SUMMARY

Environment pollution has become a major area of concern and has attracted public attention all over the world. In fact, this problem has emerged as a challenge for human beings in this scientific era with the growing population and increasing industrial development, the volume and complexity of pollution is increasing day by day.

Rohtak district has faster urbanisation which in turn led to tremendous increase in the number of vehicles in the city. Air pollution in Rohtak city is increasing day by day due to vehicular exhausts. There is no data available which could guide us to plan something in response to the air pollution. Patients having respiratory problems are increasing day by day. Not much information on the air quality of Haryana, which has experienced rapid industrial and vehicular growth during last decades, is available. The quality of environment is a matter of concern to everyone locally, nationally as well as internationally and in this context it is sensible to follow the policy of “act locally and think globally.” Very little attention has been paid to study the effects of air pollutants on the human beings directly. Therefore, the present research work was conducted to evaluate the effect of air pollution on human beings. The aim of this study was to investigate potentially abnormal lung function and respiratory symptoms in subjects living in an area with heavy motor traffic and major permanent air pollution, and in a population living in a low pollution area.
Ambient air quality was measured at six different sites (University campus, Medical mor, Delhi bye pass, New bus stand, Bhiwani stand and Hisar road) of Rohtak city in three seasons (summer, winter and monsoon). The following pollutants were monitored at Rohtak city:

1) Sulphur dioxide (SO$_2$)

2) Nitrogen dioxide (NO$_2$)

3) Ozone (O$_3$)

4) Suspended Particulate Matter (SPM)

5) Heavy Metals-
   i. Lead
   ii. Cadmium
   iii. Zinc
   iv. Nickel
   v. Copper

6) Benzene, Toluene and Xylene (BTX)

7) Polycyclic Aromatic Hydrocarbons (PAHs)

Large variations in the pollutant levels in winter, summer and monsoon season were observed at six different sites. The mean Nitrogen dioxide concentration was observed maximum at Bhiwani stand (118.35µg/m$^3$) in winter season and minimum at University campus (37.59µg/m$^3$) in monsoon season. NO$_2$ mean levels exceed the prescribed National Ambient Air Quality Standards (80µg/m$^3$) at New bus stand (81.54µg/m$^3$), Delhi bye pass (86.26µg/m$^3$), Bhiwani stand (118.35µg/m$^3$) and Hisar road (117.90µg/m$^3$) in winter and at Delhi bye pass (84.36µg/m$^3$), Bhiwani stand (105.14µg/m$^3$) and Hisar road (113.73µg/m$^3$) in summer and at Bhiwani stand (89.90µg/m$^3$) and Hisar road (93.75µg/m$^3$) in monsoon season. The average level of SO$_2$ was
below the permissible limit (80μg/m³) at all sites in all the three seasons. SO₂ was found maximum in winter season at Hissar road (38.52μg/m³) and minimum at University campus (9.25μg/m³) in monsoon season. The mean level of O₃ was observed within safety limit (90μg/m³) at all the sites. O₃ was found to be maximum in summer season at Hissar road (81.95μg/m³) and minimum at University campus (2.95μg/m³) in monsoon season. The level of SPM was observed above the safety limit (360μg/m³) at all the sites in all the three seasons, except University campus in monsoon season. The maximum concentration was found at Hissar road (1310.76μg/m³) in winter season and minimum at University campus (245.14μg/m³) in monsoon season. In the present study, the concentrations of SPM, NO₂ and SO₂ were observed maximum in winter season in comparison to summer and monsoon season. During the winter season there is increased atmospheric stability, which in turn leads to less general circulation and thus more stagnant air masses. It prevents an upward movement of air, hence atmospheric mixing is retarded and pollutants are trapped near the ground. Secondly, cold starts in winter leads to a longer period of incomplete combustion and longer warm up times for catalytic converter, which generates more pollution. The study showed that winter months had greater exposure risk as pollutants often get trapped in the lower layers of atmosphere resulting in high concentrations. The concentrations of Ozone were observed maximum in summer in comparison to winter and monsoon season. In the lower (troposphere) layer, ground-level ozone is formed by the reaction of VOCs and NOx with ambient oxygen in the presence of sunlight and high temperatures. Ground-level ozone concentrations depend on the absolute and relative concentrations of its precursors and the intensity of solar radiation, which exhibits diurnal and seasonal variations. The monsoon results in large amount of precipitation and increased humidity, while rain
became responsible for the 'washing off' of ambient air pollutants. Therefore, pollution level was found at minimum level in this season during our study at all the selected sites.

The mean concentration of Pb was found at below the permissible limit (1.5µg/m³) at all the sites in all the three seasons. The maximum concentration was found at Hissar road (0.191µg/m³) in winter season and the minimum concentration was found at University campus (0.006µg/m³) in monsoon season. The maximum concentration of Zn was found at Hissar road (0.198µg/m³) in winter season and the minimum concentration was found at University campus (0.002µg/m³) in winter season. The maximum concentration of Ni was not found more than the permissible limit (2.5µg/m³) at all the sites in all the three seasons. The maximum concentration of Ni was found at Hissar road (0.582µg/m³) in winter season and the minimum concentration was found at University campus (0.003µg/m³) in monsoon season. The maximum concentration of Cd was found at Hissar road (0.015µg/m³) in summer season and the concentration was not found at University campus in monsoon season. The maximum concentration of Cu was found at Hissar road (0.486µg/m³) in summer season and the minimum concentration was found at University campus (0.002 µg/m³) in monsoon season. The mean concentration of Benzene was found more than the permissible limit (16µg/m³) at Hissar road (16.5 µg/m³) and Delhi bye pass (22.3µg/m³) in winter season. The maximum concentration of Benzene was found at Delhi bye pass in winter season and the minimum concentration was found at University campus (2.3 µg/m³) in monsoon season. The maximum concentration of Toluene was found at Hissar road (56.2µg/m³) in winter season and the minimum concentration was found at University campus (5.0µg/m³) in monsoon season. The maximum concentration
of Xylene was found at Hissar road (9.6 pg/m³) in winter season and the minimum at University campus (1.8 μg/m³) in monsoon season.

Following PAHs were determined at Rohtak city: acenapthalene, fluoranthene, anthracene, pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, benzo(a)pyrene and benzo(ghi)perylene. It was observed that benzo(a)pyrene was found above the permissible limit (5 μg/m³) at Hissar road (7.34 μg/m³).

The AQI at different sites revealed that University campus was fairly clean; Delhi by pass, New bus stand, Medical mor were polluted; Bhiwani stand was heavily polluted and Hissar road was severely polluted site. The mean values of air pollutants were found maximum at Hissar road and minimum at University campus.

Through MANOVA analysis comparison of different pollutants in all the three seasons was done which shows that SPM was found at highest concentration in the city. MANOVA analysis of different area for pollutant shows that the mean concentration of pollutant at University campus, Medical mor, New bus stand and Delhi by pass were found to be highly significantly different with Hissar road and Bhiwani stand.

The population groups, one from low polluted site and other from highly polluted site were selected for the study. A sample of 500 people each was taken up from both low polluted and high polluted site to study the effect of pollutants on respiratory symptoms with the help of a questionnaire. It was analysed that more symptoms related to pollution were found in the subjects of HPA as compared to the subjects of LPA. Air pollution can affect our health in many ways with both short-term effects (irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia, headaches,
nausea, and allergic reactions) and long-term effects (chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys). Different groups of individuals are affected by air pollution in different ways. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging chemicals, i.e., the duration of exposure and the concentration of the chemicals must be taken into account.

Pulmonary function test (PFT) with the help of spirometer was performed on 500 subjects. PFT result showed variations in the lung parameters (FVC, FEV1, FEV1/FVC and PEF) among the population of high polluted area and low polluted area. Highly significant difference was observed in the lung parameters of two sites showing decrease in the percentage of lung parameters at high polluted area as compared to low polluted area. The prevalence of air borne disease was more in high polluted area as compared to low polluted area which could be due to high levels of air pollutants in their environment specially the SPM, as these particulates tend to deposit in alveoli and slow down the exchange of oxygen with carbon dioxide in the blood, causing shortness of breath. The total population under study was disaggregated into three age groups (15-25, 26-35 and 36-45 years). The individual symptoms were analyzed of different age groups and it was observed that the subjects residing in high polluted area, irrespective of age were likely to have more chances of suffering with the symptoms related to pollution as compared to the subjects residing in low polluted area. In the present study most of parameters were decreased significantly in the subjects of high polluted area as compared to the subjects of low polluted area. This finding indicates the restrictive nature of pulmonary involvement in the study group.
In Haematological Analysis; haemoglobin, total leucocyte count, neutrophils, lymphocyte, eosinophil, basophil, mean cell haemoglobin, mean cell volume of 50 subjects of both sites were compared. Significant difference was observed between and haemoglobin (p<0.001) total leucocyte count (p<0.001) neutrophils (p<0.001) and lymphocyte (p<0.001) and insignificant difference was observed between eosinophil (p>0.05) mean cell haemoglobin (p>0.05) mean cell volume (p>0.05) of the two sites subjects. The mean value of TLC, neutrophils, lymphocyte, eosinophil, basophil, mean cell haemoglobin and mean cell volume in the subjects of high polluted area and in the subjects of low polluted area were in the normal range whereas the mean of Hb in the subjects of high polluted area was 10.71 g/dl which was lesser than the normal range (12.0 - 18.0 g/dl) while in low polluted area it was found to be 12.15 g/dl which lies in the normal range.

The mean concentration of heavy metals in the blood showed the significant difference at P<0.001 which was observed in Copper, Zinc, Lead, Nickel and cadmium in blood samples of subjects residing at low and high polluted area. The mean value of all heavy metals was observed higher in the blood samples of the subjects of high polluted area as compared to the samples of low polluted area. The result obtained provides important information for controlling the air quality and decreasing the harmful effects of pollutants on the health of the population.

Therefore future study could be extended to evaluate status of human health. The study emphasis's the need to consider air pollution and traffic-related air pollution as a widespread cause of impaired health. Air quality in India is deteriorating at a fast pace ever since the advent of the industrial era, urbanization and the fast-growing vehicular fleet. Alarming levels of pollutants
are reported in all metropolitan cities and other urban areas. Despite such high levels there are lack of studies especially in the field of environmental epidemiology is discouraging. Immediate measures are essential to streamline recording the morbidity in a more detailed fashion. Data should be made easily available to the research community by publishing on the web or making available statistical documents in public domain. Such a reform would give great impetus to studies on air pollution and health.