Prevalence of asthma among children in an industrial town

Hacer Kamalı[1], Demet Can[1], İlker Günay[1], Hikmet Tekin Nacaroğlu[1], Canan Şule Ünsal-Karkıner[1], Türkan Günay[2], Ahmet Özdemir[1], Müge Ayanaoğlu[1]

[1]Department of Pediatric Allergy, Dr. Behcet Uz Children's Hospital, [2]Department of Public Health, Dokuz Eylul University Faculty of Medicine, Izmir, Turkey

E-mail: tekin212@gmail.com

Received: 14 February 2014, Revised: 25 February 2014, Accepted: 26 March 2014

SUMMARY: Kamalı H, Can D, Günay İ, Nacaroğlu HT, Ünsal-Karkıner CŞ, Günay T, Özdemir A, Ayanaoğlu M. Prevalence of asthma among children in an industrial town. Turk J Pediatr 2014; 56: 493-499.

Studies of the prevalence of asthma should be supported by objective markers. We aimed to measure the prevalence of childhood asthma in a particular area and age group using a questionnaire, and to compare the results with the rates of asthma diagnosed by objective measures.

All students aged 13-14 (n=1511) in Kemalpasa, Izmir, were included in the study. Children whose responses on the ISAAC Phase-I Questionnaire revealed current wheezing were invited to the district health center. The prevalence of clinically proven asthma (current wheezing supported by objective markers) was investigated.

The questionnaire was answered by 1373 (90.87%) students. Current wheezing was indicated in 428 children (31.0%), significantly more in girls than in boys (p<0.05). However, the prevalence of clinically proven asthma decreased by 42.5% when using objective markers.

This study provided important epidemiologic information about the prevalence of asthma as indicated by questionnaires as opposed to that indicated by objective measures, especially in countries where the language lacks a word for "wheezing."

***Key words:** asthma, atopy, children, epidemiology, ISAAC, industry, risk factors.*

Research regarding the prevalence of asthma in the community is commonly performed using questionnaire-based studies. In countries with advanced health systems, a question concerning "physician-diagnosed asthma" provides a significant idea about the prevalence of asthma. However, in countries like Turkey, where the health system has yet to see some of the advancements in place elsewhere, a question about physician-diagnosed asthma has limited value because of the high rates of misdiagnosis as well as the use of misnomers like allergic bronchitis instead of asthma as a diagnosis. In such countries, it is more useful to question respondents regarding "current wheezing" instead.

The International Study of Asthma and Allergy in Childhood (ISAAC) Phase One showed large worldwide variations in the prevalence of symptoms of asthma. In a number of studies, not only environmental factors, but also reliance on the ISAAC questionnaire alone were found responsible for these variations[1-3]. With the development of the ISAAC Phase Two modules, it became possible to determine the frequency of symptoms and to test for objective markers of asthma and allergy[1,4].

Allergic diseases constitute a significant health problem in Turkey. According to a recent multicenter study, the mean prevalence rates of wheezing and rhinitis in schoolchildren were 15.8% and 23.5%, respectively[4,5]. It is well known to those working in epidemiology that perception of survey questions differs regionally, even in communities using the same language. When studying asthma and allergies, this can pose a significant problem, especially in the countries where the language lacks a word for "wheezing." This is the case in Turkish; however, there do exist words denoting similar conditions. Consequently, either such words, or else descriptions of the condition, are used to replace “wheezing” in Turkish-language questionnaires concerning asthma.

Material and Methods

This study was conducted in Kemalpaşa, İzmir, Turkey. In 2010, the population of the entire district was 91,276 and that of its center, 59,984. There were 5 elementary schools in the distric center, and all students aged 13-14 attending these schools were given the ISAAC Phase One questionnaire. If a student answered “yes” to the question, “Did you have wheezing or whistling in the chest in the past 12 months?”, s/he was considered to have asthma (current wheezing) and enrolled in the study group[2].

Permission was obtained from the local ethics committee, the central and provincial directors of the Ministry of Education and the town governors. Written parental consent and student assent were obtained separately for each participant.

Study Design

1. Children with asthma (current wheezing) determined using ISAAC Phase One
2. Children with asthma (current wheezing) invited to the family physician’s office with their families
3. Parents given detailed family interview (ISAAC Phase Two Questionnaire and sociocultural status scale)
4. SPTs, PFTs, reversibility test and exercise challenge test administered to all participants

I. FAMILY INTERVIEW

a) ISAAC Phase Two Questionnaire

ISAAC Phase Two questionnaire modules were self-completed by parents of the participating students at family physician’s office. Asthma symptoms were investigated based on a positive answer to the question: “Has your child had wheezing or whistling in the chest in the past 12 months?” Rhinitis symptoms were investigated based on a positive answer to the question: “In the past 12 months, has your child had a problem with sneezing or a runny or blocked nose when he/she did not have a cold or the flu?’’[6].

Data collected by the ISAAC Phase Two questionnaire included demographic data (gender, parental age, birthplace, parental history of asthma and/or allergic rhinitis, family income, level of parental education), environmental conditions (exposure to animals, i.e., pets and/or fur, exposure to smoke, presence of dampness or mold in the house, type of heating in the house), information regarding duration of breastfeeding and time of weaning was also obtained.

b) Sociocultural Status Scale

A scale developed by Borotav and Belek[7] to assess social and cultural level was used. Sociocultural status (SCS) was determined on the basis of total points accorded to maternal education level and social class designation: 2-3 points, low SCS; 4-5 points, middle SCS; and 6-8 points, high SCS.

Mothers were divided in three groups according to their level of education and given a score: 1) illiterate, or literate but did not graduate from primary school (1 point); 2) graduated from primary school but not middle school (2 points); 3) graduated from middle school or beyond (3 points).

Social classes were determined by the occupations of household members. 1. Higher social class status was designated if the parents were working in their own business or someone else’s as lower- or mid-level workers (3 points). 2. Middle social class status was designated if the parents were white collar or blue collar workers who owned a small business (2 points). 3. Lower social class status was designated if the parents were unskilled day laborers, or unemployed (1 point.)

II. SKIN PRICK TEST

All participants were administered skin-prick tests (SPTs) for *Dermatophagoides pteronyssinus, Dermatophagoides farinae, Alternaria alternata,* cats, a grass mixture (*Phleum pratense, Poa pratensis, Dactylis glomerata, Lolium perenne, Festuca pratensis* and *Avena eliator*), a tree mixture (*Betula verrucosa, Alnus glutinosa* and *Coryllus avellena*), *Olea europea, Blatella germanica,* histamine and negative controls. Standardized core allergen extracts and controls were provided by ALK-Abello, Horsholm, Denmark.

The tests were administered using a prick test device on the volar surface of both forearms and recorded after 15 minutes. The test for a given allergen was considered positive if the mean wheal diameter was 3 mm larger compared with the negative control[8].

III. PULMONARY FUNCTION TEST and REVERSIBILITY TEST

Pulmonary function tests (PFTs) were performed using a spirometer (Cosmed Pony FX) at a health center. First, the children were informed what would be done and how would it be done; the best of three attempts was then recorded for each child. In cases where the FEV1/FVC ratio was less than 90%, it was considered airway obstruction[9], and inhaled salbutamol (four puffs) was given. After 15-20 minutes, spirometry was repeated; an increase of more than 12% in FEV1 or of at least 15% in peak expiratory flow (PEF) was regarded as reversibility.

IV. EXERCISE CHALLENGE TEST

We used an exercise challenge test to show the presence of bronchial hyperresponsiveness (BHR). In cases where spirometry was found normal, an exercise challenge test was performed[10]. If, following six minutes of running, there was a 15% decrease in FEV1, it was regarded as BHR.

All SPTs and PFTs were evaluated by a pediatric allergy fellow and PFT technicians.

V. DEFINITION of CLINICALLY PROVEN ASTHMA

All children in the study group meeting at least one of the following criteria were placed in the "clinically proven asthma" group:

i) Children in whom asthma was diagnosed and/or who had been treated for asthma by a doctor;

ii) Children who had positive reversibility on the PFT;

iii) Children who had a positive exercise challenge test.

Statistical analysis

The SPSS-15 statistical software package (SPSS Inc., Chicago, IL) was used for the statistical analyses. These included frequency and percent distributions, calculation of prevalence rates for asthma and potential risk factors, and comparisons using chi-square and Student's t-tests. Multivariate logistic regression was used to identify significant risk factors for asthma.

Results

The total number of students available was 1511; 1373 (90.8) were given the ISAAC Phase One questionnaire. Among them, there was a slight majority of girls (698, 50.5%). Asthma (current wheezing) was reported by 428 (31%) students. Children with current wheezing were invited to the family physician's office; 271 (63%) of those were selected for further investigation. Results of the ISAAC Phase Two questionnaire suggested asthma (current wheezing) in 87.4% (237/271) of these children. The prevalence of current wheezing thus decreased by 12.6% upon administration of the ISAAC Phase Two questionnaire.

Gender: Of the 428 children with current wheezing, 188 (40.1) were male; 68 (25%) of the 271 in children in the study group were male (Table 1).

Family history of allergic disease: The history of atopic diseases for the children's mothers and fathers (respectively) was: asthma, 21 (7.8%) and 9 (3.3%); seasonal allergic rhinitis, 45 (16.7%) and 18 (6.7%); and eczema, 8 (3.0%) and 9 (3.3%). For siblings, the history of allergic disease was: asthma, 11 (4.1%); seasonal allergic rhinitis, 36 (13.4%); and eczema, 7 (2.6%).

Education level of the parents: The distribution of mothers and fathers (respectively) among the three education levels designated in the study was: illiterate (14.8% and 4.9%); middle (67.7% and 55%); and high (17.5% and 40.1%).

Exposure to smoking: The rate of passive

Table I. Distribution of Selected Personal, Family and Health-Related Characteristics of Children Studied

	n	%
Male gender	68	25
Current rhinitis	223	82.9
Family history of asthma (n, %)	41	15.2
Family history of eczema (n, %)	19	7.1
Family history of allergic rhinitis (n, %)	77	28.6
Migration	185	69
Exposure to animals/pets (n, %)	22	8
Presence of mold or dampness in house (n, %)	173	63.8
Family monthly income of <320 USD	19	7
Exposure to smoking inside current house	161	59.9
Duration of breastfeeding (>6 months)	218	81.3
Starting month for weaning (>6 months)	221	83.4
Reversibility in pulmonary function test	44	18.2
Bronchial hyperreactivity	27	11.2
Presence of atopy (>3 mm) (n, %)	53	19.9
House dust mites	50	18.8
Grass pollen	18	6.8
Blatella germanica	11	4.1
Olea europea	8	3
Trees	5	1.9
Cat	4	1.5
Alternaria	3	1.1

exposure to smoking was 59.9%. In 46 (17.1%) of these cases, it was the mother who smoked; in 138 (51.3%) cases, it was the father; and in 31 (11.6%) instances, both parents smoked.

Distribution of sociocultural status: Most of the children's families were in the middle SCS group (65%); the remainder were in the high (18%) and low (16%) groups.

Heating device: A great majority of the families (80.2%) used a stove (either wood or coal) for heating.

The distribution of selected personal, family and health-related characteristics of the children in the study is shown Table I.

Atopy: Of the 53 (19.9%) children with atopic asthma, 23 (27.5%) were male. Atopic asthma was more frequent in boys ($p<0.001$) and in children whose mother had seasonal allergic rhinitis (OR 1.74, 95%, CI 1.25-2.37). The risk factors for atopic asthma are shown in Table II.

Asthma with rhinitis: Rhinitis accompanying asthma was very common (n=223; 82.3%). Among the children who had asthma with rhinitis, 50 (22.4%) were male. This condition was significantly more frequent in girls ($p<0.05$).

Clinically Proven Asthma and the Effect of Risk Factors

Of the 156 (57.5%) children who had clinically proven asthma, 43 (27.5%) were male. Clinically proven asthma was more common in the combined lower and middle SCL groups (88.4%), and in migrants (84.6%), but this was not found significant using multivariate logistic regression. Clinically proven asthma was, however, significantly more common in children with a positive family history of asthma, and a positive history of paternal atopy (Table III).

Discussion

This study demonstrated that asthma prevalence as determined by the use of questionnaires in countries such as Turkey where the native language lacks a word for "wheezing" is nearly twice the real prevalence of asthma as determined by objective measures. In our study, we used the ISAAC Phase One questionnaire to determine the prevalence of asthma among

Table II. Distribution of Selected Personal, Family and Health-Related Characteristics of Children with Clinically Proven Asthma and Atopic Asthma

	Clinically proven asthma n:156	Atopic asthma n:53
Male gender	43 (27.5%)	23 (43.4%)
Asthma plus rhinitis	124 (79.4%)	41 (77.3%)
Asthma plus eczema	52 (33.3%)	13 (24.5%)
Family history of asthma	30 (19.2%)	9 (16.9%)
Family history of allergic disease	49 (31.4%)	21 (39.6%)
Exposure to smoking inside current house	92 (58.9%)	34 (64.1%)
Lower or middle sociocultural level	138 (88.4%)	41 (77.3%)
Presence of mold or dampness in house	34 (21.7%)	15 (28.3%)
Heating with stove	123 (78.8%)	36 (67.9%)
Migration	132 (84.6%)	36 (67.9%)

students aged 13-14 years in an industrial town. We also evaluated the risk factors for asthma, as in ISAAC Phase Two. Our study, however, differed from ISAAC Phase Two in these respects: the study group was not sampled from the general population but instead consisted of children labeled as asthmatic on the basis of the ISAAC Phase One questionnaire; a different age group was studied; serum total IgE and eosinophil counts were not measured; and an exercise challenge test was used for BHR measurement. The strengths of this study were: inclusion of the whole population instead of a sample; and a detailed analysis of risk factors.

Since the vast majority of the subjects were encountering spirometry for the first time, the spirometric measurements revealed wide variability. In order to increase the specificity of the exercise challenge test, a 15% decline was considered signicant. Because of that, some asthmatic children may have been excluded. Likewise, there may have been children who did not meet the criteria for the “clinically proven asthma” group, but who were in fact asthmatic. However, the intention in this study was to place emphasis on specificity over sensitivity in the diagnosis of asthma. Confirming the results of the questionnaire with a secondary evaluation on the basis of objective measures was the cornerstone of the study. Although a high rate of asthma cases was found in our study group on the basis of the questionnaire, the clinically proven asthma rate of 57.5% was much lower. Büchele et al.[11] noted a decreased rate in ISAAC Phase Two. Therefore, we conclude in our study that determination of asthma prevalence by questionnaire alone may not be sufficient.

In the first ISAAC Phase Two study done in our country, prevalence rates were 11.5% for current wheezing, and 6.9% for physician-diagnosed asthma[12]. This prevalence increased in recent years, and a multicenter ISAAC Phase Two study showed that the frequency of children who had ever experienced wheezing ranged from 31% to 37.9% in various cities[4]. Asthma prevalence in the Aegean region, where Kemalpasa is located, increased from 3.8% in 1994 to 15.9% in 2004 [13,14]. A recent multicenter study in the same region found the prevalence of lifetime wheezing to be 36%, and current wheezing, 15% (4). In our study, the rate current wheezing was quite high (31%). This may be due to the effects of an industrialized, inner-city location. The high frequency of nonatopic asthma also indicates the contribution of unfavorable environmental conditions as well.

Living in an industrial area may increase respiratory morbidity, including asthma, due to industrial air pollution[15,16]. In fact, the major reason for conducting the study in Kemalpaşa was that higher asthma rates were expected, due to heavy industrialization and air pollution, a lower-level social and cultural structure, a high number of migrants, overcrowded housing and insalubrious environmental conditions. The housing conditions of industrial workers in Kemalpaşa resemble those of inner-city environments elsewhere. Asthma is prevalent

Table III. Risk Factors for Clinically Proven Asthma

	Subjects n/N	OR (95% CI)	p-value
Family history of asthma	30/156	1.29 (1.10-1.78)	0.029
Paternal history of allergic disease	23/156	1.52 (1.14-2.65)	0.047

in inner-city children, has increased severity, and for many patients poses difficulties in regard to achieving control of their condition. Some of the limitations to controlling asthma in inner-city children relate to socioeconomic factors, which contribute significantly to the disease burden found in these children[17]. Data also indicate that poor and minority children have higher rates of asthma[18,19].

According to a study done in Poland by Michnar et al.[16] based on the standard questionnaires, asthma was diagnosed significantly more often among children residing in an urban industrial district than among those living in a rural industrial district. On the other hand, a study using ISAAC Phase One questionnaires in New Zealand found no consistent evidence of an effect on respiratory morbidity from natural sulphur fumes, industrial air pollution or climate; the indoor environment was thought to be of greater importance[20].

In our study, migration was found to be another risk factor for asthma. Migrants provide a good example of the effects of the environment. While they have less asthma in their homeland, asthma cases among them increase considerably following their migration to an industrial area. Clinically proven asthma was more common in migrants than in other residents in our study, but not significantly so. Features common to Kemalpasa's overall population, such as low income, indoor air pollution and unfavorable living conditons, contributed to the high prevalence of asthma. Asthma disproportionately impacts low-income ethnic minority communities residing in urban areas. Environmental risk factors, particularly those related to housing and indoor air, may affect the development or exacerbation of asthma[21,22].

Yet despite the high prevalence of asthma in our study, allergic sensitization was found to be low. This seemingly contradictory situation has been found in ISAAC studies as well. For example, ISAAC showed that the prevalence of current asthma symptoms and exercise-induced bronchial responsiveness was six- to tenfold higher in England than in Albania. In contrast, the frequency of allergic sensitization in the two countries was similar[23].

We found clinically proven asthma to be more frequent in families from low and middle social and cultural levels. Similarly, in a recent multicenter study, a history of parental asthma and/or rhinitis and monthly family income of <300 US dollars were reported to be risk factors for current wheezing[6]. The ISAAC Phase Three study has definitively established that the prevalence of these diseases can indeed be very high in non-affluent centers with low socioeconomic conditions[24].

In our study, atopic asthma was more frequent in boys and in children with a mother suffering from allergic rhinitis. Atopy in males is something that can be expected. But in a recent multicenter study, males were more frequent in the nonatopic group[6].

A limitation of our study is that we did not have a control group. This would have allowed us to investigate the prevalence of asthma, using objective measures, among children without current wheezing as indicated by the questionnaire. Another limitation concerns the criteria for clinically proven asthma, since although the specificity of the exercise test is high, the sensitivity is low. A metacholine test would have a higher sensitivity[10]. We also think it would provide a lower error rate, as we have determined the diagnosis of asthma in many ways, including family consultation, physical examination and objective measures.

In conclusion, our data suggests that there is a high prevalence of asthma in industrial areas. However, the prevalence of asthma we found decreased by almost half after using objective measures for diagnosis. Our findings reveal that the asthma prevalence obtained using questionnaire results may not always match that obtained by objective measures. This situation may be due to using questionnaires prepared by native speakers of English in countries where English is not the native language. This should be considered in epidemiological research on asthma. Using a questionnaire alone to determine the prevalence of asthma is insufficient. Finally, atopy may result in a predisposition to asthma; however, residence in an industrial area was considered to have a role as well.

REFERENCES

1. Beasley R, Ellwood P, Asher I. International patterns of the prevalence of pediatric asthma the ISAAC program. Pediatr Clin North Am 2003; 50: 539-553.
2. The International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. Lancet 1998; 351: 1225-1232.
3. Asher MI, Stewart AW, Mallol J, et al. Which population level environmental factors are associated with asthma, rhinoconjunctivitis and eczema? Review of the ecological analyses of ISAAC Phase One. Respir Res 2010; 11: 8.
4. Civelek E, Cakir B, Boz AB, et al. Extent and burden of allergic diseases in elementary schoolchildren: a national multicenter study. J Investig Allergol Clin Immunol 2010; 20: 280-288.
5. Celik G, Bakirtas A, Sackesen C, Reisli I, Tuncer A. Pediatric allergy and immunology in Turkey. Pediatr Allergy Immunol 2011; 22: 440-448.
6. Civelek E, Cakir B, Orhan F, et al. Risk factors for current wheezing and its phenotypes among elementary school children. Pediatr Pulmonol 2011; 46: 166-174.
7. Giray Simşek H, Günay T, Uçku R. Effects of social inequalities on coronary heart disease risk factors: a population-based, cross-sectional study in Izmir. [Article in Turkish] Anadolu Kardiyol Derg 2010; 10: 193-201.
8. Weiland SK, Björkstén B, Brunekreef B, Cookson WO, von Mutius E, Strachan DP. Phase II of the International Study of Asthma and Allergies in Childhood (ISAAC II): rationale and methods. Eur Respir J 2004; 24: 406-412.
9. Global Initiative for Asthma. www.core.ubc.ca/asthma/gina. Date last accessed: February 23, 2012.
10. Şekerel BE, Saraçlar Y, Kalaycı O, Çetinkaya F, Tuncer A, Adalıoğlu G. Comparison of four different measures of bronchial responsiveness in asthmatic children. Allergy 1997; 52: 1106-1109.
11. Büchele G, Genuneit J, Weinmayr G, et al. International variations in bronchial responsiveness in children: findings from ISAAC phase two. Pediatr Pulmonol 2010; 45: 796-806.
12. Saraçlar Y, Kuyucu S, Tuncer A, Sekerel B, Saçkesen C, Kocabaş C. Prevalence of asthmatic phenotypes and bronchial hyperresponsiveness in Turkish schoolchildren: an International Study of Asthma and Allergies in Childhood (ISAAC) phase 2 study. Ann Allergy Asthma Immunol 2003; 91: 477-484.
13. 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: 410-414.
14. Karaman O, Turgut CS, Uzuner N, et al. The determination of asthma, rhinitis, eczema, and atopy prevalence in 9- to 11-year-old children in the city of Izmir. Allergy Asthma Proc 2006; 27: 319-324.
15. Bhopal RS, Phillimore P, Moffatt S, Foy C. Is living near a coking works harmful to health? A study of industrial air pollution. J Epidemiol Community Health 1994; 48: 237-247.
16. Michnar M, Trembas-Pietraś E, Milanowski J. Incidence of allergic respiratory diseases in the Lublin region in correlation with the level of environmental pollution. Ann Univ Mariae Curie Sklodowska Med 2003; 58: 481-487.
17. Szefler SJ. Advances in pediatric asthma in 2010: addressing the major issues. J Allergy Clin Immunol 2011; 127: 102-115.
18. Powell DL, Stewart V. Children. The unwitting target of environmental injustices. Pediatr Clin North Am 2001; 48: 1291-1305.
19. Østergaard MS, Nantanda R, Tumwine JK, Aabenhus R. Childhood asthma in low income countries: an invisible killer? Prim Care Respir J 2012; 21: 214-219.
20. Moyes CD, Waldon J, Ramadas D, Crane J, Pearce N. Respiratory symptoms and environmental factors in schoolchildren in the Bay of Plenty. N Z Med J 1995; 108: 358-361.
21. Burastero SE, Masciulli A, Villa AM. Early onset of allergic rhinitis and asthma in recent extra-European immigrants to Milan, Italy: the perspective of a non-governmental organisation. Allergol Immunopathol (Madr) 2011; 39: 232-239.
22. Johnson M, Nriagu J, Hammad A, Savoie K, Jamil H. Asthma, environmental risk factors, and hypertension among Arab Americans in metro Detroit. J Immigr Minor Health 2010; 12: 640-651.
23. Martinez FD, Wright AL, Taussig LM, Holberg CJ, Halonen M, Morgan WJ. Asthma and wheezing in the first six years of life. N Engl J Med 1995; 332: 133-138.
24. Mallol J, Crane J, von Mutius E, Odhiambo J, Keil U, Stewart A. The International Study of Asthma and Allergies in Childhood (ISAAC) Phase Three: a global synthesis. Allergol Immunopathol (Madr) 2013; 41: 73-85.