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RESPIRATORY HEALTH EFFECTS OF AMBIENT AIR POLLUTANTS ON ROAD-SIDE VENDORS IN INDUSTRIAL CITY GAJRAULA, UTTAR PRADESH, INDIA

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ABSTRACT

Road-side vendors work every day along the roadsides and rarely have any break. They are at the highest risk of the exposure to vehicular and industrial emissions. Road dust and unfavourable weather conditions harm them due to their long working-shifts. Because of long working duration at road-sides they are under high respiratory health risks. In present cross-sectional comparative study, major ambient air pollutants ($PM_{2.5}$, PM_{10}, NO_2 and SO_2) had been monitored and recorded at two study locations. Air pollution induced respiratory health issues developed in the vendors working at industrial city Gajraula had been studied during January-February 2019. The annual average means of $PM_{2.5}$, PM_{10}, NO_2 and SO_2 air pollutants were significantly higher at exposed site compared to the control site. There were high incidences of ill-respiratory symptoms among road-side vendors working at the exposed sites. The symptoms of cough, phlegm, headache and eye irritation were significantly higher in the participants from exposed site compared to the control site.

Keywords: Air pollution, particulate matters, road-side vendors and respiratory health.

INTRODUCTION

Air is the most essential part of the environment for survival of life on the earth. An average human being requires approximately 16-20 kg of air in 24 hours which is significantly more when compared to the quantity of food and water he consumed. Therefore the quality of inhaled air is of great significance than the food and water (Naddafi *et al.,* 2006). A poor air quality affects the respiratory and cardio-vascular health of the human. The response of a person against air pollution depends upon the type of the pollutants present in the air, time spent at the polluted site and the degree of exposure etc. People who work along busy roadside are more prone to air pollution exposure (Prakash *et al.,* 2013).

Vehicular emission is an important source of ambient air pollution worldwide. According to an estimate of WHO, 91% of the population of the world is living in poor quality air. Exposure to ambient air pollutants is a serious health concern for the group of people who are working near road sides. It causes 4.2 millions premature deaths worldwide with a major portion in low and middle income countries from South-East Asia and Western Pacific regions (WHO, 2018). Rapid population growth, urbanization and increased transportation by heavy vehicles on roads are the main factors behind the increase of air pollution in Indian industrial cities (Duraisamy *et al.,* 2017).

Ambient air pollution which is caused by automobile exhaust and industrial activities contributes to second biggest premature deaths in India (Saini *et al.,* 2019; Duraisamy *et al.,* 2017). These automobile exhausts and industrial activities produce particulate air pollutants such as total suspended particulate matters, PM_{10}, $PM_{2.5}$ and $PM_{1.0}$ and gaseous air pollutants like NO_2, SO_2 and CO etc. (Singh *et al.,* 2013; Cheng *et al.,* 2011). There is an association between high prevalence of respiratory health symptoms and exposure to vehicular emission (Noomnual and Shendell, 2017; Amaran *et al.,* 2016; Ingle *et al.,* 2005). These particulate and gaseous pollutants are further deposited on plant surfaces and soil, and eventually contribute to human exposure (Duraisamy *et al.,* 2017). A prolonged exposure to the air pollutants causes increase in the risk of respiratory symptoms like asthma, allergy, shortness of breath, chronic obstructive pulmonary diseases, acute lower respiratory infections in children and others health issues like headache, eye irritation, fatigue etc. (Noomnual and Shendell, 2017; Kongtip *et al.,* 2006). Studies carried out in Asian cities reported that road side vendors are more vulnerable to particulate matters, harmful gases and other air pollutants (State of Global Air Report, 2020).

Air quality is worsening day by day due to the presence of particulate matters and harmful gases in the air. Gajraula, which got the status of industrial city in 1981-82 (Down to Earth, 1999), is also facing the problems of industrial and

vehicular pollutants. Road-side vendors, traffic police men, auto rickshaw drivers and shopkeepers working along busy traffic road are uninterruptedly exposed to the polluted air.

Present studies are confined to the industrial and vehicular air pollutants like particulate matters ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). These have an adverse respiratory health effects in roadside vendors working at Gajraula city, Uttar Pradesh.

MATERIAL AND METHODS

Location of the Study

Present research work is a cross-sectional comparative study of two different sites of the city, namely *Town Basti (Control site)* and *Indra Chowk (Exposed site)* located in Gajraula city. Gajraula is an important industrial city and municipal board present at Amroha district in the state of Uttar Pradesh, India. It is vested on NH-24, which is a 4-lane highway connecting Lucknow, a state capital to New Delhi, the capital of India.

Gajraula is at about 105 km distance from New Delhi and is a hub of many industries like Jubliant Life Sciences, RACL Geartech, Navabharath Fertilizers Limited, Insilco Limited, Israeli Pharma Teva API etc. The study has been conducted on the roadside vendors from above mentioned two research sites in the months of January-February, 2019.

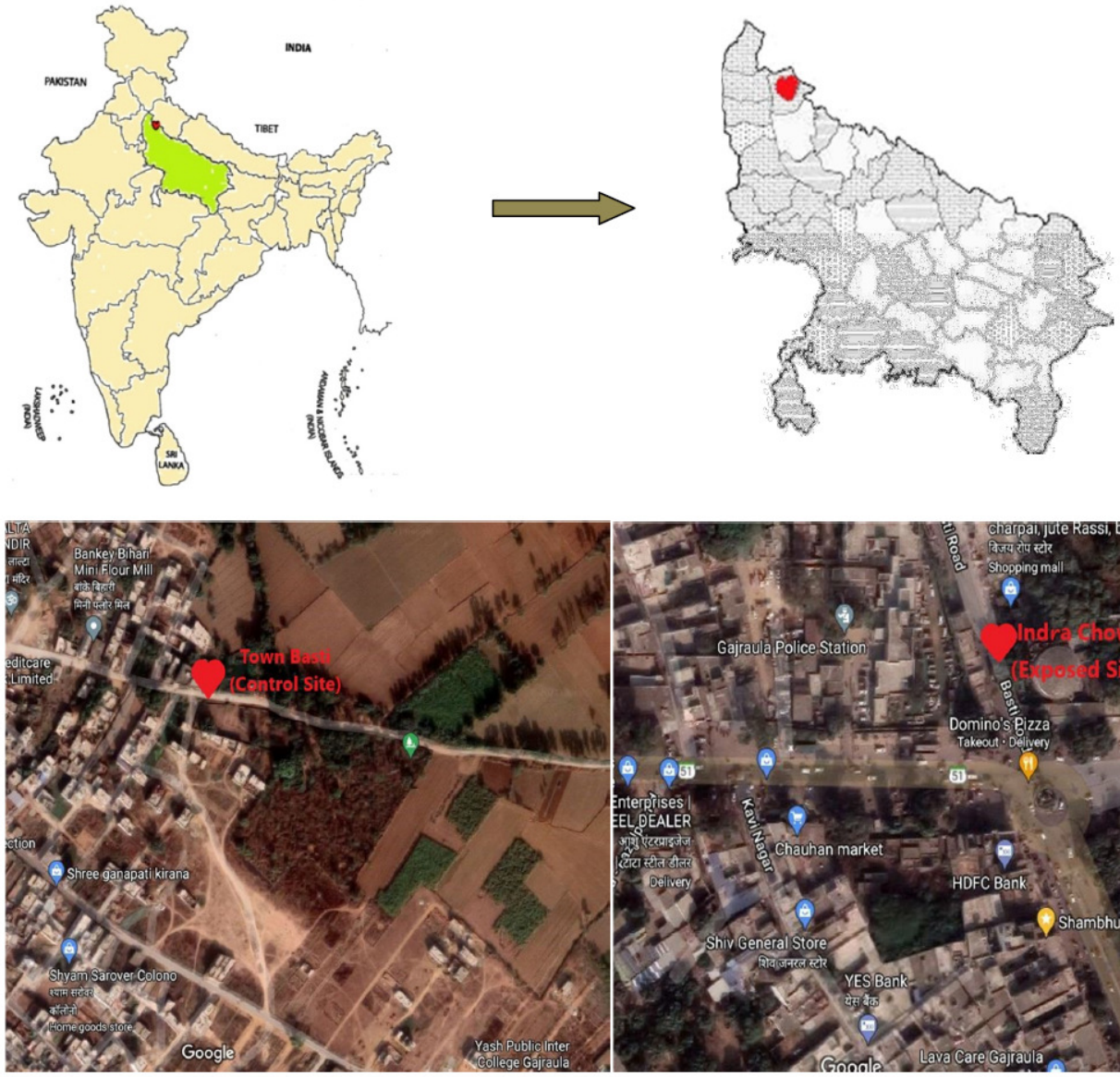

Fig. 1: Satellite images of Town Basti (Control Site) and Indra Chowk (Exposed Site)

The population as well as the traffic density of Town Basti, is less dense in comparison to Indra Chowk. The population of Town Basti is mainly involved in agriculture work that is why it has less pollution as compared to Indra Chowk. This is the reason behind choosing this site as control for present study.

Indra Chowk on the other hand is a residential area with extreme commercial activities. This site is receives more pollution caused by the emissions from the industries like Insilco Limited, TEVA API Limited and Jubilant Life Sciences Limited. Due to overcrowd, the traffic movement is also very slow in this area; traffic jam is a general phenomenon here. Obtrusions on both sides of the road, more vehicle density and railway crossing enhance the extent of

pollution in this area. This site had been taken as an exposed site.

Sampling for Respiratory Health

For the purpose of sampling, 20 willing road-side vendors (study subjects) were chosen to participate in the study. Demographic and respiratory health status of these vendors was 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 of the study are: (1) age below 55 years, (2) not suffering from asthma and tuberculosis, and (3) pleased to voluntary participates in the study. The study subjects had been provided the details about the proposed study and asked to answer the questionnaire judiciously. The body weight, height and oxygen saturation of study subjects were 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 $PM_{2.5}$, PM_{10}, NO_2, and SO_2 had been measured to find out the status of the pollution at two sites. 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), West-Geake method (1956) and modified Jacob and Hochheischer method (1958), respectively.

Statistical analysis

For critical statistical analysis, Microsoft Office Excel 2007 Analysis Tool Pak had been used. Difference between variables from both the study sites have been tested by using Pearson's coefficient. The test of significance has been carried out with the help of Chi-square (χ^2). A *p-value* <0.05 has been taken as statistically significant for all the recorded observations.

RESULTS

Demographic profile of road-side vendors

Present cross-sectional comparative study incorporated 40 participants from both the study sites. Table 1 represents the distribution of gender, marital status, age, height, weight, education level, working duration, work-shift duration and daily income. The results indicate that there are a higher percentage of males as compared to the females at both the study sites. The percentage of married participants is more than unmarried, at both the study sites. Participant's education level is most frequently primary level. At control site, more than 50% of the participants had a working duration of 2 to 5 years while from exposed site it was more than 5 years. Work-shift duration and daily income of the populations under study were significantly different at both the study sites. The distribution of gender, marital status, age, height, weight, education level and working duration were almost similar across both study groups.

Table 1: Demographic characteristics of participating road-side vendors

Variables	Control group (n=20)	Exposed group (n = 20)	χ^2	*p*-value
Sex				
a) Male	15 (75%)	14 (70%)	0.12	0.72
b) Female	5 (25%)	6 (30%)		
Marital status				
a) Single	6 (30%)	7 (35%)	0.11	0.73
b) Married	14 (70%)	13 (65%)		
Age (Year)	34.05 (±8.45)	32.3 (±10.65)	0.64	0.51
Height (cm)	165.15 (±8.06)	164.7 (±8.82)	– 0.013	0.99
Weight (kg)	61.95 (±8.77)	56 (±5.24)	1.89	0.058
Education				
a) Primary	9 (45%)	15 (75%)	3.02	0.38
b) High School	7 (35%)	3 (15%)		
c) Intermediate	2 (10%)	2 (10%)		
d) Graduate/ above	2 (10%)	0 (0%)		
Working duration				
a) < 2 Years	3 (15%)	6 (30%)	3.69	0.15
b) 2-5 Years	12 (60%)	6 (30%)		
c) > 5 Years	5 (25%)	8 (40%)		
Work-shift duration (hours/ day)	6.8 (±0.95)	8.4 (±0.82)	– 3.88	0.0001*
Daily income	198 (±37.36)	266.25 (±44.62)	– 3.94	<0.001*

Pearson's Chi-square statistics, * Significant at $p < 0.05$

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

The annual trend for pollutants ($PM_{2.5}$, PM_{10}, NO_2 and SO_2) at both the study sites is shown in Figure 2-5. Table 2 represents the annual means of pollutants at control and exposed sites. The level of these air pollutants was significantly higher at exposed site as compared to the control site (Table 3). The annual averages for particulate matters ($PM_{2.5}$, PM_{10}) have been found more than the National Ambient Air Quality Standards (NAAQS) at both the sites. The annual average of NO_2 and SO_2 on the other hand was recorded less than the NAAQS (Table 2).

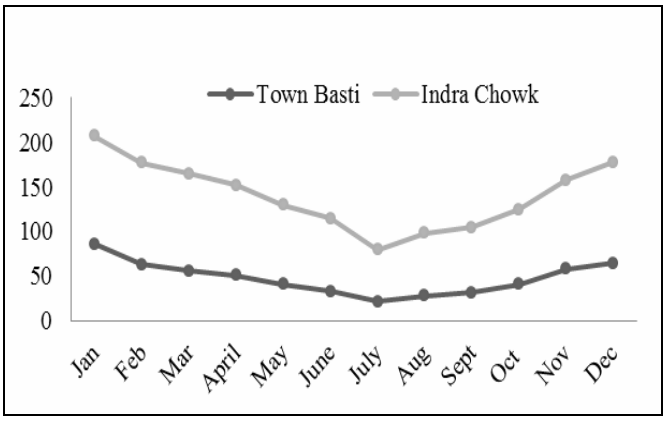

Fig. 2: Annual $PM_{2.5}$ (µg/m^3) concentration trend; Jan 2019 to Dec 2019 at Town-Basti (Control) and Indra-Chowk (Exposed) sites.

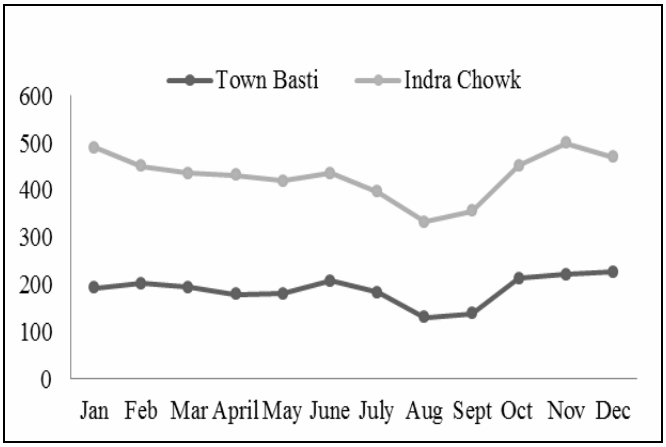

Fig. 3: Annual PM_{10} (µg/m^3) concentration trend; Jan 2019 to Dec 2019 at Town-Basti (Control) and Indra-Chowk (Exposed) sites.

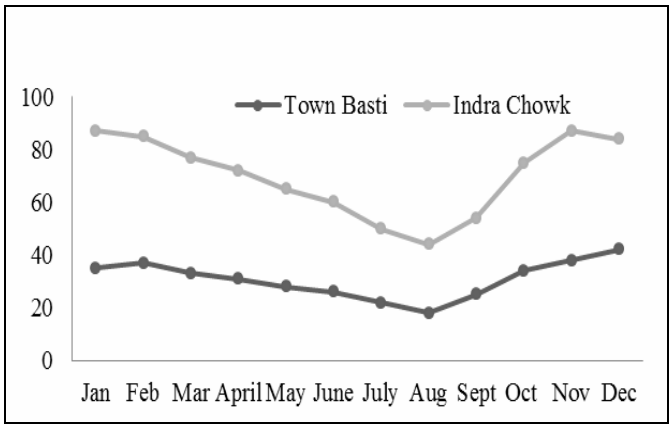

Fig. 4: Annual NO_2 (µg/m^3) concentration trend; Jan 2019 to Dec 2019 at Town-Basti (Control) and Indra-Chowk (Exposed) sites.

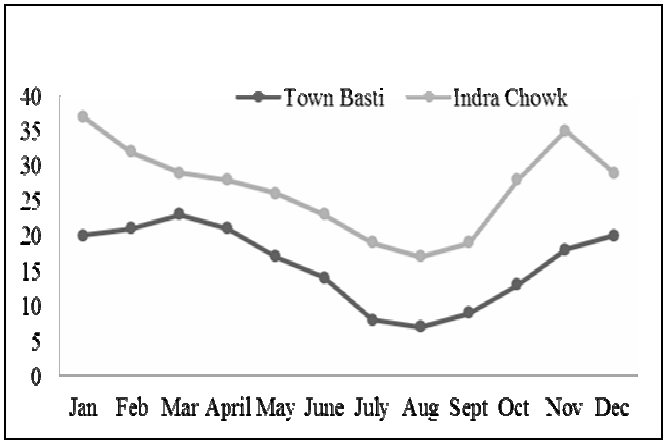

Fig. 5: Annual SO_2 (µg/m^3) concentration trend; Jan 2019 to Dec 2019 at Town-Basti (Control) and Indra-Chowk (Exposed) sites.

Table 2: Annual average means of major ambient air pollutants for the year 2019 in Gajraula city at two sites

Control site (Town Basti)

Sr. No.	Variables	Mean (± SD)	Min.	Max.	NAAQS
1.	$PM_{2.5}$	48 (±18.5)	22	86	40
2.	PM_{10}	189 (±29.9)	130	227	60
3.	NO_2	30.75 (±7.1)	18	42	40
4.	SO_2	15.91 (±5.58)	7	23	50

SD: standard deviation, NAAQS: National Ambient Air Quality Standards

Exposed site (Indra Chowk)

Sr. No.	Variables	Mean (± SD)	Min.	Max.	NAAQS
1.	$PM_{2.5}$	92.8 (±19.9)	58	121	40
2.	PM_{10}	241.5 (±26.6)	202	297	60
3.	NO_2	39.25 (±8.58)	26	52	40
4.	SO_2	26.83 (±6.3)	17	37	50

SD: standard deviation, NAAQS: National Ambient Air Quality Standards

Table 3: Comparison of pollutants level at two sites

Sr. No.	Variables	Control group (Town Basti)	Exposed group (Indra Chowk)	*Z*-score	*p*-value
1.	$PM_{2.5}$	48	92.8	-3.69504	0.0002*
2.	PM_{10}	189	241.5	-3.60844	0.0003*
3.	NO_2	30.75	39.25	-2.25167	0.0244*
4.	SO_2	15.91	26.83	-3.14656	0.0016*

*Significant at $p \leq 0.05$

Respiratory health symptoms distribution

The incidence of different respiratory health symptoms at two study sites are summarized in Table 4 and Figure 6. With a few anomalies, the incidence of respiratory health symptoms was comparable at both the study sites. Among all the respiratory health symptoms, cough, chest tightness and eye irritation were the most common symptoms. The incidence of respiratory symptoms was more in road-side vendors at exposed site due to increased level of air pollutants. The respiratory health symptoms of cough (χ^2=4.9, p=0.026), phlegm (χ^2=8.9, p<0.01), headache (χ^2=8.18, p<0.01) and eye irritation (χ^2=14.43, p<0.01) were significantly higher in the participants from exposed site than the participants from control site.

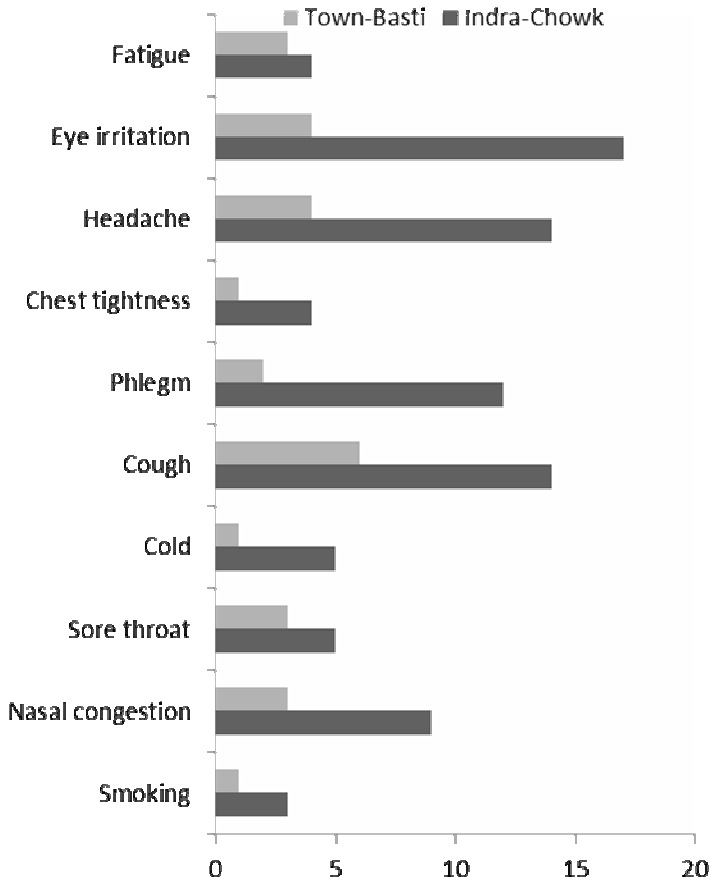

Fig. 6: Comparison of respiratory symptoms in road-side vendors at Town-Basti (Control) and Indra-Chowk (Exposed) site

Table 4: Self-reported respiratory symptoms among road-side vendors

Variables	Control group (n=20)	Exposed group (n = 20)	χ^2	*p*-value
Smoking a) Yes b) No	 1 (5%) 19 (95%)	 3 (15%) 17 (85%)	0.27	0.59
Nasal congestion a) Yes b) No	 3 (15%) 17 (85%)	 9 (45%) 11 (55%)	2.97	0.08
Sore throat a) Yes b) No	 3 (15%) 17 (85%)	 5 (25%) 15 (75%)	0.15	0.69
Cold a) Yes b) No	 1 (5%) 19 (95%)	 5 (25%) 15 (75%)	1.76	0.18
Cough a) Yes b) No	 6 (30%) 14 (70%)	 14 (70%) 6 (30%)	4.9	0.026*
Phlegm a) Yes b) No	 2 (10%) 18 (90%)	 12 (60%) 8 (40%)	8.9	0.002*

Chest tightness a) Yes b) No	 1 (5%) 19 (95%)	 4 (20%) 16 (80%)	0.91	0.33
Headache a) Yes b) No	 4 (20%) 16 (80%)	 14 (70%) 6 (30%)	8.18	0.004*
Eye irritation a) Yes b) No	 4 (20%) 16 (80%)	 17 (85%) 3 (15%)	14.43	0.0001*
Fatigue a) Yes b) No	 3 (15%) 17 (85%)	 4 (20%) 16 (80%)	0.17	0.67
SpO_2	98.45 (±0.6)	98.1 (±0.78)	1.29	0.19

Pearson's Chi-square statistics *Significant at $p < 0.05$
SpO_2 measured by pulse oximeter

DISCUSSION

Air pollution is a major environmental health issue and threats to the human respiratory health. A number of studies have been carried out to study the effects of air pollutants on respiratory health outcome (Noomnual and Shendell, 2017; Amaran *et al.,* 2016; Kumar, 2012; Kongtip *et al.,* 2006; Ingle *et al.,* 2005). The present study shows that the variation in the particulate air pollutants plays a significant role in the respiratory health status of road-side vendors, especially in the symptoms of cough, phlegm, headache and eye irritation in the persons who had been found to work more at exposed site. Same result has been reported in a study conducted at Dehradun, in which the eye irritation symptoms were more frequent in street vendors working at commercial sites as compared to the residential site. This was due to frequent road traffic which caused agitation of road dust (Prabhu *et al.,* 2019).

Road-side vendors who work in overcrowded traffic area with more work-shift duration are more vulnerable and susceptible for the exposure to various harmful air pollutants. This exposure results into different kinds of respiratory health symptoms. The findings of the present study are confirmatory to the study conducted at Tiruchirappalli, South India, who found out that road-side vendors were suffered from respiratory problems (Karthikeyan and Mangaleswaran, 2017).

CONCLUSION AND RECOMMENDATIONS

Road-side vendors are at great risk for increased respiratory health problems due to more exposure to industrial and vehicular pollutants. Educate them about health risk of exposure and advice for using face masks for outdoor work activities for betterment of their respiratory health.

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