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Children's environmental tobacco smoke exposure and its association with parental socio-economic status in Lahore Pakistan

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Abstract

Environmental Tobacco Smoke (ETS) is a widespread pollutant despite the growing awareness of its adverse effects on human health. The present study examined the factors associated with children's (aged 8–13 years) Tobacco Smoke (TS) exposure living under different socio-economic conditions in Lahore, Pakistan through a semi-structured questionnaire. Urine and saliva samples were collected from exposed and non-exposed children, and cotinine, the major metabolite of nicotine was analyzed by High Performance Liquid Chromatography (HPLC). The HPLC flow rate was 1mg/ml and the retention time of cotinine was found to be 3.4 min. A total of 300 children were interviewed; out of which, 81.3% were living with an active smoker. In children exposed to TS, redness of eyes 55.7%, cough 68%, running nose 62.3%, wheezing 24.7% and chest tightness 16% were found as the symptoms of Respiratory tract infections (RTI). Cotinine was found in urine samples range 158 to191 ng/ml as compared to saliva with a range of 142 to 191 ng/ml. No significant difference was found in the cotinine levels among children of different SECs. Results of the study showed that children's exposure to ETS remains a major public health concern, requiring immediate steps to control this menace.

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Introduction

Environmental tobacco smoke is now considered the third major health peril in the world since almost half of the world's children are exposed to it (WHO, 2010; Simsek *et al.*, 2016). Breathing smoke of other people's cigarettes (Klepeis, 2017) or the tobacco smoke produced by active smokers but inhaled by non-smokers (Quinto *et al.,* 2013) is called passive, involuntary, or secondhand smoking (SHS). Passive smoking is most popularly referred to as environmental tobacco smoke (ETS) which is defined as a combination of side-stream smoke (SSS) produced from the burning end of a cigarette and mainstream smoke (MSS) exhaled by the smoker. It is made up of millions of different size particles comprising of nicotine, hydrocarbons, phenols, heavy metals, glycerol and many other particles (Nanninga, 2018). Tobacco smoking in indoor environments amplifies levels of respirable particles like nicotine, carbon monoxide, acrolein, polycyclic aromatic hydrocarbons, nitrogen dioxide and many other substances (Chastang *et al.*, 2015). The EPA's report, "Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders," calls ETS a serious and substantial health risk for nonsmokers, particularly children (U.S. EPA, 1992).

Nicotine and cotinine can be measured in saliva, urine, blood and hairs (Avila-Tang *et al.*, 2013; Vanker *et al.,* 2018). In the biological fluids, the concentration of biomarkers reflects recent exposure, while in hair; it reflects long-term exposure (Avila-Tang *et al.*, 2013). Various methods have been used for the detection and measurement of cotinine and nicotine such as Calorimeter, Capillary electrophoresis (CE), etc. (Oberg *et al.*, 2011; Mahabee-Gittens *et al.*, 2018; Sternberg *et al.*, 2010; Bogdanovica *et al.*, 2014) and Chromatography of several types (Hutchinson *et al.*, 2018). Passive smoking at home is a major source of Tobacco Smoke Exposure to children as they spend most of their time at home and indoors (Hukkanen *et al.*, 2005; Perez-Ríos *et al.*, 2014). Children's exposure to TS begins during pregnancy and breast-feeding in babyhood when they share their mother's active or passive smoking (Caldwell *et al.,* 2018). They are considered more sensitive as their lungs are not yet developed to combat the hazards of Tobacco Smoke. In addition to this, Children have relatively higher ventilation rates which lead to higher internal exposure than adults (Annesi-Maesano *et al.*, 2013). In most of the developing countries, due to poor legislation, exposure of children to smoking takes place in public places as well as in their homes (WHO, 2015).

The World Health Organization estimates that nearly 700 million children are exposed to tobacco smoke by 1.2 billion adult smokers and about 22 million smokers in Pakistan (WHO, 2015). Pakistan Health Education Survey (1999) reported a higher incidence among the illiterate (41.2%); due to lack of considerate research work, it was difficult to compare results within the community. The objectives of the present study were to assess environmental tobacco smoke (ETS) exposure in children by quantifying the concentration of cotinine from urine and saliva of children and to determine the association of ETS with socio-economic status in the representative population of Lahore city.

Methods and materials

Study design and population

To achieve the aim of the study, a descriptive, community-based, cross-sectional study of self-reported parental smoking patterns and children's salivary and urinary cotinine concentrations was conducted from Lahore city. The study population comprised of parents and children of 8 to 13 years old from three socio-economic classes. This classification was carried out considering the average income per month per household in PKR. i.e., Upper class more than 100,000/month, Middle 50, 000/month to 100,000 and Lower classless and equal to 50, 000/month. The target population was selected randomly from the three areas of City District Lahore: Abu-baker Siddiq Colony, Bund Road UC-84 belonging to low SEC; Samanabad, UC-106 belonging to middle SEC and Model Town UC-127 (Fig 1). By simple random sampling technique, a total of 300 children and their parents (100 from each class) were

face-to-face interviewed.

Data collection using a questionnaire

A semi-structured questionnaire was developed to collect information about the smoking habits of parents/close relatives and environmental smoking exposure of children. The questionnaire was partially filled by parents and responses of children were recorded on the questionnaire by the survey team members. Two experts from the field of Science and Public Health examined the appropriateness of questions especially those related to the health of children. A pilot study was conducted with 15 parents and their children.

Children were also asked to provide information on their exposure to tobacco smoke in the previous seven days. The questionnaire was comprised of close-ended questions. The questionnaire was broadly focused on personal information of children, socio-demographic data of parents and environmental tobacco smoking inquiry questions. The data gathered firstly inquire the presence of a smoker at home. The information about a child is gathered as shown in Table 1. It was asked from the parents to respond about the room's ventilation and the type of family system a child is having.

The data for the crowding index was taken as the total number of people living in the house and the total number of rooms present. Similarly, it was asked from the respondents (parents) about the symptoms of exposure of their children in form of redness of the eyes, running of the nose, coughing, and chest tightness and wheezing. Children were inquired of their tobacco smoke exposure other than their homes during the last seven days. This was asked by getting to know where they have been in last week for play, school, or any other.

Analysis of biomarker

Parents were also requested to facilitate the sampling of urine and saliva of their children for estimation of cotinine. Cotinine in urine and saliva samples were estimated using High Performance Liquid Chromatography (HPLC). The system (Perkin Elemer 200 serrie, USA) consisted of C-18 Column (Sphere SIL, 0.5 µm, 250 × 4.6mm) and equipped with a peristaltic pump with an automatic sample injector and a UV/VIS detector. The 600 Series Link chromatography interface was connected to it while the volume of standard and sample injected was 20 µl. The chromatographic flow rate for the mobile phase was set at 1.0 ml/min. Cotinine was detected by absorbance at 260 nm and identified by a retention time of 3.4 min. The cotinine was estimated using TotalChrom workstation taking 2-Phenylimidazole as an internal standard.

Statistical analysis

Descriptive analysis and cross-tabulation were performed using SPSS version 21. Data was edited in sheets of software and a required statistical test was run.

Result and discussion

Out of the 300 participants of the study where parents or near relatives smoked at their home, 45.3% were male children and 54.7% were female children. Among the children exposed, 27% were of 9 years aged with 63% were in classes three and four (Table 1).

From these children, 76.5% of male and 97% of female children informed of their exposure to parental smoking at home (Table 2). The major source of children's exposure to ETS in different socio-economic classes was their own home but many other sources were reported to be the sources (Fig. 1). Children from the lower-income group were exposed more to schools/playgrounds, the middle-income group from the friend's houses however children from the upper-income group were exposed to TS from clubs and sports arenas.

Based on the socio-economic status of children living in different conditions, the most vulnerable group exposed to ETS was one living in a joint family system which resulted in high crowding index with poorly ventilated houses.

Table 1. Characteristics of Study Population.

Variables	Description	Frequency (%)
Gender of participated children	Males	136 (45.3)
	Females	164 (54.7)
Age (years)	8	50 (16.7)
	9	81 (27)
	10	65 (21.7)
	11	35 (11.7)
	12	23 (7.7)
	13	46 (15.3)
Level of Education (Class)	1-2	22 (7.3)
	3-4	189 (63)
	5-6	74 (24.7)
	7-8	15 (5)

Table 2. Children exposed to parental smoking with respect to gender.

% of parental smoking within gender of the children		gender of the children	
		males	females
Smoking is allowed in home of respondent	yes	76.5%	97.0%
	no	23.5%	3.0%

These three susceptible circumstances were most common in children of the low-income group (Table 3). It was further asked how many children were living with an active smoker in their homes, 81.3% of respondents have replied as "yes" which showed a greater risk of developing lung-related diseases in the early age of children livelihood. Most of the active smokers were in the upper-income group and lower-income group. In the study, a total of 99 children were randomly selected for the estimation of possible cotinine from the samples of urine and saliva. Out of this, 33 samples were taken from each SEC. 15 samples of each urine and saliva where 3 in each class were taken as control. Cotinine was detected at an absorbance of 260 nm. The retention time of cotinine was found as 3.4 min with a flow rate of 1 ml/min.

The peak for the standard solution of the cotinine was achieved at 3.4 min with the 200 ng/ml concentration of cotinine.

Table 3. Children higher susceptibility to ETS in context of their SES.

Variables	Description	Socio-economic Status		
		Lower income Class N (%)	Middle income Class N (%)	Upper income Class N (%)
Ventilation of Home	Well Ventilated	17 (5.7)	51 (17.0)	99 (33.0)
	Poorly Ventilated	83 (27.7)	49 (16.3)	1 (0.3)
Family System	Nuclear	27 (9.0)	56 (18.7)	46 (15.3)
	Joint	73 (24.3)	44 (14.7)	54 (18.0)
Crowding Index of House	Low	13 (4.3)	20 (6.7)	59 (19.7)
	Medium	4 (1.3)	38 (12.7)	25 (8.3)
	High	83 (27.7)	42 (14.0)	16 (5.3)
Living in with active smoker	Yes	78 (26.0)	68 (22.7)	98 (32.7)
	No	22 (7.3)	32 (10.7)	2 (.7)

The results showed that the respondents were strongly exposed to TS with a higher value of cotinine present as shown in the results of Caldwell *et al.*, 2018. Whereas in the exposed group, urinary cotinine results were more significant than salivary cotinine. All control samples from three SECs showed no concentration of cotinine in their urine and saliva samples. Out of the total of 90 experimental samples,

most of the urine samples had detectable cotinine concentration. Table 4 and Fig. 2 show similarly salivary cotinine was also detected in samples.

Environmental tobacco smoke poses a serious health risk in children. Over one thousand million people worldwide smoke tobacco. Although the percentage of smokers has decreased in developed countries, it is increasing in developing countries. The results of this investigation have shown strong associations between ETS exposure and different health conditions due to socio-economic status. The present study indicated that a relatively higher percentage of female children of lower and upper-income classes were exposed to Tobacco smoking as they have more tendencies to stay at home leading to their increased chances of exposure to TS. Regarding the number of smokers in the house, it was found that there was at least one regular smoker in approximately two-thirds of the surveyed houses.

Table 4. HPLC Estimation of Cotinine from Urine and Saliva of Children.

Analytes	Frequency and Range of Cotinine detected w.r.t Socio-economic Status of Children (ng/ml)		
	Lower income Class	Middle income Class	Upper income Class
Control (Not Exposed)	*Nil*	*Nil*	*Nil*
Urine (Exposed)	12/15 (158 to189)	9/15(160 to189)	13/15 (166 to 180)
Saliva (Exposed)	10/15 (166 to 197)	7/15 (165 to 182)	11/15 (155 to 179)
Total Frequency (%)	22/30 (73.3%)	16/30 (53.3%)	24/30 (80%)

Findings of this study augment the study conducted by Herman, *et al.*, 2015 which also stated that continuous passive smoking affects the health of a household negatively, especially that of children and pregnant women. The study has also pointed out that exposure of TS to children is more prevalent at sites more easily accessible to children belonging to upper-income classes like game clubs, sports zones, etc.

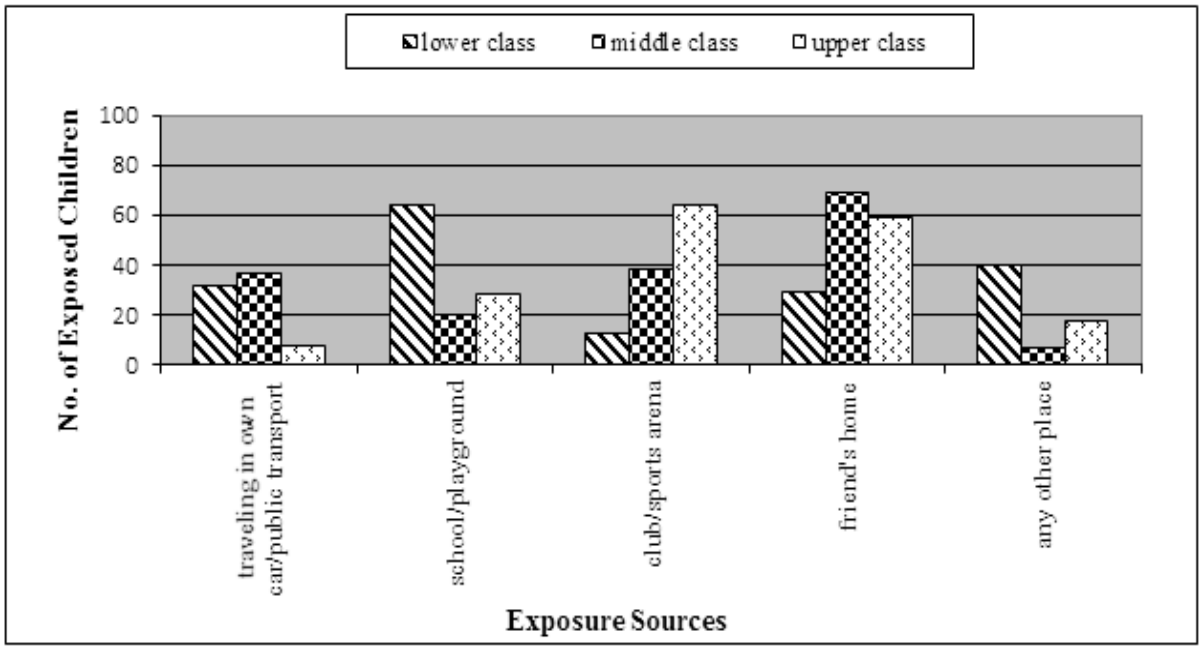

Fig. 1. Children exposure from various sources other than Home of three Socio-Economic Classes.

The present study also witnessed maternal smoking in the upper-income class. A higher level of education and economic independence was speculated to be the contributing factor of women smoking at home in this case. Although monthly income was low in lower socio-economic class due to increase rate of unemployment leading to the number of depressive conditions which could increase the desire for

cigarette smoking, while the reverse is expected in upper-income class but the data of this study suggested that more than 60% respondents informed smoking in their homes in all three SECs, irrespective of their monthly income. Similarly, most of the houses in the upper-income class are very well ventilated resulting in the minimized risk of TS polluted air, where the reverse was the scenario in the lower-income class but this study showed no significant association between living spaces and exposure to TS in both extremes of SECs. This finding of the study corresponds with the studies conducted by Tütüncü *et al.*, 2012 and Chatzimiceal *et al.,* 2008. From this study, it was clear that most of the lower-income class respondents were living in the joint family system, another risk associated with TS exposure for the children, as more people present more will be the chances of smoking and passive smoking. However, TS exposure was much less in the middle and high-income class, where the family system was mainly nuclear type. A shift from indoor to outdoor TS exposure was also observed in the present study as 25.7% of respondents were exposed to TS while traveling in a car in addition to parental smoking at home. 37.3% were exposed to TS in schools and playgrounds, 38.3% at game clubs while 52.3% were exposed during a stay at their friend's home.

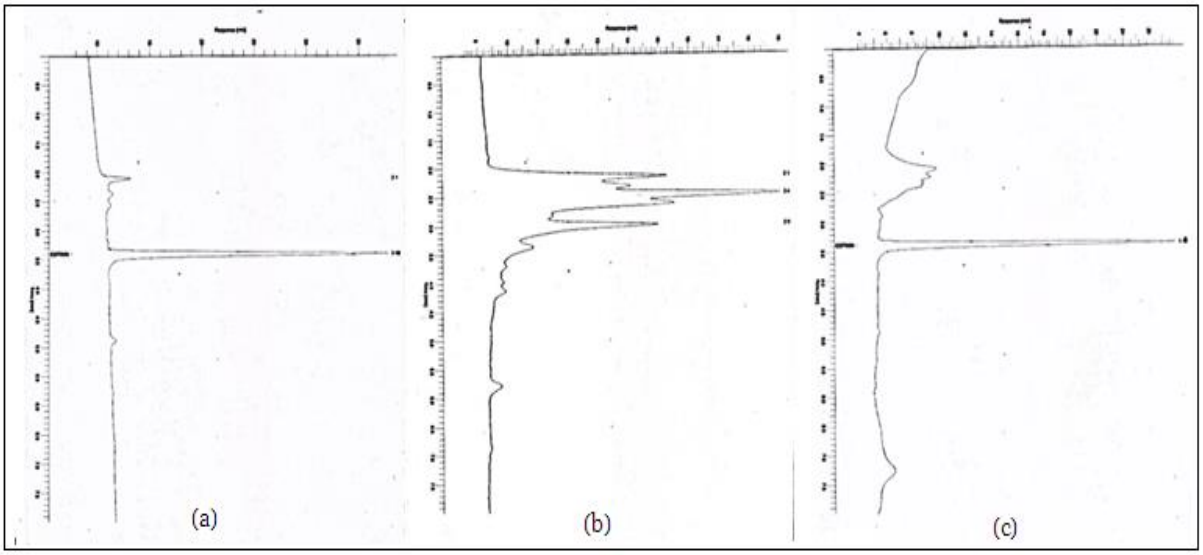

Fig. 2. Peaks of HPLC samples showing each of control (a), urine (b) and saliva (c)**.**

In conformity with the survey questionnaire, cotinine detection in urine and saliva samples showed that the cotinine level was significantly higher in the exposed group than the non-exposed group. In this study, a fairly good association was found between two different biological matrices. Results of this study were parallel to many studies of passive smoking and detection of cotinine in urine and saliva samples (Peterson and Hecht, 2017; Seyidov *et al.*, 2011). It was quite evident from the study that children who had more exposure to TS or passive smoking at their homes and other sources had higher levels of cotinine in their urine samples than saliva samples. Hence, they can suffer more adverse effects on their health of children in all socio-economic groups. The output of this study supports the urgent need for executing comprehensive tobacco control policies to inhibit children's tobacco exposure for example awareness campaigns on SHS health hazards, promoting tobacco-free environments, and parental smoking termination.

Conclusion

The present work found an association between tobacco smoke exposure due to their health disparities based on different socio-economic status. Children's exposure to tobacco smoke was reported from their schools, playgrounds, video clubs and other public places. The general public could be the source of passive smoking for a child. The study has

also reported exposure' symptoms among children of all ages. Awareness of parents is important as it can help them understand the threat of ETS to their child's health also it should be irrespective of parents' educational background; as high and low-income groups had higher values of salivary and urinary cotinine than the middle-income group. The antismoking policy can be imperative in reducing exposure to other smoke from at least public places. Efforts should be made to convince parents and the general public not to smoke close to children by informing them of the threats of passive smoking. Future studies in this regard should measure ETS exposure from bidi and huqqa especially water pipe (Sheesha smoking) as these are getting more common among youth in developing countries like Pakistan.

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