



The prevalence of pediatric asthma in the Islamic Republic of Iran: A systematic review and meta-analysis

Javad Ghaffari¹
Mohsen Aarabi^{2*}

¹Molecular and Cell Biology Research Center, Department of Pediatric Immunology and Allergy, Faculty of Medicine, Mazandaran University of Medical Sciences Sari, Iran

²Health Sciences Research Center, Mazandaran University of Medical Sciences, Sari, Iran

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ABSTRACT

The prevalence of asthma is inconsistent in different countries and even in regions of a country. Awareness of this prevalence has favorable impacts on health care system planning. The aim of this literature review and meta-analysis was to estimate the prevalence of pediatric asthma in the Islamic Republic of Iran during two recent decades.

A search was done in national (SID, Magiran, Irandoc, Iranmedex) and international databases (PubMed and Google Scholar) to find articles which evaluated asthma prevalence in pediatrics and adolescences, using the international study of asthma and allergies in children written questionnaire.

Twenty eight articles between 1992 and 2012 with a total of 96822 participants were found. 'Asthma ever' prevalence was 2.7% (95% CI: 1.9 to 3.6) and 3.5% (95% CI: 2.6 to 4.6) in children aged 6-7 and 13-14 years, respectively. 'Wheezing in the past 12 months' were 7.6% (5.6 to 9.8) and 10.7% (95% CI: 8.9 to 12.7) in children aged 6-7 and 13-14 years, respectively.

The prevalence of asthma had an increasing trend during the last two decades, therefore, the health care system should be alarmed for more meticulous planning and evaluation to control and prevent asthma.

Introduction

Allergic disorders are encountered with variable prevalence in different parts of the world. Asthma is the most common chronic disease in pediatric population.¹ Based on published literature the prevalence of allergic disorders including asthma has increased during the last decades, especially in urban areas. It is

calculated that the prevalence of asthma in the last 20 years has doubled.² Allergic disorders pose heavy social and financial burden on the family and society. Furthermore, much morbidity may complicate asthma and it may even lead to death. Asthma is the most common reason for emergency visits to hospital and

*Corresponding Author: Mohsen Aarabi, Assistant professor, Epidemiologist

Mailing Address: Health Sciences Research Center, Mazandaran University of Medical Sciences, Sari, Iran.

Tel: +98 151 2233011-15

Fax: +98 151 2234506

Email: aarabi@mazums.ac.ir

absence from school among school-aged children. Although some specific reasons have been proposed for the increased asthma prevalence, a bunch of genetic and environmental factors such as allergens, viral infections, pollutants, low birth weight, life style, socioeconomic status, geographical area, diet, and tobacco smoke have been implicated. Among these the role of environmental factors seems to be more prominent.³

The studies to determine asthma prevalence are performed based on a standardized international inventory called the international study of asthma and allergies in children (ISAAC). Epidemiologically, it is a valuable research instrument which increases the similarities and compatibility of various studies. The previous systematic reviews based on these studies demonstrated the mean prevalence of asthma in Iran from 1998 to 2003 to be 13 percent with the minimum in Kerman (2.7%) and maximum in Tehran (35.3%).⁴

The timely diagnosis and management reduces the morbidity and mortality associated with asthma while correct understanding of the true prevalence of this disorder may help in the appropriate planning not only for prevention and treatment sakes but also for the reduction in its prevalence.

The aim of this study was to review and meta-analysis of prevalence of pediatric asthma in the Islamic Republic of Iran in the past two decades.

Methods

Search strategy

Both English and Farsi language databases were searched between March 1992 and December 2012. The Medline database of the National Library of Medicine and the website of the international study of asthma and allergies in children (ISAAC) were used for finding the English language papers. In order to find the

relevant articles in Farsi language a variety of websites such as Scientific Information Database (SID), Irandoc, Iranmedex, Magiran, and Google Scholar were searched in the same time span. The searched terms were; asthma; pediatrics, children, adolescences; prevalence, frequency; and Iran. References of the found articles were used for finding more appropriate papers. Moreover, relevant national and regional conference proceedings were checked.

Study selection and data extraction

All of the studies that estimated the prevalence of pediatrics asthma in the Islamic Republic of Iran between 1992 and 2012 were included. However, studies with non-random sampling were excluded from this research. The criteria for diagnosis of asthma were the ISAAC written questionnaire. The data extraction form consisted of fields for sample size, age range, the prevalence rate, place of study, publication date and data of conducting the study.

Statistical analysis

The heterogeneity between studies was evaluated using the Chi-square test and I^2 index. The point estimates and their 95% confidence interval (CI) were also computed. The Stats Direct Statistical Software, 2.7.2 was used for all the analysis.

Results

In total, 28 studies from 19 provinces were included (Figure 1). All studies were carried out in school-aged children, aged 6-7 and 13-14 years and consisted of 96822 participants (Table 1). The response rates were more than 95% in all the studies.

The pooled weighted prevalence rate of "asthma ever" for the included studies was 3.04% (95% CI: 2.5 to 3.6) and the overall prevalence of 'wheezing in the past 12 months' was 9.3% (95% CI: 7.9 to 10.8).

Table 1: Characteristics of included studies

First author and reference	Study year	City	Age group	Sample size
Bazzazi H. ⁵	2003	Gorgan	13-14	2800
Gharagozlou M. ⁶	1998	Kashan	6-7	3003
Ghaffari J. ⁷	2010	Sari	7-12	1818
GolshanM. ^{8,9}	1998	Isfahan	6-7	3828
GolshanM. ^{10,11}	1999	Boroojerd	6-7	1331
GolshanM. ^{12,13}	2002	Zarrinshahr	7-13	1099
HabibiKhorasani A.R. ¹⁴	1999	Kerman	6-12	2217
Hasanzadeh J. ¹⁵	2009	Shiraz	6-7	3000
Hatami G. ¹⁶	2001	Bushehr	13-14	2699
Hedayatmofidi S.M. ¹⁷	2006	Gorgan	7-18	580
Heidarnazhad H. ¹⁸	2000	Tabriz	6-7	1147
Karimi M. ¹⁹	2002	Yazd	11-15	3127
MasjediM.R. ⁸	2001	Tehran	6-7 & 13-14	6127
MasjediM.R. ¹⁰	1996	Birjand	6-7 & 13-14	5422
MasjediM.R. ¹²	1996	Zanjan	6-7 & 13-14	5582
MasjediM.R. ²⁰	1995	Rasht	6-7 & 13-14	6195
MasjediM.R. ²¹	1995	Tehran	6-7 & 13-14	5147
Mirzaee M. ²²	2002	Yazd	6-7 & 13-14	2740
Mohammadzadeh I. ²³	2002	Babol	6-7 & 13-14	5933
Mortazavi Moghaddam G. ²⁴	2002	Birjand	13-14	3537
Najafizadeh K. ²⁵	2001	Rasht	6-7 & 13-14	5834
Rahimi Rad M.H. ²⁶	2002	Urmia	6-7 & 13-14	5999
Sahebi L. ²⁷	2009	Tabriz	13-14	1508
Shakurnia A.H. ²⁸	2006	Ahwaz	6-7 & 13-14	2860
ZiaeiKajbaf T. ²⁹	2009	Ahwaz	6-7 & 13-14	903
Zobeiri M. ³⁰	2007	Kermanshah	6-7 & 13-14	6236
Zohal M.A. ³¹	2002	Qazvin	6-7 & 13-14	5068

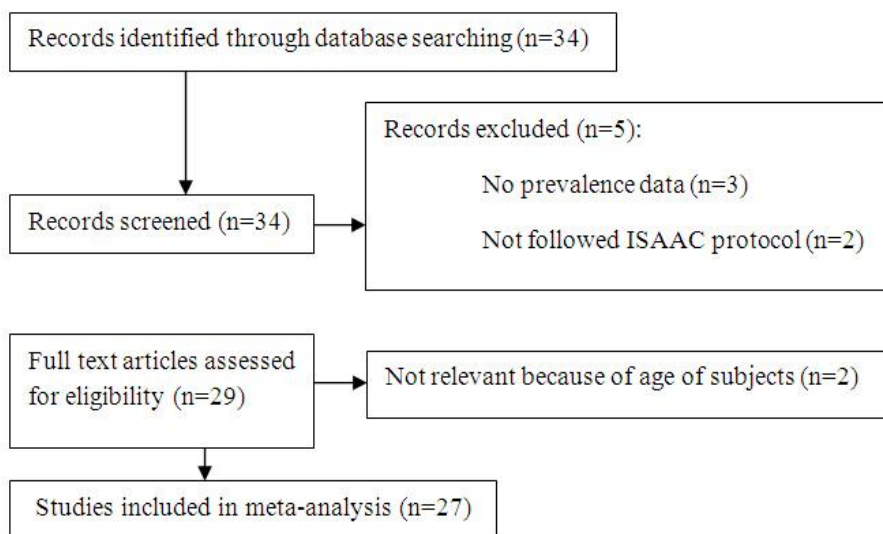


Figure 1: Process of inclusion of ISAAC articles

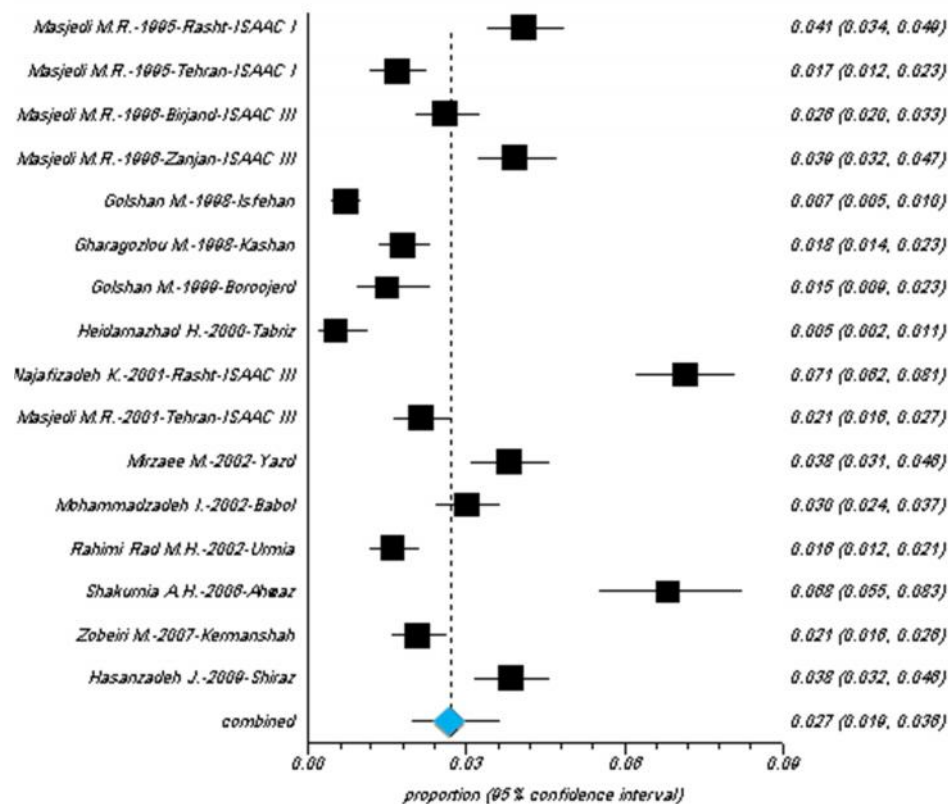


Figure 2: Proportion of “Asthma Ever” and its 95% confidence interval in 6-7-year-old children

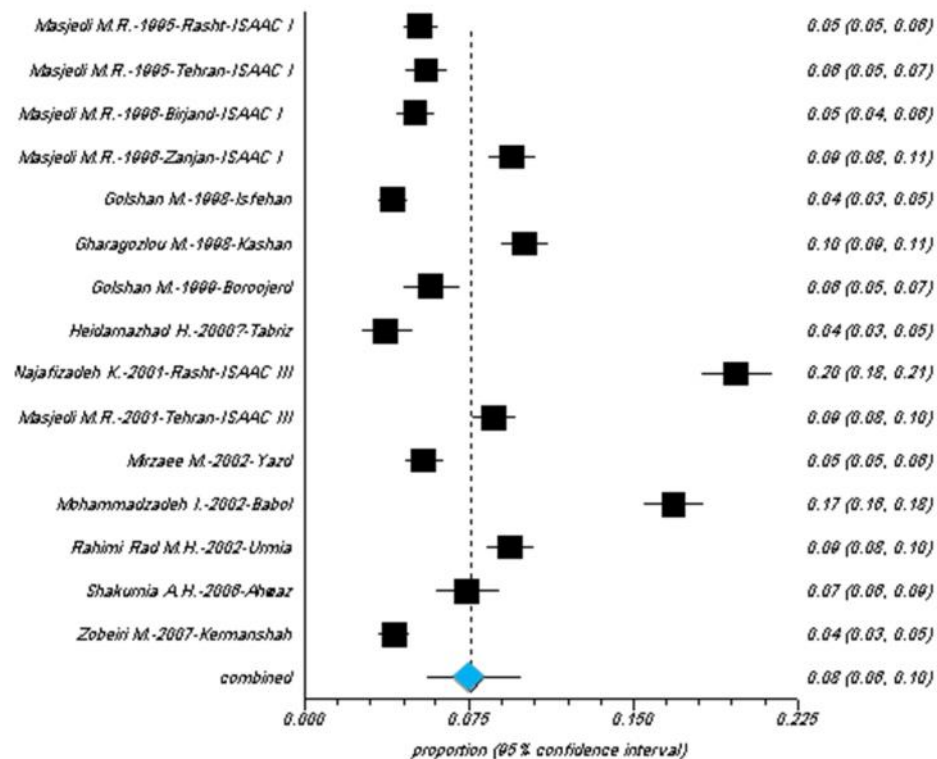


Figure 3: Proportion of “Wheezing in the past 12 months” and its 95% confidence interval in 6-7-year-old children

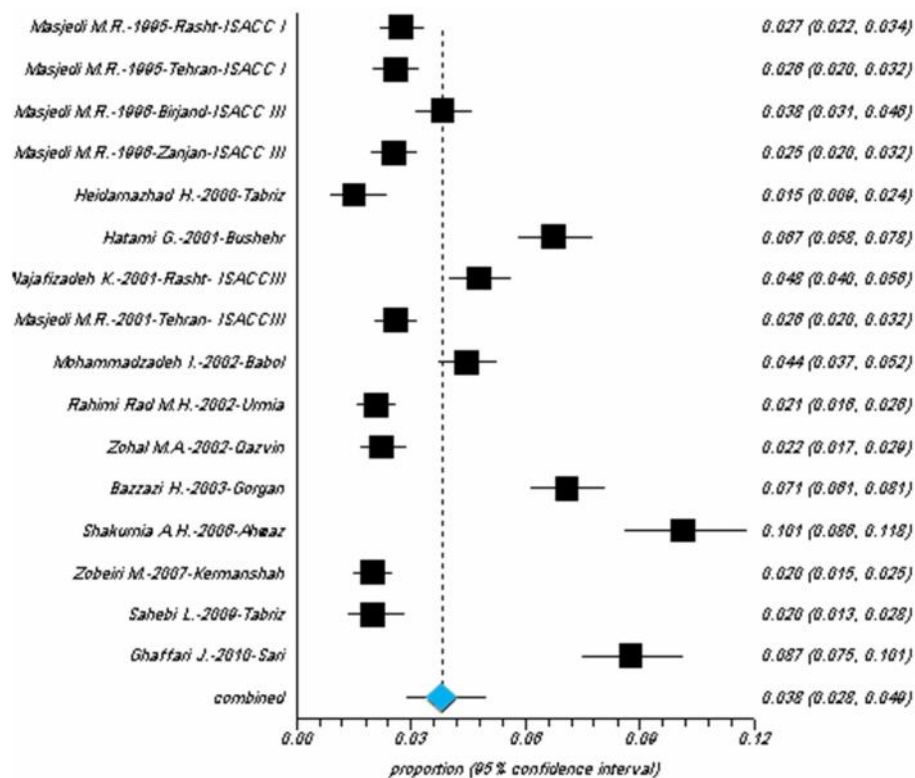


Figure 4: Proportion of “Asthma Ever” and its 95% confidence interval in 13-14-year-old children

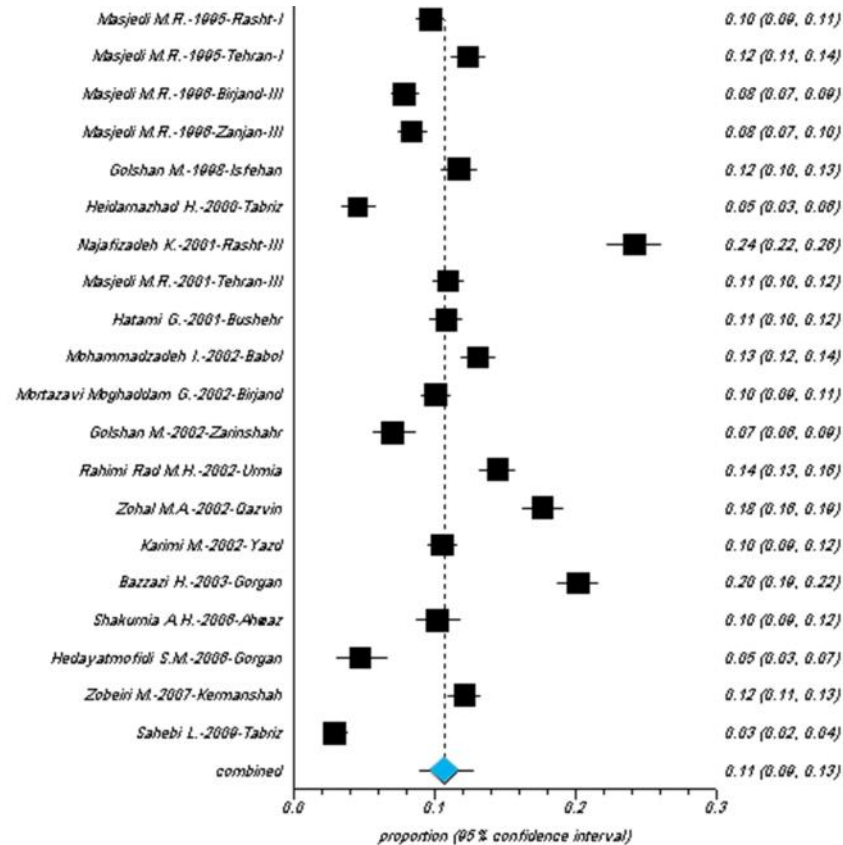


Figure 5: Proportion of “Wheezing in the past 12 months” and its 95% confidence interval in 6-7-year-old children

The estimated overall proportion of children aged 6-7 and 13-14 who had ever been diagnosed with asthma and 'wheezing in the past 12 months' are shown in figures 2,3, 4, and 5. Generally speaking the prevalence rates of 'asthma ever' and 'wheezing in the past 12 months' were higher among older children.

Boys had a higher prevalence of lifetime asthma (asthma ever) and wheezing in the past 12 months in both 6-7 and 13-14-year-old students (Figure 6).

Discussion

Prevalence rate of 'asthma ever' among Iranian children varied from 0.5 to 11.0% according to 27 articles that used the ISAAC written questionnaire (self-reported tool for ascertainment of disease). The lowest prevalence was seen in 6-7-year-old girls and the highest among the 13-14-year-old boys. The pattern was similar for the history of wheezing in the past 12 months and its prevalence rates were between 3.8 and 28.8%.

Childhood asthma is more common than adult's asthma and it is a public health challenge in the

world. The present analysis showed the prevalence of current and 'ever asthma' in two groups of 6-7 and 13-14 year olds. There is an inconsistency between different review papers for the overall estimate of prevalence rates of asthma in Iran. The main strength of this study, compared to previous reviews, is its completeness. All results of phase one and three of the ISAAC study were also taken into account in our meta-analysis, however, other papers^{4, 16, 32, 33} did not include the results accumulated in Tehran and Rasht (phase one), Birjand and Zanzan (phase three). The overall prevalence of asthma was reported 13.14% by Entezari et al (including 19 papers) and 3.9% by Mohammadbeigi et al (including 11 papers) compared to the 9.3% from current review and meta-analysis of 27 articles. The reason for this difference might be due to the including of the slightly lower prevalence rated studies of the phase one ISAAC study.

Based on our results the prevalence of childhood asthma is variable in different parts of Iran. Iran has a diverse weather with high

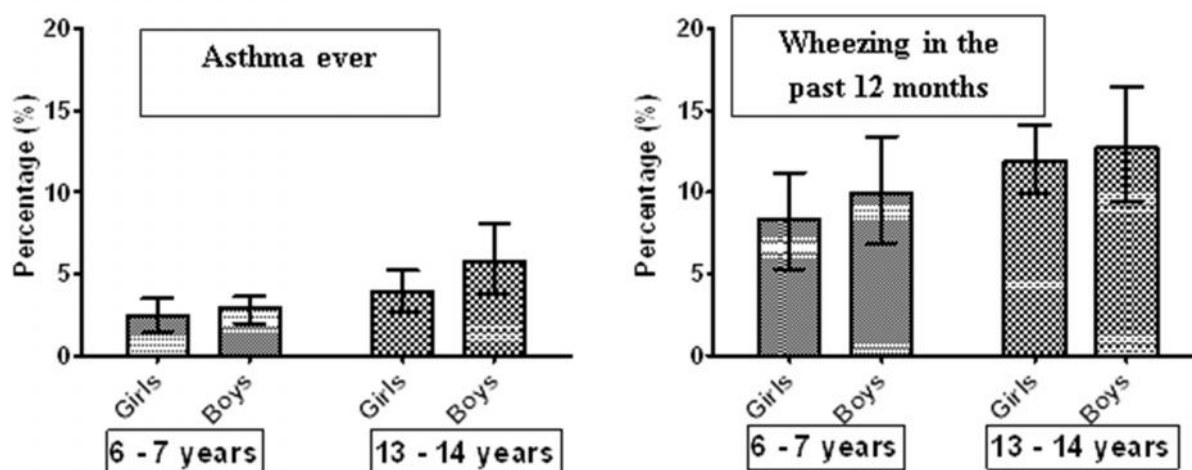


Figure 6: Prevalence of "Asthma ever" and "Wheezing in the past 12 months" based on gender and age group

humidity in the north and south, dry and warm in central areas and dry and cold in western, north-west and north-east areas. The highest prevalence of asthma was reported from studies in Rasht (north Iran) and Ahvaz (south Iran). In contrast the lowest prevalence rates were reported from studies in Tabriz (north-east of the country) with dry and cold weather. The north and south parts of Iran have higher humidity which may cause overgrowth of indoor allergens such as mites. This is not an adequate reason for the association between environmental factors and asthma prevalence rates. However, it has been suggested to have scanty effects on prevalence of asthma.³⁴

The prevalence of current asthma in Iran (9.3%) is lower than that of some other countries such as Austria (32%), United States of America (24.4%), United Kingdom (14.9%), Singapore (27.4%) and Malaysia (13 %).³⁵⁻³⁹ In developed countries, the degree of modernization could be related to the increase of prevalence of asthma.

In Brazil the prevalence of current asthma and “asthma ever” (physician-diagnosed asthma) in 13-14-year-olds were 22.6% and 11.6%, respectively which is more common than our results in Iran.⁴⁰

Similar to our results, Yangzong et al. reported a lifetime prevalence of asthma in Chinese children (1.1% to 11%). They included 74 papers that followed the ISAAC protocol.⁴¹

As a result of all of the studies in Iran being conducted in urban areas, comparison between rural and urban areas is not possible. Prevalence of asthma varied among urban areas due to differences in socioeconomic status, allergen concentration, atopy levels, etc.

Average prevalence rate of asthma in the Middle East is 10.7% (11% in Oman and Palestine and around 17% in Kuwait).^{42, 43} It was reported to be more common (23.6%; 95%CI: 21.3 to 26.0) in 6–8-year-old children in Madinah, Saudi Arabia (44).⁴⁴ In another

study of students in Saudi Arabia, the prevalence of lifetime wheezing, asthma diagnosed by physicians and wheezing in the past 12 months were reported 25.3%, 19.6% and 18.5%, respectively.⁴⁵

In studies on children aged 6–10 years in Albania, Austria, Belgium, Cyprus, Estonia, Finland, France, Georgia, Greece, Hungary, Italy, Latvia, Malta, Romania, the Slovak Republic, and Switzerland the prevalence of asthma of less than 10% were observed. Whereas it was reported higher in countries like Bulgaria (14.5%), Czech Republic (14.7%), Ireland (17.4%), and Norway (13.6%) (46). In Africa, it is less common and it was reported 2.0% in 0–9-year-olds and 1.7% in 10–19-year-olds in Ethiopia. More wheezing in the past 12 months was reported in Algeria, Kenya, Morocco and Nigeria (5%–14%). South Africa had a rate of 26.8% in 7–8-year-olds.⁴⁶

Differences between countries might be due to socioeconomic status, different climates, air pollution, exposure to respiratory infection, life style, variability of allergen levels, social habitus, diet and nutrition and diverse awareness of physicians and families (especially denial of the disease) about the diagnosis of asthma.

According to this review, the prevalence of asthma (both ‘asthma ever’ and ‘wheezing in the past 12 months’) in elementary school children is lower than that of junior high school children (13-14-year-old). It is similar to a study in Canada that showed prevalence rate of 24-30% in 13-14-year-olds and 5-20% in 6-12-year-olds.^{47, 48} vonMutius et al in Germany reported 6.4% and 7.2% in 6-7 and 13-14-year-old children, respectively (49).⁴⁹ However, our results are different from other studies such as in Chile, the prevalence was 26.2% in 7-year-olds and 17.2% in 15-year-olds.^{47, 48} In contrast to our study that showed the increase of childhood asthma prevalence with age, the

Korean investigators observed lower rates for higher age.⁵⁰ In Korea prevalence of asthma was more common in male than female in primary school children which is similar to our results. Other studies have the same results that more males have asthma before puberty as opposed to females who have more after puberty.⁵¹⁻⁵⁶

Conclusion

Our study showed that the prevalence of asthma and wheezing in the past 12 months in Iran is lower than developed countries but it is similar to other countries in the Middle East. Prevalence of asthma is more common in regions with higher humidity.

Hence, health care system should be prepared for more thorough planning and evaluation for the control and prevention of asthma from early ages in each region.

Conflict of Interest

None declared.

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References

1. Kudzyte J, Griska E, Bojarskas J. Time trends in the prevalence of asthma and allergy among 6–7-year-old children: results from ISAAC phase I and III studies in Kaunas, Lithuania. *Medicina (Kaunas)*. 2008; 44(12): 944-52.
2. Gessner BD, Neeno T. Trends in asthma prevalence, hospitalization risk, and inhaled corticosteroid use among Alaska native and nonnative Medicaid recipients younger than 20 years. *Annals of Allergy, Asthma & Immunology*. 2005; 94(3): 372-9.
3. Pal R, Dahal S, Pal S. Prevalence of bronchial asthma in Indian children. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*. 2009; 34(4): 310.
4. Entezari A, Mehrabi Y, Varesvazirian M, Pourpak Z, Moin M. A systematic review of recent asthma symptom surveys in Iranian children. *Chronic Respiratory Disease*. 2009; 6(2): 109-14.
5. Bazzazi H, Gharagozlou M, Kassaiee M, Parsikia A, Zahmatkesh H. The prevalence of asthma and allergic disorders among school children in Gorgan. *Journal of research in medical sciences*. 2007; 12(1): 28-33.
6. Gharagosloo M, Khalili S, HallajMofradM, Karimi B, Honarmand M, Jafari H, et al. Asthma, allergic rhinitis and atopic eczema in Schoolchildren Kashan (1998-1999). *Tehran University Medical Journal (TUMJ)*. 2003; 61(1): 24-30.
7. Ghaffari J, Mohammadzadeh I, Khalilian A, Rafatpana H, Mohammadjafari H, Davoudi A. Prevalence of asthma, Allergic Rhinitis and Eczema in elementary school in Sari (IRAN). *Caspian Journal of Internal Medicine*. 2012.
8. Masjedi F, Najafizadeh K, Dokouhaki P. prevalence and severity of asthma symptoms in children of Tehran-International study of asthma and allergies in childhood (ISAAC). *Iran J Allrgy Asthma Immunol* 2004;3(1):25-30.
9. Goishan M, Mohamad-Zadeh Z, Zahedi-Nejad N, Rostam-Poor B. Prevalence of asthma and related symptoms in primary school children of Isfahan, Iran, in 1998. *Asian Pacific Journal of Allergy and Immunology*. 2011; 19(3): 163-70.
10. Masjedi MR. ISAAC Phase Three Data, Birjand, Iran. [online]. [cited 2012 December 10]. Available from: <http://isaac.auckland.ac.nz/phases/phasethree/results/results.php>
11. Golshan Mb Mohammadzadeh Z, Moghaddasi M, Chegeni M. Prevalence of asthma and related symptoms in school-aged children in Boroojerd, Iran. *Tanaffos*. 2002; 1(2): 22-7.
12. Masjedi MR. ISAAC Phase Three Data, Zanjan, Iran. [online]. [cited 2012 December 10]. Available from: <http://isaac.auckland.ac.nz/phases/phasethree/results/results.php>
13. Golshan M, Meer-Alai A, Mohammadzadeh Z, Kyani Y, Loghmanian L. Prevalence of asthma and related symptoms in school-aged children in zarinshahr, Iran. *Tanaffos*. 2002; 1(2): 41-6.
14. HabibiKhorasani A, Janghorbani M, Gozashti H. Prevalence of Asthma in elementary school children in Kerman in 1999. *Journal of Kerman University of Medical Sciences*. 2002; 9(4): 184-93.
15. Hassanzadeh J, Basiri F, Mohammad-Beigi A. Prevalence of asthma symptoms and allergic diseases with ISSAC method in children, Shiraz 2009. *Zahedan Journal of Research in Medical Sciences*. 2012; 13(8): 35-9.
16. Hatami G, Amir Azodi E, Najafi A, RazaviSh,, Afrasiabi K, Afarid M, Yarandi AR, Rasapour, Meer-Alai A. Prevalence of Asthma and Asthma-related

- symptoms among 13-14 yr school children in Bushehr, ISSAC. Iranian South Med J. 2002; 2(5): 167-75.
17. Hedayatmofidi S, Ahmadi A, Badeleh M, Bakhsha F, Joshaghani H. Prevalence of Asthma among Schoolchildren in Gorgan, Iran by Questionnaire Surveys in 2006. J Med Sci. 2007; 7(6): 1054-6.
18. Heidarnazhad H, Soumi M, Azarfarin R, Charsouei S, Akbari M. Prevalence of asthma and atopic states-related symptoms in school (6-7 yrs), high school (13-14 yrs) children in Tabriz (ISAAC study). Eur Respiratory J. 2001; 18: 330-68.
19. Karami M, Mirzaei M, Ahmadian MH. Prevalence of Asthma, Allergic rhinitis and Eczema symptoms among 13-14 year-old school children in Yazd in 2003. Scientific Medical Journal. 2007.
20. Masjedi MR. ISAAC Phase One Data, Rasht, Iran. [online]. [cited 2012 December 10]. Available from: <http://isaac.auckland.ac.nz/phases/phaseone/results/results.php>
21. Masjedi MR. ISAAC Phase One Data, Tehran, Iran. [online]. [cited 2012 December 10]. Available from: <http://isaac.auckland.ac.nz/phases/phaseone/results/results.php>
22. Mirzai M, Karimi M, Mobin E, Rahim Z. . The prevalence and severity of asthma, allergic rhinitis and eczema symptoms in children 6-7 years old in Yazd. J of Yazd health faculty 2007; 6(1): 44-52.
23. Mohammadzadeh I, Ghafari J, Savadkoochi RB, Tamaddon A, Dooki MRE, Navaei RA. The Prevalence of Asthma, Allergic Rhinitis and Eczema in North of Iran. Iranian Journal of Pediatrics. 2008; 18(2).
24. Mortazavi MS., Akbari H., AR. S. Asthma in Iranian Schoolchildren: Comparison of ISAAC Video and Written Questionnaires. Iranian Journal of Medical Sciences 2005; 30(3): 110-4.
25. Najafzadeh K, Fadaizadeh L, Salek S. Prevalence and severity of asthmatic symptoms in Rasht students: A report from ISAAC study. Tanaffos. 2008; 7(1): 40-6.
26. Rahimirad M, Hejazi ME, Salary S, Behroozian R. Prevalence and severity of asthma, allergic rhinitis and atopic eczema in 13 to 14 years-old schoolchildren in Uromia, Iran (An ISAAC study). Eur Respir J. 2004; 24 (Suppl. 48): 389.
27. Shabestari MS, Sahebi L. The prevalence of asthma, rhinitis allergic and eczema among middle school students in Tabriz (Northwestern of Iran). Turk J Med Sci. 2011; 41(5): 927-38.
28. Shakurnia A, Assar S, Afra M, Latifi M. Prevalence of asthma among schoolchildren in Ahvaz, Islamic Republic of Iran. EMHJ. 2010; 16(6).
29. ZiaeiKajbaf T. The ISAAC Phase Three Results Ahvaz, Iran. [Online]. [1996]. [cited 2012 December 10]; [8 screens]. Available from: <http://isaac.auckland.ac.nz/phases/phase3/results/results.php>.
30. Zobeiri M. Prevalence, Risk Factors and Severity of Asthma Symptoms in Children of Kermanshah, IRAN: ISAAC Phase I, II. Acta Medica Iranica. 2011; 49(3).
31. Zohal M, Hasheminasab R. Prevalence of asthma among school-age children in Qazvin (2003). The Journal of Qazvin University of Medical Sciences. 2006.
32. Asher MI, Montefort S, Björkstén B, Lai CKW, Strachan DP, Weiland SK, et al. 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. The Lancet. 2006; 368(9537): 733-43.
33. Mohammadbeigi A, Hassanzadeh J, Mousavizadeh A. Prevalence of asthma in elementary school age children in Iran--a systematic review and meta-analysis study. Pakistan journal of biological sciences: PJBs. 2011; 14(19): 887.
34. Asher MI, Stewart AW, Mallol J, Montefort S, Lai CKW, Ait-Khaled N, et al. Which population level environmental factors are associated with asthma, rhinoconjunctivitis and eczema? Review of the ecological analyses of ISAAC Phase One. Respiratory research. 2010; 11(1): 8.
35. Lai C, Beasley R, Crane J, Foliaki S, Shah J, Weiland S. International Study of Asthma and Allergies in Childhood Phase Three Study Group. Global variation in the prevalence and severity of asthma symptoms: phase three of the International Study of Asthma and Allergies in Childhood (ISAAC). Thorax. 2009; 64(6): 476-83.
36. Schernhammer E, Vutuc C, Waldhör T, Haidinger G. Time trends of the prevalence of asthma and allergic disease in Austrian children. Pediatric Allergy and Immunology. 2007; 19(2): 125-31.
37. Mvula M, Larzelere M, Kraus M, Moisiwicz K, Morgan C, Pierce S, et al. Prevalence of asthma and asthma-like symptoms in inner-city schoolchildren. Journal of Asthma. 2005; 42(1): 9-16.
38. Kurukulaaratchy R, Fenn M, Twiselton R, Matthews S, Arshad S. The prevalence of asthma and wheezing illnesses amongst 10-year-old

- schoolchildren. *Respiratory medicine*. 2002; 96(3): 163-9.
39. Wang X, Tan T, Shek L, Chng S, Hia C, Ong N, et al. The prevalence of asthma and allergies in Singapore; data from two ISAAC surveys seven years apart. *Archives of disease in childhood*. 2004; 89(5): 423-6.
 40. Luna MFG, Almeida PC, Silva MGC. Prevalence of asthma among adolescents in the city of Fortaleza, Brazil. *Jornal Brasileiro de Pneumologia*. 2009; 35(11): 1060-7.
 41. Yangzong Y, Shi Z, Nafstad P, Håheim LL, Luobu O, Bjertness E. The prevalence of childhood asthma in China: a systematic review. *BMC Public Health*. 2012; 12(1): 860.
 42. Shohat T, Golan G, Tamir R, Green M, Livne I, Davidson Y, et al. Prevalence of asthma in 13-14 yr-old schoolchildren across Israel. *European Respiratory Journal*. 2000; 15(4): 725-9.
 43. Behbehani NA, Abal A, Syabbalo N, Azeem AA, Shareef E, Al-Momen J. Prevalence of asthma, allergic rhinitis, and eczema in 13-to 14-year-old children in Kuwait: an ISAAC study. *Annals of Allergy, Asthma & Immunology*. 2000; 85(1): 58-63.
 44. Nahhas M, Bhopal R, Anandan C, Elton R, Sheikh A. Prevalence of Allergic Disorders among Primary School-Aged Children in Madinah, Saudi Arabia: Two-Stage Cross-Sectional Survey. *PloS one*. 2012; 7(5): e36848.
 45. Al Ghobain MO, Al-Hajjaj MS, Al Moamary MS. Asthma prevalence among 16-to 18-year-old adolescents in Saudi Arabia using the ISAAC questionnaire. *BMC Public Health*. 2012; 12(1): 239.
 46. Patel SP, Järvelin MR, Little MP. Systematic review of worldwide variations of the prevalence of wheezing symptoms in children. *Environmental Health*. 2008; 7(1): 57.
 47. Pearce N, Sunyer J, Cheng S, Chinn S, Björkstén B, Burr M, et al. Comparison of asthma prevalence in the ISAAC and the ECRHS. *European Respiratory Journal*. 2000; 16(3): 420-6.
 48. Robertson CF, Bishop J, Sennhauser FH, Mallol J. International comparison of asthma prevalence in children: Australia, Switzerland, Chile. *Pediatric pulmonology*. 2005; 16(4): 219-26.
 49. von Mutius E, Weiland SK, Fritzsche C, Duhme H, Keil U. Increasing prevalence of hay fever and atopy among children in Leipzig, East Germany. *The Lancet*. 1998; 351(9106): 862-6.
 50. Kwon JW, Kim BJ, Song Y, Seo JH, Kim TH, Yu J, et al. Changes in the prevalence of childhood asthma in Seoul from 1995 to 2008 and its risk factors. *Allergy, asthma & immunology research*. 2011; 3(1): 27-33.
 51. Moorman JE, Rudd RA, Johnson CA, King M, Minor P, Bailey C, et al. National surveillance for asthma--United States, 1980-2004: Department of Health and Human Services, Centers for Disease Control and Prevention; 2007.
 52. Anderson H, Pottier A, Strachan D. Asthma from birth to age 23: incidence and relation to prior and concurrent atopic disease. *Thorax*. 1992; 47(7): 537-42.
 53. Becklake MR, Kauffmann F. Gender differences in airway behaviour over the human life span. *Thorax*. 1999; 54(12): 1119-38.
 54. De Marco R, Locateli F, Sunyer J, Burney P. Differences in Incidence of Reported Asthma Related to Age in Men and Women A Retrospective Analysis of the Data of the European Respiratory Health Survey. *American journal of respiratory and critical care medicine*. 2000; 162(1): 68-74.
 55. Luyt DK, Burton PR, Simpson H. Epidemiological study of wheeze, doctor diagnosed asthma, and cough in preschool children in Leicestershire. *BMJ: British Medical Journal*. 1993; 306(6889): 1386.
 56. Venn A, Lewis S, Cooper M, Hill J, Britton J. Questionnaire study of effect of sex and age on the prevalence of wheeze and asthma in adolescence. *Bmj*. 1998; 316(7149): 1945-6.