed using a standardised method and interpreted by the same team of chest physicians, the changes in airway hyperresponsiveness are likely to be more reliable than those in asthma reporting. The relationship between asthma and airway hyperresponsiveness remains controversial. Airway hyperresponsiveness is an essential feature of current asthma although a substantial proportion of subjects with airway hyperresponsiveness do not experience asthma symptoms. Studies have shown that 14–28% of young adults with airway hyperresponsiveness and a history of childhood asthma are asymptomatic.<sup>15–17</sup> Interestingly, however, there is some evidence that the presence of airway hyperresponsiveness in adolescents and young adults may precede the development of asthma symptoms.<sup>18,19</sup>

Although asthma and airway hyperresponsiveness increased similarly in both linguistic communities, the figures were consistently higher in French speaking conscripts living in the southern part of Belgium than in Flemish speaking conscripts originating from the northern part of the country. Geographical differences in asthma symptoms and airway hyperresponsiveness have been convincingly documented in previous studies.<sup>20–22</sup> The causes of these variations remain uncertain but they are likely to be related to environmental factors.<sup>23</sup>

In this study asthma symptoms and airway hyperresponsiveness increased with the age of the conscripts at call-up examination. This

finding suggests that asthma is more prevalent in young adults with a higher education level, although this apparent relationship could also result from a higher likelihood of acquiring a diagnostic label of asthma or a greater willingness to report asthma among more educated subjects.<sup>24</sup> Studies have documented that asthma<sup>25</sup> and atopy<sup>26</sup> are associated with a higher socioeconomic status, while Burney *et al* found no association between airway hyperresponsiveness and social class.<sup>27</sup>

Within its inherent limitations, this study provides supporting evidence that the increase in the prevalence of asthma observed in recent years does not result exclusively from artifacts of reporting or diagnostic fashion, since it was not accompanied by a decrease in the proportion of conscripts with airway hyperresponsiveness among those with a history of asthma. Because an increase in the prevalence of asthma could have substantial socioeconomic and medical implications, further investigation is needed to identify responsible factors and to implement preventive strategies.

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