
Differences in the prevalence of asthma and current wheeze between Jews and Arabs: results from a national survey of schoolchildren in Israel

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Background: There is evidence that the prevalence of asthma is higher in Jewish schoolchildren than in Arab schoolchildren. It is not clear to what extent other risk factors explain these differences.

Objective: To evaluate whether the population group differences in the prevalence of asthma and current wheeze remain after adjustment for several potential risk factors.

Methods: A national survey of 10,057 13- to 14-year-old schoolchildren was carried out in Israel in 1997. There were 7,436 Jewish children and 2,621 Arab children. Differences in the two population groups were examined while controlling for demographic and environmental factors such as: sex, parental education, parental smoking and asthma, crowding, and presence of older siblings.

Results: The prevalence of asthma and current wheeze was significantly higher in Jewish children compared with Arab children. The asthma prevalence was 7.8% for Jewish children and 4.9% for Arab children ($P = 0.001$), and prevalence of current wheeze was 20.7 and 10.1%, respectively ($P = 0.001$). After adjustment for demographic and environmental factors, the prevalence of asthma and current wheeze was still increased in the Jewish population (odds ratios: 1.51; 95% confidence interval [CI] = 1.06 to 2.15; 2.15 95% CI = 1.70 to 2.73, respectively). History of asthma in parents and residence in a rural area were significant risk factors for asthma and current wheeze. In addition, the presence of less than three older siblings was a significant risk factor for asthma, and female sex, ever having pets, and maternal smoking were significantly associated with current wheeze.

Conclusions: The differences between Jewish and Arab children were not explained by the studied factors. Genetic factors, different environmental exposure, and nutritional habits should be studied to further explain the differences between these populations.

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INTRODUCTION

Racial differences in the prevalence of asthma have been reported in several studies.^{1–5} In the United States, asthma prevalence and asthma mortality are more common in black children than in white children.^{1–4} In Singapore, Malay and Indian populations have more severe asthma symptoms than Chinese residents.⁵ In some studies, race remained a significant predictor of asthma after adjustment for other risk factors for asthma, including crowding, parental smoking, urban residency, and parental education.^{1,3,4}

In a study carried out in 1990 in Israel among 6- to 7-year-old schoolchildren, asthma was found to be more prevalent in Jews than in Arabs.⁶ The prevalence of asthma was 7.7% in Jewish children living in urban areas and 6.5% in those living in rural areas. Asthma prevalence was 2.7 and 1.8% in Arab children living in urban and rural areas, respectively.⁶ Results of a large national study of 13- to 14-year-old schoolchildren in 1997 showed that the prevalence of asthma was 50% higher in the subsample of Jewish children, and the prevalence of asthma symptoms was twice that of the subsample of Arab children.⁷

Most studies have found a significantly higher prevalence of asthma in children of parents of lower social class.^{1,4,8} Because the socioeconomic status (SES) of Arabs in Israel is generally low, the direction of the difference in asthma prevalence between Jews and Arabs is somewhat unexpected. It is not known how much of this difference reflects a greater exposure of Jewish schoolchildren to environmental risk factors for asthma and how much may be attributed to a genetic component that makes the Jewish population more susceptible to asthma.

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Identification of social and environmental factors that contribute to the observed population differences is important and can provide clues to prevention and more effective treatment.

In this study, we expanded the analyses of the 1997 national survey. The aims of the present study were to identify risk factors for asthma and current wheeze and to evaluate whether the differences in prevalence of asthma and current wheeze between Jews and Arabs remain after adjustment for these risk factors.

MATERIALS AND METHODS

Sampling Strategy

The data were collected as part of a national study of the prevalence of asthma, asthma symptoms, and allergy in schoolchildren across Israel carried out in 1997. A detailed description of the study methods is given elsewhere.⁷ In summary, the study was conducted on a representative sample of 13- to 14-year-old schoolchildren from 141 schools chosen at random from a list of schools provided by the Israel Ministry of Education. Because Jewish children and Arab children generally attend separate schools, sampling was performed separately for each population group. The parents of the children in the selected schools received an explanatory letter with a reply slip to return if they did not want their child to participate in the study. Children who were absent from school on the day of the study were asked to complete the questionnaire on a specified day in the following month.

Questionnaire

We used the International Study of Asthma and Allergies in Childhood (ISAAC) standard core questionnaire for wheezing and asthma.⁹ To this we added questions regarding demographic and physical factors such as the child's sex, weight, height, country of birth, area of residency, population group (Jewish or Arab), number of siblings, and parental age. To allow comparison of the results of the present study with other studies that did not use the ISAAC questionnaire, we added a question to read as follows: "Do you have asthma or spastic bronchitis?" The social and environmental factors that were studied included parental education (number of years at school), number of people residing at home, number of rooms in household, presence of furry pets, and parental smoking. The children were also asked whether either parent had a history of asthma. All questionnaires were completed in the classroom, and teachers were instructed not to help the children with the answers. The questionnaire was given to each group of children in their native language. To assure similarity in the interpretation of different questions, the questionnaire was translated from Hebrew to Arabic and then back to Hebrew. All responses were anonymous.

Definitions

Children who answered "yes" to the question: "Do you have asthma or spastic bronchitis?" were considered to have asthma, and those who had wheezing in the past 12 months

were considered to have "current wheeze." The term "spastic bronchitis" was used because that is more commonly used by the public for asthma. In accordance with the definition of the Israel Ministry of Interior Affairs, areas of residence with <2,000 inhabitants were considered rural, and those with 2,000 or more residents were considered urban. An index of crowding was defined as the number of people residing in the household divided by the number of rooms (excluding bathrooms).

Statistical Analyses

Statistical analyses were performed using the SAS package (version 6.12, SAS, Cary, NC). Comparisons between the prevalence of asthma and current wheeze by sex, place of residence, presence of older siblings, parental education, history of asthma in either parent, and other potential risk factors were carried out using the χ^2 test, and odds ratios (ORs) were calculated. To evaluate the association between population group and asthma and current wheeze (as dichotomous dependent variables) while controlling for other possible risk factors, the multiple logistic regression model was used, and adjusted ORs were calculated.

RESULTS

There were 10,057 complete questionnaires available for analysis; 7,436 were from Jewish children (73.9%), and 2,621 were from Arab children (26.1%). Response rate was 85.0% for Jewish children and 91.1% for Arab children. Table 1 summarizes some of the characteristics of the two study populations. As can be seen, parental level of education was significantly higher among Jews compared with Arabs, and there were significantly more Arab children living in more crowded conditions. Arab children had three or more older siblings significantly more often than Jewish children. Maternal age at the child's birth was significantly lower among Arabs. Although paternal smoking was significantly more common among Arabs, the opposite was found for maternal smoking.

Prevalence of Asthma by Selected Risk Factors

A total of 7.8% of the Jewish children reported having asthma, compared with 4.9% of the Arab children (OR: 1.65; 95% confidence interval [CI]: 1.35 to 2.02; $P = 0.001$). The prevalence and crude odds ratio for asthma by selected risk factors are shown in Table 2. Living in urban areas, ever having pets, maternal smoking, history of asthma in parents, low parental education (less than 12 years), and the presence of less than three older siblings were significantly associated with increased risk for asthma.

Current Wheeze by Selected Risk Factors

Jewish children had a significantly higher prevalence of current wheeze (20.8%) compared with Arab children (10.0%; OR: 2.34; 95% CI: 2.03 to 2.69; $P = 0.001$). The prevalence and crude odds ratios for current wheeze by selected risk factors are shown in Table 2. Female sex, living in urban areas, having ever had pets, maternal smoking, history of

Table 1. Characteristics of Study Participants by Population Group

Characteristic	Jews (%)	Arabs (%)	P
Sex			
Male	3639 (48.9)	1351 (51.5)	0.02
Female	3797 (51.1)	1270 (49.5)	
Maternal age at child's birth			
≤20	539 (7.9)	384 (18.2)	0.001
21–30	4525 (66.9)	1340 (63.6)	
>30	1699 (25.2)	384 (18.2)	
Body mass index			
≤18.5	3005 (52.3)	712 (38.9)	0.001
>18.5	2735 (47.7)	1119 (61.1)	
Area of residence			
Urban	6300 (84.7)	2200 (87.4)	0.001
Rural	1139 (15.3)	318 (12.6)	
Pets			
Ever had	5459 (75.5)	1250 (54.4)	0.001
Never	1767 (24.5)	1047 (45.6)	
Paternal smoking			
Yes	2632 (36.7)	1481 (59.9)	0.001
No	4546 (63.3)	990 (40.1)	
Maternal smoking			
Yes	1815 (25.3)	134 (5.4)	0.001
No	5363 (74.7)	2337 (94.6)	
History of asthma in parents			
Yes	565 (7.6)	92 (3.5)	0.001
No	6871 (92.4)	2529 (96.5)	
Crowding (no. per room)			
≤1	4071 (57.8)	593 (24.1)	0.001
>1	2969 (42.2)	1872 (75.9)	
Maternal education (years)			
<12	1190 (16.3)	1744 (67.2)	<0.001
≥12	6121 (83.7)	850 (32.8)	
Paternal education (years)			
<12	1547 (21.2)	1522 (58.5)	<0.001
≥12	5712 (78.8)	1081 (41.5)	
Presence of older siblings			
<3	5790 (86.9)	1349 (60.8)	0.001
≥3	903 (13.1)	871 (39.2)	

asthma in parents, living in less crowded conditions (≤ 1 person per room), parental low education, and the presence of less than three older siblings were significantly associated with current wheeze.

Prevalence of Asthma in Children with Wheeze

Jewish males with current wheeze had asthma significantly more often (32.5%), compared with Jewish females (23.7%; $P = 0.03$), Arab males (22.3%; $P = 0.03$), and Arab females (21.8%; $P = 0.03$). There were no significant differences in the prevalence of asthma between the other subgroups (Jewish females vs Arab males or females, and Arab males vs Arab females).

Multiple Regression Analysis

Tables 3 and 4 provide the results of multiple logistic regression analysis. After adjustment for various risk factors, population group remained a significant risk factor for asthma

and current wheeze. The magnitude of the association did not change substantially; the adjusted odds ratios were 1.51 for asthma (95% CI: 1.06 to 2.15) and 2.15 (95% CI: 1.70 to 2.73) for current wheeze. Living in a rural area and parental history of asthma remained significant risk factors for asthma and current wheeze. Having less than three older siblings was a significant risk factor for asthma, whereas female sex, having ever had pets, and maternal smoking were significant risk factors for current wheeze but not for asthma. The most prominent risk factor associated with both asthma and current wheeze was a history of asthma in parents (adjusted OR: 3.69 for asthma and 2.26 for current wheeze).

To examine whether the risk factors had a different impact on the two groups, we analyzed the data by population group and by sex. A history of asthma in parents was the most remarkable risk factor that was significant for all subgroups. The odds ratios for asthma associated with parental history of asthma were of the same magnitude for Jewish males and females (3.07 and 3.94, respectively) and were higher for Arab males and females (21.4 and 9.29, respectively). Similar results were obtained for current wheeze. The odds ratios for current wheeze in Jewish males and females were 2.36 and 1.98, respectively, and 3.78 and 6.15 for Arab males and females. Living in an urban area remained a significant risk factor only in Jewish males, and the presence of less than three older siblings remained a significant risk factor in Jewish and Arab males. However, the trend was similar in all subgroups. Ever having pets was a significant risk factor in Jewish and in Arab females. Maternal smoking was a significant risk factor in Jewish females and in Arab males. However, a similar trend was noted for these factors in all other subgroups.

Data analysis by ethnic group showed that female sex was a significant risk factor for current wheeze in Jewish children (OR = 1.35; 95% CI: 1.17 to 1.55; $P = 0.0001$) but not in Arab children (OR = 1.03; 95% CI: 0.68 to 1.56; $P = 0.88$). Sex was not a significant risk factor for asthma in either Jewish or Arab children.

DISCUSSION

In this large national study, the prevalence of asthma and current wheeze remained significantly higher in Jewish schoolchildren compared with Arab schoolchildren after adjustment for several risk factors.

Higher prevalence of asthma and current wheeze have generally been reported to be associated with lower SES.^{1,10} The Arab population in Israel is, in general, of lower SES compared with the Jewish population. In this study, lower SES is shown by lower parental education level, more crowded living conditions, and a larger family size (Table 1). Therefore, the lower prevalence of asthma and current wheezing among Arab children is somewhat surprising. However, some studies have suggested that indicators of higher SES, such as improved hygiene and health standards, are associated with increased asthma prevalence.¹¹ Heinrich et al¹² showed that the prevalence of atopic diseases was significantly higher in children from social class III (in which

Table 2. Prevalence of Asthma and Current Wheeze in Children 13 to 14 Years Old by Risk Factor

Risk Factor	Asthma (%)	OR	95% CI	P	Current Wheeze (%)	OR	95% CI	P
Population group								
Jews	7.8	1.65	1.33–1.99	0.001	20.8	2.29	1.99–2.65	0.001
Arabs	4.9				10.0			
Sex								
Male	7.3	1.09	0.92–1.25	0.26	16.1	0.78	0.70–0.86	0.001
Female	6.8				19.8			
Maternal age at child's birth								
≤20	6.9	0.96	0.73–1.28	0.92	17.5	0.92	0.76–1.10	0.24
21–30	7.2				18.3			
>30	7.0				19.8			
Body mass index								
≤18.5	7.0	0.97	0.83–1.18	0.72	18.4	0.94	0.85–1.07	0.33
>18.5	7.3				19.3			
Area of residence								
Urban	7.3	1.31	1.01–1.63	0.04	18.6	1.19	1.01–1.37	0.02
Rural	5.7				16.0			
Pets								
Ever had	7.6	1.38	1.10–1.60	0.001	19.9	1.55	1.40–1.80	0.001
Never	5.6				13.8			
Paternal smoking								
Yes	7.4	1.12	0.94–1.28	0.17	18.6	1.06	0.98–1.20	0.30
No	6.7				17.8			
Maternal smoking								
Yes	9.6	1.57	1.30–1.85	0.001	24.7	1.66	1.48–1.88	0.001
No	6.4				16.5			
History of asthma in parents								
Yes	19.2	3.59	2.92–4.48	0.001	34.5	2.61	2.20–3.09	0.001
No	6.2				16.8			
Crowding (no. per room)								
≤1	7.3	1.11	0.97–1.15	0.28	19.7	1.24	1.11–1.37	0.001
>1	6.6				16.5			
Maternal education								
<12	6.3	0.82	0.67–1.00	0.06	16.4	0.76	0.72–0.94	0.003
≥12	7.6				19.3			
Paternal education								
<12	6.0	0.79	0.65–0.96	0.02	15.7	0.79	0.69–0.89	0.001
≥12	7.4				19.2			
Presence of older siblings								
<3	7.4	1.43	1.14–1.78	0.002	19.2	1.37	1.19–1.58	0.0001
≥3	5.3				14.7			

parents had >10 years of formal education) compared with children of social class I (<10 years of parental education).

In the present study, differences between the Jewish and Arab populations in risk factors such as parental education and crowding could potentially account for the observed differences in the prevalence of asthma and current wheeze. However, after controlling for these risk factors, the differences in prevalence of asthma and current wheeze between Jews and Arabs remain significant.

A possible explanation for these differences could be a greater exposure of Arab children to certain infectious diseases early in childhood (particularly in the first year of life). Early exposure to infectious diseases has been described in some studies to be inversely associated with the frequency of

several allergic disorders.^{13–16} Ball et al¹⁷ showed that exposure of young children to older children at home or to other children at day care facilities protected against the development of asthma and frequent wheezing later in childhood. In the present study, having three or more older siblings was significantly more common in the Arab population (Table 1) compared with the Jewish population. Having fewer than three older siblings remained a significant risk factor for asthma in the multiple logistic regression analysis but did not eliminate the association between population group and asthma.

Another explanation for the observed differences between Jews and Arabs could be differences in certain relevant environmental exposures. It is possible that although suscep-

Table 3. Adjusted ORs (and 95% CIs) for Asthma in Children 13 to 14 Years Old

Factor	Odds Ratio*	95% Confidence Interval	P
Jews	1.51	1.06–2.15	0.02
History of asthma in parents	3.69	2.81–4.85	0.0001
Area of residence urban	1.59	1.15–2.20	0.005
Presence of < 3 older siblings	1.45	1.04–2.04	0.03
Ever had pets	1.20	0.93–1.53	0.15
Sex female	0.91	0.74–1.11	0.34
Maternal age at child's birth > 30	3.13	0.42–22.96	0.26
Body mass index > 18.5	1.09	0.89–1.34	0.38
Paternal smoking	1.05	0.84–1.30	0.66
Maternal smoking	1.21	0.95–1.55	0.11
Crowding (no. per room) > 1	1.04	0.84–1.29	0.71
Maternal education ≥ 12 years	1.07	0.78–1.47	0.65
Paternal education ≥ 12 years	0.86	0.65–1.15	0.32

* Adjusted for all other factors listed in the table.

tibility to these factors might be equal for Jews and Arabs, Jews were exposed to these factors first. This is suggested by the higher prevalence of parental asthma among Jews compared with Arabs, as shown in Table 1. Alternatively, differential genetic susceptibility should also be taken into account. A third explanation could be differences in breast-feeding habits between Jews and Arabs. The duration of breast-feeding is longer in the Arab population (personal communications, D. Nitzan-Kaluski, January 2001). A substantial reduction in the risk of childhood asthma has been observed when exclusive breast-feeding was continued for at least the first 4 months of life.^{18,19}

The adjusted odds ratio in Jewish children was 1.51 for asthma and 2.15 for current wheeze. The larger difference in symptoms as opposed to diagnosis could be attributed to different levels of awareness about asthma symptoms in these groups. Ethnic differences in the perception of asthma symptoms has been described in the United States between African-American and white patients.²⁰ In addition, cultural differences that influence behavior of denial were suggested as a possible explanation for racial differences in asthma prevalence.²¹

Although there is universal health insurance in Israel (as provided by the National Health Insurance Law), there could be differences in the use of health services by the two population groups, resulting in underdiagnosis of asthma in Arabs. Data from the National Health Survey conducted in 1995 showed significant differences between Jews and Arabs in presentation to a specialist for all age groups. For example, in the age group 0 to 14, 2.6% of Jews reported being seen by a specialist in the last 2 weeks compared with 0.9% of Arabs ($P < 0.001$).²²

Table 4. Adjusted OR (and 95% CIs) for Current Wheeze in Children 13 to 14 Years Old

Factor	Odds Ratio*	95% Confidence Interval	P
Jews	2.15	1.70–2.73	0.0001
Sex female	1.32	1.15–1.50	0.0001
History of asthma in parents	2.26	1.81–2.82	0.0001
Area of residence urban	1.39	1.14–1.69	0.0012
Ever had pets	1.29	1.10–1.52	0.0018
Maternal smoking	1.30	1.13–1.53	0.001
Maternal age at child's birth > 30	1.31	0.54–3.13	0.55
Body mass index > 18.5	1.07	0.94–1.22	0.31
Paternal smoking	1.05	0.91–1.21	0.48
Crowding (no. per room) > 1	1.01	0.88–1.16	0.85
Maternal education ≥ 12 years	1.12	0.92–1.37	0.26
Paternal education ≥ 12 years	0.95	0.79–1.14	0.59
Presence of < 3 older siblings	1.16	0.95–1.42	0.15

* Adjusted for all other factors listed in the table.

In accordance with the ISAAC protocol for 13- to 14-year-old children, the questionnaires were completed by the children themselves. The ISAAC questionnaire has been validated by respiratory physician evaluation, with sensitivity of 85%, and specificity of 81%.²³ Self-reports by children of respiratory symptoms have been shown to be more valid than parental reports.²⁴ Wieringa et al²¹ demonstrated underreporting of respiratory and nasal symptoms, especially by 13- to 14-year-old boys, and therefore the possibility of underreporting by Arab children should be taken into account in the interpretation of the present results. However, it seems unlikely that this is the sole explanation for the population group differences. As we mentioned above, similar differences between Jews and Arabs were observed for asthma when parents were interviewed.⁶

Racial differences in the prevalence of asthma, not explained by other factors, have been reported in the United States.^{1–4} However, in the United States, the direction of the association was in the opposite direction, and the prevalence of asthma was higher in African-Americans (who are often of lower SES) than whites. Cunningham et al³ concluded that being African American was an important risk factor for active diagnosed asthma that could not be explained by social factors. Schwartz et al⁴ and Gold et al²⁵ reported that African-Americans had a higher prevalence of asthma and persistent wheeze after adjustment for socioeconomic and environmental factors. However, Weitzman et al¹ found that much of the difference in asthma by race could be explained by social and environmental factors such as poverty, maternal smoking, home size, and maternal education.

In the current study, parental history of asthma was the most important risk factor for asthma and current wheeze. The adjusted odds ratios were 3.69 and 2.26, respectively. Parental history of asthma remained a significant risk factor after sex and population group were analyzed. These current results are consistent with those of earlier reports.^{3,25,26} Living in an urban area was also a consistent risk factor for asthma and current wheeze. The association between asthma and living in an urban area in Israel has been reported previously.⁶

Female sex, maternal smoking, and ever owning pets were also significant risk factors for current wheeze. A higher prevalence of asthma in female adolescents compared with males has been reported in other studies.^{21,27,28} Wieringa et al²¹ suggested that these sex differences could be the result of underreporting by boys. In the present study, female sex was a significant risk factor for current wheeze in Jewish children but not in Arab children. As Jewish adolescents contributed approximately 75% of the sample, and Jewish boys seem to underreport wheezing compared with the diagnosis of asthma/spastic bronchitis, the increased risk of wheezing in girls may be explained by underreporting of asthma symptoms by Jewish males compared with Jewish females.

In a systematic review of the evidence relating smoking to the prevalence of asthma and respiratory symptoms, the pooled OR for either parent smoking was 1.2 (95% CI: 1.1 to 1.3) for asthma. Maternal smoking had a greater effect than paternal smoking.²⁹

The results of studies on the association between pet ownership and asthma are not consistent. Although Hong et al³⁰ found that the odds ratio associated with current keeping of dogs or pets was 1.84, other studies failed to find such an association.³¹

This was a cross-sectional study, and we are aware of the problems in interpreting data on risk factors for allergic diseases. It is possible that exposure to certain risk factors may have changed after the onset of asthma.

CONCLUSION

This is the first large-scale study to address the differences in asthma prevalence between Jewish and Arab children. The higher prevalence of asthma in Jewish children in this study can not be explained by controlling for a large number of potential risk factors previously described in the literature. This suggests the involvement of additional factors such as environmental exposures, genetics, nutrition, and previous infectious agents in infancy and early childhood. In addition, selective underreporting of symptoms could not be ruled out.

REFERENCES

- Weitzman M, Gortmaker S, Sobol A. Racial, social and environmental risks for childhood asthma. *Am J Dis Child* 1990; 144:1189–1194.
- Marder D, Targonski P, Orris P, et al. Effect of racial and socioeconomic factors on asthma mortality in Chicago. *Chest* 1992;101:426S–429S.
- Cunningham J, Dockery DW, Speizer FE. Race, asthma, and persistent wheeze in Philadelphia schoolchildren. *Am J Public Health* 1996;86:1406–1409.
- Schwartz J, Gold D, Dockery DW, et al. Predictors of asthma and persistent wheeze in a national sample of children in the United States. *Am Rev Respir Dis* 1990;142:555–562.
- Goh DY, Chew FT, Quek SC, et al. Prevalence and severity of asthma, rhinitis, and eczema in Singapore schoolchildren. *Arch Dis Child* 1996;74:131–135.
- Amir J, Horev Z, Jaber L, et al. Prevalence of asthma in Israeli schoolchildren. *Isr J Med Sci* 1992;28:789–792.
- Shohat T, Golan G, Green MS, et al. Prevalence of asthma in 13–14 year old schoolchildren across Israel. *Eur Res J* 2000; 15:725–729.
- Ernst P, Demissie K, Joseph L, et al. Socioeconomic status and indicators of asthma in children. *Am J Respir Crit Care Med* 1995;152:570–575.
- 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.
- Litonjua A, Carey VJ, Weiss ST, et al. Race, socioeconomic factors, and area of residence are associated with asthma prevalence. *Pediatr Pulmonol* 1999;28:394–401.
- Platts-Mills TA, Woodfolk JA. Rise in asthma cases. *Science* 1997;278:1001.
- Heinrich J, Popescu MA, Wjst M, et al. Atopy in children and parental social class. *Am J Public Health* 1998;88:1319–1324.
- Abramson MJ, Walters EH. The epidemic of asthma: too much allergen or not enough infection? *Med J Aust* 2000;172: 119–121.
- Martinez FD. Role of viral infections in the inception of asthma and allergies during childhood: could they be protective? *Thorax* 1994;49:1189–1191.
- Rona RJ, Duran-Tauleria E, Chinn S. Family size, atopic disorders in parents, asthma in children, and ethnicity. *J Allergy Clin Immunol* 1997;99:454–460.
- Ponsonby AL, Couper D, Dwyer T, et al. Cross sectional study of the relation between sibling number and asthma, hay fever, and eczema. *Arch Dis Child* 1998;79:328–333.
- Ball TM, Castro-Rodriguez JA, Griffith KA, et al. Siblings, day-care attendance, and the risk of asthma and wheezing during childhood. *N Engl J Med* 2000;343:538–543.
- Oddy WH, Holt PG, Sly PD, et al. Associations between breast feeding and asthma in six year old children: findings of a prospective birth cohort study. *BMJ* 1999;319:815–819.
- Brown MA, Halonen M. Perinatal events in the development of asthma. *Curr Opin Pulm Med* 1999;5:4–9.
- Hardie GE, Janson S, Gold WM, et al. Ethnic differences: word descriptors used by African-American and white asthma patients during induced bronchostriction. *Chest* 2000;117: 928–929.
- Wieringa MH, Weyler HP, Van Bever HP, et al. Gender differences in respiratory, nasal and skin symptoms: 6–7 versus 13–14-year-old children. *Acta Paediatr* 1999;88:147–149.
- Israel Central Bureau of Statistics. Health Survey 1996–1997, General findings. Jerusalem: Central Bureau of Statistics, Publication no 1136, 1997.
- Jenkins MA, Clarke JR, Carlin JB, et al. Validation of questionnaire and bronchial hyper-responsiveness against respiratory physician assessment in the diagnosis of asthma. *Int J Epidemiol* 1996;25:609–616.

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24. Lara M, Duan N, Sherbourne C, et al. Differences between child and parent reports of symptoms among Latino children with asthma. *Pediatrics* 1998;102:1–8.
 25. Gold DR, Rotnitzky A, Damokosh AI, et al. Race and gender differences in respiratory illness prevalence and their relationship to environmental exposures in children 7 to 14 years of age. *Am Rev Respir Dis* 1993;148:10–18.
 26. Young S, Le Souef PN, Geelhoed GC, et al. The influence of a family history of asthma and parental smoking on airway responsiveness in early infancy. *N Engl J Med* 1991;324:1168–1173.
 27. Kaur B, Anderson HR, Austin J, et al. Prevalence of asthma symptoms, diagnosis, and treatment in 12–14 year old children across Great Britain (International Study of Asthma and Allergies in Childhood, ISAAC UK). *BMJ* 1998;316:118–124.
 28. Pearce N, Weiland S, Keil U, et al. Self-reported prevalence of asthma symptoms in children in Australia, England, Germany and New Zealand: an international comparison using the ISAAC protocol. *Eur Respir J* 1993;6:1455–1461.
 29. Cook DG, Strachan DP. Parental smoking and prevalence of respiratory symptoms and asthma in school age children. *Thorax* 1997;52:1081–1094.
 30. Hong CY, Ng TP, Wong ML, et al. Lifestyle and behavioral risk factors associated with asthma morbidity in adults. *Q J Med* 1994;87:639–645.
 31. Tariq SM, Matthews SM, Hakim EA, Arshad SH. The prevalence of and risk factors for atopy in early childhood: a whole population birth cohort study. *J Allergy Clin Immunol* 1998;101:587–593.
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