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SEASONAL CHANGES IN RESPIRATORY HEALTH STATUS OF ROAD-SIDE VENDORS IN INDUSTRIAL CITY GAJRAULA

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ABSTRACT

Traffic and industrial emission generate air pollutants which have been associated with respiratory health symptoms of human beings. Although there is positive association between air pollution and respiratory health, but the degree of association among different seasons varies due to the composition of different air pollutants. Present studies have been carried out to monitor and record the particulate and gaseous air pollutants ($PM_{2.5}$, PM_{10}, NO_2 and SO_2) in ambient air at Indra *Chowk*, Gajraula (U.P.) during winter and rainy seasons. The level of $PM_{2.5}$, NO_2 and SO_2 had been found significantly higher during winter as compared to the rainy season. Due to higher level of air pollutants in ambient air, the incidence of respiratory diseases increased in winter seasons. The symptoms of cough, phlegm, headache and eye irritation had been found significantly higher in the road-side venders during winter months as compared to other seasons of the year. However, their blood oxygen saturation had been recorded significantly higher during the rainy months.

KEY WORDS: Air pollutants, Ambient air pollution, Road-side vendors, Respiratory health.

INTRODUCTION

Clean air is absolute necessity for the survival of life. A person requires significantly more quantity of air in comparison to the water and food (Naddafi *et al.*, 2006; Saini and Kumar, 2021). A bad air adversely linked with the pulmonary and cardiac health (Pope *et al.*, 2002). The respiratory health status of a person is directly associated with the chemical composition of the particulate and gaseous pollutants present in the air coupled with the duration of exposure. Road side workers and traffic police man who work along busy roads are more sufferers to the respiratory health issues (Prakash *et al.*, 2013, Sharma *et al.*, 2017).

Road traffic is responsible for the deterioration of ambient air quality worldwide. 91% of the world population is breathing in bad air. Air pollution is responsible for 4.2 million premature demises in the world with a major fraction in South-East Asian and Western Pacific countries (WHO, 2018). Industrialization, urbanization and transportation are the major contributors to the elevated air pollution level in industrial cities (Duraisamy *et al.*, 2017; Saini *et al.*, 2019). Traffic exhausts and industrial emission generate particulate and gaseous air pollutants (Cheng *et al.*, 2011; Singh *et al.*, 2013). These air pollutants have been associated with respiratory symptoms such as respiratory airways allergy and infections, obstructive pulmonary diseases, shortness of breath and others health symptoms as watery eyes, eye allergy, headache, fatigue etc. (Kongtip *et al.*, 2006; Amaran *et al.*, 2016; Noomnual and Shendell, 2017; Saini and Kumar, 2021). Studies have reported that road-side vendors and traffic persons are more susceptible to particulate and gaseous air pollutants (Sharma *et al.*, 2017; State of Global Air Report, 2020). Albeit the association between air pollutants and respiratory disease is normally positive, the extent of association among different seasons fluctuates (Samet *et al.*, 2000). The changes in respiratory health have been allocated partly to the composition of the air pollutants available in different seasons (Vega

et al., 2002).

Gajraula is located in Amroha district of Uttar Pradesh, it got the industrial city status in 1981-82 (Down to Earth, 1999). Currently it is facing the problems of industrial and vehicular air pollution. The citizens who earn their bread and butter near the busy roads include road-side vendors, traffic police persons, auto rickshaw drivers and shopkeepers. They work along busy traffic roads and have constant exposure to air pollutants. The objective of present study had been to focus on the changes that occur in the respiratory health of road-side vendors during winter (January-February) and rainy (July-August) seasons of the year 2019.

MATERIALS AND METHODS

Location of the Study

Gajraula is an industrial city in the western Uttar Pradesh (Fig. 1) and is located on national highway-9, at latitude 28°83' N, longitude 78°24' E and elevation of 257 m above sea level. According to 2011 census it has a population of 55048. There are located many industries in the heart of the city *viz.* Jubliant Life Sciences, Insilco Limited, RACL Geartech, Navabharath Fertilizers Limited, and Israeli Pharma Teva API etc. Present studies had been carried out at *Indra Chowk* research site during the months of January-February and July-August in the year 2019. Indra Chowk is a residential area with excessive commercial activities. It receives industrial emissions from Insilco Limited, Jubilant Life Sciences Limited, TEVA API Limited and many more. During rush hours, the motor vehicle movement is very slow due to which traffic congestion is common feature of the city. Encroachment on either side of the road, more vehicle number and railway crossing increase the level of pollution at the site. This is the reasons; this area has been chosen for the study.

Sampling for Respiratory Health

For the purpose of sampling, a total of 40 willing road-side vendors (20 during winter and 20 during rainy months) had been selected to participate in the study. Demographic and respiratory health status of these vendors had been assessed through a modified respiratory questionnaire proposed by Kumar, who used this questionnaire for a famous work entitled, "Epidemiological study on the effects of air pollution on human health (adults) in Delhi" (Kumar, 2012). The inclusion criteria selected for the study had been: (1) The age of the participant below 55 years, (2) not suffering from asthma and tuberculosis, and (3) pleased for voluntary participation in the study. The stakeholders had been provided the details about the proposed study and asked to answer the questionnaire judiciously. The body weight, height and blood oxygen saturation (SpO_2) of the subjects had been measured with the help of portable electronic weighing scale, constant tension measuring tape and pulse oximeter (Dr. Morpen, Model No. PO-09), respectively.

Air monitoring

The level of particulate and gaseous pollutants had been measured to find out the status of the pollution during winter and rainy seasons. The values of $PM_{2.5}$, PM_{10}, NO_2, and SO_2 had been measured by Respirable Dust Sampler APM-460 NL (Envirotech, New Delhi), Fine Particulate Sampler (Envirotech, New Delhi, Model: APM-550) by West-Geake method (1956) and modified Jacob & Hochheischer Methods (1958), respectively.

Statistical analysis

For statistical analysis, Microsoft Office Excel 2007 Analysis Tool Pak and Social Science Statistics (socscistatistics) had been used. To find out the difference between categorical variables from two different seasons, Pearson's chi-square test had been applied. The Fisher exact test had been used instead of Pearson's chi-square test when the sample size was zero. A t-test was used for comparing numerical variable means from two different seasons. A *p-value* <0.05 has been taken as statistically significant for all the recorded observations.

RESULTS

Monthly averages of particulate ($PM_{2.5}$, PM_{10}) and gaseous (NO_2 and SO_2) pollutants level

The averages for pollutants ($PM_{2.5}$, PM_{10}, NO_2 and SO_2) level during winter (January and February) and rainy (July-August) seasons have been presented in Table 1. The level of $PM_{2.5}$ (t-value = –7.7, p=0.016), NO_2 (t-value = –10, p=0.009) and SO_2 (t-value = –6.1, p=0.025) pollutants had been found significantly higher during the winters as compared to the rainy season. Meanwhile, the monthly average of PM_{10} level had not been statistically different for winter and rainy seasons. The averages for particulate

Table 1. Descriptive data of the major ambient air pollutants for the months of winter and rainy seasons at *Indra Chowk*.

Particulate and gaseous pollutants	Winter season	Rainy season	*t*-value	*p*-value	NAAQS
$PM_{2.5}$ (µg/m^3)	117.5	93	-7.7	**0.016***	40
PM_{10} (µg/m^3)	273	207.5	-2.6	0.11	60
NO_2 (µg/m^3)	50	27	-10	**0.009***	40
SO_2 (µg/m^3)	34.5	18	-6.1	**0.025***	50

Winter season: Averages for the data collected during the months of January and February 2019
Rainy season: Averages for the data collected during the months of July and August 2019
NAAQS: National Ambient Air Quality Standards
* Significant at $p < 0.05$

matters ($PM_{2.5}$, PM_{10}) have been found more than the National Ambient Air Quality Standards (NAAQS) during both the seasons. However, the average of SO_2 level had been recorded less than the NAAQS. The amount of NO_2 had been recorded higher than NAAQS during the winter season.

Demographic profile of road-side vendors

The investigations had been carried out on a total 40 participants during winter and rainy seasons at *Indra Chowk* site in Gajraula city. Table-2 represents the distribution of sex, marital status, age, height, weight, education level, work-shift duration and daily income of the participants. The results indicate that there is a higher percentage of male participants as compared to the females during both the seasons. The percentage of married participants is more than the unmarried, during both the seasons. Participant's education level is most frequently primary level. Work-shift duration and daily income of the participants during both the seasons were significantly different. The distribution of sex, marital status, age, height, weight, and education level duration were almost similar during both the seasons. The working duration (*t*-value = –11.1, $p<0.001$) and daily income amount (*t*-value = –8.4, $p<0.001$) was significantly more during winter season.

Distribution of respiratory health symptoms

The occurrence of different respiratory health symptoms during both the seasons has been summarized in Table-3. The incidence of respiratory symptoms had been more common in winter season which may be due to the increased level of air pollutants (Table 1 and 3). The respiratory health

Table 2. Demographic characteristics of participating road-side vendors during winter and rainy seasons.

Variables	Winter season (n = 20)	Rainy season (n=20)	χ^2-value/ *t*- value	*p*-value
Sex				
Male	14 (70%)	18 (90%)	2.5	0.11
Female	6 (30%)	2 (10%)		
Marital status				
Single	7 (35%)	8 (35%)	0.1	0.74
Married	13 (65%)	12 (65%)		
Age (Year)	32.3 (±10.65)	30.7 (±7.79)	- 0.54	0.59
Height (cm)	164.7 (±8.82)	163.15 (±8.14)	- 0.57	0.56
Weight (kg)	56 (±5.24)	59 (±9.19)	0.99	0.32
Education				
Primary	15 (75%)	11 (55%)	1.94	0.58
High School	3 (15%)	6 (30%)		
Intermediate	1 (5%)	2 (10%)		
Graduate or Above	1 (5%)	1 (5%)		
Work-shift duration (hours/ day)	8.4 (±0.82)	5.2 (±0.96)	-11.1	**<0.001***
Daily income	266.25 (±44.62)	165 (±30.17)	-8.4	**<0.001***

Pearson's χ^2 statistics for categorical variables and *t*-test for numerical variables;
± Standard deviation; * Significant at $p < 0.05$; n: number of study subjects.

Table 3. Self-reported respiratory symptoms among road-side vendors during winter and rainy seasons.

Variables	Winter season (n = 20)	Rainy season (n=20)	χ^2	*p*-value
Smoking				
Yes	3 (15%)	2 (10%)	0	1
No	17 (85%)	18 (90%)		
Nasal congestion				
Yes	9 (45%)	1 (5%)	6.5	**0.01***
No	11 (55%)	19 (95%)		
Sore throat				
Yes	5 (25%)	2 (10%)	0.69	0.4
No	15 (75%)	18 (90%)		
Cold				
Yes	5 (25%)	3 (15%)	0.15	0.69
No	15 (75%)	17 (85%)		
Cough				
Yes	14 (70%)	3 (15%)	10.23	**0.001***
No	6 (30%)	17 (85%)		
Phlegm				
Yes	12 (60%)	4 (20%)	5.1	**0.023***
No	8 (40%)	16 (80%)		
Chest tightness				
Yes	4 (20%)	0 (0%)	-	0.1#
No	16 (80%)	20 (100%)		
Headache				
Yes	14 (70%)	0 (0%)	-	**<0.001#***
No	6 (30%)	20 (100%)		
Eye irritation				
Yes	17 (85%)	0 (0%)	-	**<0.001#***
No	3 (15%)	20 (100%)		
Fatigue				
Yes	4 (20%)	1 (5%)	0.91	0.34
No	16 (80%)	19 (95%)		
Blood O_2 saturation	98.1 (±0.78)	98.8 (±0.41)	3.5	**0.001***

* Significant at $p < 0.05$; # Fisher exact statistics

symptoms of cough (χ^2=10.23, p=0.001), phlegm (χ^2=5.1, p<0.023), headache (p<0.001) and eye irritation (p<0.001) had been significantly higher in the participants during winter season as compared to the rainy season. The blood oxygen saturation (χ^2=3.5, p=0.001) in participators had been significantly higher during the rainy season.

DISCUSSION

Air pollution is a major respiratory health concern. Several studies have been carried out to study the effects of air pollutants on respiratory health of human beings (Ingle *et al.,* 2005; Kongtip *et al.,* 2006; Kumar, 2012; Amaran *et al.,* 2016; Noomnual and Shendell, 2017; Saini and Kumar, 2021). Our study indicates the changes in the incidence of respiratory health symptoms during winter season. Winter season exhibited significantly elevated level of particulate and gaseous air pollutants when it was compared with rainy season pollutants level at *Indra Chowk* study site. The concentration of these pollutants exceeded NAAQS for particulate pollutants (Table 1). Almost equal percentage of smokers had been recorded during both the seasons, smoking can therefore be excluded as a confounding variable. Remarkable increase in nasal congestion (p=0.01), cough (p=0.001), phlegm (p=0.023), headache (p<0.001), eye irritation (p<0.001) and reduced oxygen blood saturation (p=0.001) had been recorded in road side vendors during winter season. During rainy season, there had been found a decline in air the pollution level due to suppression of particulate and gaseous pollutants by the phenomenon of wet deposition. As a consequence the quality of air becomes improved. During summers, rising hot air helps in diffusing the air pollutants from the earth surface but in winter season cold air cannot rase the pollutants and confined the air pollutants near the surface of the earth (Shukla *et al*., 2008; Cichowicz *et al*., 2017).

Inhaled air and its related pollutants encountered first in the nose and then are absorbed by nasal mucosa. This results into inflammation and nasal congestion (Trevino, 1996). Studies have also suggested that the particulate pollutants associated with increase the onset of cough episodes (Qian *et al*., 2004; Pierse *et al*., 2006) which occur more during winter season. Studies on animal showed that pollutants alter the nervous command of air passages and cough. The second hand smoke or air pollutants exposure enhance the episode of stimulated coughs and amplified the extent of stimulated bronco-constriction (Joad *et al*., 2007). A study from Canada suggested that weather conditions and particulate air pollutants may turn out neurogenic inflammation and activate repeated headaches onset (Szyszkowicz *et al*., 2009). The eye surface is in continuous contact with particulate and gaseous air pollutants which results into dry eye symptoms and signs. The dry eye symptoms and signs can be defined by the presence of dryness, foreign body sensation, burning, eye fatigue and discomfort (Mandell *et al*., 2020). Present studies have also reported more episodes of eye irritation during winter season when the pollutants level was more. Indian study carried out on 500 health care

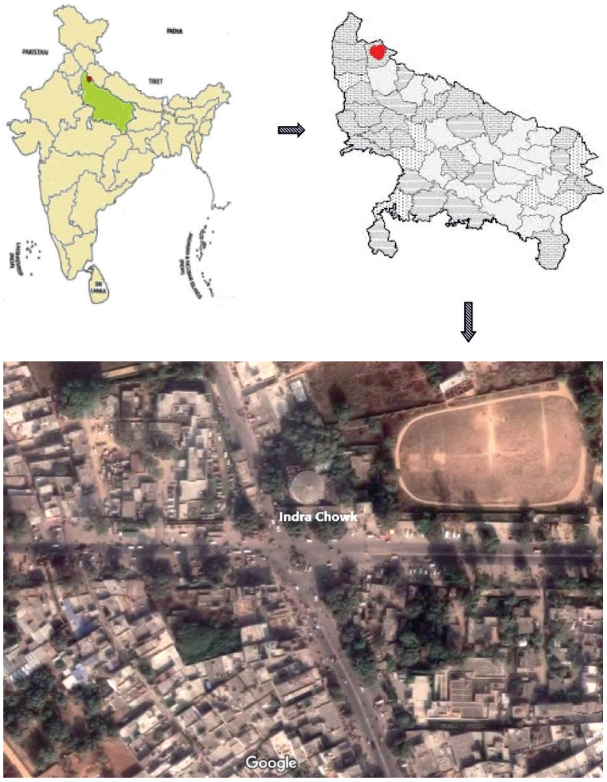

Fig. 1. Satellite images of research site, Indra Chowk

workers also reported the same results (Saxena *et al*., 2003). These studies have also recorded a significant decline in blood oxygen saturation level during winter season. During winters, low temperature results into narrowing of blood vessels which slow the blood flow and reduce oxygen saturation (Vascular Health Clinics, 2017).

CONCLUSION

Road-side vendors are more at risk for respiratory health problems during winter season due to elevated level of air pollutants near the earth surface.

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