Alomary et al. World Allergy Organization Journal (2022) 15:100623
http://doi.org/10.1016/j.waojou.2021.100623

WORLD ALLERGY ORGANIZATION JOURNAL

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Prevalence of asthma symptoms and associated risk factors among adults in Saudi Arabia: A national survey from Global Asthma Network Phase I

Shaker A. Alomary, MD[a], Ahmed J. Al MadaniMBBS[a], Wael A. Althagafi, MD[a]*, Izzeldin F. Adam, BPH, MPH, PhD[a,b], Omneya E. Elsherif, PhD[a,c], Aljoharah A. Al-AbdullaahBSc[a], Hamdan Al-jahdaliMD[d], Hani A. Jokhdar, MBBCh, MSc, PhD[e], Saeed H. Alqahtani, MD[a], Mahmoud A. Nahhas, BS.Pharm, MPH, PhD[f] and Rasha A. Alfawaz, PhD[g]

ABSTRACT

Purpose: Estimating the prevalence and severity of asthma symptoms with standardized methods of population-based surveys is a critical step in reducing asthma burden. However, no sufficient surveys have been conducted in most countries of the Middle East especially at the national level. In this survey, we applied sound measures to estimate the prevalence and severity of asthma symptoms and related risk factors in adults in Saudi Arabia.

Patients and methods: In this national cross-sectional study, the prevalence and severity of asthma symptoms were estimated throughout the country. Overall, 7955 adult individuals were selected from 20 regions across Saudi Arabia through their children at schools using a multistage, stratified cluster-sampling technique. A validated questionnaire, including the core and environmental questions of the Global Asthma Network questionnaires, was applied from March 4 to April 25, 2019. In addition, multivariate logistic regression analysis was performed to investigate the independent relationships between current wheeze and related risk factors.

Results: The overall prevalence of current wheeze (wheeze during the past 12 months) was 14.2%. Among persons with current wheeze, 38.1% were affected by severe asthma symptoms. Although a high percentage of those who had experienced asthma-ever reported that their asthma was diagnosed by doctors (83.3%), only 38.4% had a written plan for controlling their asthma. Women were more likely to develop current wheeze (adjusted odds ratio (aOR) 1.4; 95% CI: 1.1–1.7), while other statistically significant factors associated with current wheeze were jobs (aOR 11.8; 95% CI: 7.3–18.9), current exposure to moisture or damp spots (aOR 2.2; 95% CI: 1.5–3.4), heating the house when it is cold (aOR 1.7; 95% CI: 1.3–2.1), and ever using tobacco daily (aOR 2.7; 95% CI: 2.0–3.5).

[a]General Directorate of Health Programs and Chronic Diseases, Ministry of Health, Riyadh, Saudi Arabia
*Corresponding author. Riyadh, 13245 - 7518, Saudi Arabia.
E-mail: waalthagafi@moh.gov.sa
Full list of author information is available at the end of the article

http://doi.org/10.1016/j.waojou.2021.100623

Received 30 August 2021; Received in revised from 23 November 2021; Accepted 13 December 2021
Online publication date xxx

Conclusions: These findings provide enough evidence for health authorities in Saudi Arabia about the prevalence and severity of asthma symptoms, asthma control, and associated risk factors to scale up monitoring projects, control plans, and high-impact interventions.

Keywords: Allergic conditions, Asthma prevalence, Global Asthma Network, Risk factors, Middle East

INTRODUCTION

Asthma is a worldwide health problem and a major disease affecting all age groups.[1] It is a chronic disease involving the airways that carry air in and out of the lungs. In people with asthma, these airways are inflamed, making them very sensitive and often reacting to allergens or irritants. There is no cure for asthma; however, symptoms can be controlled with the proper diagnosis, medication, and management plan.[2] In light of this, appropriate and well-conducted epidemiological research is a crucial tool for developing and implementing national health care intervention programs. Asthma care is no exception to this rule, and the availability of accurate epidemiologic information is essential for establishing appropriate and timely asthma diagnosis and control programs.[3]

The World Health Organization (WHO) estimates that approximately 339 million people are affected by asthma and that most deaths occur in older adults.[4] As the Global Initiative for Asthma (GINA) reports in 2020, asthma affects 1%–18% of populations in different countries and its prevalence has been increasing around the world.[5]

Prevalence rates for asthma in Saudi Arabia have been estimated in several epidemiologic studies. A survey conducted in 2012 among 3037 participants assessing the prevalence of asthma among adolescents 16- to 18-years old in Riyadh city, reported a lifetime-wheeze prevalence of 25.3%, wheeze during the preceding 12 months of 18.5%, and physician-diagnosed asthma in 19.6%.[6] The Ministry of Health (MOH) in Saudi Arabia conducted a national cross-sectional multistage survey of adults 15 years and older in 2013 and reported the prevalence of asthma—based on self-reporting of clinician-diagnosed asthma—to be 4.05% of the population. The survey also reported on other chronic diseases, risk factors, and functional status.[7] A meta-analysis of 92 studies, published between 1996 and 2016, looking at pooled-prevalence and incidence rates for asthma in the Eastern Mediterranean Region (EMR) showed Saudi Arabia to have one of the highest prevalence rates for asthma (17.6%) alongside Kuwait (25.9%) and Qatar (19.8%) compared with other EMR countries.[8] In 2016, a SNAPSHOT program carried out in 3 Gulf cluster countries through telephone survey reported that the prevalence of asthma was 9.5% in Kuwait, 8.3% in Saudi Arabia, and 4.9% in the United Arab Emirates.[9] More recently, several city-based studies have looked at lifetime wheeze and physician-diagnosed asthma in Saudi Arabia. A meta-analysis reviewed 31 studies about asthma prevalence in Saudi Arabia up to 2018. Most of the studies were conducted on children below 16 years of age. Ten studies were based on the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaires, five on non-ISAAC questionnaires, and other studies were concerned with genetic basis of asthma. The pooled weighted prevalence of asthma was 14.3% and lifetime wheeze 16.5%.[10] Another study conducted in the Northern Borders region among 16- to 18-year-olds reported a lifetime wheeze percentage of 30.3%, wheezing during the preceding 12 months of 16.8%, and a physician-diagnosed asthma rate of 11.4%.[11] Among the adult population, a cross-sectional study involving 222 university students in Najran reported a rate of 27% for physician-diagnosed asthma.[12] In Riyadh, a study assessing asthma prevalence among adults 22–44 years old using the European Community Respiratory Health Survey (ECRHS) questionnaire reported that the prevalence of

wheezing in the preceding 12 months was 18.2%; physician-diagnosed asthma was 11.3%; and the prevalence of taking medicine for asthma was 10.6%. Moreover, the study found no significant difference between men and women.[13] Most recently, a survey among adults visiting primary care clinics in the Aseer region using a modified version of the Arabic translation of the ISAAC questionnaire for adults, reported a prevalence of asthma, based on the presence of wheezing in the past 12 months, of 19.2%.[14]

The main aim of this study was to assess the prevalence and severity of asthma symptoms and related risk factors among adults in different regions of Saudi Arabia, which can help health care programs to provide evidence-based health interventions.

MATERIAL AND METHODS

This study was based on a national cross-sectional survey that involved parents of schoolchildren aged 6 to 7 and 13 to 14 years old in 20 regions across Saudi Arabia. A multistage, stratified cluster-sampling design based on region, sex, and type of school (governmental vs private) was used to approach schoolchildren and their parents. A proportional sample size was allocated for each region in the country. Cluster sizes of 40 and 30 individuals were assigned for private and governmental schools, respectively. A compulsory sample of randomly selected schoolchildren and a recommended sample of their corresponding parents were suggested by the Global Asthma Network (GAN). In this paper, we only report the results of the dependent sample of 9335 adults who were randomly invited through their children in elementary and intermediate schools to participate in the study during the period from March 4 to April 26, 2019.

A self-administered and standardized questionnaire provided by the ISAAC and developed by the GAN was used to collect data.[15] The questionnaire consisted of sociodemographic characteristics, the prevalence and severity of asthma symptoms, asthma management, and related lifestyle and environmental risk factors.[16]

The questionnaire was nationally validated following the GAN-recommended procedures. It was translated into Arabic and back-translated into English by 2 independent bilingual experts familiar with national sociocultural aspects. Furthermore, a pilot study was carried out on a small sample representative of the study groups to test the questionnaire and make necessary modifications. In addition to the pilot group, local doctors were consulted on the most common words used to describe difficult terms related to asthma symptoms and their risk factors. The most appropriate translation for difficult terms, eg: "wheezing" or "whistling in the chest" were identified. A rating system was used to determine the commonly used names for those terms by submitting a list of possible descriptors to the children with asthma and their parents and asking them to indicate the best favor. The wording of questions according to the local use of language was considered. A group of national experts was then consulted to modify and approve the final pre-coded version of the questionnaire prior to printing the questionnaires.

In this study, all measurements were done based on the protocol of the ISAAC Phase III and its modified version, developed by the GAN.[15] Although the ISAAC Phase III self-reported height and weight, fieldworkers and/or school staff measured those indicators using a standardized protocol of GAN phase I.[15] Most of the validated questions used by ISAAC were also used unchanged for the GAN phase I. However, few questions followed by clarification questions. For instance, an additional question to clarify that a doctor had confirmed that the participant had asthma and more additional questions on the control and management of asthma were added.[15] The prevalence of asthma symptoms was estimated based on the positive responses to the question on wheeze in the last 12 months (current wheeze), while severe asthma symptoms were defined as reporting having current wheeze, in addition to experiencing frequent and severe episodes of wheeze in the past 12 months (>4 attacks of wheeze, or >1 night per week sleep disturbance from wheeze or wheeze affecting speech).[17]

Data entry was performed by trained health personnel, and data quality assurance was maintained through weekly data validation. An independent individual re-entered 10% of all entered data from the questionnaires. Subsequently,

another data analyst compared the original and re-entered data, and an entry error was estimated at 3.3% (below the maximum 5% error accepted by the GAN).

Data analysis was done using IBM SPSS Statistics for Windows, Version 26 (IBM Corp., Armonk, NY, USA). All analyses were performed after cleaning the data and excluding observations with missing values in all variables or the main symptoms (only with response to sociodemographic questions). Frequency tables were used for demographic data, and descriptive analysis was used for the study population. Quantitative data were presented as mean and standard deviation. The frequencies and percentages were calculated for the full response to the outcome and exposure variables and the missing for certain variables was imputed. The odds ratio was applied with a 95% confidence interval and P value $\leq .05$. Associations between dependent and independent categorical variables were assessed using chi-square (χ^2) test. A statistically significant relationship was considered present when the P value was less than .05. Logistic regression was used for the identification of significant factors associated with current wheeze. To build our statistical model, first, bivariate logistic models were used to estimate the strength of association between individual predictors and the prevalence of asthma symptoms. A large set of covariates included conventional and potential risk factors for asthma (socio-demographic, home conditions, life-style, nutrition, indoor and outdoor air pollution, occupational exposure, etc.) were tested. Variables with significance level of P value (<0.2) were selected for the statistical model. A multivariable logistic regression model was then used to identify the independent risk factors associated with current wheeze after adjusting for potential confounders. A backward stepwise selection was used to come up to the best final model. In the first step, all the selected variables were included, and the least significant one at each step was removed, until none meet the criterion.

The survey was approved by the Saudi MOH in addition to the Institutional Review Board. Written consent was obtained from all participants. Moreover, participants were given the opportunity to reject the invitation to fill in the questionnaire and to skip during the interview. Strict procedures were applied to protect the confidentiality of study participants during data management and analysis.

RESULTS

A total of 9335 adults were invited via their children at school to participate in this study; 7955 of them participated, representing an 85.2% response rate.

A total of 6786 participants were included for data analysis, after excluding 1106 observations with missing values in all variables and 63 observations with missing values in the main symptom variables (Fig. 1). The demographic characteristics of study participants are shown in Table 1. The mean participant age was 38.6 years, and 56.9% were men. Nearly half of the participants (49.6%) reported an education level of college or higher, with equal distribution between men and women.

Overall, 14.2% of the participants reported a current wheeze (wheeze during the past 12 months), with a higher prevalence among women compared with men (14.9% vs. 13.7%). Of those who reported current wheeze, 38.1% were affected by symptoms of severe asthma. The prevalence of asthma ever was 14.0%, with rates of 13.6% and 14.5% found among men and women, respectively. Among participants who had asthma ever, 83.3% reported that medical doctors confirmed their asthma but only 38.4% had a written plan for asthma control. More than half (50.5%) experienced an asthma attack in the past 12 months. The percentage of asthma diagnoses confirmed by medical doctors was slightly higher in women compared with men (85.3% vs. 81.7%). More women than men reported having a written plan for asthma control and experiencing an asthma attack during the past 12 months, showing statistical significance (44.8% vs. 33.3%, $P = .001$ and 56.0% vs. 46.2%, $P = .005$, respectively) (Table 2).

Prevalence rates for other specific symptoms of asthma are shown in Table 3. More than one-third (38.6%) of the participants reported ever having trouble with breathing (either rarely, repeatedly, or continuously). Of those who experienced wheezing or whistling in the past 12 months, nearly

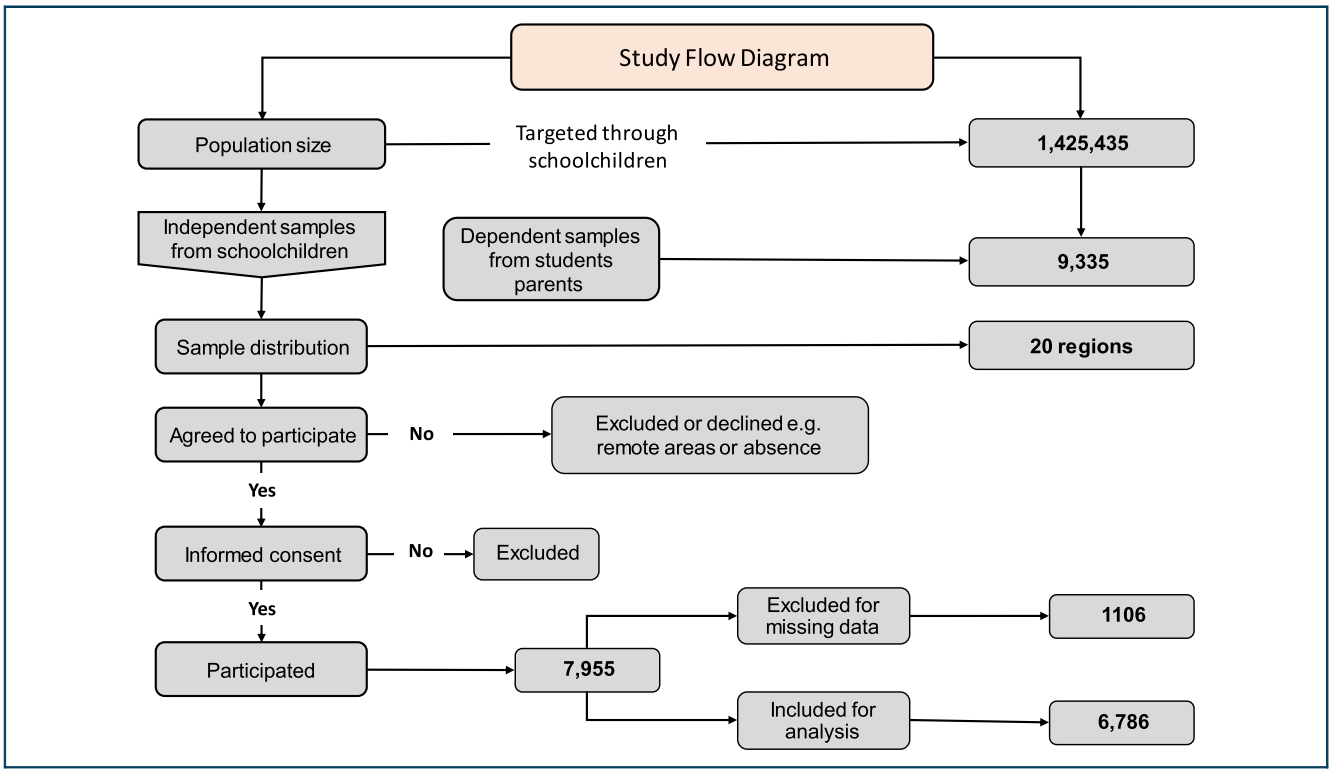

Fig. 1 Study flow diagram

	Total (n = 6367) *n (%)*	Men (n = 3620) *n (%)*	Women (n = 2747) *n (%)*
Age groups (y), mean ± SD	38.6 ± 12.2	41.9 ± 12.2	33.8 ± 10.4
<20	566 (11.0)	270 (8.9)	296 (14.0)
20–29	250 (4.8)	42 (1.4)	208 (9.8)
30–39	1692 (32.8)	702 (23.0)	990 (46.7)
40–49	1861 (36.0)	1310 (43.0)	551 (26.0)
50–59	614 (11.9)	550 (18.1)	64 (3.0)
60–69	140 (2.7)	133 (4.4)	7 (0.3)
70–79	30 (0.6)	29 (1.0)	1 (0.0)
≥80	12 (0.2)	11 (0.4)	1 (0.0)
Educational level			
Primary school	623 (11.4)	340 (10.8)	283 (12.1)
Secondary school	2141 (39.1)	1277 (40.6)	864 (37.0)
College or higher	2716 (49.6)	1526 (48.6)	1190 (50.9)

Table 1. Demographic characteristics of the study population

two-thirds (62.8%) reported sleep disturbance at least 1 night a week due to wheezing, while 59.9% and 70.3% reported sleep disturbance at least 1 night a week due to shortness of breath and coughing, respectively. Moreover, more than half (59.4%) reported ever feeling breathless when the

	Total (n = 6367) *n* (%)	Men (n = 3620) *n* (%)	Women (n = 2747) *n* (%)	*P* value
Current wheeze [a]				
Yes	882 (14.2)	483 (13.7)	399 (14.9)	.212
No	5317 (85.8)	3033 (86.3)	2284 (85.1)	
Symptoms of severe asthma [b]				
Yes	355 (38.1)	180 (35.2)	175 (41.8)	.042
No	576 (61.9)	332 (64.8)	244 (58.2)	
Asthma ever				
Yes	864 (14.0)	478 (13.6)	386 (14.5)	.315
No	5309 (86.0)	3034 (86.4)	2275 (85.5)	
Asthma confirmed by a doctor[c]				
Yes	719 (83.3)	389 (81.7)	330 (85.3)	.164
No	144 (16.7)	87 (18.3)	57 (14.7)	
Had a written plan for asthma control [c]				
Yes	325 (38.4)	157 (33.3)	168 (44.8)	.001
No	522 (61.6)	315 (66.7)	207 (55.2)	
Asthma attack in the past 12 months				
Yes	427 (50.5)	216 (46.2)	211 (56.0)	.005
No	418 (49.5)	252 (53.8)	166 (44.0)	

Table 2. Prevalence and severity of asthma symptoms among the participants. *Note: P values were obtained from χ^2 tests comparing categorical variables between males and females. [a]Participants with wheeze in the past 12 months. [b]Participants with wheeze in the past 12 months, have had >4 attacks of wheeze, or >1 night per week sleep disturbance from wheeze, or wheeze affecting speech. [c]Among participants with asthma ever*

wheezing was present, and 21.6% reported having limited speech due to wheezing in the past 12 months. The prevalence of sleep disturbance due to wheezing and sleep disturbance due to coughing in the past 12 months was significantly higher in women compared with men (67.1% vs. 59.3%, $P = .003$ and 76.3% vs. 65.8%, $P = .001$, respectively).

Prevalence rates for current wheeze by sex and age group are shown in Fig. 2. The highest percentage for current wheeze (19.2%) was seen among the age group 20–29 years old.

Table 4 shows adjusted factors associated with current wheeze. After controlling for the effects of other potentially confounding variables in our final statistical model, women were more likely to develop current wheeze (adjusted odds ratio [aOR] 1.4; 95% CI: 1.1–1.7), while other statistically significant factors associated with current wheeze were job (aOR 11.8; 95% CI: 7.3–18.9), current exposure to moisture or damp spots (aOR 2.2; 95% CI: 1.5–3.4), heating the house when it is cold (aOR 1.7; 95% CI: 1.3–2.1), and ever using tobacco (daily, [aOR 2.7; 95% CI: 2.0–3.5]; and using tobacco less than daily, [aOR 1.7; 95% CI: 1.1–2.8]).

DISCUSSION

This is the first national study to assess the prevalence and severity of asthma symptoms in Saudi Arabia using the GAN questionnaire. The overall prevalence of asthma symptoms (current wheeze) found in this study (14.2%) is comparable with rates in other developed countries.[18,19] According to the Global Burden of Disease (GBD) study, the prevalence of asthma increased by about 12.6% (9.0%–16.4%) during the period from 1990 to 2015.[20] The earlier-mentioned systematic review reported a pooled weighted prevalence of 14.3% for asthma with regional variation ranging from 3.1% in Al-Qassim to 33.7% in Al-Hofuf.[10] However, the Saudi Health Interview

	Total *n* (%)	Men *n* (%)	Women *n* (%)	*P* value
Ever had trouble with breathing				
Never	3767 (61.3)	2167 (62.4)	1600 (60.0)	.142
Only rarely	1765 (28.7)	982 (28.3)	783 (29.4)	
Repeatedly	524 (8.5)	285 (8.2)	239 (9.0)	
Continuously	85 (1.4)	41 (1.2)	44 (1.7)	
Sleep disturbance due to current wheezing				
Never woken	316 (37.2)	191 (40.7)	125 (32.9)	.003
<one night a week	318 (37.5)	180 (38.4)	138 (36.3)	
one or more nights per week	215 (25.3)	98 (20.9)	117 (30.8)	
Ever been breathless when the wheezing was present				
Yes	498 (59.4)	262 (56.8)	236 (62.4)	.100
No	341 (40.6)	199 (43.2)	142 (37.6)	
Sleep disturbance due to shortness of breath in the past 12 months				
Never	305 (40.1)	177 (41.5)	128 (38.3)	.367
<one night a week	354 (46.5)	199 (46.6)	155 (46.4)	
one or more nights per week	102 (13.4)	51 (11.9)	51 (15.3)	
Sleep disturbance due to coughing in the past 12 months				
Never	224 (29.7)	148 (34.2)	76 (23.7)	.001
<one night/a week	362 (48.0)	205 (47.3)	157 (48.9)	
one or more nights per week	168 (22.3)	80 (18.5)	88 (27.4)	
Limit in speech due to current wheezing				
Yes	186 (21.6)	96 (20.4)	90 (23.0)	.349
No	676 (78.4)	375 (79.6)	301 (77.0)	

Table 3. Prevalence of specific asthma symptoms. *Note: P values were obtained from χ^2 tests comparing categorical variables between males and females*

Survey (SHIS, 2013), which used a different methodology based on questions about doctor-diagnosed asthma, reported a lower national prevalence rate for asthma (4.1%).[7] On the other hand, the prevalence of symptoms of severe asthma (38.1%) was comparable with prevalence rates for children and adolescents globally.[17]

Not surprisingly, a large proportion of the asthmatic participants (50.5%) had experienced asthma attacks, while only 38.4% had a written plan for controlling their asthma. The percentage of asthma attacks among the asthmatic patients in this study was lower than the 76.7% reported in the SHIS study.[7] Findings from a large-scale study conducted in five countries in the region, including Saudi Arabia, revealed a rate of 44.2% for uncontrolled asthma (ACT≤19 points).[21] Because all citizens and residents in Saudi Arabia have access to health care facilities, a high rate of doctor-diagnosed asthma was expected for most self-reported asthma cases, which was indeed the case (83.3% of those who experienced asthma-ever reported that a doctor diagnosed their asthma). A similarly high percentage of doctor-diagnosed asthma (97%) was reported by a study from Canada that used the ISAAC questionnaire.[22] Our data showed a female predominance in the prevalence of asthma symptoms consistent with results of a SNAPSHOT program, conducted in 2016 to obtain updated information for the prevalence of asthma, which reported a higher prevalence of asthma in women than men among the adult general population of 5 Middle Eastern countries (Egypt, Turkey, Kuwait, Saudi Arabia, and the United Arab Emirates).[9]

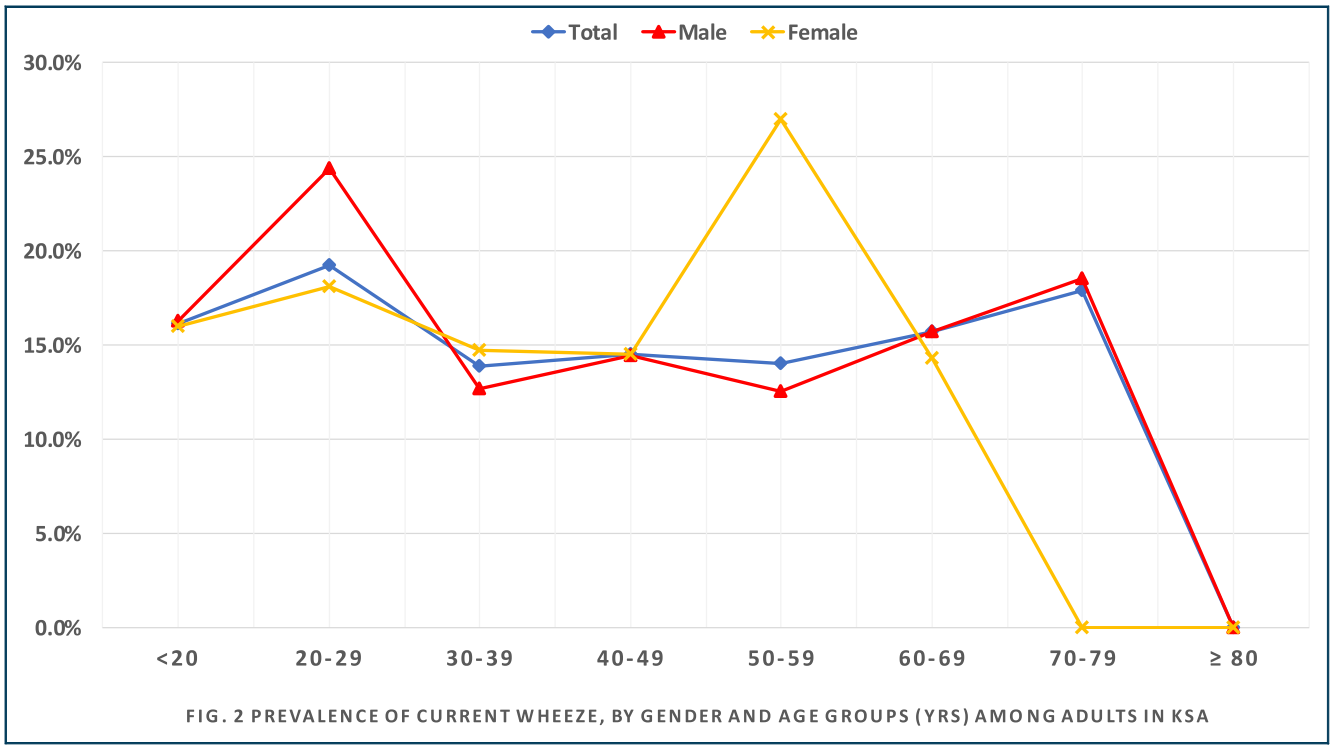

Fig. 2 Prevalence rates for current wheeze by sex and age group (in years) among adults in Saudi Arabia

Several studies have reported sex-based differences in asthma prevalence worldwide.[23,24] Although multiple gestations and the role of sex hormones in asthma genesis can explain these differences, no single mechanism can explain the sex-based differences and the impact of sex hormones on the pathophysiology of asthma.[2]

After controlling for the effects of other potentially confounding variables in our final statistical model, ever working in a job that caused wheezing was a statistically significant factor associated with current wheeze. A couple of studies reported occupational asthma caused by conditions attributable to work exposure, such as the cumulative effect of exposure to chemicals.[25,26]

Interestingly, our findings showed a positive association between heating the house when cold and current wheeze. Contrary to this, several studies have reported positive effects from using a heating system on asthma symptoms.[27,28] The discrepancy in these results can be interpreted, along with other factors, by the different heating and ventilation systems used in different countries. Expectedly, our study identified ever using tobacco daily or less than daily as a statistically significant risk factor for developing asthma symptoms. The association between ever using tobacco and asthma has been well established in studies.[29,30] Although asthma is associated with indoor and outdoor pollutants, the mechanism by which the environment influences asthma susceptibility is unknown, but modulation of the developing immune system by early exposure to antigens is one of the leading hypotheses expected.[31,32]

The main implications of this study are its national representativeness and large sample size, being population-based, and the use of the GAN questionnaire, which enable results to be easily compared with other studies using the same standardized methodology. The GAN questionnaire was developed based on the ISAAC questionnaire. A validated survey tool has better sensitivity and specificity than other methods in measuring the prevalence and severity of asthma symptoms within a population.[33,34]

We validated the Arabic language tools to address the challenges of our local setting using the instructions recommended by the GAN.

	Current wheeze (n = 6567)	
	n (%)	Adjusted OR (95% CI)
Sex		
Male	483 (13.7)	Reference
Female	399 (14.9)	1.4 (1.1–1.7)[b]
Educational level		
Primary school	105 (16.1)	Reference
Secondary school	331 (15.0)	0.9 (0.6–1.2)
College or higher	379 (13.5)	0.9 (0.7–1.3)
Ever worked in a job that caused wheezing		
No	773 (12.5)	Reference
Yes	120 (61.2)	11.8 (7.3–18.9)[c]
Current exposure to moisture or damp spots		
No	736 (13.3)	Reference
Yes	63 (25.5)	2.2 (1.5–3.4)[c]
Heating the house when it is cold		
No	237 (10.9)	Reference
Yes	633 (15.8)	1.7 (1.3–2.1)[c]
Eating meat in the past 12months		
Never or only occasionally	122 (16.6)	Reference
Once or twice per week	281 (12.8)	0.9 (0.6–1.2)
Most or all days	422 (14.3)	0.9 (0.6–1.2)
Eating fruit in the past 12months		
Never or only occasionally	146 (16.8)	Reference
Once or twice per week	384 (15.3)	1.1 (0.8–1.5)
Most or all days	279 (11.7)	0.9 (0.7–1.2)
Eating rice in the past 12months		
Never or only occasionally	115 (17.5)	Reference
Once or twice per week	198 (14.0)	0.9 (0.6–1.3)
Most or all days	482 (13.9)	0.9 (0.6–1.2)
Consumption of soft drinks in the past 12months		
Never or only occasionally	434 (14.1)	Reference
Once or twice per week	234 (13.3)	0.8 (0.7–1.0)
Most or all days	131 (16.5)	1.1 (0.9–1.5)
Ever using tobacco		
Not at all	685 (12.8)	Reference
Less than daily	39 (17.3)	1.7 (1.1–2.8)[a]
Daily	160 (23.2)	2.7 (2.0–3.5)[c]

Table 4. Adjusted factors associated with current wheeze among participants. *Note: (%), percentage of respondents reporting current wheeze per subcategory. OR, odds ratio; adjustment was performed for sex, education, job, exposure to moisture or damp spots, heating house, eating meat; fruit; rice, soft-drinks, ever use of tobacco.* [a]P < .05. [b]P < .01. [c]P < .00

Furthermore, we recruited highly trained field workers with excellent communication skills.

The limitations of this study include the challenge of determining asthma diagnosis through self-reported questions instead of clinical diagnostic tools such as spirometry. Moreover, the adults included in this study were parents of schoolchildren. This may be a potential selection bias and the sample may not be fully representative of the general population. Additionally, the study investigated dietary patterns with standardized GAN methodology without particular emphasis on the common ingredients in the Saudi kitchen, especially those in rural or semi-urban areas.

CONCLUSION

Asthma is still a highly prevalent chronic disease that contributes to the national and global burden of disease. Furthermore, Saudi Arabia is one of the largest countries in the Middle East, characterized by multiple factors associated with asthma, such as diverse geographical features, climates, rich social norms, and cultural aspects.

Regular monitoring and periodic reporting of the prevalence and severity of asthma symptoms and their related risk factors will provide reliable information for health authorities to improve health care and develop asthma control and prevention interventions.

Abbreviations

ACT, asthma control test; ECRHS, European Community Respiratory Health Survey; EMR, Eastern Mediterranean Region; GAN, Global Asthma Network; GBD, Global Burden of Disease; GINA, Global Initiative for Asthma; ISAAC, International Study of Asthma and Allergies in Childhood; IRB, Institutional Review Board; MOH, Ministry of Health; SHIS, The Saudi Health Interview Survey; WHO, World Health Organization.

Ethics statement

The Central Institutional Review Board (IRB) in the Saudi Ministry of Health reviewed and approved the protocol according to ICH-GCP (approval reference number: H-01-R-009).
Participation in this survey was voluntary. Written consent was obtained from the participants, who were also allowed to turn down the invitation to fill in the questionnaire or participate in the study.

Author contributions

IRB approval: all investigators.
Data collection: School Health employees.
Data analysis: I.A.
Writing paper: all investigators.

Financial support

This study was funded by the Ministry of Health, Saudi Arabia.

Data availability

The data sets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Agreement to publish the work

Agreed.

Declaration of competing interests

The authors declare that they have no competing interests.

Acknowledgments

The investigators would like gratefully to acknowledge every department and individual who contributed to the success of this project. This project took a lot of effort to conduct and would not have been possible without the support and help from the team.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.waojou.2021.100623.

Author details

[a]General Directorate of Health Programs and Chronic Diseases, Ministry of Health, Riyadh, Saudi Arabia. [b]Department of Epidemiology, University of Khartoum, Khartoum, Sudan. [c]Family Medicine, Cairo University Hospitals, Cairo, Egypt. [d]Department of Medicine-Pulmonary Division, King Saud Bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia. [e]Deputyship of Public Health, Ministry of Health, Riyadh, Saudi Arabia. [f]General Administration of School Health, Ministry of Health, Riyadh, Saudi Arabia. Currently, Public Health Consultant, Riyadh, Saudi Arabia. [g]Affairs for Health Improvement and Promotion, Saudi Public Health Authority, Riyadh, Saudi Arabia.

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