

PEDIATRIC

Asthma and Allergic Diseases in School Children from 1992 to 2007 with Incidence Data

AHMET U. DEMIR,^{1,*} SERHAT CELIKEL,² GÜL KARAKAYA,² AND A. FUAT KALYONCU²

¹Department of Chest Diseases, Hacettepe University School of Medicine, Ankara, Turkey.

²Department of Chest Diseases, Hacettepe University School of Medicine, Adult Allergy Unit, Ankara, Turkey.

Background. Information about change in the prevalence of asthma and allergic diseases and factors related with these diseases would be beneficial in decreasing the burden of these diseases. **Objective.** To assess (i) change in prevalence of asthma and allergic diseases; (ii) factors associated with asthma and wheeze; and (iii) incidence of asthma and wheeze. **Methods.** A questionnaire was administered to children aged 7–12 years in first five grades in the same primary school in 1992 (*n*: 1036), 1997 (*n*: 738), 2002 (*n*: 621), and 2007 (*n*: 422) and filled by the parents. A second survey in 2007 (*n*: 474, in eight grades) was conducted in the same schoolchildren, 6 months apart, to assess the incidence of asthma and wheeze and the associated factors. **Results.** Comparison of 1992, 1997, 2002, and 2007 surveys revealed that prevalence of asthma (8.3%, 9.8%, 6.4%, 3.3%, respectively), wheeze (11.9%, 13.3%, 6.4%, 3.1%, respectively), hay fever (15.4%, 14.1%, 7.2%, 3.1%, respectively), and eczema (4.0%, 4.3%, 1.8%, 1.2%, respectively) were significantly lower in 2002 and 2007 compared with that in 1992. Percentage of passive smoking decreased after 1992 (74.0%, 64.0%, 64.1%, and 65.5%, respectively). Incidence of asthma and wheeze in 2007 surveys were 0.9/100 and 1.1/100, respectively. After the adjustment for age and gender, infection in the past, family atopy, and presence of atopic disease (eczema or hay fever) were associated with asthma and wheeze. Maternal smoking and lack of breast feeding were associated with asthma. Male gender, pet ownership in the past, lack of health insurance coverage, snoring, and wood or coal used as fuel were associated with wheeze. **Conclusions.** Decreased prevalence of asthma and allergic diseases in the last 10 years could be related to decreased rate of passive smoking. Lower socioeconomic status and lack of breast feeding could increase the risk of asthma in children.

Keywords allergic disease, asthma, prevalence

INTRODUCTION

Prevalence of asthma is changing worldwide. Recent data with standard ISAAC methodology, repeated at an interval of 5–10 years (phases I–III) in 56 countries, suggested that the prevalence of asthma had stabilized or even decreased in English-speaking countries, whereas it was still increasing in some others (1). Those countries that have an increasing trend are mostly more populous and low-income countries (2). Increasing prevalence of asthma in these countries is likely to increase the burden of asthma. Thus, understanding the trend in asthma in different parts of the world would help to create a broad picture.

Large variations in the prevalence of asthma in genetically similar populations suggested that environmental factors were important determinants of asthma (3, 4). Identifying the factors associated with asthma and allergic diseases would improve our knowledge about these diseases and provide a better means to control them.

In Turkey, prevalence of asthma ranges from 2.8% to 13.8% and of wheezing from 3.4% to 13.3% (5–10). Series of cross-sectional studies found increasing prevalence of asthma among school children in the Aegean region from 1993 to 2002 (6.4–9%) and in Istanbul from 1995 to 2004 (9.8–17.8%) (10, 11).

In a series of cross-sectional studies, in 5 years' intervals, since 1992 in the same school in Ankara, Turkey, we observed a negative trend for prevalence of asthma and allergic diseases in 2002 (8).

As a fourth cross-sectional study in the same primary school, we aimed to investigate

- change in prevalence of asthma and allergic diseases;
- factors associated with asthma and wheeze; and
- incidence of asthma and wheeze.

MATERIALS AND METHODS

Prevalence of bronchial asthma and allergic diseases was investigated among school children in Ankara, Turkey, in a series of four questionnaire surveys in 1992 (*n*: 1036), 1997 (*n*: 738), 2002 (*n*: 621), and 2007 (*n*: 422). Data from the two surveys in 2007 repeated 6 months apart were used to assess the incidence of asthma and wheeze and the factors related with asthma and wheeze. Figure 1 summarizes the study population in these five surveys.

A questionnaire of two pages including information on current (in the last year) asthma and allergic diseases, and exposures, was distributed to children in the same primary school and filled by the parents at home. Participation rate in all the three surveys was above 85%. Reliability and validity of the questionnaire had been tested and found appropriate in 1994 in a pilot study of 56 children in the same age group, against exercise-induced bronchial

*Corresponding author: Ahmet U. Demir, M.D., Department of Chest Diseases, Hacettepe University, Sıhhiye, Ankara 06100, Turkey; Tel: 90-312-305-1531; Fax: 90-312-310-0809; E-mail: ademir68@gmail.com

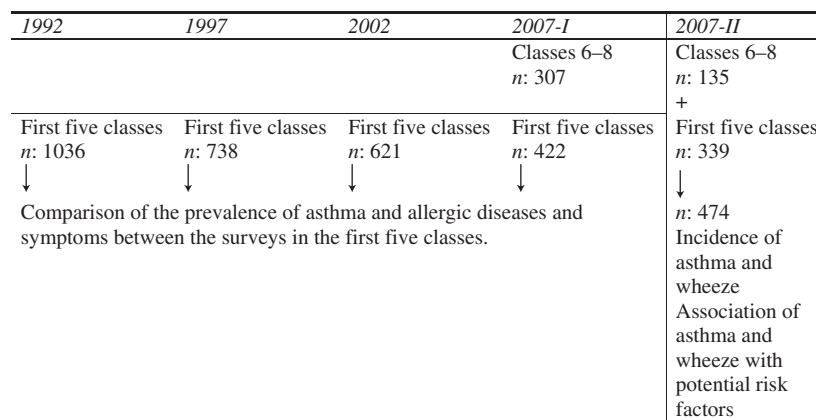


FIGURE 1.—Description of the study population in the surveys.

hyperresponsiveness. The questionnaire in the last survey included additional questions on educational status of parents, heating facilities, and dietary habits. These factors were not analyzed in the comparison of surveys.

The school is located in Ankara, the capital of Turkey with a population of above 2 million. Ankara has a dry, inland climate. The school is state owned. Socioeconomic level in the vicinity of school is mainly above the average of general population of Turkey. Air pollution is a problem in winter months, despite the use of natural gas for heating in the last 10 years, because individuals with lower socioeconomic status cannot afford it and use wood or coal for heating.

This study did not include any intervention. Participation was voluntary. Questionnaire information was collected from the parents, who signed an informed consent attached to the questionnaire. Names and addresses of the children or parents were not disclosed. Permission to use the data required signature of at least one of the parents.

Asthma and allergic diseases were defined by the “yes” response to the following:

“Has your child had in the last year. . .?”

Asthma: (physician diagnosed asthma, bronchitis, spastic bronchitis or allergic bronchitis).

Wheeze: Have you ever noticed a whistling sound or wheezing/rattle sound from the chest of your child?

Hay fever: Seasonal or whole year allergic rhinitis (hay fever).

Eczema: Eczema over the elbows and knees.

Analysis of the prevalence of asthma and allergic diseases across the surveys

Because of a structural change in the educational system in 1998, compulsory education was extended from 5 years to 8 years. For comparison of the surveys, only the data from the first five grades of primary schools were included in the analysis.

Analysis of incidence of asthma and wheeze

In the comparison of the 2007 surveys, 6 months apart, new incident asthma and wheeze was defined as “yes”

response to asthma and wheeze, respectively, reported for the first time in the second survey. The second survey was conducted in 474 of the 729 school children (65%) who could be reached and filled the questionnaire. Children who were at the eighth (last) grade in the first survey finished the school and therefore were not available in the second survey. Incidence rates of asthma and wheeze were calculated by dividing the number of new onset cases to the number of school children who did not have asthma and wheeze, respectively, in the first survey, and participated in the second survey.

Analysis of factors associated with asthma and wheeze

Association between potential explanatory factors and asthma and wheeze was investigated in children who participated in the second survey of 2007. Children who had wheeze and asthma in any of the 2007 surveys constituted the asthma and wheeze groups, respectively. Potential risk factors included presence of pet animals at home, breast feeding, smoking at home, education of parents, elder sib, fuel type, and health insurance coverage. Presence of allergic symptoms in a first-degree relative was regarded as atopic family history. Atopic disease, which was defined as the reported presence of hay fever or eczema, was used as a proxy for atopic status. These were the putative risk factors or beneficial factors (e.g., breast feeding) for asthma and wheeze, reported in previous studies.

Statistical Analysis

Categorical variables and continuous variables were reported as percentages and mean with standard deviation (SD), respectively. Comparisons between groups were tested by chi-square testing for categorical values and One-way analysis of variance test for continuous variables. Prevalence odds ratios (POR) were used to compare the prevalence of asthma and allergic diseases and symptoms in the four surveys. In these comparisons, the 1992 survey was regarded as the reference, and adjustment was made for age, gender, and other risk factors. Crude association between asthma, wheeze, and potential risk factors was expressed by OR. Multiple logistic regression analysis models were constructed to assess the independent

association between potential risk factors and asthma and wheeze after the adjustment for age and gender. Statistical significance was defined for *p*-values less than .05.

RESULTS

Comparison of the Surveys

Table 1 shows the comparison of the demographic and personal factors in the four surveys. Age (mean age in years: 9.2–9.4) and gender distribution (51–52% girls) was not different between the surveys. Breast feeding was reported above 90% in all surveys. Atopic family history was reported in 20.5%, 23%, 22%, and 18% of the school children in the 1992, 1997, 2002, and 2007 surveys, without a significant difference. Health insurance coverage was reported in 72.8%, 70.5%, 75%, and 79.1% of the school children in 1992, 1997, 2002, and 2007 surveys, with a significant difference between 1992 and 1997, 2007. Having a pet at home was reported almost two to three times that of 1992 in 1997, 2002, and 2007, respectively (7.9%, 22.9%, 21%, and 14.4%, respectively). Passive smoking because of parents was reported significantly lower than 1992 in the further surveys (74%, 64%, 64.1%, and 65.5%, respectively).

Current prevalence of asthma (8.3%, 9.8%, 6.4%, and 3.3%, respectively), wheeze (11.9%, 13.3%, 6.4%, and 3.1%, respectively), hay fever (15.4%, 14.1%, 7.2%, and 3.1%, respectively), and eczema (4.0%, 4.3%, 1.8%, and 1.2%, respectively) was significantly lower in 2002 and 2007, than in 1992 (Table 2). POR, after the adjustment for potential risk factors, suggested an abrupt decrease in the 2007 survey compared with the 1992 survey, with OR in the range 0.18–0.24 for asthma, wheeze, and hay fever. Figure 2 shows the changes in the prevalence of asthma

and allergic diseases and the number of participated schoolchildren in the four surveys. Because of the change in the school system in 1998, number of children dropped into almost half of that of the 1992 survey in 2002 and 2007 surveys.

Incidence of Asthma and Wheeze

A total of 474 of the 729 (64.9%) schoolchildren participated in both surveys, conducted 6 months apart in 2007. Those who did not participate in the second survey had a higher proportion of pet holding as ever (55.5% and 42.6%, respectively) and current (19.2% and 13.6%, respectively), wood or coal use for fuel (35.5% and 26.4%, respectively) and higher age (mean and SD, 12.0 (2.3) years and 10.1 (1.9) years, respectively) than those children who participated in both surveys.

Of these 474 school children, 4 had new onset asthma and 5 had new onset wheeze. The incidence rates were 0.9/100 children (95% CI: 0.02/100 children to 1.8/100 children) for asthma and 1.1/100 children (95% CI: 0.1/100 children to 2.1/100 children) for wheeze. Ages were 11 (in 2), 13, and 14 years and all were boys in the new onset asthma cases. Ages were 9, 11, 12, 13, and 16 years and 4 were boys in the new onset wheeze cases.

Factors Associated with Asthma and Wheeze

In the two surveys in 2007, physician-diagnosed asthma and wheeze were reported in 56 and 48 children, respectively.

Table 3 shows the factors associated with physician diagnosed asthma. Breast feeding (OR: 0.3, 95% CI: 0.1–0.9), maternal smoking (OR: 2.0, 95% CI: 1.1–3.8), infection in the past (OR: 6.4, 95% CI: 3.0–13.6), family atopy (OR: 2.8, 95% CI: 1.5–5.1), and atopic disease

TABLE 1.—Demographic data and personal characteristics of the schoolchildren in 1992, 1997, 2002, and 2007 surveys.

	1992 (n: 1036)	1997 (n: 738)	2002 (n: 621)	2007 (n: 422)	<i>P</i> (all surveys)	<i>P</i> (1997/1992)	<i>P</i> (2002/1992)	<i>P</i> (2007/1992)
Age (year), mean (SD)	9.4 (1.6)	9.2 (1.5)	9.2 (1.5)	9.2 (1.5)	.10			
Gender, Girl	51.5	51.5	51.7	52.0	.99			
Having health insurance	72.8	70.5	75.0	79.1	.003	.84	.09	.002
Breast feeding	95.4	93.1	95.8	94.8	.06			
Family atopy	20.5	23.0	22.0	18.0	.18			
Pet ownership current	7.9	22.9	21.0	14.4	<.001	<.001	<.001	.002
Passive smoking	74.0	64.0	64.1	65.5	<.001	<.001	<.001	<.001

Notes. Comparison of the four surveys included school children, attending to the first five grades of the school. Percentages are given unless otherwise specified. Significant findings are marked in bold type.

TABLE 2.—Current prevalence and comparison of asthma and allergic diseases of the school children in the 1992, 1997, 2002, and 2007 surveys.

	1992 (n: 1068) % (95% CI)	1997 (n: 738) % (95% CI)	2002 (n: 621) % (95% CI)	2007 (n: 422) % (95% CI)	<i>P</i> (all surveys)	1997 vs. 1992 POR* (95% CI)	2002 vs. 1992 POR* (95% CI)	2007 vs. 1992 POR* (95% CI)
Asthma	8.3 (6.5–10.1)	9.8 (7.6–12.0)	6.4 (4.4–8.4)	3.3 (1.5–5.1)	<.001	0.9 (0.6–1.3)	0.6 (0.4–0.9)	0.2 (0.1–0.4)
Wheeze	11.9 (10.1–13.7)	13.3 (10.9–15.7)	6.4 (4.4–8.4)	3.1 (1.5–4.7)	<.001	1.20 (0.8–1.6)	0.5 (0.3–0.7)	0.2 (0.1–0.4)
Hay fever	15.4 (13.2–17.6)	14.1 (11.6–16.6)	7.2 (5.2–9.2)	3.1 (1.5–4.7)	<.001	0.7 (0.5–0.9)	0.3 (0.2–0.5)	0.1 (0.1–0.3)
Eczema	4.0 (2.8–5.2)	4.3 (2.7–5.9)	1.8 (0.8–2.8)	1.2 (0.2–2.2)	.004	1.1 (0.6–1.8)	0.4 (0.2–0.8)	0.4 (0.2–1.0)

Notes. Comparison of the four surveys included school children, attending to the first five grades of the school.

Significant findings are marked in bold type.

*Adjustments were made for age, gender, passive smoking, family atopy, breast feeding, and having social security in multiple logistic regression models.

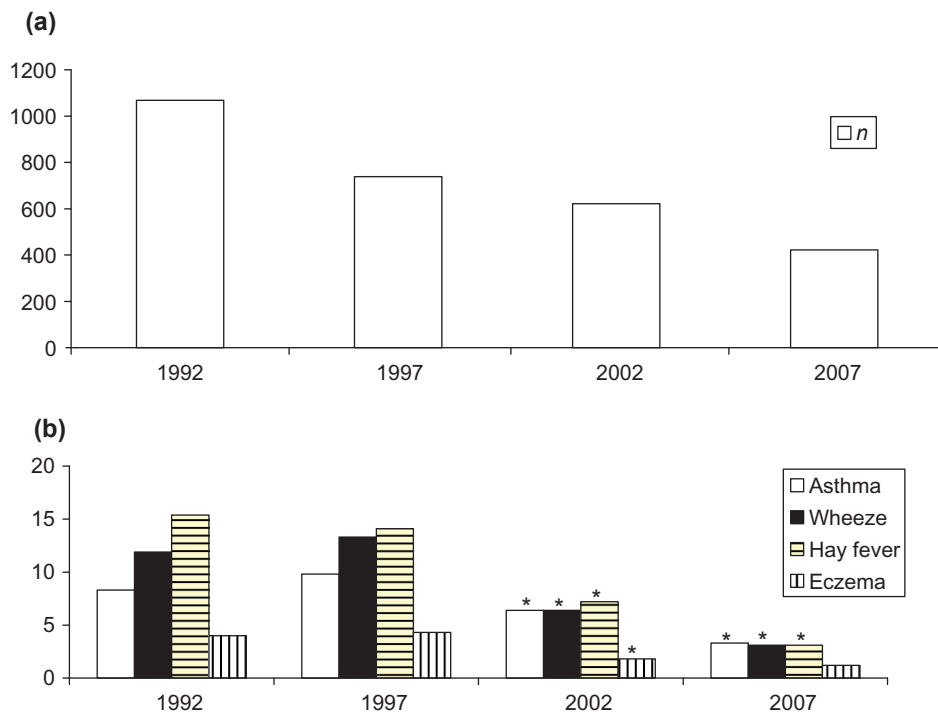


FIGURE 2.—Change in the number of schoolchildren (A) and the prevalence of asthma and allergic diseases and symptoms in the 1992, 1997, 2002, and 2007 surveys (* $p < .05$, after the adjustment for age, gender, passive smoking, family atopy, breast feeding and having social security in multiple logistic regression models, reference group: 1992 survey).

(OR: 2.9, 95% CI: 1.5–5.5) were associated factors after the adjustment for age and gender.

Table 4 shows the factors associated with reported wheeze. Gender (girl, OR: 0.5, 95% CI: 0.2–0.9), pet ownership in the past (OR: 3.5, 95% CI: 1.7–6.9), snoring (OR: 3.5, 95% CI: 1.6–6.2), infection in the past (OR: 9.2, 95% CI: 4.3–21.9), family atopy (OR: 2.8, 95% CI: 1.4–5.4), health insurance coverage (OR: 0.2, 95% CI: 0.1–0.5), wood or coal use for fuel (OR: 2.0, 95% CI: 1.1–3.8), atopic disease (OR: 3.9, 95% CI: 2.0–7.7), and age (1-year increase, OR: 0.7, 95% CI: 0.6–0.9) were associated factors after the adjustment for age and gender.

Weight, height, and BMI were not related with asthma or wheeze. Separate analyses in boys and girls and in quartiles did not reveal any significant finding.

DISCUSSION

Comparison of a series of four cross-sectional studies, 5 years apart in the same primary school in Ankara, Turkey, revealed a decreasing trend of asthma and allergic diseases in the two recent surveys of 2002 and 2007 compared with that of 1992. The trend was stronger in the 2007 survey. Decreased proportion of passive smoking and increased proportion of government coverage of insurance to those who do not have a regular job in the latter surveys (2002 and 2007) might partially explain these findings. Repeated survey in the same school children 6

months apart revealed incidence of asthma as 0.9/100 children and wheeze as 1.1/100 children.

Prevalence of Asthma and Allergic Diseases

In both the 2002 and 2007 surveys, prevalence of asthma and allergic diseases was lower than that of 1992. This trend was preserved after the adjustment of potential risk factors and was stronger in 2007 than that in 2002 (Table 2). Among the potential risk factors, proportion of passive smoking decreased, pet holding and health insurance coverage increased from 1992 to 2007. Passive smoking is a well-known risk factor for asthma and allergic diseases in children (12). Association between pet exposure and asthma is controversial (13). Although survey data are not adequately detailed to characterize the exposure, pet ownership has increased in the surveys after 1992, which could partially explain the decreasing trend of asthma and allergic diseases. However, pet exposure was not associated with asthma and allergic diseases in our surveys. Factors that could not be assessed in this study including air pollution, indoor air pollution, allergen sensitization, and obesity could be related to this trend. Our analysis suggested the protective role of using natural gas as fuel in the last 10 years. Parents who could not afford natural gas and use wood or coal reported more frequent wheeze in their children, because of indoor air pollution.

It could be likely that children who were sick because of asthma might have not been in the school and not be reached in the survey. This would result in an underestimation of the prevalence of asthma. Health selection

TABLE 3.—Association between asthma and personal characteristics of the schoolchildren.

	No asthma (n: 418)	Asthma (n: 56)	Crude OR (95% CI)	Adjusted OR (95% CI)
Gender				
Boy	45.7	53.6	1	
Girl	54.3	46.4	0.7 (0.4–1.2)	
Breast feeding	96.1	89.3	0.3 (0.1–0.8)	0.3 (0.1–0.9)
Breast feeding >4 months	83.1	71.7	0.5 (0.2–1.0)	
Pet ownership				
Never	58.3	51.8	1	
Current	13.7	12.5	1.0 (0.4–2.4)	
Past	28.0	35.7	1.4 (0.7–2.6)	
Passive smoking	66.3	69.6	1.1 (0.6–2.1)	
Mother smoked	21.8	35.7	1.9 (1.0–3.6)	2.0 (1.1–3.8)
Snoring	16.3	25.0	1.7 (0.8–3.2)	
Respiratory infection in the past	5.3	25.0	5.9 (2.8–12.5)	6.4 (3.0–13.6)
Mother illiterate	2.6	7.1	2.8 (0.8–9.2)	
Father illiterate	1.9	1.8	0.9 (0.1–7.5)	
Family atopy	15.8	35.7	2.9 (1.6–5.4)	2.8 (1.5–5.1)
Atopic disease ^a	13.5	32.1	3.0 (1.6–5.6)	2.9 (1.5–5.5)
Order of the child				
Single child	9.8	12.5	1	
Have a younger sib	33.1	30.4	0.7 (0.2–1.8)	
Have an elder sib	57.1	57.1	0.7 (0.3–1.9)	
Having health insurance	81.6	74.5	0.6 (0.3–1.2)	
Wood or coal use for fuel	26.9	21.4	0.7 (0.3–1.4)	
Margarine consumption	36.7	39.3	1.1 (0.6–1.9)	
Daily milk intake, ≥ 1 glass	41.6	43.4	1.0 (0.6–1.9)	
Daily coke consumption	9.6	7.1	0.7 (0.2–2.4)	
Daily egg eating	11.11.7	10.9	0.9 (0.3–2.2)	
Age (year), mean (SD) ^b	10.1 (1.9)	9.8 (1.9)	<i>p</i> : 0.21	
Height (cm), mean (SD) ^b	138.9 (13.4)	138.5 (11.8)	<i>p</i> : 0.76	
Weight (kg), mean (SD) ^b	34.5 (10.2)	33.8 (8.3)	<i>p</i> : 0.64	
BMI (kgm ⁻²), mean (SD) ^b	17.8 (2.9)	17.5 (3.1)	<i>p</i> : 0.41	

Notes. Adjustments were made for age and gender. Significant findings are marked in bold type.

^aPresence of eczema or hay fever.

^bInformation was available for height in 406, for weight in 442 and for BMI in 402 children.

bias could have influenced the comparison of these four surveys, if there were higher proportion of sick children because of asthma in two recent surveys (2002 and 2007) than the 1992 survey. However, participation rates were almost similar in the four surveys and such a major problem (high proportion of asthmatic children who were not at school during the survey) was not noticed in the two recent 2002 and 2007 surveys. Therefore, this possibility is not likely to explain our findings.

Although two recent surveys in different regions of Turkey found an increasing prevalence of asthma, our study found a decline in the prevalence of asthma and allergic diseases in the last 10–15 years (10, 11). Conflicting results could be due to the climate, dietary habits, and allergic sensitization of the regions.

In a series of cross-sectional studies in Edirne, prevalence of asthma and current wheeze was increased in 2004 compared with that in 1994 (14). These findings were contradictory to our study in Ankara. The methodology of the two studies (Ankara and Edirne surveys) was similar. The prevalence in 1994 in Edirne was lower than that of our survey in 1992, but increased to almost twice that of 1994 in 2004. Changes were almost similar for wheeze and diagnosis of asthma, thus differences in the recognition of symptoms by parents was not likely to explain

the contrasting findings. Edirne survey included children from both low and high socioeconomic status, whereas Ankara survey included children from a single school. Socioeconomic status of the children from the vicinity of the school or parents who were sending their children to the surveyed school might have changed in the last 10–15 years. This might be related to the decreased prevalence of asthma and wheeze in 2002 and 2007 compared with 1992 in Ankara surveys. Use of natural gas in Ankara in the last 10–15 years could be responsible for the lower amount of air pollution in the vicinity of the school and could have contributed to the decreasing prevalence of asthma in the two surveys in 2002 and 2007 compared with 1992. Wide-scale studies from these regions with the assessment of atopy and air pollution would be helpful to explain the differences between the prevalence of asthma and wheeze in this survey and Edirne survey.

Incidence of Asthma

One of the main objectives of this study was to assess the incidence of asthma. Studies from different parts of the world found incidence of asthma in children in the range of 0.5/100 person/year to 1.3/100 person/year (15–22). The estimate in our study (0.9/100 children) is within the

TABLE 4.—Association between wheeze and personal characteristics of the schoolchildren.

	No wheeze (n: 426)	Wheeze (n: 48)	Crude OR (95% CI)	Adjusted OR (95% CI)
Gender				
Boy	44.9	62.5	1	1
Girl	55.1	37.5	0.4 (0.2–0.9)	0.5 (0.2–0.9)
Breast feeding	95.5	93.8	0.7 (0.2–2.4)	
Breast feeding >4 months	82.1	80.5	0.9 (0.4–2.0)	
Pet ownership				
Never	59.2	41.7	1	1
Current	13.9	10.4	1.0 (0.3–2.9)	1.1 (0.3–3.1)
Past	26.9	47.9	2.5 (1.3–4.7)	3.5 (1.7–6.9)
Passive smoking	65.6	77.1	1.7 (0.8–3.5)	
Mother smoked	22.3	33.3	1.7 (0.9–3.3)	
Snoring	15.1	37.5	3.3 (1.7–6.4)	3.5 (1.6–6.2)
Respiratory infection in the past	5.2	29.2	7.5 (2.5–16.1)	9.2 (4.3–21.9)
Mother illiterate	2.6	8.3	3.4 (1.0–11.2)	2.4 (0.7–8.5)
Father illiterate	1.6	4.2	2.6 (0.5–12.8)	
Family atopy	16.0	37.5	3.1 (1.6–5.9)	2.8 (1.4–5.4)
Atopic disease ^a	13.2	38.3	4.0 (2.1–7.8)	3.9 (2.0–7.7)
Order of the child				
Single child	10.8	4.2	1	
Have a younger sib	33.1	29.2	2.2 (0.5–10.4)	
Have an elder sib	56.1	66.7	3.0 (0.7–13.3)	
Having health insurance	83.4	58.3	0.2 (0.1–0.5)	0.2 (0.1–0.5)
Wood or coal use for fuel	24.6	41.7	2.1 (1.1–4.0)	2.0 (1.1–3.8)
Margarine consumption	39.6	37.5	1.0 (0.5–1.9)	
Daily milk intake, ≥1 glass	41.3	45.5	1.1 (0.6–2.2)	
Daily coke consumption	9.0	11.4	1.2 (0.4–3.9)	
Daily egg eating	10.4	21.3	2.3 (1.0–4.9)	2.1 (0.9–4.6)
Age (year), mean (SD) ^b	10.2 (1.9)	9.3 (1.7)	<i>p</i> : 0.003	0.7 (0.6–0.9)^c
Height (cm), mean (SD) ^b	139.3 (13.1)	135.0 (13.9)	<i>p</i> : 0.05	
Weight (kg), mean (SD) ^b	34.6 (9.9)	32.7 (10.1)	<i>p</i> : 0.24	
BMI (kgm ⁻²), mean (SD) ^b	17.8(2.9)	17.7(3.0)	<i>p</i> : 0.85	

Notes. Adjustments were made for age and gender. Significant findings are marked in bold type.

^aPresence of eczema or hay fever.

^bInformation was available for height in 406, for weight in 442 and for BMI in 402 children.

^cOR calculated for 1 year increase in age.

range of these studies. These studies had a median duration of follow-up as 7 years (range: 1–12 years), and a median size of 2614 (range: 291–26, 265), with only one study sized smaller than ours. Incidence rate is reported for 1 year, but our surveys were repeated 6 months apart. Possibly the incidence rate of asthma “per year” could be twice our finding (1.8/100 children), which would be above to the higher end of the range. The smaller size, shorter duration, and lack of objective assessment of asthma in our study could partially explain the higher estimate of incidence in our study than these studies.

The two surveys of 2007 could reach almost two-third of the children. There was not a significant difference in the proportion of gender, asthma and allergic diseases, and related factors between the children who participated in the two surveys and those who participated only in the first survey, except for older age, higher proportion of wood or coal use as fuel, and pet ownership in those who participated only in the first survey. Thus our finding for asthma incidence is not likely to be an overestimate. However, we could not evaluate the risk factors of asthma and wheeze, because of the too few number of incident cases.

Factors Associated with Asthma and Wheeze

Previous studies revealed male gender, paternal asthma, atopic skin prick testing, short period of breast feeding, parental smoking, recurrent chest infections at 1–2 years, eczema, maternal education less than high school graduate, and maternal receipt of social aid as risk factors for asthma (15–26). These included the factors that were associated with asthma and wheeze in our study.

In our study, prevalence of wheeze was higher in children of families who did not have health insurance coverage. Most of these families had green card, which is offered by the government to individuals who are not covered by other insurance organizations. These individuals mostly do not have regular work and therefore represent lower socioeconomic status in Turkey. Social factors may be casual factors of a disease or may cause differences in the quality or amount of medical care that a patient can reach. In a birth cohort study in Sweden, lower socioeconomic status (parental occupation: white collar vs. blue collar) was associated with asthma (27). Controversy exists about the relation between socioeconomic status and asthma risk. Although some studies indicated

increased prevalence of asthma with lower socioeconomic status (27–29), some others failed to show this association (30, 31).

Usage of wood or coal as a fuel was associated with wheeze. Usage of these fuels could reflect the lower socioeconomic status, as these are cheaper than natural gas. Pollutants in the smoke released by such fuels include small particles, nitrogen dioxide, and sulfur dioxide, which may increase the risk of wheeze (32). Exposure to fume-emitting heaters during the first year of life was associated with an increased risk of having airway hyperresponsiveness and recent wheeze (33).

Respiratory infections, caused by respiratory syncytial virus and parainfluenza viruses, are common in the childhood and have been associated with asthma and recurrent wheezing (34, 35). In our study, asthma was associated with respiratory infection in the past. Increase in airway inflammation and hyperresponsiveness, and response to inhaled allergens are proposed mechanisms for increased risk of asthma.

In our study, snoring was associated with wheeze. Association between asthma and snoring has been reported in previous studies (36, 37). Airway inflammation and a general vulnerability of the respiratory tract because of viral infections and environmental exposures were suggested as an explanation for the association between asthma and snoring (37, 38).

Our study did not have an objective assessment of atopy. Reported presence of atopic disease (current hay fever or eczema) and family history of allergic diseases was found as a strong risk factor for new onset asthma in our study. Family history of allergic diseases was assessed in the questionnaire and found as a strong risk factor for the current prevalence of asthma previously (8, 9, 39). Review of the studies found association between asthma and rhinosinusitis, and asthma and eczema (40, 41).

Factors associated with asthma and wheeze in the recent (2007) survey were similar to those found in the 2002 survey (8). However, in the 2007 survey we did not find the protective role of regular milk consumption for wheeze, which was reported in 2002. This could be due to higher rate of milk consumption in this study (consumption of milk at least 1 glass/day: 38.9% and 41.8% in 2002 and 2007, respectively; no regular consumption 15.6% and 5.1% in 2002 and 2007, respectively).

Limitations and Weaknesses of the Study

Despite the weaknesses of the cross-sectional studies, which include the difficulty in interpretation of causality, series of cross-sectional studies in the same school children provided an opportunity to assess the change in the prevalence of asthma and associated factors. Lack of objective assessment of diseases, allergic sensitization, and indoor allergens makes it difficult to confirm our findings. Other factors related to atopic sensitization such as family history of allergic diseases and atopic diseases (hay fever and eczema) were used as markers of atopy. The

two definitions for asthma in our study were physician-diagnosed asthma and reported wheeze in the last 12 months. Both of these definitions have limitations. Access to health care and biases in the diagnoses of asthma could influence the validity of physician-diagnosed asthma. Sources of bias for physician-diagnosed asthma include misclassification of symptoms related to respiratory tract infections as asthma (33), and higher likelihood of diagnosing asthma in children born to atopic parents, than those born to non-atopic parents, who present with the same symptoms. Although reported wheeze is not an objective finding, it could identify the children who had asthma symptoms, but did not receive the diagnosis of asthma. Another limitation of our study was due to the few cases of new onset asthma and wheeze in the two repeated surveys, which precluded us from investigating the factors associated with the incidence of asthma and wheeze.

SUMMARY

Investigation of asthma among schoolchildren suggested a decline in the prevalence of asthma and allergic diseases in 2002 and 2007 compared with 1992. Decreased rate of passive smoking during the time period could be related to this trend. Repeated survey in the same school children 6 months apart found asthma incidence as 0.9/100 children. Infection in the past, family atopy, and atopic disease (eczema or hay fever) were associated with asthma and wheeze. Maternal smoking and lack of breast feeding were associated with asthma. Male gender, pet ownership in the past, lack of health insurance coverage, snoring, and wood or coal use as fuel were associated with wheeze. Studies with objective assessment of indoor air pollution and allergic sensitization would help to elicit the associations found in this study.

DECLARATION OF INTEREST

The authors declared no conflict of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1. Asher MI, Montefort S, Björkstén B, Lai CK, Strachan DP, Weiland SK, Williams H; ISAAC Phase Three Study Group. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases one and three repeat multicountry cross-sectional surveys. *Lancet* 2006; 368:733–743.
2. Asher MI. Recent perspectives on global epidemiology of asthma in childhood. *Allergol Immunopathol (Madr)*. 2010; 38:83–87.
3. ISAAC Steering Committee. Worldwide variations in the prevalence of asthma symptoms: the International Study of Asthma and Allergies in Childhood (ISAAC). *Eur Respir J* 1998; 351:315–335.
4. Turktas I, Selcuk ZT, Kalyoncu AF. Prevalence of asthma-associated symptoms in Turkish children. *Turk J Pediatr* 2001; 43:1–11.
5. Kalyoncu AF, Selçuk ZT, Karakoca Y, Emri AS, Cöplü L, Sahin AA, Barış YI. Prevalence of childhood asthma and allergic diseases in Ankara, Turkey. *Allergy* 1994; 49:485–498.
6. Selcuk ZT, Caglar T, Enunlu T, Topal T. The prevalence of allergic diseases in primary school children in Edirne, Turkey. *Clin Exp Allergy* 1997; 27:262–269.

7. Kalyoncu AF, Selcuk ZT, Entinli T, Demir AU, Cöplü L, Sahin AA, Artvinli M. Prevalence of asthma and allergic diseases in primary school children in Ankara, Turkey: two cross-sectional studies, five years apart. *Pediatr Allergy Immunol* 1999; 10:261–265.
8. Demir AU, Karakaya G, Bozkurt B, Sekerel BE, Kalyoncu AF. Asthma and allergic diseases in schoolchildren: third cross-sectional survey in the same primary school in Ankara, Turkey. *Pediatr Allergy Immunol* 2004;15:531–538.
9. Kurt E, Metintas S, Basyigit I, Bulut I, Coskun E, Dabak S, Deveci F, Fidan F, Kaynar H, Uzaslan EK, Onbasi K, Ozkurt S, Pasaoglu G, Sahin S, Sahin U, Oguzulgen K, Yildiz F, Mungan D, Yorgancioglu A, Gemicioğlu B, Fuat Kalyoncu A; PARFAIT Study of Turkish Thoracic Society Asthma-Allergy Working Group. Prevalence and risk factors of allergies in Turkey: results of a multicentric crosssectional study in children. *Pediatr Allergy Immunol* 2007; 18:566–574.
10. Demir E, Tanaç R, Can D, Gülen F, Yenigün A, Aksakal K. Is there an increase in the prevalence of allergic diseases among schoolchildren from the Aegean region of Turkey? *Allergy Asthma Proc* 2005; 26(5):410–414.
11. Ones U, Akcay A, Tamay Z, Guler N, Zencir M. Rising trend of asthma prevalence among Turkish schoolchildren (ISAAC phases I and III). *Allergy* 2006; 61(12):1448–1453.
12. Lewis S, Richards D, Bynner J, Butler N, Britton J. Prospective study of risk factors for early and persistent wheezing in childhood. *Eur Respir J* 1995; 8:349–356.
13. Simpson A, Custovic A. Early pet exposure: Friend or foe? *Curr Opin Allergy Clin Immunol* 2003; 3(1):7–14.
14. Selcuk ZT, Demir AU, Tabakoglu E, Caglar T. Prevalence of asthma and allergic diseases in primary school children in Edirne, Turkey, two surveys 10 years apart. *Pediatr Allergy Immunol*. 2010; 21:e711–7.
15. Arshad SH, Ramesh J, Kurukulaarachy RJ, Fenn M, Matthews S. Early life risk factors for current wheeze, asthma, and bronchial hyperresponsiveness at 10 years of age. *Chest* 2005; 127:502–508.
16. Porsbjerg C, von Linstow ML, Ulrik CS, Christensen SN, Backer V. Risk Factors for onset of asthma. *Chest* 2006; 129:309–316.
17. Larsson M, Hagerhed-Engman L, Sigsgaard T, Janson S, Sundell J, Bornehag C-G. Incidence rates of asthma, rhinitis and eczema symptoms and influential factors in young children in Sweden. *Acta Paediatr* 2008; 97(9):1210–1215.
18. Juhn YJ, Sauverb J St, Katusic S, Vargas D, Weaver A, Yunginger J. The influence of neighborhood environment on the incidence of childhood asthma: a multilevel approach. *Soc Sci Med* 2005; 60:2453–2464.
19. Pereira Vega A, Sánchez Ramos JL, Maldonado Pérez JA, Sánchez Rodríguez I, Gil Muñoz FL, García Jiménez D. Asthma incidence in Huelva, Spain at 2 stages of life: childhood and young adulthood. *Arch Bronconeumol* 2008; 44(9):464–470.
20. Marie Martel MJ, Rey E, Malo JL, Perreault S, Beauchesne MF, Forget A, Blais L. Determinants of the incidence of childhood asthma: a two-stage case-control study. *Am J Epidemiol* 2009; 169:195–205.
21. Rudd RA, Moorman JE. Asthma incidence: data from the national health interview survey, 1980–1996. *J Asthma* 2007; 44:65–70.
22. Rönmark E, Jönsson E, Platts-Mills T, Lundbäck B. Incidence and remission of asthma in schoolchildren: report from the obstructive lung disease in northern Sweden studies. *Pediatrics* 2001; 107:E37.
23. Zejda JE, Kowalska M. Risk factors for asthma in school children – results of a seven-year follow-up. *Cent Eur J Public Health* 2003; 11(3): 149–154.
24. Rönmark E. Incidence rates and risk factors for asthma among school children: a 2 year follow-up. Report from the Obstructive Lung Disease in Northern Sweden (OLIN) studies. *Res Med* 2002; 96:1006–1013.
25. Dik N, Tate RB, Manfreda J, Anthonisen NR. Risk of physician-diagnosed asthma in the first 6 years of life. *Chest* 2004; 126:1147–1153.
26. Sears MR, Burrows B, Flannery EM, Herbison GP, Holdaway MD. Atopy in childhood: I. Gender and allergen related risks for development of hay fever and asthma. *Clin Exp Allergy* 1993; 23:941–948.
27. Almqvist C, Pershagenz G, Wickman M. Low socioeconomic status as a risk factor for asthma, rhinitis and sensitization at 4 years in a birth cohort. *Clin Exp Allergy* 2005; 35:612–618.
28. Lindbaek M, Wehring KW, Grangard EH, Ovsthus K. Socioeconomical conditions as risk factors for bronchial asthma in children aged 4–5 years. *Eur Respir J* 2003; 21:105–108.
29. Poyser MA, Nelson H, Ehrlich RI, Bateman ED, Parnell S, Puterman A, Weinberg E. Socioeconomic deprivation and asthma prevalence and severity in young adolescents. *Eur Respir J* 2002; 19:892–898.
30. Rona RJ, Hughes JM, Chinn S. Association between asthma and family size between 1977 and 1994. *J Epidemiol Community Health* 1999; 53: 15–19.
31. Strachan DP, Anderson HR, Limb ES, O'Neill A, Wells N. A national survey of asthma prevalence, severity, and treatment in Great Britain. *Arch Dis Child* 1994; 70:174–178.
32. Bruce N, Perez-Padilla R, Albalak R. Indoor air pollution in developing countries: a major environmental and public health challenge. *Bull World Health Organ* 2000; 78(9):1078–1092.
33. Phoa L, Toelle BG, Ng K, Marks GB. Effects of gas and other fume emitting heaters on the development of asthma during childhood. *Thorax* 2004; 59:741–745.
34. Sigurs N, Bjarnason R, Sigurbergsson F, Kjellman B, Björkstén B. Asthma and immunoglobulin E antibodies after respiratory syncytial virus bronchiolitis: a prospective cohort study with matched controls. *Pediatrics* 1995; 95:500–505.
35. Litonjua AA, Carey VJ, Burge HA, Weiss ST, Gold DR. Exposure to cockroach allergen in the home is associated with incident doctor-diagnosed asthma and recurrent wheezing. *J Allergy Clin Immunol* 2001; 107:41–47.
36. Ersu R, Arman AR, Save D, Karadag B, Karakoc F, Berkem M, Dagli E. Prevalence of snoring and symptoms of sleep-disordered breathing in primary school children in Istanbul. *Chest* 2004; 126(1):19–24.
37. Kuehni CE, Strippoli MP, Chauillac ES, Silverman M. Snoring in preschool children: prevalence, severity and risk factors. *Eur Respir J* 2008; 31(2):326–333.
38. Verhulst SL, Aerts L, Jacobs S, Schrauwen N, Haentjens D, Claes R, Vaerenberg H, Van Gaal LF, De Backer WA, Desager KN. Sleep-disordered breathing, obesity, and airway inflammation in children and adolescents. *Chest* 2008; 134(6):1169–1175.
39. Lundback B. Epidemiology of rhinitis and asthma. *Clin Exp Allergy* 1998; 28:3–10.
40. van der Hulst AE, Klip H, Brand PL. Risk of developing asthma in young children with atopic eczema: a systematic review. *J Allergy Clin Immunol* 2007; 120(3):565–569.
41. Lai L, Hopp RJ, Lusk RP. Pediatric chronic sinusitis and asthma: a review. *J Asthma* 2006; 43(10):719–725.