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Prevalence of childhood bronchial asthma and its associated factors: A community-based study in Egypt.

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ABSTRACT

Objective: To estimate the prevalence of bronchial asthma (BA) among children in Dekerness district, Egypt and to identify its risk factors in the community setting.

Population and Methods: This is a community-based cross-sectional descriptive study carried out in Dekerness District, Dakahlia Governorate, Egypt during a period of 1 year from May 1, 2016 to April 30, 2017. The targeted population was children aged 2–17 years living in the study locality. A proportional multi-stage cluster sample was taken from both rural and urban areas. Data were collected by a questionnaire completed through direct interview with the mother or caregiver and the child. Asthma was diagnosed according to International Study of Asthma and Allergies in Childhood questionnaire.

Results: This study included 1,500 children with 13.4% overall prevalence of BA. Using logistic regression analysis, the independent predictors of BA prevalence were age less than 5 years old, being a male, children with birth order of three or more, passive smoking, and positive family history of BA.

Conclusion: BA is highly prevalent among children and adolescents in Dekerness district. This prevalence is higher than previous reports from school-based studies. There is a need for effective prevention and management programs.

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Bronchial asthma; prevalence; socioeconomic state; risk factors

Introduction

Bronchial asthma (BA) is a public health problem in all countries irrespective of their level of development, being generally under-diagnosed and undertreated, and most asthma-related deaths commonly occurs in low-income and lower-middle income countries [1]. Asthma is reported to be one of the most common chronic diseases in childhood, impairing not only the quality of life of the patients but also their families and incurring high costs to the health care system and society [2].

In the Middle East, asthma prevalence ranging from 5% to 23% has previously been reported to be lower than in developed countries [3,4]. This variation in rates suggests that environmental factors and variations in the presence of aeroallergens may affect its development. Genetic factors and temperature have a very close inverse correlation with the seasonal distribution of asthmatic attacks while humidity has a direct correlation. There are insufficient data to fully explain the variations in prevalence within and between populations [5].

In Egypt, many school-based studies estimated that the prevalence of BA among school children ranged from 6.2% in Assiut city in Upper Egypt [6] up to 46.1% in Cairo [7]. However, to the best of the researcher's knowledge, there is no community-based study about the magnitude of BA and its risk factors in Egypt. This study aims to estimate the prevalence of BA among children in Dekerness district and to identify its associated risk factors in the community setting.

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Population and Methods

This is a cross-sectional descriptive study carried out in Dekerness District, Dakahlia Governorate, Egypt during a period of 1 year from May 1, 2016 to April 30, 2017. The targeted population was children aged 2–17 years.

Sample size

Sample size was calculated using EPI INFO 7 of the Center for Disease control (CDC) (http://www.cdc.gov/epiinfo). According to the statistics of Dekerness Health Administration, the total children aged from 2 to 17 years in 2015 were about 150,000. A previous study using International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire [8] reported a prevalence of BA among school children to be 7.7% in Nile Delta. Alpha error = 0.05, study power = 80%, 2% precision, and design effect of two due to cluster sampling method. Then, the final sample size is at least 1,358.

Sampling method

Proportional multi-stage cluster sample was taken. Dekerness district was divided into rural and urban areas. The urban area was divided into residential sectors. One or more cluster was selected from each sector. In rural areas, a list of villages was obtained and a random sample of villages was selected and one or more cluster was selected from each village. Each cluster was composed of 30 children.

Tools

Data were collected at home visits after coordination with the head of the family. Questionnaire was completed through direct interview with the mother or caregiver and the child. Questionnaire included the following items:

Socio-demographic characteristics of each family were fully addressed using the socioeconomic scale (SES) of El-Gilany et al. [9]. This SES is a valid and reliable scale consisting of seven domains with a total score of 84 (a higher score indicating better SE status). The seven domains are: Education and culture, occupation, family structure, family possessions, economic, home sanitation, and health care utilization pattern. The scale was categorized into four socioeconomic levels according to three quartiles.

Child data including: Name, age, sex, child birth order, and education.

ISAAC questionnaire was used for the diagnosis of childhood BA. Phase I ISAAC Arabic questionnaire was translated into Arabic and validated by Osman [10]. BA was operationally defined based on the history of both wheezing or whistling in the chest in the last 12 months and ever had asthma whether physician diagnosed or not (Questions 2 and 6).

Ethical consideration

Protocol was approved by the institutional review board (IRB) of Faculty of Medicine, Mansoura University. Consent of the head of the family for home visits and interview on the mutually agreed day and time was obtained.

Statistical methods

Data entry and analysis was done using Statistical Package for Social Sciences (SPSS) version 16. Qualitative variables were summarized by number and percent. Pearson Chi-square test was used to compare the qualitative variables between groups. Crude odds ratio (OR) as their 95% confidence interval (CI) was calculated. Significant factors in bivariate association were entered into binary stepwise logistic regression model using a forward Wald method to determine independent predictors of BA, adjusted ORs, and their 95% CI were calculated. *P* value was considered as statistically significant when it was ≤0.05.

Results

This study included 1,500 children and their age ranged from 2 to 17 years, 51.1% of them are males and 14.7%, 58.8%, and 26.5% are from slum, rural, and urban areas, respectively.

The overall prevalence of BA is 13.4%. This prevalence is significantly higher in <5 years old age group compared to 5–9 and 10–17 years old groups (17.2%, 12.3%, and 7.6%, respectively). Asthma is significantly higher in male than female (15.4% *vs*. 11.3%), higher in slums than rural and urban areas (21.7%, 11.2%, and 13.6%; respectively), and higher in children with birth order of more than three compared to children with birth order of three or less (27.1% *vs*. 12.7%) (Table 1). Among various risk factors for BA, passive smoking and family history (FH) of allergy (BA, allergic dermatitis, and allergic conjunctivitis) were significantly associated with BA (Table 2).

The logistic regression analysis shows that the independent predictors of BA are: Age less than 5 years old [adjusted OR (AOR) = 2.4], being a male (AOR = 1.49), children with birth order of three or

Table 1: Overall prevalence of BA and its variation according to family socioeconomic status and child characteristics.

	Total *N* (%)	Asthmatic *N* (%)	Significance test	COR (95% CI)
Overall	**1,500**	**201 (13.4)**	**----**	**(11.6–15.1)**
Residence:				
Slums	221	48 (21.7)	$\chi^2 = 6.7$, $p \leq 0.001$	1.76 (1.12–2.77)
Rural	882	99 (11.2)	$\chi^2 = 1.47$, $p = 0.2$	0.8 (0.56–1.16)
Urban (r)	397	54 (13.6)	-	1
Father's education:				
Illiterate*	179	31 (17.3)	$\chi^2 = 3.25$, $p = 0.07$	1.59 (0.93–2.7)
< secondary	159	23 (14.5)	$\chi^2 = 0.79$, $p = 0.3$	1.28 (0.71–2.29)
Secondary/technical	810	106 (13.1)	$\chi^2 = 0.46$, $p = 0.49$	1.14 (0.77–1.71)
Above secondary (r)	352	41 (11.6)	-	1
Mother's education:				
Illiterate*	139	13 (9.4)	$\chi^2 = 2.59$, $P = 0.1$	0.6 (0.3–1.17)
Less than secondary	113	13 (11.5)	$\chi^2 = 0.7$, $P = 0.38$	0.75 (0.37–1.48)
Secondary/technical	862	118 (13.7)	$\chi^2 = 0.26$, $P = 0.6$	0.92 (0.64–1.31)
Above secondary (r)	386	57 (14.8)	-	1
Father's occupation:				
Unemployed	49	4 (8.2)	$\chi^2 = 0.6$, $p = 0.4$	0.65 (0.19–1.99)
Unskilled/skilled manual worker	867	114 (13.1)	$\chi^2 = 0.27$, $p = 0.6$	1.1 (0.75–1.62)
Trades/business	203	37 (18.2)	$\chi^2 = 3.62$, $p = 0.056$	1.62 (0.9–2.67)
Semi-professional/professional (r)	381	46 (12.1)	-	1
Mother's occupation:				
House wife	1,188	163 (13.7)	$\chi^2 = 0.6$, $p = 0.4$	1.17 (0.77–1.8)
Others**	44	6 (13.6)	$\chi^2 = 0.1$, $p = 0.7$	1.16 (0.41–3.17)
Semi-professional/professional (r)	268	32 (11.9)	-	1
Crowding index:				
> one person per room	1,126	160 (14.2)	$\chi^2 = 2.28$	1.35 (0.92–1.97)
≤ one person per room (r)	374	41 (11)	$p = 0.1$	1
Socioeconomic level:				
Very low	420	65 (15.5)	$\chi^2 = 2.9$, $p = 0.3$	1.74 (0.95–2.27)
Low	293	41 (14)	$\chi^2 = 1.05$, $p = 0.3$	1.31 (0.81–2.11)
Middle	399	52 (13)	$\chi^2 = 0.5$, $p = 0.4$	1.2 (0.77–1.89)
High (r)	388	43 (11.1)	-	1
Child age:				
< 5	645	111 (17.2)	$\chi^2 = 16.48$, $p > 0.0001$	2.5 (1.56–4.07)
5–9	528	65 (12.3)	$\chi^2 = 4.66$, $p = 0.03$	1.7 (1.02–2.83)
10–17 (r)	327	25 (7.6)	-	1
Birth order:				
1st and 2nd (r)	1,430	182 (12.7)	$\chi^2 = 11.9$, $p = 0.001$	1
3rd and more	70	19 (27.1)	-	2.6 (1.7–3.1)
Sex:				
Male	767	118 (15.4)	$\chi^2 = 5.3$, $p = 0.02$	1.42 (1.04–1.95)
Female (r)	733	83 (11.3)	-	1

*Illiterate means do not read and write. **Others: skilled–unskilled manual worker-trade and business.
r = reference group.

more (AOR = 2.5), passive smoking (AOR = 1.58), and positive FH of BA (AOR = 4.5) (Table 3).

Discussion

Epidemiologic studies have shown that the prevalence of asthma is increasing all over the world, especially in non-industrialized countries [1]. In the present study, the overall prevalence of childhood asthma in Dekerness district using questionnaire-diagnosed asthma was found to be 13.4% which is higher than the different school-based studies carried out in Egypt which varied over time and regions. It varied from 8.2% in Cairo [11] to 14.7% in El Nozha region [4], up to 46.1% in Al Maadi and Al Maasara region [7]. While in the Nile Delta region, the overall prevalence was 7.7% [8], in Damietta Governorate was 9.1% [12] while in Menoufiya Governorate, it was 6.5% [13]. The asthma prevalence in Assiut city, Upper Egypt was 6.2% [6], in Abu Khalifa village. In El-Ismailia Governorate, it was 9.6% [14] while in Fayoum city it was 6.3% [15]. These variations in prevalence rates may be attributed to different population studied, asthma

Table 2: Variation of BA prevalence according to some risk factors.

Risk factors	Total	Asthma no (%)	Significance	OR (95% CI)
Consanguinity among parents:				
Yes	252	39 (15.5)	$\chi^2 = 1.12$	1.23 (0.82–1.82)
No (r)	1,248	162 (13.0)	$p = 0.2$	1
Passive smoking:				
Yes	605	106 (17.5)	$\chi^2 = 14.8$	1.79 (1.33–2.4)
No (r)	895	95 (10.6)	≤0.001	1
FH of BA:				
Yes	342	103 (30.1)	$\chi^2 = 106.7$	4.6 (3.4–6.3)
No (r)	1,158	98 (8.5)	$p \leq 0.001$	1
FH allergic rhinitis:				
Yes	168	30 (17.9)	$\chi^2 = 3.2$	1.4 (0.9–2.2)
No (r)	1,332	171 (12.8)	$p = 0.07$	1
FH allergic dermatitis:				
Yes	169	31 (18.3)	$\chi^2 = 4.01$	1.5 (1.006–2.3)
No (r)	1,331	170 (12.8)	$p = 0.04$	1
Allergic conjunctivitis:				
Yes	55	14 (25.5)	$\chi^2 = 7.14$	2.3 (1.2–4.2)
No (r)	1,445	187 (12.9)	$p = 0.007$	1
Contact with birds:				
Yes	970	121 (12.5)	$\chi^2 = 2.02$	0.8 (0.5–1.08)
No (r)	530	80 (15.1)	$p = 0.1$	1
Contact with pets:				
Yes	237	33 (13.9)	$\chi^2 = 0.06$	1.05 (0.7–1.5)
No (r)	1,263	168 (13.3)	$p = 0.7$	1
Carpets:				
Yes	1,316	176 (13.4)	$\chi^2 = 0.01$	0.9 (0.6–1.5)
No (r)	184	25 (13.6)	$p = 0.9$	1

r = reference group.

Table 3: Logistic regression analysis of independent predictors of BA.

Predictors	*B*	*P*	AOR (95% CI)
Age in years:			
< 5 years	0.90	< 0.001	2.4 (1.5–3.9)
5–9 years	0.50	0.05	1.6 (1.00–2.7)
10–17 years (r)	-	-	1
Sex:			
Male	0.40	0.01	1.49 (1.08–2.05)
Female (r)	-	-	1
Birth order:			
1st and 2nd (r)	-	-	1
3rd and more	0.93	0.002	2.5 (1.4–4.6)
FH of chest allergy:			
Yes	1.52	< 0.001	4.5 (3.3–6.2)
No (r)	-	-	1
Passive smoking:			
Yes	0.46	0.004	1.58 (1.15–2.17)
No (r)	-	-	1
Constant		−3.47	
Percent correctly predicted		86.6	
Model χ^2		132.48; $P \leq 0.001$	

r = reference group.

definition, and variation of asthma risk factors. Also, school prevalence of asthma does not represent the actual prevalence as school absence is common in asthmatic children and most of the questionnaire used in the previous studies was self-administrated questionnaire. BA appears to be prevalent also in different Arabic countries and represents a major health problem; its prevalence was estimated to be 24% in Saudi Arabia [16], 22.3% in Iraq [17], and 20.7% in Oman [18].

In the literature, there is a controversy about sex and asthma prevalence. In the present study, asthma was more prevalent among males, this agrees with other studies [14,19]. It has been reported that asthma occurs more common in boys during childhood with a male-to-female ratio of 2:1 until puberty when the male-to-female ratio becomes 1:1 and symptoms are more likely to decrease in boys by adolescence [20]. The exact reason for male predominance is unknown but it may be related to a greater degree of bronchial liability in males. Airways in boys are also smaller in comparison to their lung sizes when compared to girls [21]. Also, it was hypothesized that boys have a more severe airway hyper-responsiveness than girls [22]. Higher exposure of males to outdoor allergens may partially explain this finding as most of them tend to spend most of their time outside home.

In this study, the prevalence of BA was higher in children less than 5 years old compared to different age groups. It was reported that approximately 25% of children with persistent asthma have begun wheezing before 6 months of age and 75% by the age of 3 years [23]. In a hospital-based case-control study in Yemeni children, asthma started in the first year of life in 36.0% of cases, between 1 and 3 years old in 46.0% of cases, and after the third year in 18.0% of cases [24] and this observation was also reported by El-saify et al. [25] who found that age of onset of asthma was before 4 years of age in 82.2% of cases, and nearly half cases of pediatric asthma (51%) had the onset of disease before their first year of age.

There was a significant association between asthma and child birth order, the prevalence was higher after the 2nd child birth order and this coincides with Karmaus and Botezan [26] and Dik et al. [27]. Davis, and Bulpitt [28] found that there is an apparent predominance of atopy and wheeze in larger families related directly to the number of children in those families. Also, it was found that birth order was significantly associated with increase in the risk of asthma prevalence [29].

Positive FH of asthma was a significant risk factor for asthma which agrees with other studies [6,8,12,14]. Genetic predisposition in terms of FH of asthma proved to be a major influence for asthma. This confirms past findings of the importance of heredity to the occurrence of childhood wheeze and asthma [30]. The chance of having one asthmatic child was three times greater in the families in which one parent was asthmatic and six times higher when both parents were having asthma [31].

Exposure to tobacco smoking is a significant risk factor for asthma. This agrees with a previous study [32]. It was reported that most of asthmatic children precipitate their asthma attacks after exposure to tobacco smoking [6,15]. Also, in Saudi Arabia, it was found that 17% of asthmatic children had at least one or more family members who were cigarettes smoker [33]. On the contrary, other studies stated that passive smoking showed a non-significant association with asthma [8,34].

An important note to be mentioned is that previous studies reported an association between obesity and indoor and outdoor pollutants, among other risk factors, with childhood asthma. A positive association between obesity and childhood asthma was reported by many researchers [35–38]. It was explained that obesity influences lung physiology with reductions in pulmonary compliance and limitations in airflow, systemic inflammation, dysfunctions of the sympathetic nervous system, and common genetic factors [39]. The association between environmental pollution and childhood asthma is controversial. Both early-life exposure to ambient air pollution and daily continuous exposures to pollutants were found to be associated with childhood asthma [40,41]. However, Mölter et al. [42] found no significant association between air pollution exposure and childhood asthma prevalence in five European birth cohorts.

Conclusions

BA is highly prevalent among children and adolescents in Dekerness district. A positive FH of allergy and the presence of one or more type of other allergic diseases were significantly associated risk factors for asthma development. A campaign to raise awareness of the harmful effects of passive smoking and its role in precipitating asthma attacks is recommended. Adequate education programs for high risk of asthma especially to families with positive history of allergy and those with higher birth order is needed.

Study Limitations

This is a single district study and its results cannot be generalized to all Egyptian children. Also, there are some important risk factors that were not studied (such as pollution or obesity) due to logistics and difficulties in the field work. Furthermore, the diagnosis was based on parents and/or child reports and possibility of recall bias cannot be excluded. Also, no clinical examination or respiratory function tests were done due to the same logistic and difficulties in field study.

Conflict of Interest

There are no conflicts of interest to declare.

References

[1] World Health Organization (WHO). Bronchial asthma. Available via http://www.who.int/mediacentre/factsheets/fs206/en/ (Accessed 11 September 2016).

[2] Global Initiative for Asthma. Global strategy for asthma management and prevention, 2016. Available via http://ginasthma.org/ (Accessed 10 September 2016).

[3] Shohat T, Green MS, Davidson Y. Differences in the prevalence of asthma and current wheeze between Jews and Arabs: results from a national survey of schoolchildren in Israel. Ann Allergy Asthma Immunol 2002; 89:386–92.
[4] Georgy V, Fahim HI, El-Gaafary M. Prevalence and socioeconomic associations of asthma and allergic rhinitis in northern Africa. Eur Respir J 2006; 28:756–62.
[5] Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald JM, et al. Global strategy for asthma management and prevention: GINA executive summary. Eur Respir J 2008; 31(1):143–78.
[6] Abdallah A, Sanusy K, Said W, Mahran DG, Mohamed-Hussein AA. Epidemiology of bronchial asthma among preparatory school in Assiut district. Egypt J Pediatr Allergy Immunol 2012; 10(2):109–17.
[7] Al Dhduh MAA, Mohamed Sabri NA, Fouda EM. Prevalence and severity of allergic diseases among Egyptian pediatric in different Egyptian areas. Int J Pharm Sci Res 2015; (1):107.
[8] Zedan M, Settin A, Farag M, Ezz-Elregal M, Osman E, Fouda A. Prevalence of bronchial asthma among Egyptian school children. Egyptian J Bronchol 2009; 3(2):124–30.
[9] El-Gilany A, El-Wehady A, El-Wasify M. Updating and validation of the socioeconomic status scale for health research in Egypt. East Mediterr Health J 2012; 18(9):962–8.
[10] Osman E. Prevalence of bronchial asthma among Egyptian school children: MD thesis in Pediatrics, Mansoura University, Mansoura, Egypt, 2009.
[11] El-Hefny AM, Nassar SI, El-Heneidy FM, Said M, ElBeleidy AS, El-Marsafy E, Moustafa NA, El-Falaky M, Haddad Z. Epidemiology of childhood asthma in Cairo. Med J Cairo University. 1994; 62(2):505–518.
[12] Mansour A, Yasein A, Ghandour A, Zaidan O, Abo El-Abaas MM. Prevalence of bronchial asthma and its impact on the cognitive functions and academic achievement among preparatory school children in Damietta Governorate, Egypt. J Am Sci 2014; 10(7):119–27.
[13] El-Mashad GM, Mahmoud AA, Abdel Hafez AA. The prevalence of bronchial asthma among primary school children in Menoufiya Governorate (El-Bagour Center). Menoufia Med J 2016; 29:89–94.
[14] Halim WB, Khalil KA, Sobhy SA. Prevalence of bronchial asthma among secondary schools students at Abu-Khalifa Village, Ismailia Governorate. Med J Cairo Unversity 2013; 81(2):19–24.
[15] Ahmed E, Kamel A, Amin S, Hashem AE. Epidemiology of childhood asthma in Fayoum City (District) Egypt. UK J Pharm Biosci 2016; 4(4):67–75.
[16] Al-Frayh AR, Hasnain SM. Prevalence of bronchial asthma in children in Saudi Arabia. World Allergy Organ J 2007; 5:167–8.
[17] Al-Thamiri D, Al-Kubaisy W, Ali SH. Asthma prevalence and severity among primary-school children in Baghdad. East Mediterr Health J 2005; 11:79–86.
[18] Al-Riyami BM, Al-Rawas OA, Al-Riyami AA, Jasim LG, Mohammed AJ. A relatively high prevalence and severity of asthma, allergic rhinitis and atopic eczema in schoolchildren in the Sultanate of Oman. Respirology 2003; 8:69–76.
[19] Al Ghobain MO, Al-Hajjaj MS, Al Moamary MS. Asthma prevalence among 16- to 18-yearold adolescents in Saudi Arabia using the ISAAC questionnaire. BMC Public Health 2012; 12:239. Available via http://www.biomedcentral.com/1471-2458/12/239 (Accessed December 10, 2015).
[20] El-Saify M, Malak A, Sahar MA. 10 years retrospective study of pediatric asthma in pediatric chest clinic Ain Shams University. MD thesis, Faculty of Medicine, Ain Shams University, Cairo, Egypt, 2005.
[21] Sears MR, Burrows B, Flannery EM, Herbison GP, Holdaway MD. Atopy in childhood gender and allergen related risks for development of hay fever and asthma. Clin Exper Allergy 1993; 23:941–8.
[22] Abd El-Khalek KA, Deraz TE, Rafik M. Assessment of urinary leukotriene E4 and pulmonary function tests before and after leukotriene antagonist modifying agents in asthmatic children. Egypt J Pediatr 2004; 7:31–54.
[23] Mannino DM, Homo DM, Pertowski CA. Surveillance for asthma—United States, 1960–1995. MMWR CDC Surveill Summ 1998; 47(1):1–27.
[24] Al-eryani A, Al-khorasani A, Al-sonboli N, Al-aghbari NA. Clinical presentation and risk factors of bronchial asthma in Yemeni children. Med J Cairo Univ 2016; 84(2):437–44.
[25] El-saify MY, Shaheen MA, Sabbour SM, Basal AA. Epidemiological pattern and management of pediatric asthma review of Ain shams pediatric hospital chest clinic data Cairo, Egypt 1995–2004. Egypt J Pediatr Allergy Immunol 2008; 6(2):51–6.
[26] Karmaus W, Botezan C. Does a higher number of siblings protect against the development of allergy and asthma? A review. J Epidemiol Community Health 2002; 56:209–17.
[27] Dik N, Tate RB, Manfreda J, Anthonisen NR. Risk of physician-diagnosed asthma in the first 6 years of life. Chest 2004; 126:1147–53.
[28] Davis JB, Bulpitt CJ. Atopy and wheeze in children according to parental atopy and family size. Thorax 1981; 36:185–9.
[29] Kusunoki T, Mukaida K, Morimoto T, Sakuma M, Yasumi T, Nishikomori R, et al. Birth order effect on childhood food allergy. Pediatr Allergy Immunol 2012; 23(3):250–4.

[30] Arshad S, Kurukulaaratchy RJ, Fenn M, Matthews S. Early life risk factors for current wheeze, asthma, and bronchial hyperresponsiveness at 10 years of age. Chest 2005; 127:502–8.
[31] Chatkin MN, Menezes AMB. Prevalence and risk factors for asthma in school children in southern Brazil. J Pediatr 2005; 81(5):411–6.
[32] Al-Dawood KM. Schoolboys with bronchial asthma in Al-Khobar City, Saudi Arabia: Are they at increased risk of school absenteeism? J Asthma 2002; 39:413–20.
[33] Al Frayh AR, Shakoor Z, El Rab MG, Hasnain SM. Increased prevalence of asthma in Saudi Arabia. Ann Allergy Asthma Immunol 2001; 86:292–6.
[34] Behl RK, Kashyap S, Sarkar M. Prevalence of bronchial asthma in school children of 6–13 years of age in Shimla City, Department of Pulmonary Medicine, Indira Gandhi Medical College, Shimla, India. Chet Dis Allied Sci 2010; 52:145–8.
[35] Granell R, Henderson AJ, Evans DM, Smith GD, Ness AR, Lewis S, et al. Effects of BMI, fat mass, and lean mass on asthma in childhood: a mendelian randomization study. PLoS Med 2014; 11:e1001669.
[36] Egan KB, Ettinger AS, Bracken MB. Childhood body mass index and subsequent physician-diagnosed asthma: a systematic review and meta-analysis of prospective cohort studies. BMC Pediatr 2013; 13:121.
[37] Flaherman V, Rutherford GW. A meta-analysis of the effect of high weight on asthma. Arch Dis Child 2006; 91:334–9.
[38] Delgado J, Barranco P, Quirce S. Obesity and asthma. J Investig Allergol Clin Immunol 2008; 18:420–5.
[39] Brashier B, Salvi S. Obesity and asthma: physiological perspective. J Allergy 2013; 2013:198068, 11.
[40] Hulin M, Caillaud D, Annesi-Maesano I. Indoor air pollution and childhood asthma: variations between urban and rural areas. Indoor Air 2010; 20:502–14.
[41] Deng Q, Lu C, Norbäck D, Bornehag C, Zhang Y, Liu W, et al. Early life exposure to ambient air pollution and childhood asthma in China. Environ Res 2015; 143:83–92.
[42] Mölter A, Simpson A, Berdel D, Brunekreef B, Custovic A, Cyrys J, et al. A multicentre study of air pollution exposure and childhood asthma prevalence: the ESCAPE project. Eur Respir J 2015; 45:610–24.