Exposure to environmental tobacco smoke and respiratory morbidity among adolescents in a Middle-Eastern country

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Abstract

Background: There is increasing evidence linking exposure to environmental tobacco smoke (ETS) at homes to the development of respiratory morbidity including asthma among adolescents. Few studies have addressed this issue in the Middle-Eastern countries including Kuwait. Therefore, this study cross-sectional assessed the prevalence of ETS exposure at home, prevalence of asthma and other respiratory morbid conditions and examined the ETS exposure and personal smoking status as risk factors for asthma among high-school students in Kuwait. Methods: During October 2015, a cross-sectional study design was implemented using a self-administered, modified version of the ISAAC (International study of asthma and allergies in childhood) questionnaire among students enrolled in nine high-schools of Hawally Governorate of Kuwait. Prevalence of ETS exposure, and eczema were computed. Multivariable log-binomial regression models were used to evaluate association between exposures of interest and asthma status. Results: Of 800 invited students, 746 (92.2%) participated, of whom 74.8% were Kuwaiti and 50.1% were female with a mean (SD) age of 16.8 (0.68) years. ETS exposure prevalence at home was 54% and personal current smoking was 12.4%. Asthma prevalence was 20.5%. Furthermore, the prevalence of physician-diagnosed asthma, wheezing during the last 12 months and wheezing ‘ever’ was 16.4%, 20.1% and 26.2%, respectively. Final multivariable log-binomial regression model showed that compared to the adolescents without asthma, adolescents with asthma tended to be current smokers (adjusted prevalence ratio (adjusted PR) = 1.86; 95% CI: 1.37 - 2.53; p < 0.001) or significantly more likely to have had ETS exposure at home (adjusted PR = 1.64; 95% CI: 1.21 - 2.23; p = 0.002). Conclusions: We recorded high prevalence of ETS exposure at home, high prevalence of asthma and identified ETS exposure at home and being a current smoker as strong risk factors for asthma among adolescents. Voluntary household smoking bans may substantially minimize the ETS exposure among adolescents. Additionally, such restriction may inculcate an antismoking attitude and prevent smoking initiation among adolescents. Such efforts are likely to pay dividends in terms of reduction in ETS exposure and associated asthma risk and other smoking-related morbidities in this and other similar settings.
Asthma is one of the most important diseases of childhood, causing substantial morbidity [1-3], increases the hospital admission rates and primary care contacts [4-6]. Data from the ISAAC (International Study of Asthma and Allergies in Childhood) Phase-III study have shown an estimated global asthma prevalence among adolescents as 14.1% with an average annual increase of 0.28% from previous estimate during ISAAC Phase II study [7, 8]. Furthermore, the results of ISAAC Phase -III study showed that virtually all the countries reported increases in the lifetime asthma prevalence between phases I and III. Globally, a wide variability (range: 2.1% - 32.2%) in the asthma prevalence has been recorded, not only between the regions and countries but also within the same country suggesting a crucial role of local environmental characteristics [7, 9]. This prevalence of asthma was particularly high in English speaking countries and Latin America [9]. Also, the highest 12-month prevalence was recorded in the UK, Australia, New Zealand, and Republic of Ireland, followed by North, Central, and South America; the lowest prevalence was reported from several Eastern European countries, Indonesia, Greece, China, Taiwan, Uzbekistan, India, and Ethiopia [10]. In Saudi Arabia, lately a ISAAC study, reported the prevalence of physician-diagnosed asthma among adolescents as 19.6% [11]. In Kuwait, among 13-14 years adolescents, the estimated physician-diagnosed prevalence of asthma during ISAAC Phase I (16.8%) [12], and III (15.6%) [13], nearly remained unchanged. However, little published data on the recent status of asthma among adolescent in the Middle-Eastern countries including Kuwait are available.

The effect of exposure to environmental tobacco smoke (ETS) on respiratory health has been of interest for many years [14]. The epidemiological evidence on the relationship between ETS exposure and childhood asthma has form studies carried out in Western countries. Little published data are available from the Middle-Eastern countries [15]. In Kuwaiti population, tobacco consumption by different modes is highly prevalent including cigarettes, waterpipe etc. It is estimated that one-third of the Kuwaiti population are smokers [16], and in this country 54% of adolescents get exposed to ETS at homes [17]. To decrease ETS exposure in Kuwait, the public health authorities regularly conduct educational campaigns through electronic print media and has banned the use of tobacco products in public places, such as malls, public offices, public gardens, etc. However, the impact
evaluation of such efforts on the burden of allergic conditions including asthma among children through ETS exposure is still awaited. Therefore, the objectives of this cross-sectional study were to assess i) the prevalence of asthma, and ii) examine the association between ETS exposure and asthma among adolescents enrolled in various high-schools in Kuwait.

Methods

**Study population, setting and design**

The study population, setting and design have been previously described elsewhere [17], and briefly outlined here. During October 2015, we conducted a cross-sectional study among high-school students in Hawally - one of the six Governorates of Kuwait to i) assess the prevalence of exposure to ETS mainly due to smoking at home among high-school students, ii) assess the prevalence of various allergic conditions including asthma and eczema among high-school students, and iii) evaluate the association between exposure to ETS and selected allergic conditions. The main consideration in choosing this population was their known high frequency and period of exposure to environmental tobacco smoke and expected high prevalence of asthma and other allergic conditions. We obtained a list of schools from the Ministry of Education’s website. From the list of 10 schools for boys, 9 schools for girls and 44 private schools with co-education system, for this study, nine schools were selected including three public sector schools each for male and female students and three private schools with co-education [17].

**Questionnaire**

For collection of data on socio-demographic variables, smoking status, and exposure to smoke at home and in public areas, a structured and self-administered questionnaire was developed in English. For the diagnosis of asthma, the standardized International study of asthma and allergies in childhood (ISAAC) core questionnaire was used [5]. For this study, respondent was considered to have had asthma, if during past months, he or she reported to have had four or more episodes of wheezing or one or more episodes of wheezing with the use of an inhaler or the respondent was ever diagnosed as asthmatic by a physician [5]. The questionnaire was developed in English and the final version was
also translated in Arabic for actual use. The questionnaire was pre-tested on 20 students alike our potential study participants and modifications were made as needed. The questionnaire comprised 21 questions and took on average five minutes for its completion [17].

**Data collection**

From each of the selected schools, we intended to include about 100 students from various sections of 11th and 12th grade. For this purpose, we requested the respective section in-charge teachers in getting the questionnaire filled in by the students at the end of the class, who explained the study objectives to the students. Students were further informed that their participation in the study is voluntary. We used the same data collection procedure for both private and public-sector schools. In this analytical cross-sectional study, a sample of 380 students each in ETS exposed and ETS unexposed groups was considered adequate to achieve 85% power to estimate a prevalence ratio (PR) of 2.5 relating ETS with asthma in study population assuming the proportion of asthmatic students in ETS un-exposed group as 0.04 at a significance (α) level of 0.05. To accommodate any potential refusals, sample size was inflated as 450 students in each of the study group. The study protocol was approved by Kuwait University, Health Sciences Center’s Ethics Committee for Students Research.

**Statistical analysis**

For the descriptive analysis, mean (standard deviation (SD)) for quantitative variables and frequencies (%) for categorical variables were computed. The chi-square test was used to test the statistical significance of association of each of the independent variable with asthma status. Since, odd ratio overestimates the association of predictors with common outcomes we used the PR both crude and adjusted as a measure of association between the independent variables and asthma status. Univariable log-binomial regression model was used to quantify the magnitude of unadjusted association of each of categorical variables with asthma status. The variables significantly (\( p \leq 0.150 \)) related with asthma on univariable analysis were considered for inclusion in multivariable log-
binomial regression model. Log-binomial regression analysis was performed to select the variables which were independently and significantly \((p < 0.05)\) related to asthma status. Adjusted PRs and their 95% confidence intervals (CI) were used to interpret the final model.

Results

**Descriptive statistics, prevalence of asthma**

We invited 800 high school students from 9 schools to participate in the study. Of these, 746 (92.2%) participated and completed the modified version of the ISAAC questionnaire. The selected schools included 3 public schools for boys, 3 public schools for girls and 3 private schools which have co-education comprising male and female students. Non-respondents’ age and gender distributions were nearly similar to those of respondents. The mean (SD) age (years) of the participants was 16.78 (0.68). The majority (74.8%) of the study participants Kuwaiti, female (50.1%), and 56.1% of the adolescents come from families having total monthly family income more than 1000 Kuwaiti Dinars. Of the respondents, 91 (12.4%) were current regular smokers, of which 55 (62%) have been smoking for more than 2 years. Of the study participants, 398 (54%) had ETS exposure at home (i.e. had one or more smokers at home). Moreover, 52.3% of the participants reported to have had ETS exposure for three or more hours a week at public places. The prevalence of self-reported asthma in this study sample was 20.5%. Additionally, the prevalence of physician-diagnosed asthma, wheezing during last 12 months and wheezing ‘ever’ was 16.4%, 20.1% and 26.2%, respectively (Table 1).

**Univariable and multivariable log-binomial regression models**

On univariable analyses, the characteristics significantly associated with self-reported asthma status were adolescent’s current smoking status (PR = 1.96; CI: 1.43 - 2.69; \(p < 0.001\)), ETS exposure at home (presence of one or more smokers at home) (PR = 1.75; CI: 1.29 - 2.37; \(p < 0.001\)), and ETS exposure at public places (PR = 1.46; CI: 1.09 - 1.96; \(p = 0.013\)). Gender, nationality and monthly total family income (Kuwaiti dinars) were not significantly associated with asthma status in univariable analysis (Table 2). A multivariable log-binomial regression model showed that compared to adolescents without asthma, adolescents with asthma tended to be current smokers (adjusted PR = 1.86; 95% CI: 1.37 - 2.53; \(p < 0.001\)) or significantly more likely to have had ETS exposure at home.
Discussion

This cross-sectional study assessed the prevalence of asthma and examined ETS exposure, active tobacco smoking along with demographic, and other lifestyle and behavioural characteristics in relation to asthma status among adolescents in Hawalli Governorate, Kuwait. The prevalence estimate of self-reported asthma in our study sample was 20.5%, while the 12-month prevalence of wheezing was 20.1%. These prevalence estimates for asthma and 12-month wheezing are higher than the figures reported from in earlier ISAAC studies conducted in Kuwait during 1995-1996 (16.8%, 16.1%) [12], and 2001-2002 (15.6%, 7.6%).[12, 13] The estimate of self-reported asthma in this study is also greater than the estimate reported in a recent study conducted among university students in Kuwait (14.6%) [18], and slightly higher than the figure reported in a study among high-school students in the neighboring Saudi Arabia (18.5%) [11, 18]. The differences in the prevalence of asthma could possibly be due to varying distributions of underlying contributing factors such as differing age of study populations, dietary habits, microbial exposure, economic status, indoor or outdoor environment, climatic variation, and disease awareness [19, 20]. With 20.5% prevalence estimate of self-reported asthma, Kuwait can be bracketed with the group of countries with high prevalence of self-reported asthma among adolescents estimated using ISAAC methodology [9, 10]. Additionally, the 12-month prevalence of wheezing in the current study is higher than the global estimate of 14.8% among adolescents aged 13-14 years [7]. On the other hand, the prevalence estimate of physician-diagnosed asthma (16.4%) in this study is largely in agreement with the estimates from the 1995-1996 (16.8) [12], and 2001-2002 (15.6%) ISAAC studies in Kuwait [12, 13].

Multivariable log-binomial regression model showed that compared to non-smokers participants, current smoker adolescents were significantly more likely to be asthmatic. This finding is in congruent with that of a study in Argentina [21], and finding of a national survey in Britain [22]. Concerted efforts at high school-level to increase the awareness regarding deleterious effects of tobacco smoking may help in reducing tobacco consumption among adolescents.

Our final multivariable log-binomial regression also revealed that the adolescents were significantly
more likely to be asthmatic, if they have had ETS exposure at home. This finding is in agreement with the results of earlier studies undertaken in various other regions across the globe using ISAAC methodology [21, 23]. The results of these reports showed that adolescents were more likely to develop asthma if either or both parents were smokers compared to non-smoking parents [14, 21, 23]. Additionally, there was a clear dose-response relationship between the number of cigarettes smoked by the parents and prevalence of asthma symptoms, which tended to support a notion of causal relationship [14]. Additionally, cumulated anecdotal evidence on the link between ETS exposure and asthma risk among adolescents based on the results of cohort and case-control studies also warned the causal relationship [24, 25]. Thus, with the available epidemiological evidence, some of the cardinal Hill Bradford’s criteria such as temporality, consistency, dose-response, and strength of association for establishing causation between ETS exposure and asthma among adolescents appeared to be fulfilled.

There are a few notable strengths of this study. First, the study sample comprised participants who were homogenous with regard to age. Second, the use of gender stratified sampling allowed enrollment of an almost equal number of male and female participants. Final, the use of the standardized and validated ISAAC questionnaire for the outcome assessment facilitated comparison of the results of this study with that other local and/or international studies. Some limitations of this study should be considered while interpreting the results. First, this was a cross-sectional study, and this design has inherent limitation in establishing temporal relationship between the studied exposures such as self-smoking status, ETS exposure at home and asthma. Second, data were collected using a self-administered questionnaire with chances of recall bias. Final, the responses on outcome questions were self-reported and were not validated by more objective measurements. However, the ISAAC questionnaire has been validated in multiple languages in different countries including Kuwait [12-14].

Conclusions
We recorded high prevalence of ETS exposure at home, a high prevalence of self-reported asthma and identified ETS exposure at home and being a current smoker as strong risk factors associated
with asthma status among adolescents. ETS exposure is currently only avoidable risk factor for which considerable evidence of an etiologic link with asthma among adolescents is available. Therefore, voluntary household smoking bans may substantially minimize the ETS exposure among adolescents at home. Furthermore, such a restriction may inculcate an antismoking attitude and prevent smoking initiation among adolescents. Such efforts are likely to pay dividends in terms of reduction in ETS exposure and associated risk for asthma and other smoking related morbidities in this and other similar settings as have been shown in other populations [26, 27].

Declarations

**Abbreviations**

ETS: Environmental Tobacco Smoke; ISAAC: International Study of Asthma and Allergies in Childhood; SD: Standard Deviation; PR: Prevalence Ratio; CI: Confidence Interval

**Ethics approval and consent to participate**

The study protocol was approved by Kuwait University, Health Sciences Center’s Ethics Committee for Students Research. All the participants provided written informed consent to participate in study before completing the questionnaire.

**Consent to publish**

Not applicable

**Availability of data and materials**

The data collected and analyzed are included in this manuscript and can be made available on reasonable request.

**Competing interests**

None declared.
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Authors’ contributions

SA conceptualize the study question and design. HB, MA, SAL. AB AA, OA participated questionnaire design, data collection, data analysis and preparing the first draft of the manuscript. SA reviewed and edited the draft manuscript. All authors read and approved the final manuscript.

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### Tables

Table 1. Socio-demographic characteristics, cigarette smoking status and exposure to environmental tobacco smoke at home prevalence of asthma among participants. October 2015 (N = 746)

| Characteristics                                               | n   | %    |
|---------------------------------------------------------------|-----|------|
| Type of school                                                |     |      |
| Government                                                   | 594 | 79.0 |
| Private                                                       | 157 | 21.0 |
| Age, mean (SD)                                                |     |      |
|                                                            | 16.78 (0.68) |
| Gender                                                       |     |      |
| Male                                                         | 372 | 49.9 |
| Female                                                       | 374 | 50.1 |
| Nationality                                                  |     |      |
| Kuwaiti                                                      | 552 | 74.8 |
| Non-Kuwaiti                                                  | 186 | 25.2 |
| Income (Kuwaiti Dinars)                                       |     |      |
| < 500                                                        | 32  | 4.7  |
| 500-1000                                                     | 126 | 18.3 |
| 1001-1500                                                    | 144 | 20.9 |
| 1501-2000                                                    | 105 | 15.3 |
| > 2000                                                       | 281 | 40.8 |
| Respondent smoking status (cigarettes per day)               |     |      |
| None                                                         | 643 | 87.6 |
| Less than 10                                                 | 45  | 6.1  |
| 10 or More                                                   | 46  | 6.3  |
| Smoking duration                                             |     |      |
| < 1 year                                                     | 13  | 14.6 |
| Between 1-2 years                                            | 21  | 23.6 |
| > 2 years                                                    | 55  | 61.8 |
| Smokers at home                                              |     |      |
| None                                                         | 338 | 45.9 |
| One or more                                                  | 398 | 54.1 |
| ETS exposure at public places (hours per week)               |     |      |
| < 3                                                          | 336 | 47.7 |
|                                                              | 205 | 29.1 |
Table 2: Univariable analysis of adolescents’ characteristics associated with their asthma status in Kuwait: A cross-sectional study (n=746)

| Characteristics                      | Total n | Asthma (yes vs. no) n (%) | Unadjusted prevalence ratio (95% CI) | p-value* |
|-------------------------------------|---------|---------------------------|-------------------------------------|----------|
|                                    |         | Asthma                     |                                     |          |
| Gender                              |         |                            |                                     |          |
| Female                             | 374     | 69 (18.4)                  | 1.00 -                               |          |
| Male                               | 372     | 85 (22.8)                  | 1.24 (0.93 - 1.64)                 |          |
| Nationality                         |         |                            |                                     |          |
| Non-Kuwaiti                        | 186     | 37 (19.9)                  | 1.00 -                               |          |
| Kuwaiti                            | 552     | 115 (20.8)                 | 1.05 (0.76 - 1.47)                 |          |
| Income (Kuwaiti Dinars)             |         |                            |                                     |          |
| < 500                               | 32      | 5 (15.6)                   | 1.00 -                               |          |
| 500-1000                            | 126     | 28 (22.2)                  | 1.42 (0.60 - 3.39)                 |          |
| 1001-1500                           | 144     | 33 (22.9)                  | 1.38 (0.58 - 3.30)                 |          |
| 1501-2000                           | 105     | 19 (18.1)                  | 1.34 (0.54 - 3.33)                 |          |
| > 2000                              | 281     | 64 (22.8)                  | 1.69 (0.73 - 3.92)                 |          |
| Respondent’s current smoking status|         |                            |                                     |          |
| No                                  | 643     | 119 (18.5)                 | 1.00 -                               |          |
| Yes                                 | 91      | 33 (36.3)                  | 1.96 (1.43 - 2.69)                 |          |
| Number of smokers at home           |         |                            |                                     |          |
| None                                | 338     | 50 (14.8)                  | 1.00 -                               |          |
|                                    | 398     | 103 (25.9)                 | 1.75 (1.29 - 2.37)                 |          |
TABLE 3. Multivariable log-binomial regression models of the variables associated with the respondent’s asthma and ecze
Kuwait: A cross-sectional study, October 2015

| Variables                                                                 | Asthma (yes vs. no) | p-value |
|---------------------------------------------------------------------------|---------------------|---------|
|                                                                           | Adjusted prevalence ratio (95% confidence interval) |         |
| Respondent current smoking status (yes vs. no)                            | 1.86 (1.37– 2.53)   | < 0.001 |
| Number of smokers at home (one or more vs. none)                          | 1.64 (1.21 – 2.23)  | 0.002   |

ETS: Environmental Tobacco Smoke
* p-values are for Yate’s corrected Chi-squared statistic unless stated otherwise,
** p-value for Chi-squared statistic for trend.

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