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The Influences of Socioeconomic Status of Primary Schools' Students on Their Respiratory Health

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ABSTRACT

Although researchers in this decade have proposed several answers concerning the association between socio-economic levels of health, still one question is not well understood: whether in school or domestic environments, low and high socio-economic status may influence asthma and respiratory symptoms on primary school students. The aim of this study was to investigate the extent to which primary school with environment low and high socio-economic status, and respiratory health among the students. Respiratory symptoms and asthma among Australian school students' within high and low socio-economic backgrounds were studied in 2007. A cross sectional study in three stages questionnaire survey, indoor air quality monitoring in schools and indoor air quality assessment in houses were carried out to explain the impact of school and domestic air quality on respiratory symptoms among primary school students at schools with high and low socio-economic backgrounds. The data were analysed using statistical tests like Correlation, One-Way ANOVA and T-test. The study results have shown that school children with low socio-economic backgrounds showed more respiratory symptoms. Also, there was a significant difference between boys and girls respiratory symptoms. Those who studied in schools with higher SES had fewer asthma and respiratory symptoms. Several elements such as smoking at home, the amount of particular matters and volatile organic compounds inside the house and usage of detergents inside the classrooms were the main reasons to student's respiratory symptoms. This study concluded that there is a negative correlation between SES and respiratory symptoms among school students and low socio-economic status of school's environments itself is a risk factor for respiratory symptoms and astma among school childrens.

KEYWORDS: *School environment, Respiratory symptoms, Primary school students, Socio-economic status (SES)*

INTRODUCTION

Respiratory symptoms are the leading cause of school absenteeism in children, and result in missed workdays and lost productivity in adults as well [1]. The evidence strongly suggests that poor indoor air quality in schools can have impact on the respiratory health of children. According to Mendel and Heath (2005) children are at greater risk of the development of respiratory diseases in poor environmental conditions because their immune system is still developing [2-3] have demonstrated that the exposure levels of indoor pollutants, such as Volatile Organic Compounds and formaldehyde are significant risk factors for asthma in children.

Researchers have pointed out the poor indoor air quality (IAQ) may have a role in exacerbation of allergic disorders [4-5], although the socio-economic status may also have a key role in the development and progress of respiratory

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symptoms and asthma, especially in schoolchildren [6-8]. The "hygiene theory" hypothesized that children who grew up with other siblings or animals in their houses early in life have more developed immune systems due to frequent exposure to allergens and pollutants, resulting in more tolerance to irritants that may cause asthma. The influence of socio-economic status could be explained by current and past individual exposure to lifestyle and environmental factors.

Although researchers in this decade have proposed several answers concerning the association between socio-economic levels and health [9-13], the study was seeking answers to whether schools' environments with low and high socio-economic status might influence asthma and respiratory symptoms among school children.

MATERIALS AND METHODS

We carried out a cross sectional study in three stages using questionnaire survey, indoor air quality monitoring in schools and indoor air quality assessment in houses to explain the impact of school and domestic air quality on respiratory symptoms among primary school students at schools with high and low socio-economic backgrounds. Following contact with 196 primary school principals in each area with low and high socio-economic [15] backgrounds, 6 (16.2%) schools from low SES and 5 (13.5%). Schools from high SES were selected for investigations towards this study. All primary schools and houses were selected based on socioeconomic indexes of Australian Bureau of Statistics [15]. All adjacent primary schools and houses adjacent to roads, highways and streets had been deleted from the study due to high levels of air pollutants. This study was conducted at residential areas in Western Australia at different suburbs [15].

All the eleven Public primary schools participated in this survey in the year 2007-2008. The classrooms with students in grade 2-5 from each school were selected and indoor air quality was monitored in each classroom for 8 hours twice a week (once at the beginning of the week and once at the end) during winter and summer. The primary school cleaners were asked questions regarding usual cleaning products. The Material Safety Data Sheets (MSDS) for cleaning materials were also reviewed. One of the primary schools was deleted from the survey because it was adjacent to a busy high way. Of the remaining ten primary schools, only two primary schools were renovated during the last five years and these were located in low socio-economic status areas.

Study population criteria: School children aged between 6-9 year old, enrolled in primary school grade 2-5 and living in the same suburb as the selected school were chosen to investigate in the study. Students' parents or caregivers have signed the consent form to allow their children to participate in the study.

Stage One: Exposure assessment: To achieve the purpose of investigating the relationship between school socio-economic status, indoor air quality and the prevalence of respiratory symptoms the classrooms and domestic environments were initially inspected for signs of building dampness including visible mold growth on indoor surfaces as well as other signs of building dampness (water leakage, signs of dampness from floor construction such as bubbles under the floor coating, and molds odor). Measurements were made in March 2007. Thirty-six classrooms were assessed through monitoring the indoor pollutants twice on each day, Monday and Friday during winter and summer seasons. The reason for measurements during two days in a week was to investigate the difference in the level of indoor pollutants and climate parameters in classes between occupied and unoccupied hours by students.

One classroom was not considered because it was used for other purpose during summer sampling time. Classroom details on construction materials, type of ventilation and heating system during winter and summer, cleaning routines, cleaning material safety data sheets (MSDS) and number of students present were noted.

During the survey, the following pollutants were measured: volatile organic compounds (VOCs), formaldehyde (HCHO), Particulate Matter with size 10 microns in diameter. They were collected over about eight hours between 8:00 am -15:30 pm, which corresponds to the hours that students are likely to be in the classroom. In each classroom, room temperature and relative air humidity were measured by Tinytalk II Data Loggers during sampling time. Particulate matter ($PM_{2.5}$) was also monitored in each room using a DUST TRAK MODEL 8520. Ultra-fine particles were monitored indoors twice a day before and after school time during morning and afternoon on the sampling day for 10 seconds using a P-TRAK Model 8525.

Home visits were carried out during the winter of 2007 and summer 2008. Samples of formaldehyde and VOCs were collected from the children's bedrooms or living rooms, in which each child spent majority of time for 8 hours with a passive sampler.

The sampler was set at a height of 0.8 m in the open space. The collected samples were transported into plastic containers with diameters 5 and 10 cm from the field to laboratory and stored in a refrigerator before analysis. Particulate matter ($PM_{2.5}$) was also measured. Temperature and relative humidity were also monitored in those houses on the sampling day.

Stage one (a): Indoor air quality assessment in school environment: At this stage, indoor air quality in 36 classrooms of the ten study schools were investigated through the measurement of primary indoor air pollutants including Volatile Organic Compounds (VOCs) (µg/m^3), formaldehyde (HCHO) (µg/m^3) and particulate matter with size 2.5 microns in diameter ($PM_{2.5}$) (µg/m^3). Indoor temperature (TCº) and relative humidity (RH) (%) were also covered.

Stage one (b): Indoor air monitoring in domestic settings: This stage included domestic indoor air quality monitoring. Representative samples of 30 houses from each area were selected.

Stage two: Questionnaire survey: The questionnaire employed for the study was based on the comprehensive standardized questionnaire of the American Thoracic Society (ATS), with little modification. The questionnaire comprised two parts. The first part of the questionnaire was related to the demographic status and child's health status, child's age, gender, date and country of birth, home address. The child's health status, including current wheeze, bronchitis, and asthma diagnosed by a physician and recent asthma attacks, were covered. Some further questions associated with personal susceptibility, such as the child's hay fever and allergic reactions, were asked. Questions were asked about common respiratory symptoms, for example phlegm, cough, whistling and wheeze. In addition, questions asked included if the child had ever had asthma and, for the children who were known to be asthmatic cases, they were asked if they ever had an asthma attack or any medication for asthma in the last 12 months. Runny or blocked nose, itchy rash, sneezing and other symptoms related to hypersensitivity were also covered. Family history and any atopic diseases related to family, such as respiratory symptoms and asthma among siblings, eczema and hay fever in first-degree relatives, were also covered.

The second part of the questionnaire was mainly related to the child's domestic environment and his/her socio-economic background. These included parents' employment, family income, number of children in the family and parents' educational levels. Further questions, about maternal and paternal smoking habits, visitors smoking, and exposure to gas appliances, kerosene, space heater, fireplaces or wood fire, were included. The questionnaire also included questions such as age of dwellings, heating and cooling facilities, floor covering, recent renovation, new furniture and type of cooking (gas or electric). It also included questions related to damp or mold occurring inside the house, pet ownership, type of cleaning products and materials and in the household ventilation and traffic around the location of the residence were also covered in this part.

"Socio-economic disadvantage can take many forms, including low income, poor education, and unemployment, limited access to health services, living in poor houses and working in an unsatisfactory or unskilled job environment. Alone or in combination, and over time, these stressful economic and social circumstances have an effect on health and wellbeing" [14]. The Index of Relative Socio-economic disadvantage was used to illuminate socio- economic effects, which include variables that reflect or measure relative disadvantage. The variables include low-income, low educational attainment, all factors likely to influence how a community copes with changing circumstances [15]. To measure family socio-economic status, children were asked questions regarding the highest qualification of their parents, as well as their occupations. The average weekly family income was also covered.

Data and statistical analysis: Questionnaire data and measurement data of the schools and domestic environments were added into SPSS data formatting before doing statistical analysis. Data checking and screening were done after data entry. Implausible and inconsistent entries were identified and corrected. Data analysis was carried out using SPSS version 17.0.

Chi-square tests were employed to measure the difference in prevalence of respiratory symptoms between schools in different socio-economic areas. To further examine the association between risks of interest and the binary outcomes, logistic regression models were chosen to estimate the odd ratios. For levels of pollutants and other continuous variables, the distributions were investigated first. Respective means or geometric means were presented. ANOVA or corresponding nonparametric methods were used to compare the difference in levels of pollutants in domestic and school environments located in the different socio-economic areas. To further investigate the contributing factors related to levels of pollutants, linear regression models were prepared. Multivariate analysis techniques such as logistic and linear regression analysis have also been conducted to examine the associations and relationships between variables after adjusting for possible confounders. All the data were analyzed with SPSS and STATA the probability of 0.05 was selected for the statistical significance.

Questionnaire survey data: Collected data have shown that most variables are categorical variables. Chi-square tests were utilized to measure the relationships among variables. Categorical variables have also been presented as rates (%) and their 95% confidence intervals (95% CIs). The continuous variables were presented as Means and Standard Deviations (SDs). To evaluate the differences between variables, independent Sample T-test was employed. However, to analyze the collected data that were not found in normal distribution, nonparametric statistics have been employed to analyze collected data.

RESULTS

The oldest primary school was built in 1898 and the latest in 1983. Out of ten primary schools, three were built more than a hundred years ago , while two primary schools were between 76 and a hundred years old , followed by one 51 to 75, and two between 26-50 years old. Schools survey data showed only two of the selected primary schools were built less than 25 years ago.

The numbers of boys with asthma were higher. However, statistical analyses showed no significant difference between boys and girls with asthma.

Statistical analyses have demonstrated that 32% of mothers with low SES had university degree and 25% with TAFE qualifications and 43% had graduated from high school. The percentage of mothers with high SES that graduated from universities was 66.7%; followed by 15% with TAFE qualifications and 16% of participants had graduated from high school. The differences between educational levels among participating mothers with different socio-economic status was that those from high SES appeared to be more educated ($P<0.05$).

Among fathers with low SES, 30.8% had a university degree followed by 31% with TAFE qualifications and 37% graduated from high school. Among the high SES families 59% of fathers had a university degree followed by 20.5% with TAFE and 20.6% graduated from high school. This study found significant differences between educational levels of fathers with low and high SES ($P=0.007$).

Although there was a significant difference between mothers' type of jobs among low and high SES, the majority reported home duties (36.9%), teachers (7.7%), followed by nurses (4.6%) and administrative affairs (3.1%,). The other 47.7% of the mothers reported different activities.

The current weekly family income was classified as low and high. Statistical analysis showed that of the 219 families who participated in this study, 44.3% (97) were classified as the low SES and 55.7% (122) as high SES families. Of all participants, 63% (138), had reported low income (<1500) and 37% (81) had high income ($1500-$2499) weekly.

Multivariate Binary Logistic Regression did not demonstrate significant differences between respiratory symptoms and asthma among schoolchildren from low and high socio-economic status. Logistic Regression Analysis found statistically significant association between low SES and wheeze among school students ($P=0.005$, ORs=3.294; 95% CI=1.425-7.616). In addition, low SES could appear as a risk factor for asthma ($P=0.033$, ORs=2.951 95% CI=1.091 and 7.977). Additionally, there was a significant association ($P=0.008$) between child's asthma and biological mother's hay fever, with ORs=0.224 (95%CI 0.074-0.679). In addition, statistical analysis found marginally significant association between child's hay fever and mother's hay fever ($P=0.079$, ORs=0.419, 95% CI=0.59-1.105). Marginal significant relationship was also found between a child's allergic rash and their mother's eczema ($P=0.061$, ORs=0.304, CI=0.087 and 1.059) and with biological father's eczema ($P=0.090$, ORs= 0.206, CI=0.033 and 1.277). The relationship between parents' and siblings' histories of eczema and other allergic conditions for child's eczema became marginally significant ($P=0.062$, ORs=0.359, CI=0.122 and 1.053).

The Mann Whitney test for significance has demonstrated that there were significant differences between respiratory symptoms and house characteristics. The further multivariate analysis has established that families who live near busy roads are four times more likely to have children with upper respiratory symptoms. According to multivariate regression analysis after adjusting for SES, children's age and gender, parents' employment and educational levels, busy roads appeared to be risk factors for upper respiratory symptoms, wheeze and asthma Families who lived near industries were almost six times more likely to have children with dry cough at night.

In accordance with statistical analysis, dry cough, asthma and snoring were more than five times more likely for children who live near to industry areas compared to those who do not.

The logistic regression analysis showed that air conditioning is a significant risk factor for upper respiratory symptoms, asthma allergy and itchy rash. Children who live in houses with reverse air conditioners were almost 8 times more likely to suffer from upper respiratory symptoms compared to those who did not have reverse air conditioner. The Mann Whitney test for significance has demonstrated that damp clothes, condensation and molds are some of the major risk factors for respiratory symptoms and asthma. Families who reported condensation in their houses are four times more likely to have children suffering from upper respiratory symptoms and asthma.

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Based on Logistic Regression Analysis, molds in houses could increase the risk of asthma among children almost three times. Further Logistic Regression Analysis has established that low socioeconomic status could be a statistically significant risk factor for wheeze. Children from low socioeconomic status backgrounds are three times (ORs =2.99, 95% CI 1.018 - 8.785; P= 0.046) more likely to have a wheeze. Damp patches also appeared to be a significant risk factor for dry cough and wheeze. Logistic regression demonstrated that low SES is a statistically significant risk factor for runny or stuffy nose, after the adjustment for children's age and gender, parents' employment and education levels, house's proximity to busy roads and house's proximity to industries. It has also been evident that using air conditioners in the house during summer time is a major risk factor for runny nose followed by wheeze, increasing the risk by almost three times as evident from Table 1 living rooms and children bedrooms' floor covering could be a major component of respiratory symptoms and asthma among schoolchildren.

Data analysis has demonstrated that the frequency of indoor smoking is higher among families from low SES when compared with those from high socio-economic status areas. After adjustment for age, gender, family history of respiratory symptoms and asthma, dampness, molds and condensation at home, there is still an association between passive smoking and respiratory symptoms (Table 2). It is evident that parents who smoke are almost seven times more likely to have children with upper respiratory symptoms and wheeze.

Table1. Odd ratios of the house characteristic for respiratory symptoms and asthma

Predictor	**Respiratory symptoms**	**Crude ORs**	**95% CI**		**P value**
			Lower	**Upper**	
Living room with linoleum floor covering	Snore	5.00	0.87	8.86	0.072
	Asthma	9.25	1.37	12.09	0.022
Living room with parquet floor covering	Wheeze	5.60	1.39	9.63	0.016
	Runny or stuffy	8.88	1.02	77.32	0.048
Living room with carpet floor covering	Dry cough night	2.91	1.30	6.55	0.009
Living room with tiles floor covering	Wheeze	9.68	1.17	80.10	0.035
Child's bedroom carpet floor covering	Itchy rash	3.13	1.08	9.01	0.035
Child's bedroom carpet floor covering	Asthma	4.20	1.18	15.03	0.027
	Runny or stuffy	6.60	2.34	18.63	0.000
Child's bedroom tiles floor covering	Asthma	5.20	1.39	19.39	0.014

Table2. Odd ratios of smoking for respiratory symptoms and wheeze

Predictor	**Respiratory symptoms**	**Crude ORs**	**95% CI**		**P value**
			Lower	**Upper**	
Smoking	Upper respiratory	6.860	1.780	26.437	.005
	Wheeze	6.400	2.360	17.354	.000

Smoking in houses: Regarding respiratory symptoms and asthma, crude odds ratio shows smoking at home increases the risk of asthma by almost twice. Furthermore, the Regression Analysis showed that indoor smoking could contribute to runny or stuffy nose by almost three and half times.

Formaldehyde in houses: The concentrations of formaldehyde in domestic settings were measured during summer and winter. The study result showed that there were no statistically significant differences between concentrations of formaldehyde between families from low and high socio-economic status.

However, according to Logistic Regression Analysis, formaldehyde is a significant risk factor for upper respiratory symptoms (ORs= 1.019, 95% CI 1.000-1.039; P=0.050).

Particulate matter (PM_{10}) (μg/m^3) in houses: Logistic Regression Analysis showed that an indoor concentration of particles PM_{10} increased the risk of asthma by almost one and half times (Table 3).

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Particulate matter (PM_{10}) (µg/m^3) in houses: Logistic Regression Analysis showed that an indoor concentration of particles PM_{10} increased the risk of asthma by almost one and half times (Table 3).

Ultra-fine particulate matter ($PM_{2.5}$) (µg/m^3) in houses: After the adjustment for SES, smoking, mold or condensation at home, PM_{10} (µg/m^3) and any other possible confounders, a marginally significant difference was found between ultra-fine particles (winter) and runny or stuffy nose symptoms (Table 3). There is a strong relationship between watery eyes, snoring and smoking. The statistical analysis indicates that exposure to cigarette smoke at home can increase the risk of snoring in children (Table 3).

Table3. The crude odd ratios of children with respiratory symptoms and asthma with indoor air pollutants

Predictor	Respiratory symptoms	P value	ORs	95% CI Lower	95% CI Upper
SES (low)		0.071	8.919	0.83	9.24
Total PM_{10}	Asthma	0.033	1.218	1.02	1.464
Smoking at home		0.050	1.739	0.68	4.48
MP xylene	Runny stuffy nose	0.075	2.126	0.93	4.88
Ultra-fine particles(winter)		0.062	2.121	0.99	3.14
Smoking		0.014	3.272	1.27	8.44
	Watery eyes	0.025	2.550	1.127	5.80
	Snoring	0.093	2.162	0.887	5.32
o- xylene (winter)	Allergy	0.063	4.370	0.927	20.67

Volatile organic compounds (VOCs) in houses: As evident from Table 4, the multivariate analysis for the association between respiratory symptoms and domestic indoor air in the studied population after adjustment for multi confounders have revealed a marginal association between runny or stuffy nose and MP-xylene levels in winter. Table 3 also illustrates the contribution of oxyelene on child's allergy. Indoor concentrations of toluene (summer), which is another volatile organic compound, also appeared to be a significant factor for dry cough at night with ORs= 1.042 (95%CI=1.005 - 1.080; P= 0.025).

Respiratory symptoms and asthma in association with the school characteristics: In the multivariate analysis for association between respiratory symptoms and the school characteristics, adjustments were made for parents' socio-economic status and education, children's age and gender, family history of respiratory symptoms and asthma, smoking at home and other related risk factors at home. As can be seen in Table 5, school characteristics could be considered as having a major association with respiratory symptoms and asthma.

Table4. Odd ratios of the school characteristic for respiratory symptoms and asthma

Predictor	Respiratory symptoms	P value	Crude ORs	95% CI Lower	95% CI Upper
Adjacent to busy road	Runny nose	0.017	3.37	1.24	9.11
	Dry cough at night	0.004	4.89	1.66	14.38
	Allergy	0.065	3.00	0.94	9.62
	Snore	0.014	3.00	1.25	7.19
New carpet in classroom	Asthma	0.069	3.04	0.92	10.08
Wall painted	Watery eyes	0.59	2.14	0.97	4.72
Clean carpet	Hay fever	0.086	6.20	0.77	49.90
Tiles floor covering		0.064	2.40	0.95	6.06
Linoleum floor covering	Snore	0.053	2.19	0.99	4.82
Special cleaning materials		0.056	2.55	0.98	6.66
Ceilings / wall fan (summer)	Wheeze	0.014	2.81	1.23	6.42
Special cleaning materials		0.021	2.94	1.17	7.37

According to the statistical analysis, school characteristics including proximity to a busy road, new carpet or other floor covering in classrooms, wall painting, and carpet as well as cleaning could be major contributors to respiratory symptoms and asthma among children. In the following Table, the results of the association between school characteristics and respiratory symptoms were presented.

DISCUSSION

The relationship between, respiratory symptoms, socio-economic status and environmental assessment at school was deduced.

Formaldehyde in schools: Descriptive statistical analysis has demonstrated that children who attended schools in low SES areas were exposed to higher levels of formaldehyde in summer but to lower levels in winter, compared to those in schools from high SES areas. It has also been found that formaldehyde concentrations during wintertime could present a risk factor for wheeze with ORs=1.280 (95%CI=1.002-1.452; P=0.009).

Volatile organic compounds (VOCs) in schools: To investigate the effect of volatile organic compounds on human health, a number of exposure standards have been established. In Australia, the National Health and Medical Research Council (June 1993) revealed total VOCs concentrations of indoor air as 500 (μg/m^3). This concentration for single VOCs will not be considered more than 50% of the total levels [16]. The exposure guidelines for benzene, toluene and o-xylene were considered 5–20 μg/m^3, 5–150 μg/m^3 and 870 μg/m^3 (annual average) respectively [17]. The study found different ambient Mean concentrations for evaluating VOCs during winter and summer among schools from low and high socioeconomic areas. These concentrations are less than the established NHMRC and WHO recommended standards. The present study established significant associations between VOC levels and respiratory symptoms. Tables 5(a) and (b) show that some VOCs could be considered risk factors for respiratory symptoms. Logistic Regression Analysis showed that exposure to heptane during summer and winter times could be a significant risk factor for runny nose among children from low SES. Children from low SES are four times more likely to have runny nose in winter (ORs=3.731, 95% CI=0.959-14.513; P=0.058) compared to those from high SES.

Table5(a). Odd ratios for school indoor air, VOCs' and respiratory symptoms

Respiratory	Predictor	P value	Crude ORs	Lower 95 % CI	Upper 95 % CI
Asthma	Toluene (s)	0.040	5.59	1.08	29.06
Dry cough	Ethyl benzene(s)	0.093	2.72	0.85	8.74
at night	Heptane (s)	0.050	3.89	1.00	15.13
	Heptane (w)	0.067	2.27	0.94	5.48
Wheeze	Benzene (s)	0.024	1.11	1.01	1.22
	Heptene (w)	0.022	4.87	1.25	18.96
	Toluene (w)	0.099	3.09	0.81	11.79
	mp-xylene (w)	0.022	5.04	1.30	28.16
Wheeze	mp-xylene (s)	0.074	3.90	0.88	17.34
	o-xylene (w)	0,066	4.36	0.91	21.02
	Cumene (s)	0.056	4.05	0.96	17.06

Table5(b). Odd ratios for school indoor air VOCs' and respiratory symptoms

Respiratory symptoms	Predictor	P value	Crude ORs	95 % CI	
				Lower	Upper
	Heptane (w)	0.069	4.13	0.90	18.99
Runny or stuffy nose	Toluene (s)	0.021	4.99	1.28	19.55
	m- xylene (w)	0.028	3.29	1.14	9.58
	mp_xylene (w)	0.085	3.46	0.84	14.24
Watery eyes	Heptene (w)	0.011	4.99	1.44	17.32
	m- xylene (w)	0.018	2.98	1.20	7.39
Allergy	Toluene (s)	0.035	4.51	1.11	18.31
	Heptane (s)	0.040	3.86	1.06	14.06
	Heptene (w)	0.034	3.17	1.09	9.22
	Cumene (s)	0.020	5.32	1.30	21.83
Hay fever	Toluene (w)	0.095	1.70	0.91	3.18
	Toluene (s)	0.033	2.50	1.08	5.79
Itchy rash	mp-xylene (s)	0.013	4.50	1.37	14.69
	m- xylene (s)	0.042	3.06	1.04	8.99

Particulate matter in schools: The Multivariate Regression Analysis showed that exposure to higher levels of particles (PM_{10}) in classrooms is significantly associated with respiratory symptoms and asthma. It has become evident that PM_{10} concentrations (μg/m^3) in classrooms could increase the risk of asthma by almost one and a half times (ORs=1.320, CI=1.042 and 2.052 P=0.049). It has also been found that PM_{10} (μg/m^3) concentrations could present a risk for itchy rash (ORs=1.280, 95%; CI=1.002 and 1.452 P=0.009). The study found significant differences between medians of ultrafine particles at schools from low and high SES groups.

Children from schools in high SES were exposed to a higher number of ultrafine particles in both winter and summer. However, Multivariate Regression Analysis could not demonstrate statistically significant differences between socio-economic status, ultrafine particles and respiratory symptoms. The statistical analysis showed that ultrafine particulates could increase the risk of upper respiratory disorders by almost one and half times (ORs=1.250, 95% CI=1.302 and 1.952 P=0.043). Furthermore, Multivariate Regression Analysis indicated that ultrafine particles might be considered as a major indoor air pollutant which increases the risk of asthma among school children by almost one and a half times (ORs=1.280, CI=1.002 and 1.452; P=0.009).

Our result did not demonstrate significant difference in the relative humidity and temperature between schools and houses located in low and high SES areas. However, there was a significant difference in temperature and relative humidity between winter and summer times (t=6.8; df=172; P=0.001) (t=11.64; df=1792; P=0.013).

CONCLUSION

According to the study results, low socio-economic status has not been found to be a protective factor for asthma and respiratory symptoms among schoolchildren. The study results have also shown that schoolchildren from low socio-economic groups were generally exposed to higher levels of air pollutants in houses and schools. There are several explanations for the higher prevalence of respiratory symptoms and asthma among school children from the backgrounds of low socio-economic status:

1. SES itself was found to be a significant contributing factor for higher prevalence of respiratory symptoms.
2. Low socio-economic status is probably associated with an unhealthy lifestyle from the social, behavioral, nutritional and financial points of view.
3. Asthma prevalence within different socio-economic status groups was consistently lower in neighborhoods of greater socio-economic status.
4. We found that respiratory symptoms and asthma prevalence were associated with measures of socio-economic status. Participants studying at schools with low SES were more likely to have asthma and respiratory symptoms than schools with high SES.
5. The family and social environment are also important in the recognition, management, and prevention of asthma symptoms.
6. This study indicates an association between low socio-economic level, respiratory symptoms and asthma in school children for both individual and area-based indicators.

For several reasons, indoor air quality in schools must be considered as a significant factor for children's health as school children spend at least 1,100 hours per year at school. Furthermore, these children's respiratory and immune systems are still developing and therefore the environment of these children (where they live and study) is of significant importance.

To protect respiratory health of school children from different socio-economic status, different practical procedures could be implemented.

One of the first steps should be recognizing the health issues related to indoor pollutants, so the best evaluation and control intervention programs were considered and implemented.

Following the results of the current study, the following recommendations were proposed.

- To advocate for reduced indoor air pollutants in classrooms by establishing guideline values.
- To provide effective school building maintenance.
- To evaluate indoor air quality at schools periodically.
- To maintain effective ventilation systems.
- To avoid accumulating and using unnecessary stuff in classes and teaching area.
- To limit staff's use of perfume and fragrance during classes.
- Chemical cleaning materials should be used with caution.
- To over viewing both frequency of cleaning and materials.
- To develop effective indoor air quality control intervention program at schools.
- To monitor the hazardous exposure and health outcomes.
- To implement medical surveillance and provide information on the health effects and also the priorities for preventive and control actions
- To do effective school environmental inspections or walk-through surveys.
- To use natural ventilation properly during summer and winter.
- To maintain the air conditioning system

inspection and repairing them on regular basis.
- To replace carpets and tile floor coverings with locally available materials.

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