

# The prevalence of asthma in Iranian adults: The first national survey and the most recent updates

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## Abstract

**Background:** The worldwide increase in the prevalence of asthma has made it a major public-health concern. We aimed to identify the prevalence of asthma and asthma symptoms in adults living in urban and rural areas of Iran as a populated country with about 80 millions of residents.

**Methods:** This cross-sectional study was conducted to estimate the prevalence of asthma in adults between 20 and 44 years old in all provinces of Iran. Data were collected by personal interview via a standardized questionnaire [European Community Respiratory Health Survey (ECRHS)] between November 2015 and February 2016.

**Results:** A total of 24 344 individuals were enrolled. The prevalence of asthma was 8.9% [95% confidence interval (CI): 8.5–9.3]. The most common asthma symptoms were wheezing (14.2%,  $n = 3465$ ), nocturnal cough (13.3%,  $n = 3234$ ) and chest tightness (11.3%,  $n = 2760$ ). Additionally, the prevalence of current asthma (taking asthma medications or asthma attack) was estimated to be 4.7% ( $n = 1155$ ). Asthma was significantly more prevalent in males compared to females ( $P = .002$ ), while no significant relationship was detected between gender and asthma after adjusted analysis with other variables. The prevalence of asthma was significantly higher in older participants ( $P < .001$ ) and individuals with low educational level ( $P < .001$ ). Interestingly, there was no significant relationship between asthma and area of residency ( $P = .8$ ).

**Conclusions:** The prevalence of asthma in Iran was similar to other Asian and European countries. However, repeated national surveys are required to determine the trend of asthma prevalence in Iran in comparison to other countries.

## KEYWORDS

adult, asthma, Iran, prevalence

## 1 | INTRODUCTION

Asthma as the most common chronic respiratory disease; affects about 330 million people around the world.<sup>1</sup> This global problem is characterized by airflow obstruction,

airway hyperresponsiveness and inflammation. Despite the increase in the worldwide prevalence of asthma in the second half of the last century, no clear temporal pattern has been detected.<sup>2</sup> Considering the variable prevalence of asthma around the world, some relatively standardized studies have

**Abbreviations:** ECRHS, cone-beam computed tomography; AR, allergic rhinitis.

been conducted the results of which revealed that the prevalence of asthma varied between 1% and 18% for children and adults.<sup>3</sup> Differences in sociodemographic, economic and geographic conditions between urban and rural areas causes variation in asthma prevalence.

Asthma is considered as a burden to high-income countries. However, considering the increase in prevalence of asthma and asthma-related deaths in low and middle-income countries, determining its prevalence and trend is of great importance for further controlling strategic plans. Asthma is now considered as the 14th most important chronic disease in terms of the prevalence and disability.<sup>4</sup>

Definition of asthma is dissimilar in different studies. While self-reported wheeze has been considered to be asthma in some studies,<sup>5</sup> others define it as a combination of asthma symptoms or physician diagnosis.<sup>6</sup> Spirometry, peak expiratory flow or skin allergy tests have been applied in a few other evaluations. However, asthma remains a clinical diagnosis even in the absence of further confirmatory tests.<sup>2</sup> Nevertheless, worldwide epidemiological surveys have been performed, using European Community Respiratory Health Survey (ECRHS) questionnaire as a standardized method to identify the prevalence of asthma symptoms.

Considering the fact that few studies in limited sample size have been conducted to verify the prevalence of asthma in Iran in recent years, we aimed to investigate the prevalence of asthma in Iranian adults living in urban and rural areas. This national study was performed using ECRHS questionnaire to identify the prevalence of asthma symptoms and its possible relationship with AR and cigarette smoking in adults in Iran.

## 2 | MATERIALS AND METHODS

### 2.1 | Sampling method

Iran is located in southwest Asia and ranks 18th in size among the countries worldwide. Iran has a variable climate, which is arid in general. A dramatic increase in Iran's population was recorded during the 20th century. In this regards, from a total of 79 109 272 individuals living in Iran, 37 059 347 people (46.7%) were aged from 20 to 44 years old in 2015.<sup>7</sup> This cross-sectional study was according to a multistage stratified cluster sampling in order to investigate the prevalence of asthma and asthma symptoms in Iranian adults aged between 20 and 44 years old, living in different 31 provinces of Iran. Sampling was performed according to the clusters of population in each urban and rural area and in accordance with the sample size in each province using postal codes. In summary, population of adult individuals aged 20–44 years old, living in urban and rural areas of each distinct province, was obtained from the Statistical Center of Iran (national census of population).<sup>7,8</sup> Then, the sample size of

each province was calculated for each rural and urban region considering a 95% confidential interval and 3% precision level. Multistage stratified cluster sampling was performed, considering each province as a distinct stratum, and random strata of rural and urban areas were determined for each province. Every cluster of urban areas consisted of 50 individuals, while rural areas included 20 individuals in each cluster to reach adequate sample size in each province. Postal code was applied for random sampling in each cluster. Finally, a total of 24 344 individuals were enrolled in the study.

### 2.2 | Questionnaire

The ECRHS questionnaire was initially translated to Persian and four asthma and allergy specialists edited the translated questionnaire. Two questions regarding the educational level and smoking status (active or passive) of participants was also added to the questionnaire. Different educational levels were defined as follows: low (primary school), moderate (high school and associated degree) and high (bachelor, master and doctorate degrees) educational levels.

Subsequently, back translation of the questionnaire was performed by a person with a master's degree in English language with no significant difference with the original questionnaire. The validity and reliability of the translated questionnaire were evaluated using Cronbach's alpha in a group of 50 individuals at different ages with physician-diagnosed asthma. The alpha coefficient was 0.854, suggesting the high internal consistency of the items. Face to face interview was performed by health care providers and questionnaires were filled between November 2015 and February 2016.

The applied questionnaire is summarized in Appendix. Accordingly, wheezing with dyspnea in the last 12 months was considered as the main criteria for 'asthma', while a positive answer to asthma attack or receiving asthma medications were considered as 'current asthma'.<sup>9</sup>

### 2.3 | Statistics

Statistical analyses were carried out using the statistical software SPSS, Version 22.0 (SPSS Inc., Chicago, Illinois). The prevalence of each of the symptoms was calculated and binary logistic regression was performed to predict the odds. A  $P < .05$  was considered to be statistically significant.

## 3 | RESULTS

Gender distribution was 12 103 females (49.7%) to 12 156 males (49.9%). Mean  $\pm$  SD age was  $31.7 \pm 6.9$  years (median: 31 years) with  $31.8 \pm 6.9$  years for urban and  $31.4 \pm 6.9$  years for rural areas. A total of 5607 participants

**TABLE 1** The prevalence of asthma symptoms, allergic rhinitis and smoking status

| Asthma symptoms, AR, smoking status | Total ( <i>n</i> = 24 344) |            | Gender   |            |          |            | <i>P</i> value |
|-------------------------------------|----------------------------|------------|----------|------------|----------|------------|----------------|
|                                     |                            |            | Female   |            | Male     |            |                |
|                                     | <i>N</i>                   | Prevalence | <i>N</i> | Prevalence | <i>N</i> | Prevalence |                |
| Wheezing                            | 3465                       | 14.2       | 1444     | 12         | 2004     | 16.5       | < .001         |
| Wheezing with dyspnea (asthma)      | 2156                       | 8.9        | 1000     | 8.3        | 1143     | 9.4        | .002           |
| Wheezing in the absence of a cold   | 2160                       | 8.9        | 925      | 7.6        | 1222     | 10.1       | .043           |
| Chest tightness                     | 2760                       | 11.3       | 1351     | 11.2       | 1395     | 11.5       | .43            |
| Nocturnal dyspnea                   | 2156                       | 8.9        | 1076     | 8.9        | 1068     | 8.8        | .80            |
| Nocturnal cough                     | 3234                       | 13.3       | 1624     | 13.4       | 1592     | 13.1       | .48            |
| Asthma attack                       | 796                        | 3.3        | 417      | 3.5        | 370      | 3.1        | .08            |
| Medications for asthma              | 871                        | 3.6        | 467      | 3.9        | 399      | 3.3        | .017           |
| Physician-diagnosed asthma          | 893                        | 3.7        | 473      | 3.9        | 414      | 3.4        | .02            |
| Current asthma                      | 1155                       | 4.7        | 615      | 5.1        | 530      | 4.4        | .009           |
| History of AR                       | 5139                       | 21.1       | 2754     | 22.9       | 2369     | 19.6       | < .001         |
| Passive smoking                     | 6510                       | 26.7       | 3280     | 27.1       | 3205     | 26.4       | .22            |
| Active smoking                      | 3066                       | 12.6       | 287      | 2.4        | 2769     | 22.9       | < .001         |

(23.1%) were 20–25 years old, 10 905 (44.8%) were 26–35 years old and 7808 individuals (32.1%) were 36–44 years old. Data analysis showed that 68.7% (*n* = 16 717) and 31.3% (*n* = 7627) of the participants were from urban and rural areas, respectively. In addition, 36.7% (*n* = 8936) of individuals had low educational level, while 43.2% (*n* = 10 499) and 19.9% (*n* = 4214) of the participants had moderate and high educational levels, respectively.

The prevalence of asthma symptoms, AR and cigarette smoking in total population and among genders are summarized in Table 1. Accordingly, the prevalence of asthma was found to be 8.9%, ranged from 4.1% to 15.9% (*n* = 2156) [95% confidence interval (CI): 8.5–9.3] in different provinces. Figure 1 shows the prevalence of asthma in different provinces of Iran. Accordingly, south-eastern (Sistan and Baluchistan) and southwestern (Khuzestan) provinces had the highest prevalence of asthma between all the provinces. Statistical analysis revealed that the overall mean prevalence of current asthma was 4.7%, ranged from 2% to 12.5% (*n* = 1155) (95% CI: 4.5–4.9). The most common asthma symptoms were wheezing (14.2%, *n* = 3465), nocturnal cough (13.3%, *n* = 3234) and chest tightness (11.3%, *n* = 2760). As shown in Table 1, the prevalence of AR was 21.1%, ranging from 7.1% to 37.5% (*n* = 5139) in different provinces. Additionally, 26.7% (*n* = 6510) and 12.6% (*n* = 3066) of participants were passive and active smokers, respectively.

Wheezing and active smoking were more prevalent in men ( $P < .001$ ), while asthma, wheezing without cold,

taking asthma medications, current asthma, physician diagnosed asthma and AR were more prevalent in women ( $P < .001$ ,  $P = .043$ ,  $P = .017$ ,  $P = .009$ ,  $P = .02$  and  $P < .001$ , respectively).

Nocturnal cough, taking asthma medications and AR were more prevalent in urban areas compared to rural areas ( $P = .003$ ,  $P < .001$  and  $P < .001$ , respectively). However, the prevalence of asthma attack and passive smoking was higher in rural areas compared to urban areas ( $P = .012$  and  $P < .001$ , respectively).

The prevalence of different variables between patients with asthma and current asthma are shown in Table 2. The relationship between asthma and age, gender, educational level, smoking behavior and AR were found to be significant ( $P < .05$ ), while no significant relationship was detected between area of residency and asthma ( $P = .88$ ). However, when the analysis was performed after adjustment for age, gender, educational level, area of residence, smoking behavior and AR, no significant relationship was detected between asthma and gender ( $P = .13$ ) as well as area of residency ( $P = .71$ ). Additionally, about two-thirds of patients with asthma were diagnosed by a physician (66.4%, 95% CI: 63.4–69.7). Furthermore, 45.5% of participants with asthma had a history of AR, while 19% (*n* = 975) of patients with AR had asthma.

Similar to asthma, the relationship between current asthma and all variables except area of residency ( $P = .89$ ) were found to be significant. Nevertheless, beside gender



**FIGURE 1** The prevalence of asthma among Iranian adults in different provinces of Iran

and area of residency ( $P = .16$  and  $.2$ ), no significant relationship was found between current asthma and active or passive smoking behavior after adjustment ( $P = .08$  and  $.59$ , respectively).

It is worth to mention that the prevalence of both asthma and current asthma was significantly higher in older patients (36–44 years old) and those with lower educational level, while no significant difference were found among place of residence in urban or rural areas. In addition, there was a significant relationship between both active/passive smoking behavior and asthma attack ( $P < .001$ ).

## 4 | DISCUSSION

The prevalence of asthma seems to have increased in the developing countries in the last decades that may be

attributed to lifestyle changes, urbanization, air pollution and other unknown reasons, while it has reached a plateau in developed countries.<sup>10</sup> In spite of previous investigations to determine the prevalence of childhood asthma in Iran,<sup>11</sup> no clear picture has been provided to find the prevalence of asthma in adults by the coverage of all the provinces. To the best of our knowledge, no national survey with such a notable sample size ( $n = 24\,344$ ) has investigated the distribution of adult asthma in Iran using a standardized questionnaire. According to the results of the present study the estimated prevalence of asthma in the Iranian adult population was 8.9%.

The cross-sectional world health survey showed that the respective global prevalence rates of diagnosed asthma, clinical/treated asthma and wheezing in adults were 4.3%, 4.5% and 8.6% with a variation by as much as 21-fold among 70 countries.<sup>12</sup> The results of the present study revealed that

**TABLE 2** Comparison of the prevalence of different variables between asthma and current asthma

|                                | Asthma % (95% CI) |                  |                             |                          | Current asthma % (95% CI)   |                          |                             |                          |
|--------------------------------|-------------------|------------------|-----------------------------|--------------------------|-----------------------------|--------------------------|-----------------------------|--------------------------|
|                                | <i>P</i>          | (95% CI)         | <i>P</i> value <sup>a</sup> | OR (95% CI) <sup>a</sup> | <i>P</i> value <sup>b</sup> | OR (95% CI) <sup>b</sup> | <i>P</i> value <sup>a</sup> | OR (95% CI) <sup>a</sup> |
| Age groups (years)             | 20–25             | 7.1 (6.4–7.8)    |                             |                          |                             |                          | 3.5 (3–4)                   |                          |
|                                | 26–35             | 8.1 (7.6–8.6)    | <.001                       | N/A                      | <.001                       | 1.14 (1.06–1.22)         | 4.4 (4.4–8)                 | .002                     |
|                                | 36–44             | 11.2 (10.3–11.6) |                             |                          |                             |                          | 6.3 (5.7–6.8)               | 1.19 (1.06–1.34)         |
| Gender                         | Male              | 9.4 (8.9–9.9)    | .002                        | 0.86 (7.9–9.4)           | .13                         | –                        | 4.4 (4.4–8)                 | .16                      |
|                                | Female            | 8.3 (7.8–8.8)    |                             |                          |                             |                          | 5.1 (4.7–5.5)               | –                        |
| Educational level <sup>c</sup> | Low               | 11.1 (10.5–11.8) | <.001                       | N/A                      | <.001                       | 0.79 (0.73–0.84)         | 6.2 (5.7–6.7)               | <.001                    |
|                                | Moderate          | 7.7 (7.2–8.2)    |                             |                          |                             |                          | 3.8 (3.5–4.1)               | .002                     |
|                                | High              | 6.9 (6.2–7.6)    |                             |                          |                             |                          | 4.8 (4.5–5)                 | 0.83 (0.74–0.93)         |
| Region                         | Urban             | 8.9 (8.4–9.4)    | .88                         | –                        | .71                         | –                        | 4.8 (4.4–5.2)               | .2                       |
|                                | Rural             | 8.8 (8.3–9.5)    |                             |                          |                             |                          | 4.8 (4.4–5.2)               | –                        |
| Active smoking                 | 16.5              | <.001            | 2.34 (2.1–2.6)              | <.001                    | <.001                       | 2.25 (1.98–2.56)         | 6                           | .08                      |
| Passive smoking                | 12.3              | <.001            | 1.7 (1.55–1.87)             | <.001                    | <.001                       | 1.27 (1.14–1.42)         | 5.9                         | .59                      |
| AR                             | 19 (18–20)        | <.001            | 3.59 (3.27–3.93)            | <.001                    | <.001                       | 2.9 (2.6–3.2)            | 12.3 (11.4–13.2)            | <.001                    |
|                                |                   |                  |                             |                          |                             |                          | 4.98 (4.41–5.62)            | 3.59 (3.05–4.22)         |

<sup>a</sup>Nonadjusted analysis, *P* = prevalence.<sup>b</sup>Logistic regression (adjusted analysis).<sup>c</sup>Low educational level (primary school), moderate educational level (high school and associated degree) and high educational level (bachelor, master and doctorate degrees).

the prevalence of physician-diagnosed asthma was lower (3.7%), while wheezing was higher (14.2%) than the global reports. Considering the fact that the prevalence of asthma is usually underdiagnosed by the application of this criterion, physician-diagnosed asthma may not be a precise index for determining the prevalence of asthma.

Different studies were performed by ECRHS questionnaire in different countries to estimate the prevalence of asthma worldwide. ECRHS questionnaire was mailed to 3000–4000 Canadian citizens aged 20–44 years. The results revealed that the respective prevalence of asthma was 11.6% and 15.4% among male and females,<sup>13</sup> while lower prevalence was found in the current study in both male and female populations. In a recent study from three population surveys in Sweden,<sup>14</sup> the prevalence of asthma decreased from 1996 to 2006, and further to 2016 (14.4%, 13.3% and 13.2%, respectively), while the prevalence of current asthma increased in this time-point (8.4%, 9.8% and 10.8%, respectively). However, the prevalence of both asthma and current asthma were lower in Iranian population. de Marco et al evaluated the trends in the prevalence of asthma and AR in Italy.<sup>15</sup> Accordingly, in spite of the fact that the prevalence of asthma decreased from 1991 to 2000 (7.7–5.7), a slight increase was found in its prevalence from 2000 to 2010 (5.7–8.5). Comparatively, the prevalence of asthma was slightly higher as obtained in the present study. Similar to these studies, repeated cross-sectional investigations are required in Iranian population to achieve a reliable estimation of the trend of asthma prevalence in Iran. A cross-sectional telephone interview survey including all municipalities of Portugal was performed to evaluate the prevalence of asthma by the application of a questionnaire based on the Portuguese version of the GA2LEN survey.<sup>16</sup> Accordingly, the prevalence of current asthma was 6.8% with a strong relationship with AR, which is higher than the prevalence of current asthma in the present study.

Asia is the largest and most populated continent covering 30% of the Earth's lands and hosting 60% of the world's current population.<sup>17</sup> However, the epidemiological features of asthma are mainly unknown in this continent. According to a review article in 2014 regarding the epidemiology of adult asthma in Asia, from a total of 14 reports from nine countries with a wide variation of asthma definition, the prevalence of asthma varied from 0.7% to 11.9%.<sup>18</sup>

Similar studies with the same questionnaire were conducted in Asian countries. The respective prevalence of asthma and current asthma among adults in rural areas of Denizli province (Turkey) was 10.3% and 5.9%.<sup>19</sup> The authors suggested that older population and higher exposure to allergens in the rural areas may be the possible causes of this higher prevalence. Dinmezel et al reported that the prevalence of asthma was as 16% in the city center of Antalya province (Turkey).<sup>20</sup> These discrepancies may be attributed

to the higher risk factors in a polluted city like Antalya. Mahboub et al assessed the prevalence of asthma symptoms in established quotas of seven Emirates in the United Arab Emirates.<sup>21</sup> The results of which showed that the prevalence of asthma was 8.9% in young adults which is equal to the prevalence of asthma in the present study.

Table 3 depicts a comparison of the prevalence of adult asthma symptoms found in Iran with some of the centers worldwide using ECRHS questionnaire. We found that the prevalence of asthma in Iran is lower than Turkey and Sweden, while its prevalence is higher than Italy. However, same results were obtained from the present study and United Arab Emirates in terms of the prevalence of this variable. Accordingly, the median prevalence of asthma in Europe was estimated to be 9.8% in 1996 as compared to the current study that was 8.9%.

The main goals of asthma treatment are controlling the symptoms and reducing the attacks by a long-term management of asthma. By better diagnosis, reducing underdiagnosed patients and increasing the adherence, complete asthma control will be achieved. Despite current asthma can show increased asthma attacks, it is also a good index for using asthma medication and excellent asthma control. So, higher rates of current asthma/asthma ratio may reflect long-term asthma treatment. Schatz et al concluded that better quality-of-care outcomes and reduced emergency hospitalization may be attained if higher controller medication/total asthma medication ratio is achieved.<sup>22</sup> Current asthma/asthma ratio is also demonstrated in Table 3. The possible reasons of variation between studies may be attributed to the differences in the prevalence of asthma attack and receiving asthma medication among countries. As depicted in Table 3, current asthma/asthma ratio increased from 0.18 to 0.41 in Tehran between 2010 and 2015. Considering the fact that increase in applying asthma medication was higher than asthma attacks raising and the prevalence of asthma did not change significantly over time, this index may show a noteworthy decrease in under-treated patients in Tehran. Although this difference may be due to the limitations of telephone survey study performed in 2010, increased asthma knowledge both among patients and health care providers as well as better management strategies (national asthma guideline)<sup>23</sup> may have a significant role in increasing this index. Similar trend in increase of this index is observed in Turkey (0.12–0.57 from 1995 to 2009). Increased ratio in countries such as Sweden (from 0.58 to 0.81 between 1996 and 2016) and Italy (from 0.53 to 0.77 between 1991 and 2010) may be due to better diagnosis and treatment strategies in two decades or even decrease in the occurrence of asthma with preventive strategies. Still, more long-term strategies are required to reach other countries with better asthma management policies.

**TABLE 3** Comparison of the prevalence of adult asthma symptoms and smoking behavior in Iran with other centers using ECRHS questionnaire

|                                 | Wheezing<br>(%) | Wheezing<br>with<br>dyspnea<br>(asthma)<br>(%) | Wheezing<br>without<br>cold (%) | Nocturnal<br>chest<br>tightness<br>(%) | Nocturnal<br>dyspnea<br>(%) | Nocturnal<br>cough<br>(%) | Asthma<br>attack<br>(%) | Asthma<br>medication<br>(%) | Current<br>asthma<br>(%) | Allergic<br>rhinitis<br>(%) | Passive<br>smoking<br>(%) | Active<br>smoking<br>(%) | Current<br>asthma/<br>asthma<br>(%) |
|---------------------------------|-----------------|------------------------------------------------|---------------------------------|----------------------------------------|-----------------------------|---------------------------|-------------------------|-----------------------------|--------------------------|-----------------------------|---------------------------|--------------------------|-------------------------------------|
| Iran, Tehran, 2010 <sup>a</sup> | 24              | 10.8                                           | 11.5                            | 11.3                                   | 10.4                        | 10.4                      | 1.6                     | 1.9                         | 2                        | NR                          | 16.5                      | 11.9                     | 0.18                                |
| Iran, Tehran, this study        | 18              | 11                                             | 11.6                            | 12.9                                   | 10                          | 16.5                      | 2.5                     | 3.7                         | 4.5                      | 22.8                        | 25.5                      | 15.9                     | 0.41                                |
| Iran, this study                | 14.2            | 8.9                                            | 8.9                             | 11.3                                   | 8.9                         | 13.3                      | 3.3                     | 3.6                         | 4.8                      | 21.1                        | 26.7                      | 12.6                     | 0.54                                |
| Turkey (three regions), 1995    | 22.6            | 19.2                                           | 18.1                            | 16.3                                   | 15.3                        | 17                        | 4.4                     | 4.2                         | 2.3                      | 10.5                        | NR                        | 32.8                     | 0.12                                |
| Turkey (five regions), 2005     | 24.9            | 15.7                                           | 12.7                            | NR                                     | 17.1                        | NR                        | NR                      | NR                          | 6.6                      | 10.7                        | 59.2 <sup>b</sup>         | 29.4                     | 0.42                                |
| Turkey, Denizli, 2009           | 12.7            | 10.3                                           | 9.7                             | 18.8                                   | 20.5                        | 19.9                      | 2.3                     | 5.7                         | 5.9                      | NR                          | 27.2                      | 19.7                     | 0.57                                |
| UAE (seven Emirates), 2009      | 10              | 8.9                                            | 8                               | 9.8                                    | 9.1                         | 10.4                      | 8                       | 8                           | NR                       | 6.8                         | NR                        | NR                       | NR                                  |
| Portugal, <sup>a</sup> 2012     | 18.1            | NR                                             | NR                              | 11.9                                   | 6.8                         | 28                        | 3.2                     | 5                           | NR                       | 22.1                        | NR                        | 12.5                     | NR                                  |
| Italy, 1991–1993                | 10.1            | 7.7                                            | NR                              | 7.6                                    | NR                          | NR                        | NR                      | 48 <sup>c</sup>             | 4.1                      | 16.8                        | NR                        | NR                       | 0.53                                |
| Italy, 1998–2000                | 12              | 5.7                                            | NR                              | 7.8                                    | NR                          | NR                        | NR                      | 64.1 <sup>c</sup>           | 4.6                      | 19.4                        | NR                        | 33.5                     | 0.8                                 |
| Italy, 2007–2010                | 13.9            | 8.5                                            | NR                              | 10.2                                   | NR                          | NR                        | NR                      | 58.1 <sup>c</sup>           | 6.6                      | 25.8                        | NR                        | 27.7                     | 0.77                                |
| Sweden (three regions), 1990    | 20.3            | 11.2                                           | 12.1                            | 11.2                                   | 5.3                         | 26.6                      | 3.2                     | 5.2                         | 6                        | 21.6                        | NR                        | 21.6                     | 0.53                                |
| Sweden (three regions) 2008     | 16.1            | 10.2                                           | 10.2                            | 10.9                                   | 4.9                         | 24.7                      | 4.4                     | 6.9                         | 8                        | 30.9                        | NR                        | 30.9                     | 0.78                                |
| Sweden, Norrnotten, 1996        | 18.6            | 14.4                                           | NR                              | NR                                     | NR                          | NR                        | NR                      | 10.9                        | 8.4                      | 23                          | NR                        | 27.4 <sup>d</sup>        | 0.58                                |
| Sweden, Norrnotten, 2006        | 18.6            | 13.3                                           | NR                              | NR                                     | NR                          | NR                        | NR                      | 12.4                        | 9.8                      | 24.8                        | NR                        | 19.3 <sup>d</sup>        | 0.73                                |
| Sweden, Norrnotten, 2016        | 18.1            | 13.2                                           | NR                              | NR                                     | NR                          | NR                        | NR                      | 13.5                        | 10.8                     | 27.8                        | NR                        | 12.3 <sup>d</sup>        | 0.81                                |
| ECRHS (median), 1996            | 20.7            | 9.8                                            | 12.7                            | 13.5                                   | 7.3                         | 27.7                      | 3.1                     | 3.5                         | 4.5                      | 21                          | NR                        | NR                       | 0.46                                |

Abbreviation: NR, not reported.

<sup>a</sup>Telephone interview survey.<sup>b</sup>Smoking within the household during childhood.<sup>c</sup>In current asthma group.<sup>d</sup>Current smokers.

The results of our previous telephone survey that was conducted in Tehran (Capital of Iran) in 2010 showed that the prevalence of asthma and current asthma was 10.8% and 2%.<sup>24</sup> Although the prevalence of asthma medications, current asthma and AR were significantly different between men and women in the present study, the differences were not statistically different in our previously published study. Similar cross-sectional studies with different methodology and sample size have been performed in some cities of Iran. Accordingly, the prevalence of asthma in Urmia (northwest of Iran),<sup>25</sup> Sari (north of Iran),<sup>26</sup> Mashhad (northeast of Iran)<sup>27,28</sup> and rural areas of Isfahan<sup>29</sup> was estimated to be 3.3%, 13.3%, 2.8%, 2.3% and 6.1%, respectively. In spite of limited studies in different cities of Iran and lack of periodic investigations, the prevalence of asthma seems to have increased as compared by the results of the present national survey in each city (data not shown). More local evaluations are required especially in the southeastern and southwestern areas with the highest prevalence of asthma (as shown in Figure 1) to discover the potential risk factors and determine the best preventive modalities.

The results of the present survey revealed that the prevalence of asthma was considerably higher in men. However, there was no statistical significance after adjustment of this factor with other variables, confirming the multifactorial characteristics of asthma. Additionally, current asthma and physician-diagnosed asthma were more prevalent in women. It has been demonstrated that diagnosis of asthma is higher in women than men.<sup>30</sup> Both endogenous and exogenous sex steroid hormones cause women to have higher asthma risk after puberty.<sup>31</sup> Despite the persistence of sex discordance in childhood asthma,<sup>32</sup> there is no convincing evidence regarding the association of asthma and gender in adults.

Geographical features seem to have a crucial role in the prevalence of asthma especially in urban and rural areas. Although the fact that many studies have shown a higher prevalence of asthma in urban areas compared to rural areas, this relationship was not confirmed in some other researches.<sup>33</sup> Similarly, our results showed no statistically significant difference between these two areas that may be partly contributed to changes in lifestyle. Considering the differences in parameters such as dissimilar humidity, population, air pollution and particulate matters between urban and rural areas, more longitudinal studies with the same methodology should be conducted to draw more firm conclusions and evaluate the role of epigenetic factors and lifestyle changes in urban and rural areas.

## 5 | CONCLUSION

The prevalence of asthma in Iranian adults was 8.9% with a significant increase among individuals in older age groups

and those with low education level. Considering the worldwide increase in the prevalence of asthma and its high prevalence in Iran, a strategic plan for the prevention and control of chronic respiratory diseases is underway. However, more prospective studies are required to evaluate the trend in asthma prevalence for further long-term therapeutic strategies with a hope to decrease the prevalence of asthma in Iran.

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## CONFLICT OF INTEREST

None of the authors have any conflict of interest.

## AUTHOR CONTRIBUTION

*Conception and design:* Fazlollahi, Najmi, Fallahnezhad, Mahloujirad, Pourpak, Moin

*Translation and validation of the questionnaire:* Bidad

*Acquisition of data:* Shoormasti

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*Drafting the article:* Sabetkish

*Revising the manuscript critically for important intellectual content:* Fazlollahi, Najmi, Fallahnezhad, Kazemnejad, Bidad, Shoormasti, Mahloujirad, Pourpak, Moin

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## ETHICS

This study was approved by ethics committee of Tehran University of Medical Sciences (Tehran, Iran). Participants were informed about the study before entering the study.

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**APPENDIX: MODIFIED ECRHS QUESTIONNAIRE**

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|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Part A              | <ul style="list-style-type: none"><li>• What is your current age?</li><li>• Are you male or female?</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Part B              | <ul style="list-style-type: none"><li>✓ Have you had wheezing in your chest at any time in the last 12 months?</li><li>✓ Have you been breathless when the wheezing noise was present?</li><li>✓ Have you had this wheezing when you did not have a cold?</li><li>✓ Have you had a feeling of tightness in your chest at any time in the last 12 months?</li><li>✓ Have you woken up with a feeling of breathless and/or cough at any time in the last 12 months?</li><li>✓ Have you had an attack of asthma in the last 12 months?</li><li>✓ Are you currently taking any medicine for asthma?</li><li>✓ Do you have any nasal allergies including hay fever?</li></ul> |
| Part C <sup>a</sup> | <ul style="list-style-type: none"><li>❖ What is your educational level?</li><li>❖ Have you ever smoked or been exposed to cigarette smoke for as long as a year?</li><li>❖ Has your asthma ever been diagnosed by a physician?</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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<sup>a</sup>Questions of “part C” have been added to the original short screening ECRHS questionnaire.