

Smoking Patterns Among Adolescents With Asthma Attending Upper Secondary Schools: A Community-Based Study

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ABSTRACT. *Objective.* Smoking among people who have asthma may be a serious health problem. We studied the prevalence of smoking and the relations between smoking and asthma, symptoms, medicine, and gender differences among adolescents with asthma.

Methods. A national cross-sectional study on health and lifestyles was performed in 1996–1997 using a computerized questionnaire in upper secondary schools in Denmark. We included 1887 pupils with asthma (defined as self-reported asthma diagnosed by a physician) and 20 688 controls. Smoking was categorized as daily, occasional, ex-smokers, and never smoked. We adjusted for age, gender, parents' job and smoking, family type, body mass index, and exercise habits.

Results. In total, 37.7% smoked currently and 16.5% smoked daily; more girls than boys smoked. More pupils with asthma than without smoked daily (adjusted odds ratio [OR]: 1.15; 95% confidence interval [CI]: 1.04–1.33), they smoked significantly more cigarettes daily (10.3 vs 9.6), and more were heavy smokers (≥ 15 cigarettes daily; adjusted OR: 1.47; 95% CI: 1.14–1.91). Furthermore, nearly twice as many pupils who had asthma with symptoms but were not using medicine smoked as pupils who had asthma without symptoms and were using medicine (adjusted OR: 1.84; 95% CI: 0.99–3.41). More boys with asthma than without started smoking before 14 years of age (adjusted OR: 1.75; 95% CI: 1.09–2.81). However, more pupils with asthma had tried to quit (adjusted OR: 1.26; 95% CI: 0.99–1.60). Pupils with and without asthma were occasional smokers and ex-smokers at a similar prevalence.

Conclusions. More pupils with asthma than without smoked daily, and they also smoked more cigarettes per day. This is a major health concern, as adolescents have a high smoking prevalence in Denmark. *Pediatrics* 2003;111:e562–e568. URL: <http://www.pediatrics.org/cgi/content/full/111/5/e562>; *asthma, adolescents, smoking prevalence, smoking pattern.*

ABBREVIATIONS. OR, odds ratio; CI, confidence interval.

Smoking is a health risk, a pattern of behavior usually acquired during adolescence. In Western countries, 13% to 35% of adolescents smoke.¹ Although most of the effects of smoking are long term, smoking also has immediate effects on people with asthma. Smoking among people with asthma increases coughing and the inflammation of

airways,² and smoking is associated with asthmatic symptoms.^{3–5} Furthermore, physicians generally advise people with asthma not to smoke. Adolescents with asthma would therefore be expected to smoke less than adolescents without asthma. Nevertheless, the literature indicates that the smoking prevalence of adolescents with asthma is higher than^{6–8} or similar to^{9,10} that of adolescents without asthma. Only 1 study found that adolescents with asthma smoke less than those without asthma.¹¹ More girls with asthma seem to smoke^{8,12} and to smoke more cigarettes than girls without asthma,¹² and adolescents with asthma start smoking at a younger age than those without asthma.⁷ However, these studies suffer from methodological problems such as small sample size^{8,9,11} and the lack of a definition of smoking,⁶ and only 1⁶ adjusted for potential confounders. Little is known about the prevalence of smoking, the pattern of smoking, the relations between smoking and asthmatic symptoms, and medicine and gender differences among people with asthma.

We postulated that adolescents with asthma have a higher prevalence of smoking than adolescents without asthma and especially that girls with asthma smoke more often than girls without asthma. We also postulated that asthma symptoms are associated with a higher smoking prevalence. Finally, we expected adolescents with asthma to smoke more cigarettes and start at a younger age than adolescents without asthma.

METHODS

This investigation was a national cross-sectional study based on a computerized questionnaire combined with a physical test for investigating lifestyles, health, and self-assessed mental and physical health among pupils who attended general upper secondary schools in Denmark.¹³ Data were collected between September 1, 1996, and January 20, 1997.

The study population was all pupils in Denmark, the Faeroe Islands, and Greenland who attended 1 of the 2 types of general upper secondary schools: gymnasium or schools that prepare pupils for the Higher Preparatory Examination. The schools decided whether they wanted to participate and how many classes to include in the survey. Likewise, the pupils were free to decide whether they wanted to participate. Of the 155 general upper secondary schools (~71 500 pupils), 91 (24 686 pupils) wanted to participate. At some schools, all classes participated; at others, a few or only 1 participated.

This study included all pupils from 15 to 20 years of age in the 89 participating schools in Denmark; schools in the Faeroe Islands and Greenland were excluded because of cultural differences from Denmark. Of the 24 310 pupils who participated, we excluded 408: 41 were missing information on gender or age, 72 had not filled in the questionnaire seriously, 5 were younger than 15 years, and 290 older than 20 years. Thus, the study cohort consisted of 23 902 pupils from 1229 classes in 89 schools.

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Statistics from the Ministry of Education¹⁴ provide the average number of pupils in the classes in various educational programs and grade levels for the school year 1996–1997. On the basis of these, ~56% of the total number of pupils in upper secondary schools participated, and on average 69% of the pupils had been invited to take part in the study at the 89 schools. Furthermore, the 1229 classes had ~29 571 pupils, and the participation rate is therefore estimated to be 80.8% of the pupils in the classes included.

The National Institute of Public Health developed the computerized questionnaire together with the information technology company Marienhoff BI. The pupils completed the questionnaire using PCs available at the schools. Each class was given a set of 28 diskettes that contained 83 questions each. Each pupil was given a personal password to access the questionnaire, and for security reasons, no pupil could reopen the questionnaire after the file had been closed. We used the following questions to collect information on effect variables, outcome variables, and possible confounders.

Effect Variables

- Q1) Has a physician told you that you have asthma? (yes/no)
Q2) Have you had asthma within the past year or earlier? (yes, within the past year/yes, earlier/no)
Q3) Indicate whether you have taken asthma medicine within the past 14 days. (yes/no)

We defined a person as having asthma when he or she answered yes to Q1 and Q2 and as not having asthma when he or she answered no to all 3 questions. People with other combinations of answers were defined as not classifiable and excluded. A “yes, within the past year” to Q2 is referred to here as “having asthma symptoms.”

Outcome Variables

- Q1) Do you smoke? (yes, every day/yes, at least once a week/yes, but not every week/yes, but only on special occasions/no, I do not smoke)
Q2) Have you smoked previously? (yes, only on special occasions/yes, but only a few times/yes, but I quit <6 months ago/yes, I quit between 6 and 12 months ago/yes, but I quit >12 months ago/no, I have never smoked)
Q3) Have you tried to quit smoking? (yes/no)
Q4) How old were you when you started smoking regularly? (present and previous daily smokers were asked)
Q5) How much do you smoke or did you smoke? (give the number of cigarettes per day or grams of pipe tobacco per week)

We defined 4 groups: 1) daily smokers (Q1: yes, every day), 2) occasional smokers (Q1: yes, at least once a week, not every week, on special occasions), 3) ex-smokers (Q2: any yes answer), and 4) people who had never smoked (Q2: I have never smoked). We converted the grams of tobacco per week into cigarettes per day, using 1 g per cigarette.

Possible Confounders

We used information on possible confounders from the questionnaire: age, gender, weight and height, parents’ job and smoking, family type, body mass index (weight in kg/[height in meters]²), and exercise habits.

Statistics

We used logistic regression to estimate the prevalence and the crude and adjusted odds ratios (OR) with 95% confidence intervals (CIs) for the various smoking patterns comparing people with and without asthma. We used people with and without asthma who had never smoked as reference groups. We adjusted for gender, age (1-year categories), and possible confounders that we expected to be relatively time-stable—confounders that may have been present before people started to smoke, such as parents’ smoking and parents’ job, body mass index, and exercise habits using the categories shown in Table 1.

To estimate the relations between smoking, symptoms of asthma, and use of asthma medicine, we performed subanalyses by stratifying for 1) asthma symptoms (yes/no), 2) asthma medicine (yes/no), and 3) a combination of these possibilities using logistic regression and the same potential confounders as described above. Among the daily smokers, we also estimated the

OR of “tried to quit smoking,” heavy smokers (≥ 15 cigarettes per day), and the age of smoking start in age groups (7–13, 14, 15, 16–20) using the same potential confounders as described above.

To estimate the average daily consumption of cigarettes and average age at smoking start, we performed crude and multiple linear regression analyses using the same potential confounders as described above. To estimate the effect of gender, we repeated all subanalyses by stratifying further for gender.

RESULTS

Of the 23 902 pupils, we included all 22 575 for whom we had information on asthma and smoking. We excluded 1327 (5.6%): 1119 because of information on asthma (69 not responding to Q1, 526 not responding to Q2, and 524 who were not classifiable) and 208 without information on smoking. The proportion for whom there was no information on smoking was similar among pupils with asthma (1.2%) and without asthma (0.9%).

The cumulative prevalence of asthma diagnosed by physicians was 8.4% (1887): 8.8% of girls and 7.7% of boys. Of the total sample, 5.8% (1307) reported both physician-diagnosed asthma and asthma symptoms within the past year, more girls (6.3%) than boys (4.9%), and 2.6% reported physician-diagnosed asthma but no asthma symptoms within the past year. A total of 4.7% (1066) had taken asthma medicine within the past 2 weeks (4.9% girls and 4.4% boys). Among the pupils with asthma, 76.7% may have had current asthma (symptoms and/or using medicine or no symptoms using medicine) and 23.3% had no symptoms and used no medicine, which may indicate remission of asthma. Table 1 shows the baseline characteristics of the pupils with and without asthma.

Smoking Pattern

In total, 59.4% had ever smoked (37.7% smoked currently, including 16.5% daily and 21.2% occasionally, and 21.7% were ex-smokers) and 40.6% had never smoked. Generally, more girls than boys smoked (adjusted OR: 1.29; 95% CI: 1.22–1.36).

The crude smoking prevalence among pupils with asthma was 18.9% versus 16.3% among pupils without asthma (Table 2). Pupils with asthma were more often daily smokers (adjusted OR: 1.15; 95% CI: 1.00–1.33), as were pupils who had asthma with symptoms (adjusted OR: 1.21; 95% CI: 1.02–1.43) and pupils who had asthma and were not using asthma medicine (adjusted OR: 1.25; 95% CI: 1.00–1.53) compared with pupils without asthma (Table 3). Furthermore, exclusion of pupils with asthma in remission increased the OR for daily smoking among pupils with current asthma (adjusted OR: 1.20; 95% CI: 1.03–1.39; data not shown).

Pupils who had asthma with symptoms did not smoke more often than pupils who had asthma without symptoms (adjusted OR: 1.17; 95% CI: 0.87–1.88); neither did pupils who had asthma and were using medicine than pupils who had asthma and were not using medicine (adjusted OR: 1.10; 95% CI: 0.84–1.45; data not shown). However, nearly twice as many pupils who had asthma with symptoms but were not using medicine smoked daily as pupils who had

TABLE 1. Baseline Characteristics of Pupils With and Without Asthma

Variable	Asthma		Controls	
	<i>n</i>	%	<i>n</i>	%
All	1887	100	20 688	100
Gender				
Boys	668	35.4	7984	38.6
Girls	1219	64.6	12 704	61.4
Age (mean; y [range])	17.28	15–20	17.23	15–20
BMI				
<18.5	163	8.6	2071	10.0
18.5–24.9	1520	80.6	16 714	80.8
25.0–29.9	137	7.3	1364	6.6
>30	25	1.3	147	0.7
BMI missing	42	2.2	392	1.9
Exercise (h/wk)				
<1	311	16.6	3418	16.8
1–2	474	25.4	5561	27.3
2–4	432	23.2	4834	23.7
4–7	382	20.5	3897	19.1
> 7	266	15.3	2687	13.2
Family type				
2 parents	1290	68.5	14 685	71.4
1 parent and 1 stepparent	142	7.5	1385	6.7
1 parent or 1 stepparent	265	14.1	2901	14.0
Others	187	9.9	1691	8.2
Father's smoking behavior				
No	1064	56.4	11750	56.8
Yes	759	40.2	8,100	39.2
Do not have a father	52	2.8	761	3.7
Response missing	12	0.6	77	0.4
Mother's smoking behavior				
No	1164	62.7	13 071	63.2
Yes	674	35.7	7129	34.5
Do not have a mother	39	2.1	420	2.0
Response missing	10	0.5	68	0.3
Father's job				
Salaried employee I	526	27.8	5827	28.3
Salaried employee II	328	20.2	391	18.8
Salaried employee III	191	10.1	1943	9.4
Skilled worker	230	12.2	2598	12.6
Unskilled worker	129	6.8	1412	6.8
Unemployed	27	1.4	406	2.0
Training or education	11	0.6	95	0.5
Self-employed	247	13.1	2859	13.8
Retired or permanently outside the labor force	49	2.6	466	2.3
Homemaker	0	(–)	20	0.1
Dead	10	0.5	135	0.7
Classification not possible or missing	86	4.6	1036	5.0
Mother's job				
Salaried employee I	175	9.2	1974	9.5
Salaried employee II	634	33.6	6837	33.0
Salaried employee III	513	27.2	5584	27.0
Skilled worker	22	1.2	315	1.5
Unskilled worker	176	9.3	2089	10.1
Unemployed	40	2.1	509	2.5
Training or education	50	2.6	476	2.3
Self-employed	73	3.9	920	4.4
Retired or permanently outside the labor force	44	2.3	408	2.0
Homemaker	76	4.0	802	3.9
Dead	10	0.5	54	0.3
Classification not possible or missing	76	4.0	724	3.5

BMI indicates body mass index.

asthma without symptoms but were using medicine (adjusted OR: 1.84; 95% CI: 0.99–3.41; data not shown).

More girls with than without asthma were daily smokers (adjusted OR: 1.30; 95% CI: 1.06–1.58), but the boys did not differ (Table 3). The interaction between asthma and gender, however, was not significant ($P = .16$). Pupils with and without asthma

were occasional smokers and ex-smokers at a similar prevalence (data not shown).

Attempts to Quit Smoking Among Daily Smokers

Approximately two thirds (64.3%) of daily smokers had tried to quit smoking, and girls had generally tried to quit more often than boys (adjusted OR: 1.36; 95% CI: 1.17–1.58; data not shown). More pupils with

TABLE 2. Crude Prevalence of Smoking and Smoking Pattern Among Pupils With and Without Asthma Stratified According to Gender, Symptoms, and Medicine*

	<i>n</i>	Smoking Prevalence			
		Daily Smokers	Occasional Smokers	Ex-smokers	Never Smoked
Entire sample					
Controls	20 688	16.3	21.2	21.9	40.7
All with asthma	1887	18.9	21.4	19.9	39.7
Asthma symptomst	1307	19.4	20.1	20.2	40.3
No asthma symptomst‡	580	17.9	24.3	19.3	38.4
No asthma medicine§	821	19.6	22.9	20.0	37.5
Asthma medicine	1066	18.4	20.3	19.9	41.5
Asthma symptomst and no medicine§	381	20.2	22.3	19.2	38.3
Asthma symptomst and medicine	926	19.0	19.2	20.6	41.1
No asthma symptomst‡ and no medicine§	440	19.1	23.4	20.7	36.8
No asthma symptomst‡ and medicine	140	14.3	27.1	15.0	43.6
Girls					
Controls	12 704	17.2	22.5	22.1	38.2
All with asthma	1219	20.9	22.1	20.4	36.5
Asthma symptomst	883	20.8	21.5	20.6	37.0
No asthma symptomst‡	336	21.1	23.8	19.9	35.1
No asthma medicine§	534	22.1	23.0	19.5	35.4
Asthma medicine	685	20.0	21.5	21.2	37.4
Asthma symptomst and no medicine§	275	21.8	24.4	18.2	35.6
Asthma symptomst and medicine	608	20.4	20.2	21.7	37.7
No asthma symptomst‡ and no medicine§	259	22.4	21.6	20.8	35.1
No asthma symptomst‡ and medicine	77	16.9	31.2	16.9	35.1
Boys					
Controls	7984	14.8	19.1	21.5	44.6
All with asthma	668	15.3	20.1	19.0	45.7
Asthma symptomst	424	16.3	17.2	19.3	47.2
No asthma symptomst‡	244	13.5	25.0	18.4	43.0
No asthma medicine§	287	15.0	22.6	20.9	41.5
Asthma medicine	381	15.5	18.1	17.6	48.8
Asthma symptomst and no medicine§	106	16.0	17.0	21.7	45.3
Asthma symptomst and medicine	318	16.4	17.3	18.6	47.8
No asthma symptomst‡ and no medicine§	181	14.4	26.0	20.4	39.2
No asthma symptomst‡ and medicine	63	11.1	22.2	12.7	46.0

* The prevalence is shown as percentages (the percentages do not total 100% because of rounding).

† Asthma symptoms within the past year.

‡ No asthma symptoms within the past year.

§ No asthma medicine within the past 2 weeks.

|| Asthma medicine within the past 2 weeks.

than without asthma tended to have tried to quit (adjusted OR: 1.26; 95% CI: 0.99–1.60; Table 4).

Numbers of Daily Cigarettes Among Daily Smokers

Pupils with asthma smoked more cigarettes per day than pupils without asthma (10.3 vs 9.6; adjusted multiple linear regression, $P = .021$). Boys with asthma smoked more than boys without (12.3 vs 10.7; adjusted multiple linear regression, $P = .004$), whereas the girls with and without asthma smoked similar numbers (9.4 vs 8.9; adjusted multiple linear regression, $P = .31$; test for asthma-gender interaction, $P = .06$). Furthermore, more pupils with asthma were heavy smokers (≥ 15 cigarettes per day; adjusted OR: 1.47; 95% CI: 1.13–1.91; Table 5), especially girls with asthma, but the tests for asthma-gender interaction were not statistically significant (data not shown).

Age at Which Daily Smokers Started Smoking Regularly

Pupils with and without asthma started smoking regularly at the same age (14.6 vs 14.8 years of age; adjusted multiple linear regression, $P = .91$). However, more boys with than without asthma smoked

regularly before 14 years of age (adjusted OR: 1.75; 95% CI: 1.09–2.81) and fewer between 16 and 20 years (adjusted OR: .52; 95% CI: .31–.85; test for asthma-gender interaction, $P = .029$ and $.045$, respectively; Table 6). We repeated the analysis without excluding the 524 pupils who had asthma and were not classifiable and found similar estimates (data not shown).

DISCUSSION

We found that smoking behavior is a serious problem among pupils in general upper secondary schools in Denmark, as 37.7% were current smokers and 16.5% smoked daily. The problem of smoking behavior was even greater among pupils with than without asthma, as more pupils with asthma smoked daily, and they also smoked more cigarettes daily. In addition, more pupils with asthma were heavy smokers (≥ 15 cigarettes per day). Boys with asthma smoked more cigarettes and started smoking earlier than did boys without asthma. Nearly twice as many pupils who had asthma with symptoms but were not using medicine smoked daily as those who had asthma without symptoms but were using medicine. Approximately two thirds of all daily smokers had

TABLE 3. Adjusted OR for Daily Smoking in Pupils With and Without Asthma and Stratified According to Gender, Symptoms, and Medicine Use*

	Daily Smokers					
	All		Girls		Boys	
	OR	95% CI	OR	95% CI	OR	95% CI
Controls	1.00	(reference)	1.00	(reference)	1.00	(reference)
All with asthma	1.15	(1.00–1.33)	1.24	(1.04–1.48)	1.00	(0.79–1.26)
Asthma symptom [†]	1.21	(1.02–1.43)	1.30	(1.06–1.58)	1.05	(0.79–1.26)
No asthma symptom [‡]	1.03	(0.80–1.34)	1.12	(0.81–1.55)	0.91	(0.60–1.39)
No asthma medicine [§]	1.25	(1.00–1.53)	1.28	(0.99–1.65)	1.13	(0.77–1.63)
Asthma medicine	1.11	(0.92–1.34)	1.22	(0.97–1.53)	0.92	(0.67–1.27)
Asthma symptom [†] and no medicine [§]	1.29	(0.95–1.74)	1.37	(0.95–1.93)	1.13	(0.62–2.00)
Asthma symptom [†] and medicine	1.18	(0.97–1.43)	1.26	(0.99–1.60)	1.03	(0.73–1.44)
No asthma symptom [‡] and no medicine [§]	1.16	(0.87–1.56)	1.19	(0.83–1.71)	1.12	(0.69–1.82)
No asthma symptom [‡] and medicine	0.70	(0.41–1.21)	0.88	(0.44–1.78)	0.52	(0.22–1.22)

* We adjusted in both logistic regression analysis and multiple linear regression for gender, age (1-year categories), family type, parents' smoking pattern and job, BMI, and exercise habits categorized as shown in Table 1. The subjects who had never smoked were used as a reference group. Tests for asthma-gender interaction were not significant.

[†] Asthma symptoms within the past year.

[‡] No asthma symptoms within the past year.

[§] No asthma medicine within the past 2 weeks.

^{||} Asthma medicine within the past 2 weeks.

TABLE 4. Crude Prevalence and Adjusted OR for Attempts to Quit Smoking Among Daily Smokers With and Without Asthma and Stratified According to Gender*

	Daily Smokers					
	All		Girls		Boys	
	Asthma	Controls	Asthma	Controls	Asthma	Controls
<i>n</i>	355	3362	255	2182	100	1180
Prevalence (%)	68	64	68	66	67	59
OR (95% CI)	1.26	(0.99–1.60)	1.18	(0.89–1.58)	1.44	(0.93–2.23)

* We adjusted in both logistic regression analysis and multiple linear regressions for gender, age (1-year categories), family type, parents' smoking pattern and job, BMI, and exercise habits categorized as shown in Table 1. The test for asthma-gender interaction was not statistically significant. Information on attempts to quit smoking was missing for 2 pupils with asthma and 6 pupils without asthma.

TABLE 5. Adjusted OR for Various Ranges of Cigarette Consumption for Daily Smokers With and Without Asthma and Stratified According to Gender*

No. of Cigarettes per Day	No. of Smokers (Asthma/Controls)	Daily Smokers					
		All		Girls		Boys	
		OR	95% CI	OR	95% CI	OR	95% CI
1–4	44/489	0.83	0.59–1.16	0.87	0.59–1.28	0.76	0.37–1.56
5–9	127/1,169	0.99	0.78–1.25	0.99	0.75–1.31	0.99	0.63–1.56
10–14	84/958	0.79	0.61–1.03	0.74	0.54–1.03	0.95	0.60–1.49
≥15	99/737	1.47	1.13–1.91	1.51	1.10–2.07	1.26	0.80–1.99

* We adjusted in both logistic regression analysis and multiple linear regression for gender, age (1-year categories), family type, parents' smoking pattern and job, BMI, and exercise habits categorized as shown in Table 1. Tests for asthma-gender interaction were not statistically significant. Information on cigarette consumption was missing for 3 pupils with asthma and 15 without asthma.

tried to quit smoking, girls more often than boys, and more with than without asthma had tried to quit. Pupils with and without asthma were occasional smokers and ex-smokers at a similar prevalence.

Our results are based on pupils in upper secondary school, and smoking among pupils with asthma may therefore be a more serious problem than our results indicate, as the prevalence of smoking is higher among adolescents with less schooling than upper secondary school and among adolescents who drop out of school.^{15,16} Adolescents with asthma seem to be at risk for taking up smoking, and espe-

cially those with a poor compliance (symptoms but not using medicine) may be a high-risk group for taking up smoking, or, conversely, taking up an unhealthy lifestyle habit such as smoking may be associated with poor self-care after poor compliance.

Most studies find that smoking increases the asthmatic symptoms,^{3–5,17} but the causal relation between smoking and asthma is not clear-cut. One study found that the onset of asthma in 90% of the subjects had preceded the smoking start,¹⁷ whereas another found that smoking may increase the incidence of asthma among adolescents.⁸ Furthermore,

TABLE 6. Adjusted ORs for Age of Starting Smoking Regularly for Daily Smokers With and Without Asthma and Stratified According to Gender*

Age of Starting Regular Smoking	n (Asthma/Controls)	Test for Asthma-Gender Interaction (P)	All		Girls		Boys	
			OR	95% CI	OR	95% CI	OR	95% CI
7-13	72/629	.029	1.13	0.85-1.50	0.92	0.64-1.32	1.75	1.09-2.81
14 y	89/721	.303	1.23	0.95-1.60	1.34	1.00-1.81	0.95	0.56-1.65
15 y	96/912	.201	0.96	0.74-1.23	0.86	0.63-1.17	1.22	0.78-1.90
16 y or older	98/1097	.045	0.80	0.62-1.02	0.94	0.70-1.25	0.52	0.31-0.85

* We adjusted in both logistic regression analysis and tests for trend for gender, age (1-year categories), family type, parental smoking pattern and parental job, BMI, and exercise categorized as shown in Table 1. Statistically significant tests for asthma-gender interaction are presented in the results. Information on age of starting smoking regularly was missing for 2 pupils with asthma and 9 pupils without asthma.

smoking may increase the risk of relapse of prolonged remission of childhood wheezing at 33 years of age.¹⁸ Although the asthma diagnoses were physician-based, the validity is unknown. Some adolescents may therefore have asthmatic symptoms as a result of smoking, or smoking may have induced asthma or relapse of asthma. Unfortunately, as we did not know when asthma had been diagnosed, we could not estimate these risks or validate the diagnoses. These issues may be important but were not especially important for this study, which mainly focused on smoking among adolescents with physician-diagnosed asthma, because we believe that adolescents with asthma should not be smoking, regardless of the reason for their asthma or asthmatic symptoms.

Our findings that more pupils with asthma smoke daily and that they smoke more cigarettes per day than pupils without asthma and that pupils with asthma start smoking at a younger age are consistent with previous findings.^{6-8,12} Previous studies have shown that adolescents with asthma have a higher prevalence of smoking, but not much attention has been given to this major health problem. One explanation may be that physicians and nurses do not generally ask adolescents with asthma about their smoking behavior, as they may assume that these adolescents do not smoke.

However, clinical staff, general practitioners, pediatricians, and school nurses should become aware of this problem and start programs that specifically focus on preventing smoking and motivating and supporting those who want to quit, with a specific focus on adolescents with asthma. As approximately two thirds of the adolescent smokers have tried to quit and pupils with asthma tended to have tried more often than pupils without asthma, the adolescents, especially the girls, therefore, seem to be motivated to quit but need support to succeed.

Our study has both strengths and limitations. The study was large, including 20 688 adolescent without asthma and 1887 with asthma diagnosed by a physician, and the gender distribution of the cohort was similar to that of all general upper secondary schools in Denmark.¹⁴ Although only 59% of these schools wanted to participate, 80.8% of the adolescents in the targeted classes participated. We do not believe that the study had differential selection bias in terms of people with asthma or smoking pattern, but it is not without random error. Both the physician-based

asthma diagnosis and the smoking were self-reported; we believe that our data are reliable because the prevalence of asthma is similar to that in other studies of self-reported physician-diagnosed asthma in Denmark¹⁹ and because self-reported smoking provides reliable data.^{20,21} Although we excluded all pupils with uncertain information on asthma, some asthma may have been misclassified. The real prevalence of asthma may be higher than the level that we found, partly because of the excluded respondents and because asthma is probably underdiagnosed,²² and the underestimation of asthma may bias the result toward 0.

Our study was cross-sectional, which can present only associations and not causal relations. We adjusted only for confounders that may have been present before smoking started. Smoking is associated with many other factors, such as smoking among peers and siblings, alcohol intake, drugs, social problems, and personality, and several cohort studies show that having friends who smoke increases the risk that nonsmokers will start to smoke.²³⁻²⁵ As we did not have any information on whether smoking or smoking peers came first, we did not adjust for these variables in the analyses. For the same reasons, we did not include factors such as alcohol consumption,²⁶ drug abuse,²⁷ personality, or psychosocial factors,²⁸⁻³¹ although they are closely associated with smoking.

CONCLUSIONS

Smoking is a serious health problem among pupils in general upper secondary schools in Denmark and even more serious among those with physician-diagnosed asthma. More pupils with than without asthma smoke daily; they smoke more cigarettes per day, and boys with asthma start smoking at an earlier age. However, approximately two thirds of daily smokers have tried to quit smoking, those with asthma more often than those without asthma.

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