MEDICAL SCIENCE

Awareness of asthmatic patients to the association between the environmental risk factors and asthma exacerbation in Al-Qassim region, Saudi Arabia

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ABSTRACT

Background: Asthma is the chronic airway inflammatory illness that exhibits substantial etiological, clinical and historical heterogeneity. Current knowledge of prevalence, aetiology and management is crucial for appropriately managing respiratory allergies. Consequently, the current study's objective was to determine the asthmatic patients in the Al-Qassim region of Saudi Arabia who were aware of environmental risk factors and their link with asthma exacerbations. *Methodology:* A cross-sectional study was conducted in the form of a survey. Data was gathered using a semi-structured questionnaire. The information covered sociodemographic traits, knowledge, previous asthma-related medical history and awareness of aggravating factors besides family history. *Results:* In the current study, we were able to collect data from 106 asthmatic patients, where 67.9 % of them were females. We discovered that 88.7% of the participants who were asthmatic patients were aware that environmental risk factors contribute to asthma exacerbations. Air pollutants (95.3%), respiratory illnesses (90.6%), house dust mites (90.6%) and excess utilization of detergents and other household pesticides (90.6%) were the most well-known environmental risk factors. According to 65.1% of the participants, house dust mites were the main cause of asthma flare-ups. This was followed by respiratory illnesses (62.3%), air pollutants in 59.4% of the participants' reports and excessive detergent use (46.2%). *Conclusion:* In the Qassim region, we identified that asthmatic patients had good understanding of the environmental aggravation. However, this information is not linked to the frequency of asthma attacks; rather, it was linked to patients' growing propensity to avoid

these circumstances.

Keywords: Asthma, risk factor, smoking, infection

1. INTRODUCTION

Asthma is a long-term inflammatory disease of the airways which is marked by a bronchial hyper reaction reversible airways obstruction (Alahmadi et al., 2019). It's one of the most frequent long-term illnesses. Asthma affects 2 million individuals in Saudi Arabia, with the prevalence of asthma in children being significantly greater than in adults, with regional differences ranging from 9% to 33.7 percent (Al-Moamary et al., 2021). Its growth is viewed as a complex interplay of genetic and environmental variables (Eder et al., 2006). Coughing, wheezing, shortness of breath and stiffness in the chest are only a few of the symptoms (Duksal et al., 2014; Kumar, 2008). In 2014, in response to the high asthma rate in the region, Saudi Arabia started an asthma awareness campaign.

When an asthmatic patient is exposed to specific environmental triggers, an asthma attack might develop. Individual asthma triggers differ. Tobacco smoke, dust mites, cockroach allergies, pets, mildew and wood smoke, for example, are all major asthma triggers (Gilmour et al., 2006). Asthma is a group of diseases with a wide range of symptoms, aetiology and pathophysiology. Genetic, environmental and host variables are all risk factors for each known asthma subtype. Although having a family history of asthma is frequent, it is not required or sufficient for the onset of asthma (Elfaki and Shiby, 2017).

There are many risk factors that contribute to asthma, according to research. Risk factors may raise a person's risk of acquiring asthma or of developing other health issues as a result of their asthma (Al-Moamary et al., 2009). In terms of environmental and psychological aspects, these variables might be categorised as indoor or outdoor allergens and air pollutants (Desalu et al., 2013). Tobacco (smoking) exposure, excessive use of detergents and other household pesticides, furred animals and cockroaches are the most common indoor air pollutants (Nguyen et al., 2010). Most treatments to minimise exposure to these triggers are beneficial, but they are unlikely to be enough to manage asthma (Al-Moamary et al., 2009). Outdoor allergens such as pollen and mould, on the other hand, are hard to entirely avoid. Food and food additives are unusual asthma causes, which is fascinating (Georgy et al., 2006).

In different high-income countries as well as middle and low-income countries, the prevalence of asthma increases. Asthma prevalence is rising in many high-income nations as well as countries with incomes ranging from moderate to low. Poor understanding, lack of awareness among primary care physicians who care for asthma patients and fear of new medications are key reasons for the KSA's asthma burden. Asthma patients suffer from these conditions. Saudi asthmatic patients understanding of bronchial asthma is poor and efforts should be made to increase asthma awareness about the environmental risk factors. In order to prevent and manage respiratory allergies properly and to avoid the spray allergenic illnesses in the KSA, current knowledge on prevalence, causes and therapy is highly necessary. Therefore, the aim of the current study was to assess the level of awareness about the environmental risk factors and its related asthma exacerbation among the asthmatic patients in Al-Qassim region, Saudi Arabia.

2. METHODOLOGY

This was a cross-sectional study that was conducted electronically in a format of survey. The study was held in Qassim University Medical City's clinics, King Fahad Specialist hospital, Buraydah Central Hospital, King Saud Hospital. The research was carried out between January 2022 and October 2022. Consecutive sampling techniques, any individual who fit inclusion criteria were included. Inclusion criteria included all participants 14 years or older, were diagnosed with asthma and agreed to participate in the current study. All participants who were younger than 14 years old or diagnosed with any other disease other than asthma were excluded. Stratified sampling was used for sampling techniques. The asthmatic patients were first divided into relevant strata or subgroups and then, using the simple random sample method, a sample was drawn from each stratum. A semi-structured questionnaire was used for collecting data. Data collection tool was developed by the investigators team. Data included socio-demographic characteristics, knowledge, past medical history of asthma, awareness about exacerbating factors besides family history.

The study was conducted after having the ethical approval of from the regional ethical committee of Qassim health directorate. Ethical approval number: 1443-956195. All participants participated voluntarily and the current study did not cause any participant to experience stress, discomfort, worry or a loss of self-esteem, nor invade their privacy.

The survey was conducted on a small sample of the target demographic. After that, the data was evaluated to ensure that the questionnaire is clear and to identify any gaps in the project plan. The results of the pilot research were not included in the project's

final analysis. No changes were conducted on the questionnaire depending on the pilot study. IBM SPSS Statistics Version 26.0 was used for the statistical analysis. The sample means were compared using an ANOVA and an independent samples t-test. The mean asthma scores from surveys were compared using a paired sample T-test. The Pearson correlation coefficient "r" was used to calculate the relations between continuous data. The threshold of significance (P-value) was set at 0.05, with a 95 percent confidence interval (CI).

3. RESULTS

We were able to gather information from 106 asthmatic patients in the Qassim region of Saudi Arabia for the current study. Among the participants, 67.9% of them were females with females to male's ratio of 2.12:1. Moreover, 38.7% of the participants were older than 45 years old while 29.2% were aged between 18-25 years old. Considering the educational level, 36.8% of the participants reported having bachelor's degree while 20.8% had high school degree and 11.3% had diploma degree. Moreover, 22.8% of the participants reported not working while 18.8% were students, 18.8% were teachers and 12.9% were housewives. Among patients with asthma, 33.0% of them reported that asthma exacerbations occurred once during the last year while 28.3% of them reported four exacerbations, 22.6% of them reported two exacerbations and 16.0% reported three exacerbations during the last years (Table 1).

Table 1 Demographic factors of the participants (N=106)

		N	N %
Gender	Male	34	32.1%
	Female	72	67.9%
Age	18-25	31	29.2%
	26-35	13	12.3%
	36-45	21	19.8%
	>45	41	38.7%
Educational level	Primary school	11	10.4%
	Secondary school	10	9.4%
	High school	22	20.8%
	Diploma	12	11.3%
	Bachelor's degree	39	36.8%
	Master's degree	3	2.8%
	Doctorate degree	2	1.9%
	Other	7	6.6%
Occupation	Not working	23	22.8%
	Student	19	18.8%
	Housewife	13	12.9%
	Teacher	19	18.8%
	Governmental employee	10	9.9%
	Own work	8	7.9%
	Retired	9	8.9%
How many asthma exacerbations happened to you for the last year?	1	35	33.0%
	2	24	22.6%
	3	17	16.0%
	4	30	28.3%

Among the asthmatic patients, we determined that 88.7% of respondents were aware that environmental risk factors contribute to asthma exacerbations. The most commonly known environmental risk factors included air pollutants like dust, chemicals, smog, ozone and other air pollutants (95.3%), respiratory infections (90.6%), house dust mite that present in the furniture, carpets and curtains (90.6%) and excessive use of detergents and other household pesticides (90.6%). Moreover, the least known environmental

risk factors included cockroaches which are only known by 12.3 % of the participants; mold that known by 28.3%, mildew that present in places with high humidity like walls of bathrooms (41.5%) and pollens (58.5%). The participants in the present study were generally able to identify 7.29 (SD=2.07) of the 11 available risk factors of asthma where 64.2% of the participants were able to identify two third of the risk factors successfully (Table 2).

Table 2 The knowledge of the participants toward environmental risk factors

	No/I do not know		Yes	
	N	%	N	%
Do you think that the environmental risk factors have a role in asthma exacerbations?	12	11.3%	94	88.7%
Do you think that smoking exposure has a role in asthma exacerbations?	14	13.2%	92	86.8%
Do you think that house dust mite that present in the furniture; carpets and curtains have a role in asthma exacerbations?	10	9.4%	96	90.6%
Do you think that excessive use of detergents and other household pesticides may cause asthma exacerbations?	10	9.4%	96	90.6%
Do you think that pet's dander have a role in asthma exacerbations?	37	34.9%	69	65.1%
Do you think that cockroaches have a role in asthma exacerbations?	93	87.7%	13	12.3%
Do you think that mildew that present in places with high humidity like walls of bathrooms have a role in asthma exacerbations?	62	58.5%	44	41.5%
Do you think that pollens have a role in asthma exacerbations?	44	41.5%	62	58.5%
Do you think that mould have a role in asthma exacerbations?	76	71.7%	30	28.3%
Do you think that cold and dry weather has a role in asthma exacerbations?	32	30.2%	74	69.8%
Do you think that respiratory infections have a role in asthma exacerbations?	10	9.4%	96	90.6%
Do you think that air pollutants like dust, chemicals, smog, ozone and other air pollutants may cause asthma exacerbations?	5	4.7%	101	95.3%
The mean correct answers	7.29 (2.07)			
Knowledge	Inadequate		38	35.8 %
	Adequate		68	64.2 %

House dust mite was the most common cause of asthma exacerbation reported by 65.1% of the participants followed by respiratory infections (62.3%), air pollutants like dust, chemicals, smog and ozone in 59.4% of the participants and excessive use of detergents (46.2%). The least common cause of asthma exacerbation among the patients was cockroaches reported by 1.9% of them followed by moulds (3.8%) and mildew (3.8%). Smoking was the main reasons for asthma exacerbation in 33.0% of the participants while cold and dry weather was responsible for asthma exacerbation in 39.6% of them (Figure 1).

Among the participants, 91.5% of them reported that they tried before to decrease the exposure to these risk factors where 94.7% of those patients reported that avoiding exposure to risk factors effectively lowers the likelihood of asthma attacks (Figure 2).

In Table 3, we showed the relation between demographic factors of the patients and their level of knowledge. According to the Table 3, we discovered no statistically significant variations among the two genders considering their knowledge of the environmental risk factors where the females were able to recognize 7.38 risk factors compared with 7.12 and 66.7% of females had adequate knowledge which is slightly higher than 58.8% of males (P=0.432). Moreover, we found no significant difference considering age (P=0.063) however, the results showed that patients aged 36 years or older had slightly higher level of knowledge than younger participants where the mean scores of patients aged 36-45 and > 45 years old were 7.90 and 7.49 (81.0% and 70.7% were adequate knowledge) compared with 6.68 and 7.15 in patients aged 18-25 and 26-35 years old (51.6% and 46.2% had adequate knowledge) respectively. Moreover, educational level of the participants had no significant impact on level of knowledge (P=0.632) however, it seems that those with primary schools were the least populations able to recognize all risk factors (6.64). Moreover, it was found that having adequate knowledge about the environmental risk factors have a significant impact on times of asthma

exacerbations (P=0.882). Having higher knowledge considering the environmental risk factors was associated with higher tendency to avoid them among the patients significantly (P=0.033) where those reported trying to avoid exposure to risk factors were able to identify 7.42 risk factors compared with 5.89 in those reported no avoidance (Table 3).

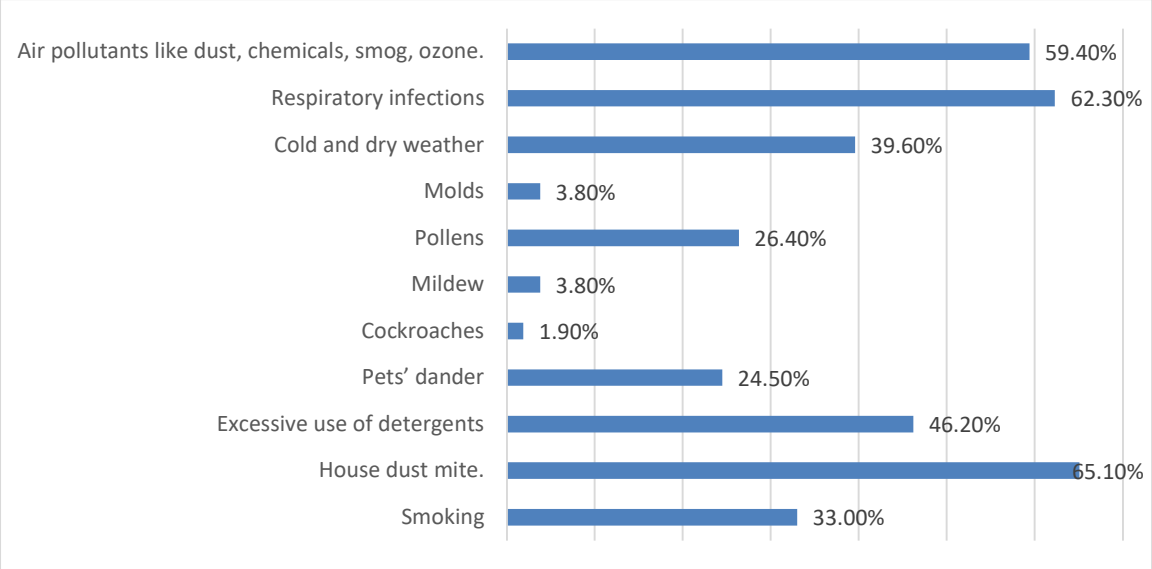

Figure 1 Which one of these is the most frequent cause of your exacerbation?

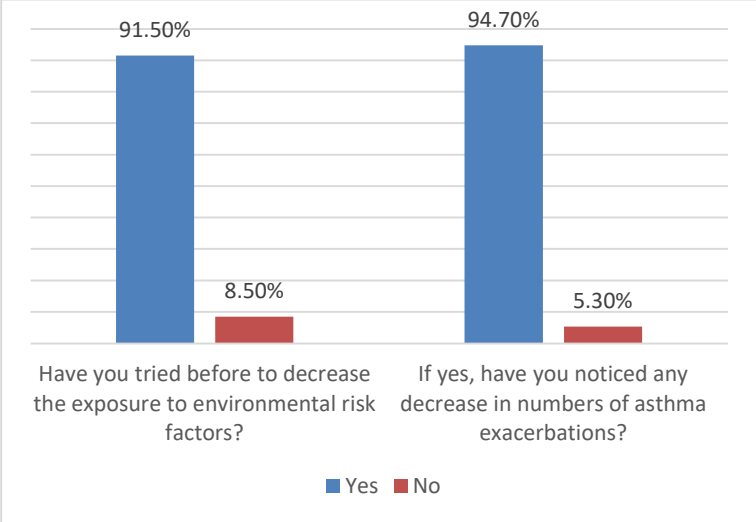

Figure 2 The attitude toward reducing the exposure to risk factors and its impact on exacerbations

Table 3 The relation between demographic factors of the patients and their knowledge considering the environmental risk factors

		Knowledge score		Knowledge				
		Mean	Standard Deviation	Inadequate		Adequate		P-value
				Count	Row N%	Count	Row N%	
Gender	Male	7.12	2.11	14	41.2%	20	58.8%	0.432
	Female	7.38	2.07	24	33.3%	48	66.7%	
Age	18-25	6.68	2.15	15	48.4%	16	51.6%	0.063
	26-35	7.15	2.44	7	53.8%	6	46.2%	
	36-45	7.90	1.73	4	19.0%	17	81.0%	
	>45	7.49	2.00	12	29.3%	29	70.7%	
Educational level	Primary school	6.64	1.75	5	45.5%	6	54.5%	0.632
	Secondary school	7.30	2.95	3	30.0%	7	70.0%	

	High school	7.77	1.66	5	22.7%	17	77.3%	
	Diploma	7.42	2.23	4	33.3%	8	66.7%	
	Bachelor's degree	7.13	2.25	16	41.0%	23	59.0%	
	Master's degree	8.33	2.52	1	33.3%	2	66.7%	
	Doctorate degree	8.00	.00	0	0.0%	2	100.0%	
	Other	6.86	1.21	4	57.1%	3	42.9%	
How many asthma exacerbations happened to you for the last year?	1	7.31	2.08	11	31.4%	24	68.6%	0.882
	2	7.04	2.16	10	41.7%	14	58.3%	
	3	7.53	1.87	6	35.3%	11	64.7%	
	4	7.33	2.19	11	36.7%	19	63.3%	
Have you tried before to decrease the exposure to them?	No	5.89	2.32	4	44.4%	5	55.6%	0.033*
	Yes	7.42	2.01	34	35.1%	63	64.9%	

4. DISCUSSION

Asthma is one of the chronic inflammatory diseases of the airways and is associated with difficult breathing in patients. There are many cross-sectional studies that confirmed the increase in the prevalence of asthma over the past 2-3 decades over the world however less is known about its fundamental immunologic, genetic and environmental mechanisms that is associated with the incidence and occurrence of its exacerbations (Rosenberg et al., 2014). In the current study, we aimed to assess the awareness of asthmatic patients considering the environmental risk factors of exacerbation of asthma.

The current study showed that air pollutants including dust, chemicals and smog were the most known environmental risk factors of the patients. Many studies had related between ambient air pollution and the exacerbation of pre-existing asthma (Louisias et al., 2019). A previous meta-analysis that was conducted by Orellano et al., (2017) the authors investigated the association between outdoor air pollution and exacerbations of asthma where the subgroup analysis of children showed a significant association between asthma exacerbation and higher concentration of NO2, SO2 and PM2.5 (aerodynamic diameter of 2.5 microns or less) and CO. Even short-term exposure to air pollutes including ozone, NO_2, SO_2 can increase children's asthma symptoms (Naja et al., 2018). In addition, a different study found a connection between exposures to air pollution caused by traffic and increased hospital readmission rates due to asthma flare-ups (Pollock et al., 2017).

Moreover, respiratory infection was one of the most commonly known environmental risk factors followed by house dust mite that present in the furniture, carpets and curtains and excessive use of detergents and other household pesticides. In a previous study conducted by Alharbi et al., (2020) according to the research, 72% of participants were aware of the link between respiratory infections and asthma aggravation and 93% of respondents were familiar of the triggers that might cause asthma attacks, such as smoke, fragrances and paint fumes. Respiratory infections are sometimes referred to as the "September epidemic" because of its seasonal pattern (Johnston et al., 2005). Rhinoviruses are the most common associated viruses with respiratory infections as well as respiratory syncytial virus, enterovirus, coronavirus and human metapneumovirus which interact with allergens to induce asthma exacerbation as well as hospitalization (Murray et al., 2006).

On the other hand, cockroaches, mold and mildew were known by less than half of the participants. In a previous study, the Thorne et al., (2015) showed that the presence and exposure to cockroaches was associated with asthma exacerbations and according to another study, patients with lower economic status have higher exposure to indoor allergens as dust, cockroaches, mold and mildew (Macintyre and Ellaway, 2003). Therefore, the low knowledge about the role of these factors in exacerbating asthma symptoms could be associated with uncontrolled asthma which is confirmed by some previous studies reported in Saudi Arabia which showed that patients with low-economic were more likely to be exposed to those risk factors and uncontrolled asthma (Al-Zahrani et al., 2014; Bin-Saeed et al., 2014; Al-Jahdali et al., 2008).

In the current study, house dust mite was the most common cause of asthma exacerbation. In another study conducted in UAE, the authors reported that many asthma patients reported having pets and carpets in their houses which make them exposed to persistent source of pet's allergen, dust and dust mites which was significantly associated with allergic exacerbation of asthma (Mahboub et al., 2012). In another study conducted by Wieringa et al., (1997) the authors reported that house dust mite allergy is the most common determinant of occurrence of asthma in urban region. Moreover, sudden heavy exposure to dust and sand storms may be associated with acute severe asthma exacerbations (Waness et al., 2011).

Moreover, respiratory infections were considered one of the main causes of asthma exacerbation among asthmatic patients. This is similar to the results of previous study which showed that more than 80% of asthma exacerbations in children were caused by viral infections (Busse et al., 2010). Moreover, another study conducted by Ansari et al., (2020) showed that exacerbation of asthma is more likely in those with respiratory tract infections with 5.62 times where respiratory infections were reported in 38.4% of patients with asthma exacerbation compared with 10% of control group). Moreover, another study showed that exacerbations of asthma symptoms are frequently associated with upper respiratory tract infection (Papadopoulos et al., 2011).

The present study was unable to find any significant factor that is associated with better or worse knowledge considering risk factors of asthma. Moreover, the results showed that the knowledge of environmental risk factors is not associated with frequency of asthma exacerbations. In addition, it was associated with increasing tendency of patients toward avoidance of these factors. In a previous study conducted by Al-Moamary et al., (2009) the authors demonstrated the value of using interventions to lessen exposure to certain triggers. However, it will not help in achieving asthma control and reducing asthma exacerbation alone (Al-Moamary et al., 2009). This could be an explanation of why knowledge is not affected with less exacerbation. Another factor might be that it is impossible to totally avoid outdoor irritants like pollen and mould (Georgy et al., 2006).

5. CONCLUSION

We found that asthmatic patients in Qassim region had good knowledge considering the environmental exacerbation. However, this knowledge is not associated with frequency of asthma exacerbations. Moreover, it was associated with increasing tendency of patients toward avoidance of these factors. House dust mite, respiratory infections, air pollutants like dust, chemicals, smog and ozone and excessive use of detergents were the most common cause of asthmatic exacerbations. Globally, asthma tends to have a significant influence on public health. Based on the findings, it was determined that there are a variety of risk factor patterns for asthma; these patterns appear to play a significant role and most certainly add to the severity of this burden. Health education and training initiatives were strongly suggested to decrease Saudis' exposure to triggers.

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Ethical approval

The regional ethical committee of Qassim health directorate gave its approval to the study. Code for ethical approval: 1443-956195.

Author's contributions

Introduction/literature review: Sami M Alrasheedi, Hanee Mateg Alrashidi, Emad Bani Alharbi, Faisal Abdulaziz Almutairi, Khalid Saad Alrashdi, Farah Saleh Allabun and Ghada Abdullah Aljutaily. Methods: Sami M. Alrasheedi, Hanee Mateg Alrashidi, Emad Bani Alharbi and Faisal Abdulaziz Almutairi. Data collection/analysis: Sami M Alrasheedi, Khalid Saad Alrashdi, Farah Saleh Allabun and Ghada Abdullah Aljutaily. Discussion/conclusion: Sami M Alrasheedi, Mousa N Alrashdi, Ahmad Alkhdairi and Abdullah Alrasheedi.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES AND NOTES

1. Alahmadi TS, Banjari MA, Alharbi AS. The prevalence of childhood asthma in Saudi Arabia. Int J Pediatr Adolesc Med 2019; 6(2):74-77. doi: 10.1016/j.ijpam.2019.02.004
2. Alharbi SA, Kobeisy SA, Al-Khater SA, Alharbi AS, Alqwaiee MM, Alotaibi FN, Alawam KA, Alahmadi TS, Al-Somali FM, Almaghamsi TM, Yousef AA. Childhood

asthma awareness in Saudi Arabia: Five-year follow-up study. J Asthma Allergy 2020; 13:399-407. doi: 10.2147/JAA.S272850
3. Al-Jahdali HH, Al-Hajjaj MS, Alanezi MO, Zeitoni MO, Al-Tasan TH. Asthma control assessment using asthma control test among patients attending 5 tertiary care hospitals in Saudi Arabia. Saudi Med J 2008; 29(5):714-717. http://www.ncbi.nlm.nih.gov/pubmed/18454220
4. Al-Moamary M, Alhaider S, Alangari A, Idrees MM, Zeitouni MO, Al-Ghobain MO, Alanazi AF, Al-Harbi AS, Yousef AA, Alorainy HS, Al-Hajjaj MS. The Saudi initiative for asthma-2021 update: Guidelines for the diagnosis and management of asthma in adults and children. Ann Thorac Med 2021; 16(1):4. doi: 10.4103/atm.ATM_697_20
5. Al-Moamary M, Al-Hajjaj M, Idrees M, Zeitouni MO, Alanezi MO, Al-Jahdali HH, Al-Dabbagh M. The Saudi initiative for asthma. Ann Thorac Med 2009; 4(4):216. doi: 10.4103/1817-1737.56001
6. Al-Zahrani SS, Morsy E, Dorgham LS. The impact of bronchial asthma on quality of life among affected children and adolescents in Taif city, Saudi Arabia. Life Sci J 2014; 11(6):283-291.
7. Ansari SF, Memon M, Kumar R, Rizwan A. Risk factors associated with frequent acute exacerbations of asthma. Cureus 2020; 12(10):e11090. doi: 10.7759/cureus.11090
8. Bin-Saeed AA, Torchyan AA, Alsadhan AA, Almidani GM, Alsubaie AA, Aldakhail AA, Al-Rashed AA, Al-Fawaz MA, Alsaadi MM. Determinants of asthma control among children in Saudi Arabia. J Asthma 2014; 51(4):435-439. doi: 10.3109/02770903.2013.876649
9. Busse WW, Lemanske RF, Gern JE. Role of viral respiratory infections in asthma and asthma exacerbations. Lancet 2010; 376(9743):826-834. doi: 10.1016/S0140-6736(10)61380-3
10. Desalu O, Fadare J, Adekoya A, Adeoti A. Risk factors for asthma hospitalization and emergency department visit in Nigeria: The role of symptoms frequency and drug utilization. Indian J Allergy Asthma Immunol 2013; 27(2):129. doi: 10.4103/0972-6691.124395
11. Duksal F, Becerir T, Ergin A, Akcay A, Guler N. The prevalence of asthma diagnosis and symptoms is still increasing in early adolescents in Turkey. Allergol Int 2014; 63(2):189-197. doi: 10.2332/allergolint.13-OA-0612
12. Eder W, Ege MJ, Mutius EV. The asthma epidemic. N Engl J Med 2006; 355(21):2226-2235. doi: 10.1056/NEJMra054308
13. Elfaki NK, Shiby AY. Risk factors associated with asthma among Saudi adults in Najran. J Clin Respir Dis Care 2017; 03(03). doi: 10.4172/2472-1247.1000133
14. Georgy V, Fahim HI, El-Gaafary M, Walters S. Prevalence and socioeconomic associations of asthma and allergic rhinitis in northern Africa. Eur Respir J 2006; 28(4):756-762. doi: 10.1183/09031936.06.00089005
15. Gilmour MI, Jaakkola MS, London SJ, Nel AE, Rogers CA. How exposure to environmental tobacco smoke, outdoor air pollutants and increased pollen burdens influences the incidence of Asthma. Environ Health Perspect 2006; 114(4):627-633. doi: 10.1289/ehp.8380
16. Johnston NW, Johnston SL, Duncan JM, Greene JM, Kebadze T, Keith PK, Roy M, Waserman S, Sears MR. The September epidemic of asthma exacerbations in children: A search for etiology. J Allergy Clin Immunol 2005; 115(1):132-138. doi: 10.1016/j.jaci.2004.09.025
17. Kumar R. Prenatal factors and the development of asthma. Curr Opin Pediatr 2008; 20(6):682-687. doi: 10.1097/MOP.0b013e3283154f26
18. Louisias M, Ramadan A, Naja AS, Phipatanakul W. The effects of the environment on asthma disease activity. Immunol Allergy Clin North Am 2019; 39(2):163-175. doi: 10.1016/j.iac.2018.12.005
19. Macintyre S, Ellaway A. Neighborhoods and Health: An overview. In: Neighborhoods and Health. Oxford University Press New York 2003; 20-42. doi: 10.1093/acprof:oso/9780195138382.003.0002
20. Mahboub B, Vats M, Afzal S, Sharif W, Iqbal MN. Environmental exposure and nonadherence with medicines directly correlate with exacerbations and hospitalization for asthma: A population-based survey from UAE. ISRN Pulmonol 2012; 2012:1-10. doi: 10.5402/2012/831687
21. Murray CS, Poletti G, Kebadze T, Morris J, Woodcock A, Johnston SL, Custovic A. Study of modifiable risk factors for asthma exacerbations: Virus infection and allergen exposure increase the risk of asthma hospital admissions in children. Thorax 2006; 61(5):376-382. doi: 10.1136/thx.2005.042523
22. Naja AS, Permaul P, Phipatanakul W. Taming asthma in school-aged children: A comprehensive review. J Allergy Clin Immunol Pract 2018; 6(3):726-735. doi: 10.1016/j.jaip.2018.01.023
23. Nguyen K, Peng J, Boulay E. Effect of smoking on the association between environmental triggers and asthma severity among adults in New England. J Asthma Allergy Educ 2010; 1(6):210-218. doi: 10.1177/2150129710377348
24. Orellano P, Quaranta N, Reynoso J, Balbi B, Vasquez J. Effect of outdoor air pollution on asthma exacerbations in children and adults: Systematic review and multilevel meta-analysis. PLoS One 2017; 12(3):e0174050. doi: 10.1371/journal.pone.0174050
25. Papadopoulos NG, Christodoulou I, Rohde G, Agache I, Almqvist C, Bruno A, Bonini S, Bont L, Bossios A, Bousquet J, Braido F, Brusselle G, Canonica GW, Carlsen KH, Chanez P, Fokkens WJ, Garcia-Garcia M, Gjomarkaj M, Haahtela T,

Holgate ST, Johnston SL, Konstantinou G, Kowalski M, Lewandowska-Polak A, Lødrup-Carlsen K, Mäkelä M, Malkusova I, Mullol J, Nieto A, Eller E, Ozdemir C, Panzner P, Popov T, Psarras S, Roumpedaki E, Rukhadze M, Stipic-Markovic A, Todo-Bom A, Toskala E, Cauwenberge PV, Drunen CV, Watelet JB, Xatzipsalti M, Xepapadaki P, Zuberbier T. Viruses and bacteria in acute asthma exacerbations: A GA² LEN-DARE systematic review. Allergy 2011; 66(4):458-468. doi: 10.1111/j.1398-9995.2010.02505.x

26. Pollock J, Shi L, Gimbel RW. Outdoor environment and pediatric asthma: An update on the evidence from North America. Can Respir J 2017; 2017:1-16. doi: 10.1155/2017/8921917
27. Rosenberg SL, Miller GE, Brehm JM, Celedón JC. Stress and asthma: Novel insights on genetic, epigenetic and immunologic mechanisms. J Allergy Clin Immunol 2014; 134(5):1009-1015. doi: 10.1016/j.jaci.2014.07.005
28. Thorne PS, Mendy A, Metwali N, Salo P, Co C, Jaramillo R, Rose KM, Zeldin DC. Endotoxin exposure: Predictors and prevalence of associated asthma outcomes in the United States. Am J Respir Crit Care Med 2015; 192(11):1287-1297. doi: 10.1164/rccm.201502-0251OC
29. Waness A, El-Sameed YA, Mahboub B, Noshi M, Al-Jahdali H, Vats M, Mehta AC. Respiratory disorders in the Middle East: A review. Respirology 2011; 16(5):755-766. doi: 10.1111/j.1440-1843.2011.01988.x
30. Wieringa M, Weyler J, Bastelaer FV, Nelen V, Sprundel MV, Vermeire P. Higher asthma occurrence in an urban than a suburban area: Role of house dust mite skin allergy. Eur Respir J 1997; 10(7):1460-1466. doi: 10.1183/09031936.97.10071460