Review Article

The Prevalence of Asthma among Iranian Children and Adolescent: A Systematic Review and Meta-Analysis

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Background. Asthma is an important reason for hospitalization in children aged under five years. Information about the current status of asthma in Iranian children can help the Iranian health sector plan carefully and prevent asthma incidence by educating the families. The present systematic review and meta-analysis is aimed at estimating asthma prevalence in Iranian children and adolescents.

Method. Data were found using keywords such as prevalence, epidemiology, asthma, adolescent, children, pediatrics, Iran in Web of Science, Scopus, PubMed, Cochrane, and Embase databases. Three national databases, including Magiran, Barakat Pharmed Co (Iran medex), and Scientific Information Databank (SID) were searched until 1 October 2020. Cross-sectional and original studies were included in the study, and then, quality assessment was done using the National Institutes of Health’s Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. A pooled estimated prevalence of asthma was calculated using Der Simonian-Laird random model. Egger’s test was used to evaluate publication bias. The data were analyzed using the STATA software version 16.

Results. 30 studies were selected and investigated. The prevalence of asthma in children and adolescents was 6% and 8%, and the prevalence in boys and girls was 9% and 8%, respectively. Among the asthma symptoms, wheezing had the most prevalence (17% in children and 19% in adolescents) and sleep disturbance had the lowest prevalence (6% in children and 6% in adolescents).

Conclusion. The prevalence of asthma in Iranian children and adolescents is lower than in the world. Existing strategies should be pursued followed. Also, guidelines for asthma control and prevention should be considered in the future.

1. Background

Asthma is an airway inflammatory disease characterized by variable symptoms like chest tightness, breathlessness, wheeze, and cough. Asthma is one of the leading chronic respiratory diseases in children in the world. This disease is one of the main reasons for hospitalizations of children under five years old and has been increasing in recent years [1].

The estimations suggest that more than 300 million people are affected by asthma worldwide, and more than
400 million persons will experience asthma in the future. The prevalence of asthma in children varies according to geographical variation. However, the global prevalence is from 9.1% to 9.5% in children and from 9.1% to 10.4% in adolescents [2].

It seems that factors such as age, sex, economic status, genetics, and exposure to pollutants can affect asthma prevalence [3]. Asthma causes growth disturbance, increased health care costs, decreased quality of life, absence at school, etc. Implementation of proper strategies for recognizing the epidemiology of asthma and, consequently, appropriate treatment of the disease has effectively decreased disease burden [4].

The prevalence of asthma symptoms in children and adolescents increased worldwide, in recent years, particularly in low-middle income countries [5]. Many studies have been performed to estimate the prevalence of asthma in children and adolescents in various cities in Iran. Heidarnia et al. evaluated 19 studies between 1998 and 2003; all of them used ISSAC protocol. The lowest and the highest prevalence were reported in Kerman (2.7%) and Tehran (35.4%), respectively [6]. The overall prevalence of asthma was estimated to be 13.14%. In another meta-analysis, Ghaifari et al. evaluated 27 studies between 1992 and 2012. They reported asthma prevalence to be 2.7% and 3.5% in children aged 6-7 and 13-14 years, respectively [7]. These two meta-analyses showed a noticeable difference in the total asthma prevalence; also, there is no updated information about asthma status in Iranian children in recent years.

Information about the current status of asthma in Iranian children can help the Iranian health sector plan carefully and prevent asthma incidence by educating the families. It can also help neighboring countries to control the incidence of this disease because management of the health of this generation is important for any country. Due to Iran’s geographical variety, the prevalence of this disease varies from region to region. As there is no updated comprehensive study to evaluate asthma prevalence in Iranian children and adolescents, the present systematic review and meta-analysis was performed to estimate asthma prevalence in children and adolescents in Iran.

2. Method and Material

The present study was performed based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) instruction [8] to examine asthma prevalence among children and adolescents in Iran.
2.1. Search Strategy. Data were found using keywords such as asthma, prevalence, epidemiology, children, pediatrics, adolescent, Iran in Scopus, PubMed, Web of Science, Cochrane and Embase databases.

For PubMed databases, this syntax was used: (Prevalence[Mesh] OR Prevalence[TAIB] OR Epidemiology[Mesh] OR Epidemiology[TAIB]) AND (Asthma[Mesh] OR Asthma[TAIB] AND (Child[Mesh] OR Child[TAIB] OR “Adult Children”[Mesh] OR “Adult Children”[TAIB] OR Pediatrics[Mesh] OR Pediatrics[TAIB])) AND (Iran[Mesh] OR Iran[Text word]). Also, all the big cities searched separately to find the possible related studies. Three national databases, including Magiran, Barakat Pharmed Co (Iran medex), and Scientific Information Databank (SID) were searched until 1 October 2020. All articles published in internationally accredited journals, national conferences, and all available dissertations that attempted to assess the prevalence of asthma in different parts of the country were collected. All references were reviewed manually.

2.2. Inclusion Criteria. Studies that evaluated asthma prevalence in Iranian children were reviewed. The instrument used for data collection was ISSAC or SF-questionnaires, which study participants or their parents completed. Children were categorized as 0 to 10 years old, and those aged 11 to 19 were classified as adolescents. Cross-sectional and original studies were included in the study, and review articles or letter to editors was removed.

2.3. Exclusion Criteria. Unrelated topics, non-Iranian subjects, nonstandard questionnaires, incomplete data, and studies not defined the age group were excluded from the present study. Also, review articles and case-control studies were excluded.

2.4. Quality Assessment. In this step, the papers were independently evaluated by two authors. For quality assessment, we used the National Institutes of Health’s Quality Assessment Tool for Observational Cohort and Cross-Sectional

Table 1: The score of the studied based on National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.

| Author/studies          | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 |
|-------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|
| Boskabady and Karimian  | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✓  | ✓   | NR  | ✓   | ✓   | ✓   |
| Tootoonchi              | ✗  | ✓  | ✓  | ✓  | ✓  | NA | CD | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Hatami et al.           | ✓  | ✓  | ✓  | ✓  | ✓  | NR | NR | ✓  | ✓   | NA  | ✓   | CD  | ✓   | ✓   |
| Habibi et al.           | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Zohal and Hasheminasab  | ✓  | ✓  | ✓  | ✓  | ✓  | NA | NR | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Ghazi et al.            | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Masjedi et al.          | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Abbasi                  | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Bazzazi et al.          | ✗  | ✓  | ✓  | ✓  | ✓  | NA | NR | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Karimi et al.           | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Bidad et al.            | ✓  | NR | ✗  | ✓  | ✓  | NA | ✗  | ●  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Shakurnia et al.        | ✗  | ✓  | ✓  | ✓  | ✓  | NA | NR | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Rahimi Rad et al.       | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Fadaeizadeh et al.      | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Mohammazadeh et al.     | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Sahebi and Shabestray   | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Rajaefard et al.        | ✓  | ✓  | ✓  | ✓  | ✓  | NA | NR | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Zobeiri                 | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Tavacol et al.          | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Hassanzadeh et al.      | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | CD | ✔   | NA  | ✗   | NR  | ✓   | ✓   |
| Hajavi et al.           | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Gooya et al.            | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Farrokhi et al.         | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Nasiri Kalmarzi et al.  | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Ghozikali et al.        | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Zamanfar et al.         | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Mehravar et al.         | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Assadi et al.           | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Khazaei et al.          | ✗  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
| Fazlollahi et al.       | ✓  | ✓  | ✓  | ✓  | ✓  | NA | ✓  | ✓  | ✔   | NA  | ✓   | NR  | ✓   | ✓   |
Table 2: Characteristics of all eligible asthma prevalence studies in children and adolescents in Iran.

| Author name            | Year | City (province)       | Method  | Prevalence in children (n) | Prevalence in adolescent (n) | Prevalence in girl (n) | Prevalence in boy (n) | References |
|------------------------|------|-----------------------|---------|-----------------------------|-----------------------------|-----------------------|----------------------|------------|
| Boskabady and Karimian | 2000 | Mashhad (Khorasan Razavi) | ISSAC    | 22 1201                     | 25 618                      | 19 583                |                      | ([27])     |
| Tootoonchi             | 2001 | Tehran (Tehran)       | ISSAC    | 4 24                        | 3 9                         | 5 15                  |                      | ([28])     |
| Hatami et al.          | 2002 | Bushehr (Bushehr)     | ISSAC    | 1 19                        | 2 27                        | 3 33                  |                      | ([29])     |
| Habibi et al.          | 2002 | Kerman (Kerman)       | ISSAC    | 3 32                        | 2 80                        | 2 64                  |                      | ([30])     |
| Zohal and Hasheminasab | 2003 | Ghazvin (Ghazvin)     | ISSAC    | 2 57                        | 2 45                        | 2 59                  |                      | ([31])     |
| Ghazi et al.           | 2003 | Tehran (Tehran)       | ISSAC    | 32 215                      | 37 507                      | 34 343                | 37 379               | ([32])     |
| Masjedi et al.         | 2004 | Tehran (Tehran)       | ISSAC    | 2 64                        | 3 80                        | 3 80                  | 2 64                 | ([33])     |
| Abbasi                 | 2005 | Rasht (Gilan)         | ISSAC    | 7 213                       | 5 136                       | 5 144                 | 7 205                | ([34])     |
| Bazzazi et al.         | 2006 | Gorgan (Golestan)     | ISSAC    | 7 196                       | 6 86                        | 8 110                 |                      | ([35])     |
| Karimi et al.          | 2006 | Yazd (Yazd)           | ISSAC    | 4 118                       | 7 212                       | 6 99                  | 9 106                | ([36])     |
| Bidad et al.           | 2006 | Tehran (Tehran)       | ISSAC    | 7 212                       | 6 99                        | 9 102                 |                      | ([37])     |
| Shakurnia et al.       | 2007 | Ahvaz (Khorasan)      | ISSAC    | 7 96                        | 10 144                      |                      |                      | ([38])     |
| Rahimi Rad et al.      | 2007 |Ormia (West Azarbaijan)| ISSAC    | 7 62                        | 10 144                      |                      |                      | ([39])     |
| Fadaiezadeh et al.     | 2008 | Tehran, Rasht (Tehran, Gilan) | ISSAC    | 5 283                       | 4 222                       |                      |                      | ([40])     |
| Mohammadzadeh et al.   | 2008 | Babol (Mazandaran)    | ISSAC    | 3 91                        | 4 128                       | 5 119                 | 5 133                | ([41])     |
| Sahebi and Shabestray  | 2009 | Tabriz (East Azarbaijan) | ISSAC    | 2 30                        | 7 23                        | 13 39                 |                      | ([42])     |
| Rajaefard et al.       | 2010 | Yasuj (Kohgiluyeh and Boyer-Ahmad) | ISSAC    | 10 62                       | 7 23                        | 13 39                 |                      | ([43])     |
| Zobeiri                | 2011 | Kermanshah (Kermanshah) | ISSAC    | 2 63                        | 3 99                        | 4 110                 | 2 52                 | ([44])     |
| Tavacol et al.         | 2011 | Ahvaz (Khorasan)      | ISSAC    | 4 35                        | 6 54                        |                      |                      | ([45])     |
| Hassanzadeh et al.     | 2011 | Shiraz (Fars)         | ISSAC    | 4 115                       | 3 51                        | 4 64                  |                      | ([46])     |
| Hajavi et al.          | 2011 | Gonabad (Khorasan)    | ISSAC    | 3 54                        | 7 23                        |                      |                      | ([47])     |
| Gooya et al.           | 2014 | Bushehr (Bushehr)     | ISSAC    | 6 11                        | 15 34                       | 13 38                 | 6 7                  | ([48])     |
| Farrokhi et al.        | 2014 | Bushehr (Bushehr)     | ISSAC    | 7 86                        | 8 85                        |                      |                      | ([49])     |
| Nasiri Kalmarzi et al. | 2016 | Kurdistan             | ISSAC    | 5 80                        | 4 75                        |                      |                      | ([50])     |
| Ghozikali et al.       | 2016 | Tabriz (East Azarbaijan) | ISSAC    | 12 142                      | 12 142                      |                      |                      | ([51])     |
| Zamanfar et al.        | 2016 | Mazandaran            | ISSAC    | 12 362                      | 9 140                       | 16 222                |                      | ([52])     |
| Mehrvar et al.         | 2016 | Golestan              | ISSAC    | 11 84                       | 22 200                      | 18 156                | 15 128               | ([53])     |
| Assadi et al.          | 2017 | Bushehr (Bushehr)     | ISSAC    | 4 20                        | 7 38                        | 5 25                  | 5 33                 | ([54])     |
| Khaezai et al.         | 2018 | Tehran (Tehran)       | ISSAC    | 4 40                        | 8 82                        | 6 63                  | 6 59                 | ([55])     |
| Fazlollahi et al.      | 2018 | Tehran (Tehran)       | ISSAC    | 9 1543                      | 12 2090                     | 10 16                  | 12 12                | ([56])     |
Studies, which resolve past versions’ flaws. In this questionnaire, scoring is shown by a scale of “No,” “Yes,” “cannot be determined,” “Not Applicable,” and “Not reported” [9].

2.5. Data Extraction. The data extracted from all articles were used in the present study and qualified as a checklist. This checklist includes the author’s name, type of study, year of publication, assessment tool, study location, sample size, age, gender, asthma prevalence, and associated risk factors.

2.6. Subgrouping the Outcome. In this study, the prevalence of asthma in children, adolescents, girls, and boys was considered the primary outcome. Other related information such as geographical area and asthma symptoms were considered as the secondary outcome.

2.7. Statistical Analysis. A pooled estimated prevalence of asthma was calculated using Der Simonian-Laird random-effects DerSimonian-Laird model [10], and the results were reported by 95% confidence interval (CI). To examine the heterogeneity, $I^2$ threshold was used [11]. Also, subgroup was done based on asthma symptoms and geographical areas. For finding the possible reasons of heterogeneity, metaregression was used based on the sample size and publication years. Sensitivity analysis was performed to ensure the stability of the results. Egger’s test was used to evaluate publication bias [12]. The data were analyzed using the STATA software version 16.

3. Results

3.1. Search Results. In the first stage, 1270 articles were found; by reviewing the articles, 1090 duplicate and irrelevant articles with inadequate data and other exclusion factors were removed and finally, 30 articles were selected for this systematic review study (Figure 1).
3.2. Quality Assessment Results. This study used the National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. The studies’ assessment showed that most of the studies had satisfactory quality and low-risk bias; however, most of them did not mention blinding of the outcome assessors. Most of the studies did not mention the research’s timing in the title (Table 1).

3.3. Descriptive Results. Descriptive information of all studies was shown in Table 2. There are 30 studies in this table, of which the lowest prevalence of asthma in children was 2% in Masjedi et al.’s study in Tehran. The lowest prevalence of asthma in adolescents was 1% in the study of Hatami et al. in Bushehr. The highest prevalence of asthma in children was 32% in Tehran and 37% in adolescents. The majority of the study population was between 1,000 and 10,000. Only

| Study                        | Prevalence with 95% CI | Weight (%) |
|------------------------------|------------------------|------------|
| Boskabady et al, 2000        | 0.22 [0.21, 0.23]      | 3.61       |
| Habibi Khorasani, 2002       | 0.03 [0.02, 0.04]      | 3.63       |
| Hatami et al, 2002           | 0.01 [0.00, 0.01]      | 3.66       |
| Mirsaedi Ghazi et al, 2003   | 0.37 [0.35, 0.40]      | 3.39       |
| Zohal et al, 2003            | 0.02 [0.02, 0.03]      | 3.65       |
| Masioudi et al, 2004         | 0.03 [0.02, 0.03]      | 3.65       |
| Abbasi et al, 2005           | 0.05 [0.04, 0.05]      | 3.64       |
| Bazzazi et al, 2006          | 0.07 [0.06, 0.08]      | 3.62       |
| Karimi et al, 2006           | 0.04 [0.03, 0.04]      | 3.65       |
| Bidad et al, 2006            | 0.07 [0.06, 0.08]      | 3.62       |
| Shakurnia et al, 2007        | 0.10 [0.08, 0.11]      | 3.56       |
| Rahimi Rad, 2007             | 0.02 [0.02, 0.03]      | 3.65       |
| Fadai et al, 2008            | 0.04 [0.03, 0.05]      | 3.65       |
| Mohammarzadeh et al, 2008    | 0.04 [0.04, 0.04]      | 3.64       |
| Sahebi et al, 2009           | 0.02 [0.01, 0.03]      | 3.64       |
| Zobeiri et al, 2011          | 0.03 [0.02, 0.04]      | 3.65       |
| Hassananzadeh et al, 2011    | 0.04 [0.03, 0.05]      | 3.64       |
| Tavacol et al, 2011          | 0.06 [0.05, 0.08]      | 3.55       |
| Haji et al, 2011             | 0.03 [0.02, 0.04]      | 3.63       |
| Gooya et al, 2014            | 0.15 [0.11, 0.20]      | 2.89       |
| Farrokhi et al, 2014         | 0.08 [0.06, 0.09]      | 3.56       |
| Kalmarzi et al, 2016         | 0.04 [0.03, 0.04]      | 3.64       |
| Ghanbari Ghozikali et al, 2016| 0.12 [0.11, 0.14]     | 3.51       |
| Zamanfar et al, 2016         | 0.12 [0.11, 0.13]      | 3.60       |
| Mehravar et al, 2016         | 0.22 [0.19, 0.24]      | 3.38       |
| Assadi et al, 2017           | 0.07 [0.05, 0.09]      | 3.49       |
| Khazaei et al, 2018          | 0.08 [0.06, 0.10]      | 3.54       |
| Fazlollahi et al, 2018       | 0.12 [0.12, 0.13]      | 3.65       |
| Overall                      | 0.08 [0.06, 0.10]      |            |

Heterogeneity: $T^2 = 0.00$, $I^2 = 99.32\%$, $H^2 = 147.55$
Test of $\bar{\theta} = \bar{\theta}$: $Q(27) = 3983.94$, $P = 0.00$
Test of $\bar{\theta} = 0$: $Z = 8.98$, $P = 0.00$

Random-effects DerSimonian-Laird model

Figure 3: Prevalence of asthma in Iranian adolescents (11–19).

| Region      | Studies | Sample All % | Heterogeneity I2 | P value |
|-------------|---------|--------------|-----------------|---------|
| Children    | Central | 30425 8      | 99.30%          | <0.001  |
|             | North   | 6881 7       | 97.64%          | <0.001  |
|             | South   | 5955 6       | 79.62%          | <0.001  |
|             | East    |              |                 |         |
|             | West    | 4823 3       | 94.82%          | <0.001  |
| Adolescent  | Central | 37130 9      | 99.58%          | <0.001  |
|             | North   | 12605 10     | 98.53%          | <0.001  |
|             | South   | 11175 6      | 97.83%          | <0.001  |
|             | East    | 7160 13      | 99.85%          | <0.001  |
|             | West    | 10954 4      | 99.51%          | <0.001  |

Table 4: The prevalence of asthma by geographical area of Iran.
two studies had a population of less than 1,000. All studies use ISSAC questionnaire to gather the data. Most studies were performed in Tehran province (8 studies).

3.4. The Overall Prevalence of Asthma. Table 3 shows the prevalence of asthma in the four groups of children, adolescents, boys, and girls in the selected articles. As shown in Table 3, the prevalence of asthma in children was 7% (95% CI: 5-9) with heterogeneity of 98.37% (Figure 2). The prevalence of asthma in adolescents was 9% (95% CI: 7-11) with heterogeneity of 99.32% (Figure 3). The prevalence of asthma in girl and boy were 8% (95% CI: 6-10) and 9% (95% CI: 7-11), respectively. The odds ratio for male/female and children/adolescents was 0.13 and 0.82, respectively. Sensitivity analysis showed that the results before and after this analysis did not change, and the findings were stable.

Table 5: Asthma symptoms in Iranian children and adolescent.

| Item                  | Prevalence | P value | $I^2$          | OR       | Number of study |
|-----------------------|------------|---------|----------------|----------|-----------------|
| **Wheezeing**         |            |         |                |          |                 |
| Children              | 17% (13-20)| <.001   | 98.65%         | 0.78 (0.64-0.95) | 16              |
| Adolescent            | 19% (15-23)| <.001   | 99.58%         | 0.61 (0.46-0.80) | 23              |
| Boy                   | 19% (15-23)| <.001   | 98.83%         | 0.04 (-0.18-0.26) | 16              |
| Girl                  | 18% (15-21)| <.001   | 98.61%         |          | 18              |
| **Dry cough**         |            |         |                |          |                 |
| Children              | 11% (9-14) | <.001   | 98.47%         | 0.61 (0.46-0.80) | 15              |
| Adolescent            | 17% (15-20)| <.001   | 98.85%         | 0.17 (-0.01-0.35) | 21              |
| Boy                   | 18% (15-21)| <.001   | 98.03%         |          | 14              |
| Girl                  | 15% (12-17)| <.001   | 98.41%         |          | 14              |
| **Exercise wheezeing**|            |         |                |          |                 |
| Children              | 7% (5-9)   | <.001   | 99.03%         | 0.33 (0.26-0.41) | 13              |
| Adolescent            | 16% (13-19)| <.001   | 98.94%         | 4.31 (3.79-4.82) | 18              |
| Boy                   | 17% (12-22)| <.001   | 98.73%         |          | 13              |
| Girl                  | 12% (9-14) | <.001   | 99.55%         |          | 13              |
| **Wheezeing attack**  |            |         |                |          |                 |
| Children              | 13% (9-17) | <.001   | 98.43%         | 0.82 (0.78-0.86) | 5               |
| Adolescent            | 14% (9-18) | <.001   | 99.25%         | 1.03 (0.93-1.14) | 7               |
| Boy                   | 15% (7-22) | <.001   | 98.87%         |          | 4               |
| Girl                  | 14% (7-21) | <.001   | 98.85%         | 0.15 (0.06-0.24) | 4               |
| **Sleep disturbance** |            |         |                |          |                 |
| Children              | 6% (4-7)   | <.001   | 96.28%         | 1.03 (0.93-1.14) | 11              |
| Adolescent            | 6% (4-7)   | <.001   | 98.02%         |          | 14              |
| Boy                   | 8% (6-11)  | <.001   | 98.02%         | 0.06 (-0.05-0.18) | 7               |
| Girl                  | 7% (5-9)   | <.001   | 98.48%         |          | 7               |

Figure 4: Publication bias in the studied researches (children and adolescent).
The prevalence of asthma in Iranian children and adolescents was higher than in children (OR = 0.82, CI: 0.64-1.06, and \( P < 0.001 \)). This was consistent with several studies, such as Soto-Martínez et al., Al-Herz, de Oliveira et al., and Singh et al. [13, 17]. This may be because adolescents spend more time outside the home and are more exposed to contaminants and other allergens and pollen. This finding may also be due to changes during puberty, since hormonal changes at this age can affect the incidence and severity of asthma [3]. Smoking as well is more common in this age group and can increase the prevalence of asthma. Other causes of increased asthma prevalence in adolescents could include increased consumption of foods and drinks containing preservatives.

In this systematic review and meta-analysis, the prevalence of asthma was found to be higher in boys (9%, 95% CI: 7-11) than in girls (8%, 95% CI: 6-10) (OR = 0.13, CI: -0.04-0.30, and \( P < 0.001 \)). Several studies were similar to the present study, such as the study of Chinratanapisit et al. in Bangkok, and other studies in Turkey and Korea [16, 21, 22]. Also in Japan, the prevalence of asthma was higher in boys (6%) than girls (4%) [23]. These gender differences might be ascribed to a narrower airways caliber in males than females in early life due to different hormonal factors. Other reasons include physical and social differences. Since smoking is more prevalent in boys than in girls, it can influence this disease [24].

The other causes of the difference in asthma prevalence include climate dispersal in a different region of Iran. In the present systematic review and meta-analysis, among region
subgroups, the highest and lowest prevalence of asthma in children was 8% and 3% in the Center and the West of Iran, respectively. Also, the highest and lowest prevalence of asthma in adolescent were 13% in the East and 4% in the West of Iran. As a result, the central region’s prevalence was higher, which may be due to air pollution and contaminants in central populated cities such as Tehran. According to Lashanizand and Gholamrezaie’s study, atmospheric conditions directly and indirectly affect the prevalence of asthma, and ambient moisture reduces asthma attacks, according to the present study. It can be concluded that the northern and southern regions of the sea margin have suitable ambient humidity, which results in a lower prevalence of asthma in these regions [25]. In addition to climate change, air pollution and vehicle overcrowding in crowded cities, diet in different areas, and genetic changes can also affect asthma prevalence. Also, scattering vegetation in different cities and exposure to pollen in different seasons can affect asthma prevalence. As shown in the study of Zhang et al., SO₂, relative humidity and sunshine are associated with asthma prevalence [26].

Descriptive information including wheezing, dry cough, sleep disturbance, wheezing attacks, and exercise wheeze was estimated in the present study. The prevalence of asthma symptoms in children and adolescents worldwide increased from 11.1% to 11.6% and from 13.2% to 13.7%, respectively, between ISAAC phase I and phase III. According to the present systematic review and meta-analysis, wheezing prevalence was higher in Iranian adolescents than in children (17% in children and 19% in adolescents). In a study in Thailand (Southeast Asia), wheezing was reported 14.6% in children and 29.9% in adolescents [16]. A study by Mallol et al. reported the prevalence of wheezing from 11.11% in 1994 to 13.4% in 2015 among adolescents [3]. It was 35.1% in children and 35.4% in adolescent in Costa Rica [17]. The prevalence of wheezing in Thailand was lower than in the present study but higher in Brazil and Costa Rica than in the present study. It was higher in adolescents than children in the present study; this is in line with Costa Rica study. The prevalence of dry cough was higher in adolescents than in children (11% in children and 17% in adolescents). The prevalence of dry cough in a study in Thailand (24.2% in children and 29.9 in adolescents) was similar to the present study; however, the result of Costa Rica study (28.5% in children and 24.4% in adolescent) was different with our result [16, 17]. In Mallol et al.’s study (2015), it was reported to be 33.1% in adolescents. The prevalence of dry cough in the present study was lower than studies done in Thailand, Costa Rica, and South-Santiago. The prevalence of exercise-induced wheezing was higher in adolescents than in children (7% in children and 16% in adolescents). In Chinratanapisit et al.’s study in Thailand, it was 3% in children and 14.8% in adolescents [16], which was higher than the amount reported in the present study.

The prevalence of wheezing attacks was significantly higher in adolescents than in children, and this finding is in line with a study in Thailand [16]. Having stress during this period of life is more than childhood and can affect asthma wheezing attacks. The prevalence of wheezing attacks in the present study was lower than in children and higher than in adolescents in Thailand. As shown, the prevalence of asthma symptom in adolescent was higher than children. The reasons can also be attributed to the increased prevalence of asthma in adolescents than children.

Publication bias of the asthma prevalence was significant. The quality of the papers affects the bias. Most of the studies did not mention blinding of the outcome assessors. Also, most of them did not mention the research’s timing in the title. The results may affect by some limitation in the researches. Also, heterogeneity was encountered perhaps due to various center settings, populations enrolled, etc. In some parts of the country, we do not find any research; few studies have been done in other parts. This limitation may affect the results and cause publication bias. This study was not registered in PROSPERO.

5. Conclusion

Overall, the present study showed that asthma prevalence in Iranian children and adolescents is lower than in regions in

![Figure 6: Metaregression for prevalence of asthma and sample size of studies (children and adolescent).](image-url)
the world. Given that the disease affects the quality of life of the studied age group and the quality of their education and economic situation, the existing strategies should be pursued as well, on the provision of medicines and the cost of treatment. Also, guidelines for asthma control should be considered in the future, such as providing asthma medicines throughout the country (especially villages), measures to reduce air pollution, and training parents to quit smoking, alternatively, smoking in a place far away from their children.

Data Availability

All data generated or analyzed during this study are included in this published article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors’ Contributions

All the authors contributed equally.

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