Seasonal variation of SO2 and its impact on respiratory human health: A case study of Gwalior city

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Abstract - Due to the rapid urbanization and traffic density the air quality in India is deterioting. India experienced the rapid industrial growth. The unsystematic utilization of natural resources has led to the environment pollution. In many Indian cities, Air pollution has resulted in poor urban air quality. The air pollution can be attributed to emission from transportation, industrial, and residential activities. During the study seasonal variation of air pollutant SO2 were investigating during 2015-17 by chemical methods along with temperature, relative humidity, and wind direction in Gwalior city in three zones. Health survey was carried out in various hospitals, clinics, and dispensaries of three study centres. The main objective of this study was to estimate the level of air pollutant and its involvement in the human health.

KeyWords - SO2, Gwalior, Respiratory human health.

Introduction

Air pollution is a major problem of recent decades, which has a serious toxicological impact on human health and the environment. The sources of pollution vary from small unit of cigarettes and natural sources such as volcanic activities to large volume of emission from motor engines of automobiles and industrial activities.[1,2] Long-term effects of air pollution on the onset of diseases such as respiratory infections and inflammations, cardiovascular dysfunctions, and cancer is widely accepted;[3,4,5,6] hence, air pollution is linked with millions of death globally each year.[7,8,9] Air pollution has now emerged in developing countries as a result of industrial activities and also increase the quantity of emission sources such as inappropriate vehicles.[11,12,13] About 4.3 million people die from household air pollution and 3.7 million from ambient air pollution, most of whom (3.3 and 2.6 million, respectively) live in Asia.

Sulfur dioxide

SO_2 is a colorless, highly reactive gas, which is considered as an important air pollutant. It is mostly emitted from fossil fuel consumption, natural volcanic activities, and industrial processes. SO_2 is very harmful for plant life, animal, and human health. People with lung disease, children, older people, and those who are more exposed to SO_2 are at higher risk of the skin and lung diseases.

The major health concerns associated with exposure to high concentrations of SO_2 include respiratory irritation and dysfunction, and also aggravation of existing cardiovascular disease. SO_2 is predominantly absorbed in the upper airways. As a sensory irritant, it can cause bronchospasm and mucus secretion in humans. Residents of industrialized regions encountered with SO_2 even at lower concentrations (<1 ppm) in the polluted ambient air might experience a high level of bronchitis.

The penetration of SO_2 into the lungs is greater during mouth breathing compared to nose breathing. An increase in the airflow in deep, rapid breathing enhances penetration of the gas into the deeper lung. Therefore, people who exercise in the polluted air would inhale more SO_2 and are likely to suffer from greater irritation. When SO_2 deposits along the airway, it dissolves into surface lining fluid as sulfite or bisulfite and is easily distributed throughout the body. It seems that the sulfite interacts with sensory receptors in the airways to cause local and centrally mediated bronchoconstriction.

According to the Environmental Protection Agency (EPA) of the USA, the level of annual standard for $SO_2$is 0.03 ppm. Due to its solubility in water, SO_2 is responsible for acid rain formation and acidification of soils. SO_2 reduces the amount of oxygen in the water causing the death of marine species including both animals and plants. Exposure to SO_2 can cause damages to the eyes (lacrimation and corneal opacity), mucous membranes, the skin (redness, and blisters), and respiratory tracts. Bronchospasm, pulmonary edema, pneumonitis, and acute airway obstruction are the most common clinical findings associated with exposure to SO_2.[50]

AQI LEVEL AND HEALTH IMPACT 2015

NUMBER	REMARK	HEALTH IMPACT
1-50	GOOD	MINIMAL IMPACT
51-100	SATISFACTORY	MINOR BREATHING,DISCOMFORT TO SENSITIVE PEOPLE
101-200	MODERATE	BREATHING DISCOMFORT WITH PEOPLE WITH LUNGS,ASTHAMA,AND HEART DISEASE

201-300	POOR	BREATHING DISCOMFORT TO MOST PEOPLE WITH ON PROLONGED EXPOSURE
310-400	VERY POOR	RESPRATORY ILLNESS ON PROLONGED EXPOSURE
401-500	SEVERE	EFFECTS HEALTHY PEOPLE WITH SERIOUS IMPACT TO THOSE WITH EXISTING PROBLEM

SOUCCE:IND-AQI(National Air Quality Index) as approved by CPCB, New Delhi in Oct,2014
http://www. Who.mt/media centre/news/release/2014/experts
National Ambient Air quality Standards (NAAQS) for 24 hours time average

Pollutant	Residential/commercial	Industrial area
SO2	80	80
NO2	80	80
SPM	200	500
RSPM	100	100

SOURCE: Central Pollution Control Board (CBCP), 2009 New Delhi, India
Registered vehicles in Gwalior city

Years	No.of vehicles registered	No. of vehicles added
Previous	190000	0
2011-2012	280000	40000
2012-2013	285000	5000
2013-2014	330000	45000
2014-2015	380000	50000
2015-2016	440000	60000

Source: RTO Gwalior
Monthly Mean Temperature from 2014-17

Season	Month	Temperatures		
		Min	Max	Average
Winter	January	6	25	14
	February	8	28	17
	March	12	35	23
Summer	April	18	41	29
	May	21	44	34
	June	22	44	34
Monsoon	July	26	42	31
	August	25	38	30
	September	24	36	29
Post monsoon	October	18	37	27
	November	10	33	21
	December	5	34	14

Source: Meteorological data of Gwalior

Air Pollution Report of Gwalior

Air pollution is responsible for an increasing number of mortality and morbidity cases in Indian cities. According to WHO Gwalior is among the top four cities with the dirtiest air. The data available of previous years indicated worse air pollution in Gwalior.

The central pollution control boards data which puts Gwalior at the very top of Indians eleven most polluted cities in terms of particulate matter, has caught the Mady pradesh government on a wrong foot. According to pollution control board the particulate matter in Gwalior stands at 329 micrograms per cubic meter which is over five times the permissible limit of 60 micrograms. Gwalior, the city of Madyapradesh located 319 kms south of Delhi. The area of Gwalior is 780km2 with area rank 35th and elevation and population of about 1,901,981 and density 5,478 per km .The vehicular registration is MP 07.According to WHO Gwalior is among the top four cities with dirties air .The data of previous years indicated worse air pollution in Gwalior.

Many factors contribute to this increase, including reliance on fossil fuels such as coal-fired power plants, dependence on private motor vehicles for transport, inefficient use of energy in buildings, and use of biomass for cooking and heating. In Gwalior, some officers blame it on vehicular pollution. Gwalior's rising air pollution is also being heard at National Green Tribunal (NGT), Bhopal bench. "We have submitted a report on this matter to NGT," transport commissioner Sanjay Chaudhary told TOI.

Air pollution is a complex issue, fuelled by multiple sources ranging from – vehicle exhaust, suspended dust on the roads due to vehicle movements, industrial flumes, construction debris, garbage burning, domestic cooking and heating, and some seasonal sources such as agricultural field residue burning, dust storms and sea salt (for coastal areas). While state and national authorities are taking necessary action and introducing interventions in varying capacities to curb these emissions and reduce ambient pollution levels, a lack of coherent policy as well as unplanned growth across sectors (construction, transport, industry) is hindering these efforts. Accelerating growth in the transport sector, burning coal fire powered plants , high use of energy in buildings, and use of biomass for cooking and heating are responsible for worsening air pollution in Gwalior city.

While estimates of health impacts are effective in raising overall concern about air quality, they do not specifically answer the question of where the pollution is coming from and how much each of these sources contributes towards air pollution. Further uncontrolled growth will lead to more pollution and require large recurring investments to air pollution .In Gwalior the rising of air pollution is a very big problem.

MATERIALS AND METHODS

In this study Sulphur dioxide, Nitrogen dioxide, Suspended particulate matter, Respirable suspended particulate matter and surface along with air temperature, relative humidity, wind speed, wind direction and traffic density will be monitored in Gwalior at three sites . SO2 and NO2 estimation has been done spectrophotometrically by Systronic 108 UV visible spectrophotometer. West-Gaeke6 and Jacob- Hocheiser(1958)7 method will be used for the determination of SO2 and NO2 respectively.GF/A what man's filter paper No. 1 will be used to collect Suspended particulate matter. The GIS mapping will be used to examine the relationship between air pollution and human health. The mapping of disease research will be useful to understand the functional relation between disease concerned with pollutants and their intrinsic special characteristic such as location, type, and diffusion poles, socioeconomically and behavioural patterns of patients in connection with factors of pollutant sources, health facilities, ignorance, poverty, labour demand and supply their special processes and diffusion patterns. Thus, GIS mapping is essential to identify and map the population at risk.

Human Health: The health survey of the city Gwalior was conducted as per the 2011 census. The impact of air pollution on the health (respiratory health) in the concerned study areas of Gwalior was carried out at hospitals, Clinics, Pathological labs to get the respiratory problems such as Eye and skin irritation, coughing, shortness of breath, headache, fatigue, Dizziness, Nose and throat irritation etc. Questionnaire survey was also carried out to get the impact of air pollutants on human health. 100 Questionnaire were selected for each study area to get the responses of the respondents and the involvement of air pollutants in the human respiratory health.

Results and Discussion:

The average concentration of SO2 in residential area was observed highest during summer (21.41ug/cu-m) and lowest during monsoon (17.6). In commercial area average concentration of SO2 is observed highest during summer (21.54ug/cu-m) and lowest during monsoon (17.2). In industrial area the highest average concentration of SO2 is observed in summer (22.24ug/cu-m) and lowest in monsoon (18.5ug/cu-m)

Table28: Seasonal SO2 (ug cu-m) Concentration trends during 2015-17

Site	Monsoon	Post monsoon	Winter	Summer
Residential	17.6	17.9	19.2	21.41
Commercial	17.2	19.6	20.7	21.54
Industrial	17.33	17.35	22.4	22.24

Source: Sampling and laboratory analysis

Figure: 28(a)

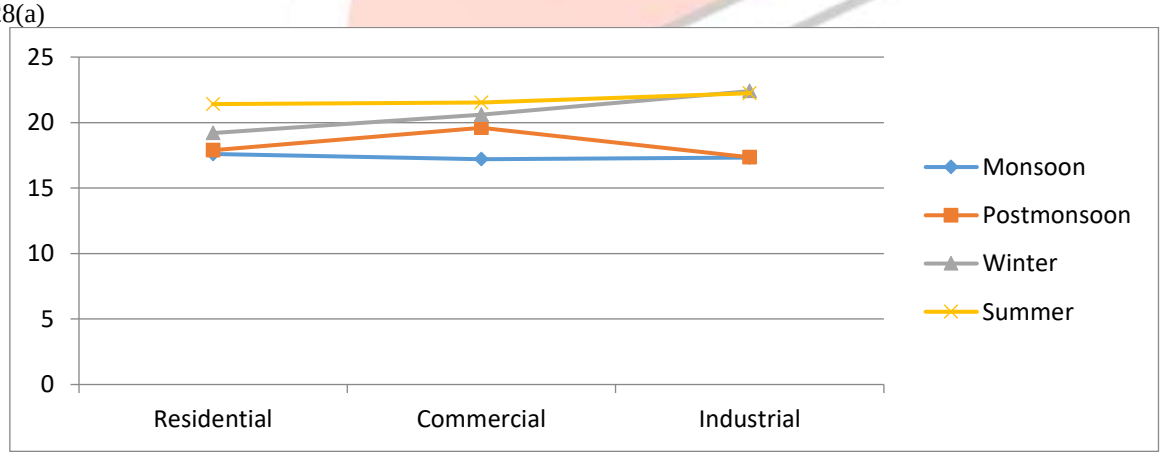
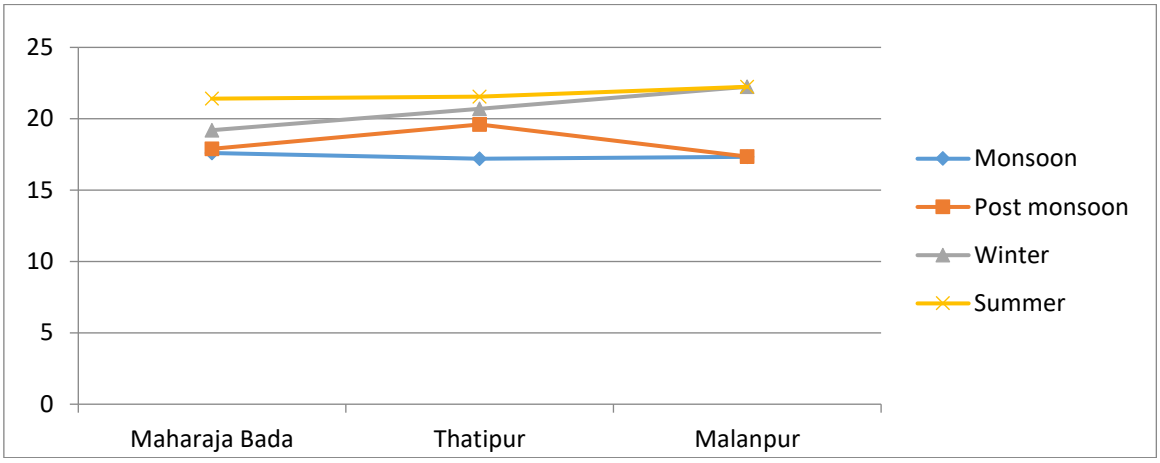


Table 29: Average concentration of SO2 in different locations of Gwalior during 2015-17

Locations	Monsoon	Post monsoon	Winter	Summer
Maharaja Bada	17.6	17.9	19.2	21.41
Thatipur	17.2	19.6	20.7	21.54
Malanpur	17.33	17.35	22.24	22.24

Source: compiled by the researcher (sampling and laboratory analysis

Figure: 29(a)



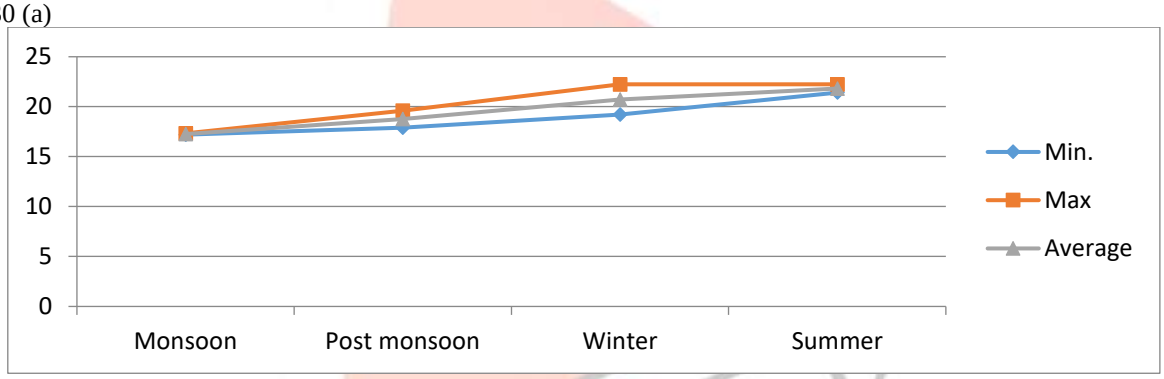
Source: Table 29

Table 30: Seasonal variation of SO2 in ambient air of Gwalior 2015-17

Season	Min	Max	Average
Monsoon	17.2	17.33	17.26
Post monsoon	17.9	19.6	18.75
Winter	19.2	22.24	20.72
Summer	21.41	22.24	21.82

Source: compiled by the researcher (sampling and laboratory analysis)

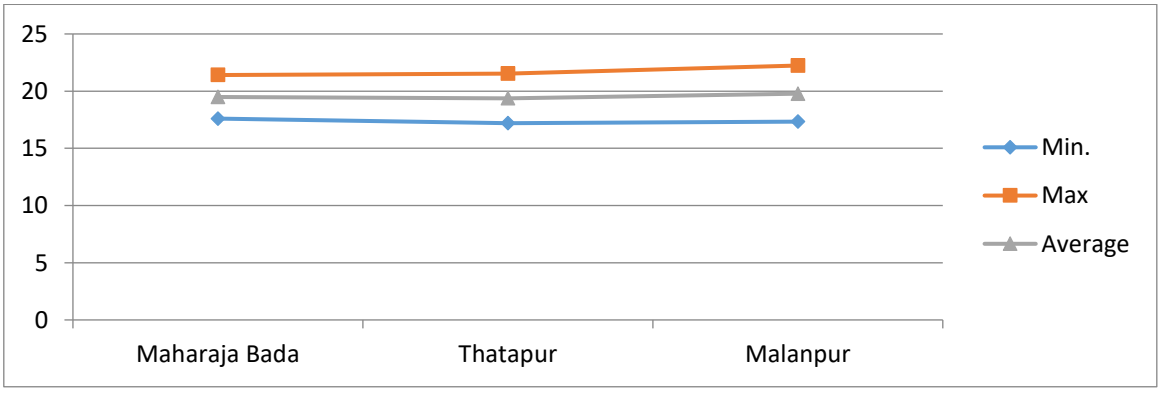
Figure: 30 (a)



Source: Table 30

Table 31: Location wise variation of SO2 in ambient air of Gwalior during 2015-17

Location	Minimum	Maximum	Average
Maharaja Bada	17.6	21.41	19.5
Thatipur	17.2	21.54	19.37
Malanpur	17.33	22.24	19.78



Source: compiled by the researcher (sampling and laboratory analysis)
Figure: 31(a)
Source: Table 31

Table18: Hospital admissions, Clinics, Pathological labs for the treatment of respiratory cases in the particular study areas.

Year	Season	Adult Male	Adult female	Male Child	Female Child	Month with high rate of admission

2015	Summer	53	74	40	25	Apr. and May
	Monsoon	302	710	412	418	Sep. and Oct.
	Winter	45	262	37	93	Nov. and Feb
		400	1046	489	536	
2016	Summer	132	279	156	184	Apr. and May
	Monsoon	170	422	156	150	During all months
	Winter	318	469	187	255	Very high, during all months
		620	1170	499	589	
2017	Summer	380	455	354	241	During all months
	Monsoon	414	441	425	474	July to Sep.
	Winter	39	136	488	360	Nov to Feb
		833	1032	1267	1075	

Source: Hospitals, Clinics, Pathological labs

Figure: 18(a)

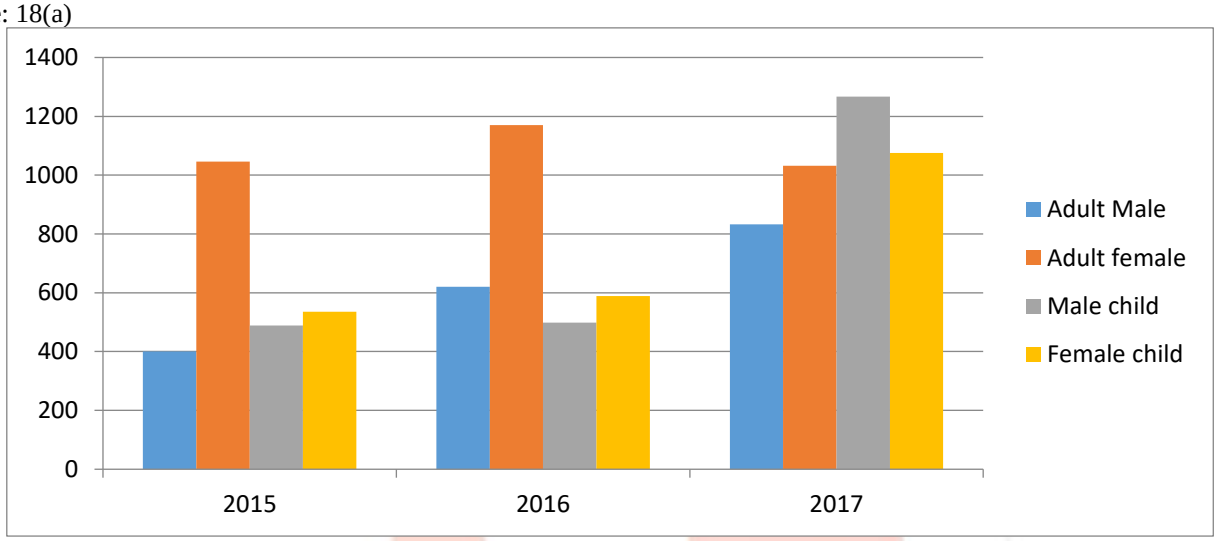


Figure: Table 18

Season wise distribution of the respondents of hospital admissions, clinics, and pathological labs were taken during various seasons for the treatment of respiratory problems is given in a bar chart 18 (a) from April 2014 t0 Feb 2016. Hospital admission, clinics and pathological survey of respondents with respiratory problems on season wise is shown in the table (18). Generally both adult males and females were affected by respiratory problems from the concerned air pollutant monitoring zones. Females were more affected and were more in number for respiratory treatment. As for children's both males and females were affected.

After assimilating different kinds of emissions from large number of hours, the respiratory effects on the respondents in the study areas like fatigue, Coughing, shortness of breath, dizziness, nose and throat irritation, eye and skin irritation have been observed. The percentage respiratory effects of these respiratory problems observed in commercial and Industrial area is highest as compared to the residential area. This may be due the fact that tempos, auto rickshaws, minibuses, two wheelers, private cars, trucks, and industrial activities in these areas. The effects are observed among the people through day and night because these activities are going on through the clock. It has also been observed that the auto rickshaws, tempos along with road are the well managed. The respondents within these areas (mostly drivers) are mainly affected by eye and skin irritation, headaches, and fatigue this may be due to the fact that they spent most of their time within the vehicles. The shortness of breath was very common in these areas. This was due to the fact that the auto rickshaws, tempos, busses are usually overloaded in these areas and there is no room for more air spaces inside the vehicles in these areas.

References:

1. Robinson DL. Air pollution in Australia: *Review of costs, sources and potential solutions*. Health Promot J Austr. 2005;16:213–20. [PubMed]

2. Habre R, Coull B, Moshier E, Godbold J, Grunin A, Nath A, et al. *Sources of indoor air pollution in New York city residences of asthmatic children.* J Expo Sci Environ Epidemiol. 2014;24:269–78.[PubMed]

3. Rumana HS, Sharma RC, Beniwal V, Sharma AK. *A retrospective approach to assess human health risks associated with growing air pollution in urbanized area of Thar Desert, Western Rajasthan, India.* J Environ Health Sci Eng. 2014;12:23. [PMC free article] [PubMed]

4. Yamamoto SS, Phalkey R, Malik AA. *A systematic review of air pollution as a risk factor for cardiovascular disease in South Asia: Limited evidence from India and Pakistan*. Int J Hyg Environ Health. 2014;217:133–44. [PubMed]

5. Zhang W, Qian CN, Zeng YX. *Air pollution: A smoking gun for cancer*. Chin J Cancer. 2014;33:173–5.[PMC free article] [PubMed]

6. Brucker N, Charão MF, Moro AM, Ferrari P, Bubols G, Sauer E, et al. *Atherosclerotic process in taxi drivers occupationally exposed to air pollution and co-morbidities*. Environ Res. 2014;131:31–8. [PubMed]

7. Biggeri A, Bellini P, Terracini B. *Meta-analysis of the Italian studies on short-term effects of air pollution* – MISA 1996-2002. Epidemiol Prev. 2004;28(4-5 Suppl):4–100. [PubMed]
8. Vermaelen K, Brusselle G. *Exposing a deadly alliance: Novel insights into the biological links between COPD and lung cancer*. *Pulm Pharmacol* Ther. 2013;26:544–54. [PubMed]
9. Kan H, Chen B, Zhao N, London SJ, Song G, Chen G, et al. Part 1. *A time-series study of ambient air pollution and daily mortality in Shanghai*, China. Res Rep Health Eff Inst. 2010;154:17–78. [PubMed]
10. Zhou N, Cui Z, Yang S, Han X, Chen G, Zhou Z, et al. *Air pollution and decreased semen quality: A comparative study of Chongqing urban and rural area*s. Environ Pollut. 2014;187:145–52. [PubMed]
11. Chen B, Kan H. *Air pollution and population health: A global challenge*. Environ Health Prev Med. 2008;13:94–101. [PMC free article] [PubMed]
12. Molina MJ, Molina LT. *Megacities and atmospheric pollution*. J Air Waste Manag Assoc. 2004;54:644–80. [PubMed]
13. Chi CC. Growth with pollution: *Unsustainable development in Taiwan and its consequences.* Stud Comp Int Dev. 1994;29:23–47. [PubMed]
14. Chen TM, Gokhale J, Shofer S, Kuschner WG. Outdoor air pollution: *Nitrogen dioxide, sulfur dioxide, and carbon monoxide health effects.* Am J Med Sci. 2007;333:2 56. [PubMed]
15. Chen TM, Gokhale J, Shofer S, Kuschner WG. Outdoor air pollution: Nitrogen dioxide, sulfur dioxide, and carbon monoxide health effects. Am J Med Sci. 2007;333:249–56. [PubMed]
16) Organised by Envirotech Centre for R and B (2008). *A short course on ambient air and source emission monitoring.*, New Dehli.
17) Balakrishnan K, Sambandam S, Ramaswamy P, Metha S, Smith KR 2004 . *Exposure assessment for respirable particulates associated with house hold fuel use in rural districts of Andhra Pradesh*, India. J Expo Sci Environ Epidemiol.;14: S14-25
18) CBCP(2010). National Ambient *Air Quality Satindard, Centeral Pollution Control Board*, New Dehli, available at,hhtp//cpcb.nic.in/National Ambient Air Quality Satindard.php(assessed on 15-3-2014.
19) Census of India(2011). *Population Data*, India.
20) Centeral Bureau of Health Intellegence (2012). *Directorate General of Health Survices, Ministry of Health anf Family Welfare*, Government India,53-83.
21) Charan P.D. and Sahel H. (2014). *Study of Respirable dust in ambient air of Bikaner city and its Impact on Human Health*. Applied Journal of Hygine,3,11-14.
22) Chithra VS, Nagendra SMS (2014) . *Impact of outdoor matereology on indoor PM10, PM2.5 and PM1 Concentrations in naturally ventilated classrooms*. Urban Clim.;17:77-9
23)Massey D, Masih J, Kulshrestha A, Habil M, Taneja A (2009). *Indoor/outdoor relationship of fine particles lessthan 2.5um(PM2.5) in residential homes locations in Central Indian region.* Build Environ.;44(10):2037-45.
24)Messey DD, Kulshrestha A, Taneja A (2013) . *Particulate matter concentration and their related matter toxicity in rural residential environment of semi-arid regions of India*. Atmos Environ.;67:278-86.
25)Rao GV, Rao CV, Reddy VS. *Perceptions on effects of environmental pollutants in Hyderabad City. India J Public Health(Internet).* 43(2):67-70. Available from: http://www.ncbi.nlm.gov/pubmed/11243069.
26) West W. Philip and Gaeke G.C(1956). *Refrence method for the determination of SO2 in the atmosphere (Pararosaniline method)*. Analytical Chemistry, 28, 1816-1819.