Chemical Estimation of SPM, RSPM and its Impact on Respiratory Human Health.

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Abstract

The present study focuses on the chemical estimation of air pollutants SPM, RSPM in the ambient air of Gwalior. In this present study investigation was carried at different traffic sites/junctions in Gwalior during 2015-16. The estimation of SPM, RSPM was carried out at three zones Residential, Commercial, and Industrial. A health survey was carried out at hospitals, Clinics, Pathological labs to get symptoms of respiratory problems such as sneezing, sore throat, shortness of breath, wheezing, chest tightness, skin irritation and nausea etc. The main objective of this study is to investigate the quality of air in Gwalior city and to investigate the involvement of air pollutants on human respiratory health.

Key words: Ambient air, Gwalior, Health impact, SPM, RSPM.

Introduction:

The environment is becoming continuously polluted due to the increased concentration of air pollutants like N02, SO2, RSPM, SPM, etc. These pollutants are the major constituents of automobile exhaust. In Madhya Pradesh particular in Gwalior the problem of air pollution has becoming a serious issue, which mainly depends on the use of fossil fuels, Private Motor vehicles, incompetent utilize of energy in buildings, and employ biomass preparation and heating is contributing to this alarming increase in pollution level. The Gwalior has the highest particulate stuff in India at 329 micro grams per cubic meter by Central Pollution Control Board (CBCP) report on "national ambient air quality standards". But the current statistics explain that the foreign particle in the city stands at 141 micrograms per cubic meter before this year, the CBCP data exposed Gwalior highest in the list of top polluted cities in India. The statistics explained that the permissible limit is 60 micrograms per cubic meter, particulate matter in Gwalior is 329 micro grams per cubic meter which is more than five times the permissible limit. Only 12% of people is living in cities that report the air quality comply with WHO guidelines.

It is well known that mitigating outdoor air pollution remains a major challenge in most developing countries. Annually, outdoor air pollution contributed to 3.2 million deaths and 76 million life years lost worldwide in 2010, two-thirds of which occurred in Asian countries (Lim et al., 2012). Most Indian cities face an acute problem of outdoor air pollution, with concentration levels often exceeding the permissible limits.

Gwalior is the most pollutant city in India not Delhi. WHO reports 2016 comparing on the level of PM10 and the most PM2.5 Delhi features in the top list in India? In terms of PM10 Delhi ranks fourth and fifth in PM2.5.A recent report of WHO has revealed Gwalior is the most polluted city in India in terms of air pollution the reports also suggested that the Indian population living outside Kashmir and Himalaya belt are exposed to pollution behind the WHO safe limits. Meanwhile, Delhi, touted as the most polluted city in the world, does not feature in the list of cities with high pollution levels.

The researcher collected air pollution data from their study from nearly 3,000 cities globally between 2008 to 2015.However Delhi does not feature in the top 10 cities with highest level of pollution. Nigerians Onitsha tops the list with PM10 level globally 594 micrograms/cubic meters. Only one city from India features in the list is Gwalior. For Gwalior PM10 is 329

micrograms/cubic meter and PM2.5. WHO prescribed safe limits PM10 and PM2.5 are 10 micrograms/cubic meter and 20 micrograms/cubic meter respectively. On the other hand India prescribed limit for the same is 20 micrograms/cubic meter and 60 micrograms/cubic meter.

Table 1 LIST OF CITIES WITH HIGHEST LEVEL OF PM10 ARE: WHO 2016

COUNTRY	CITY	PM10
NIGERIA	ONITSHA	594
IRAN	ZABAL	527
PAKISTAN	PESHAWER	540
PAKISTAN	RAWALPANDI	448
NIGERIA	KANDWA	423
SAUDI ARABIA	RIYAD	373
SAUDI ARABIA	AL JUBAIL	368
AFGHANISTAN	MAZARE SHAREIF	334
INDIA	GWALIOR	329

Source: WHO 2016

Table 2 LISTS OF CITIES WITH HIGHEST LEVELS OF PM2.5: WHO 2016

COUNTRY	CITY	PM2.5
	ZABOL	217
INDIA	GWALIOR	176
INDIA	ALLAHABAD	170
INDIA	PATNA	149
INDIA	RAIPUR	144
CHINA	BAODING	126
CHINA	XINGLAR	128
SAUDI ARABIA	AL JHUBAIL	152
SAUDI ARABIA	RIYADH	158
CAMEROONS	BANADA	132

SOURCE: WHO 2016

Table 3: LIST OF INDIAN CITIES PM 10: WHO 216

WHO PRESCRIBED LIMIT 60 MICROGRAMS/CUBIC METER

CITY	PM10
GWALIOR	329
ALLAHABAD	317
RAIPUR	268
DEHLI	229
LUDHIANA	228
KANPUR	215
KHANNA	213
FIROZABAD	212
LUKNOW	211
AMRITSAR	202

SOURCE: WHO 2016

Table 4: LIST OF INDIAN CITIES PM2.5: WHO 2016

WHO PRESCRIBED LIMIT 20 MICROGRAMS/CUBIC METER

CITY	PM2.5
GWALIOR	176
ALLAHABAD	170
PATNA	149
RAIPUR	144
DEHLI	122
LUDHAINA	122
KANPUR	115
KHANA	114
FIROZABAD	113
FIROZABAD	113

SOURCE: WHO 2016

Table 5: LIST OF POLLUTED CITIES IN THE WORLD: WHO 2015 PM 2.5

CITY	COUNTRY	PM2.5
DEHLI	INDIA	153
PATNA	INDIA	149
GWALIOR	INDIA	144
RAIPUR	INDIA	134
KARACHI	PAKISTAN	111
PISHAWER	PAKISTAN	101
RAWALPANDI	PAKISTAN	102
KHEREMABAD	IRAN	100
AHMADABAD	INDIA	96
LUKNOW	INDIA	96
FIROZABAD	INDIA	93
DAHA	QATAR	93
KANPUR	INDIA	93
AMRITSAR	INDIA	92
LUDHIANA	INDIA	91
IGDIR	TURKEY	90
NARYONGANJ	BANGLAFDESH	89
ALLAHABAD	INDIA	88
AGRA	INDIA	88
KHANA	BANLADESH	88

SOURCE: PUBLISHED DECEMBER 2015 GREEN PEACE INDIA Green peace.org/India

Table 6: 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

Source: 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

Table 7: 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

Table 8: 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: Regional transport, Gwalior

Table 9: Monthly Mean Temperature from 2014-16

Month	Temperatures		
	Min	Max	Average
November	27	34	29
December	21	31	26
January	15	22	19
February	18	32	25
March	25	38	33
April	37	45	40
May	40	47	43

Source: Matereological parameters of Gwalior compiled by the researcher

MATERIALS AND METHODS:

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 sneezing, sore throat, shortness of breath, wheezing, chest tightness, skin irritation, and nausea, etc. Questionnaire survey was also carried out to get the impact of air pollutants on human health. Hundred questionnaires for each study area were prepared to see the involvement of air pollutants on respiratory health.

Estimation of pollutants: In this study SPM,RSPM along with air temperature, relative humidity, wind speed, wind direction and air pollution source density has been monitored in Gwalior city in three zones Residential (Thatipur,),commercial (Maharaja Bada), Industrial (Deendayal Nagar). In the study zone areas GF/A filter whatmanns filter papers has been used to collect the suspended particulate matter.

Results and Discussion

Seasonal variation of pollutants:

In residential area highest concentration of SPM was found in summer (423ug/cu-m) and lowest during monsoon. In commercial area highest concentration was found in summer (535 ug/cu-m) and lowest in monsoon (411 ug/cu-m) while in industrial area highest value(597 ug/cu-m) was investigated in summer and lowest value (411 ug/cu-m) in monsoon.

The highest value of RSPM in residential value was investigated in summer (188 ug/cu-m) and lowest which is below the permissible limit in monsoon (95 ug/cu-m). In commercial area the highest concentration was observed in summer (248 ug/cu-m) and lowest in monsoon (115 ug/cu-m) while as in industrial area the highest value was observed in summer (309 ug/cu-m) and lowest value was observed in monsoon (139 ug/cu-m)

Ambient air pollutants RSPM and SPM at different locations during different representative months from 2014-16

Table 10: Sampling sites in Gwalior during 2014-16

Area	Location
Residential	Maharaja Bada
Commercial	Thatipur
Industrial	Malanpur

Table 11: 2 year (8 hourly) combined concentration (ug/m3) of SPM, RSPM from 2014-16

Site location	Monsoon (July to sep)		Post monsoon (oct-nov)		Winter (Dec-feb)		Summer (March-june)	
	SPM	RSPM	SPM	RSPM	SPM	RSPM	SPM	RSPM
Maharaja bada	226	95	335	114	359	123	423	188
Thatipur	338	115	448	170	493	166	553	248
Malanpur	411	139	514	251	517	287	597	309
Average	338.33	116.33	432.33	178.33	456.33	192	518.33	248.33
Standard dev.	72.50	22.03	90.52	68.87	85.14	85.03	88.18	60.50

%CV	21.42	18.93	20.93	38.61	18.65	44.28	17.1	24.36

Source: Sampling and laboratory analysis

Table 12: Seasonal SPM, RSPM (ug/m3) trends during 2014-16

Site	Pollutant	Monsoon	Post monsoon	Winter	Summer
Residential	SPM	266	335	349	423
	RSPM	95	114	123	188
Commercial	SPM	338	448	493	535
	RSPM	115	170	166	248
Industrial	SPM	411	514	517	597
	RSPM	139	251	287	309

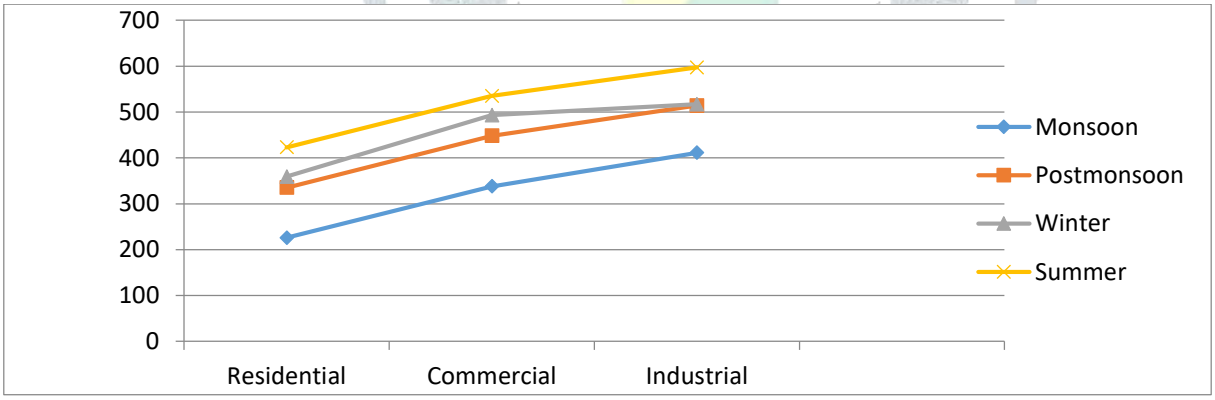
Source: Sampling and laboratory analysis

TABLE 13: Seasonal SPM (ug/m3) concentration trends during 2014-16

Site	Monsoon	Post monsoon	Winter	Summer
Residential	226	335	359	423
Commercial	338	448	493	535
Industrial	411	514	517	597

Source: Sampling and laboratory analysis

Figure: 13 Seasonal SPM(ug/m3) concentration trends during 2014-15



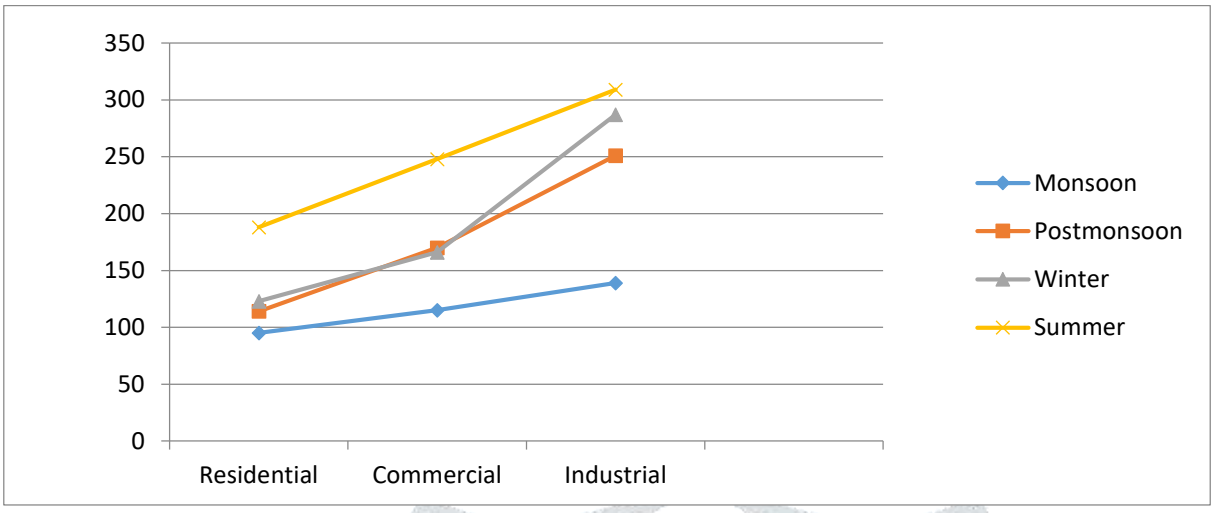
Source: Table 13

Table 14: Seasonal RSPM (ug/m3) Concentration trend during 2014-16

Site	Monsoon	Postmonsoon	Winter	Summer
Residential	95	114	123	188
Commercial	115	170	166	248
Industrial	139	251	287	309

Source: Compiled by the researcher

Figure: 14 Seasonal RSPM (ug/m3) concentration trend during 2014-16



Source: Table 14

Table 15: Respiratory Health problems faced by respondents during 2014-16

Occupation	Types of Respiratory Problems						
Respondent	Sneezing (MB,T,M)	Sore Throat (MB,T,M)	Shortness of breath (MB,T,M)	Wheezing (MB,T,M)	Chest tightness (MB,T,M	Skin irritation (MB,T,M)	Nausea (MB,T,M)
Driver(pvt/personal)	(1,4,5)	(2,4,2)	(2,2,3)	(1,2,1)	(0,3,2)	(1,2,3)	(1,2,3)
Conductors	(0,2,5)	(1,3,3)	(1,3,3)	(1,1,2)	(1,4,3)	(1,4,3)	(1,5,5)
Commuters	(2,2,2)	(2,2,5)	(3,2,4)	(1,0,2)	(1,2,3)	(0,2,4)	(1,2,3)
Traders	(3,4,3)	(2,2,5)	(2,1,2)	(2,0,1)	(3,0,0)	(2,0,0)	(2,0,O)
Students	(1,1,2)	(3,1,2)	(2,1,2)	(0,0,0)	(2,1,2)	(1,0,2)	(2,0,1)
Office workers	(1,1,1)	(2,2,1)	(2,1,1)	(0,0,0)	(1,0,3)	(0,4,0)	(2,0,0)
Market women	(1,0,2)	(2,0,2)	(2,0,2)	(0,3,0)	(2,0,3)	(2,0,3)	(1,0,2)
Street hawkers	(1,1,0)	(1,2,0)	(2,0,2)	(0,0,3)	(2,0,3)	(1,1,2)	(2,0,0)
Residents	(2,1,1)	(1,0,2)	(2,1,1)	(1,1,0)	(2,0,2)	(2,0,3)	(1,0,2)
Total	(12,16,21)	(16,16,22)	(18,11,20)	(6,7,9)	(14,10,21)	(10,13,20)	(13,9,16)

Source: compiled by researcher

Table 16: Distribution of the respondents in the study areas

Respondent	Maharaja bada		Thatipur		Malanpur		Total
	Male	Female	Male	Female	Male	Female	
Drivers(pvt/pernl)	10	4	13	3	16	4	50
Conductors	11	-	10	-	15	-	36
Commuters	9	7	12	5	9	5	47
Traders	12	-	8	-	10	-	30
Students	15	12	13	10	16	8	74
Office Workers	5	1	3	2	7	1	19
Market women	-	3	-	1	-	1	5
Street hawkers	3	-	7	-	4	-	14
Residents	7	2	3	1	7	5	25
Total	63	29	69	22	84	24	300

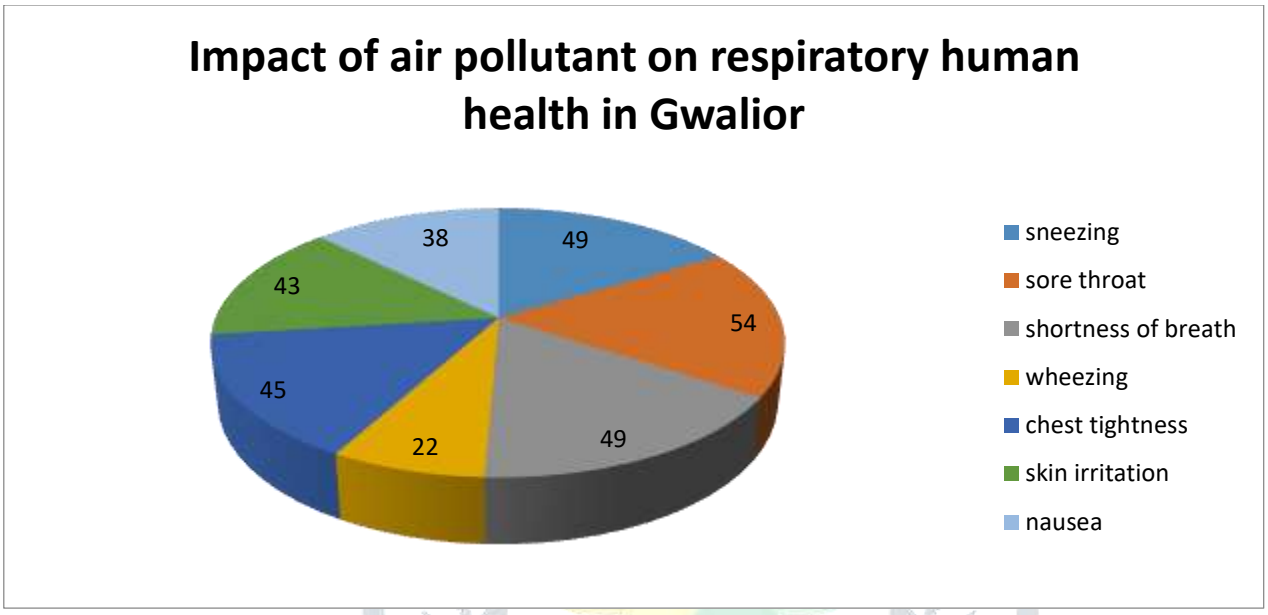
Source: Primary data

Table 17: Effect of air pollutants on the respiratory health of respondents in the study area

Complaint	Maharaja bada	Thatipur	Malanpur	Total
Sneezing	12	16	21	49(16.33)
Sore Throat	16	16	22	54(18)
Shortness of breath	18	11	20	49(16.33)
Wheezing	6	7	9	22(7.33)
Chest tightness	14	10	21	45(15)
Skin irritation	10	13	20	43(14.33)
Nausea	13	9	16	38(12.66)

Source: Primary data

Figure: 17 Effect of air pollutant on the respiratory health in the study area



Source: Table 17

Table 18: 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
2014	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	
2015	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	
2016	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 Hospital, Clinics, and pathological labs for the treatment of respiratory problems

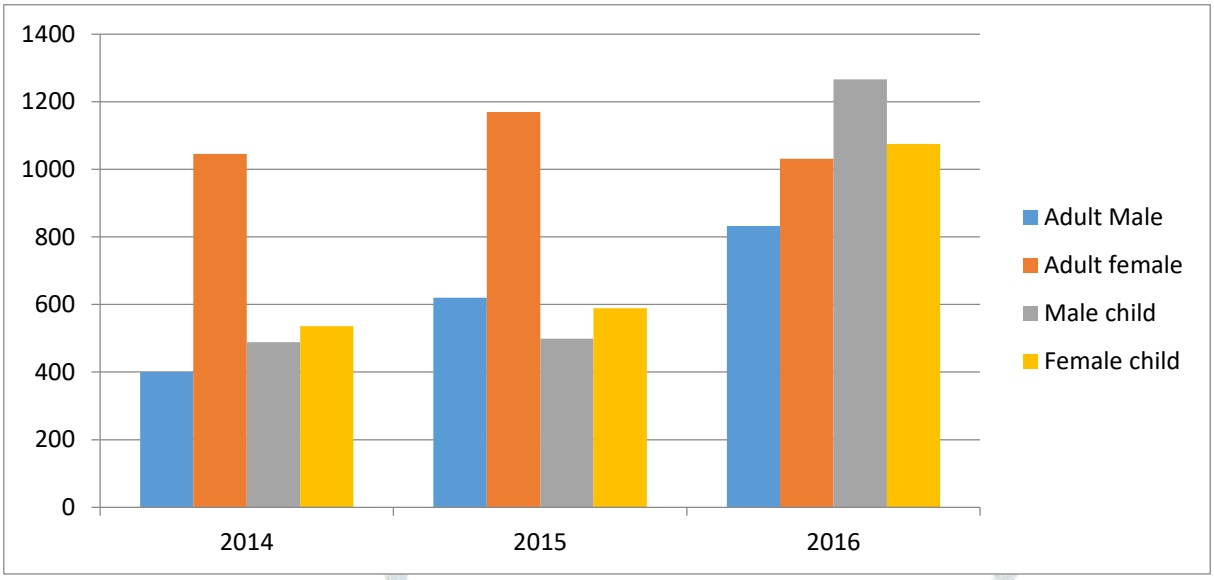


Figure: Table 18

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.

In winter and summer the maximum values of SPM was observed in commercial area are (423ug/cu-m and 359ug/cu-m), residential areas are (535ug/cu-m and 493ug/cu-m),industrial area (597ug/cu-m and 517ug/cu-m) as per NAAQS and CBCP 2009. The minimum values in monsoon and post monsoon were observed in commercial (226ug/cu-m and 335ug/cu-m), residential area (338ug/cu-m and 448ug/cu-m), and industrial area as (411ug/cu-m, 514ug/cu-m)

The RSPM in winter and summer the maximum value observed in Residential are (188ug/cu-m and 123ug/cu-m), commercial are (248ug/cu-m and 166ug/cu-m), and industrial area are (309ug/cu-m and 287ug/cu-) and minimum values observed in monsoon and post monsoon in residential (114ug/cu-m and 195ug/cu-m), commercial (115ug/cu-m and 170ug/cu-m), and Industrial are (139ug/cu-m and 251ug/cu-m).

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.

Conclusion:

We found that air pollution in Gwalior is worst by the world health organization (WHO) report. The major factors towards this are vehicular pollution but we cannot ignore the participation of industries, urbanization, and rough roads in the air quality status of Madhya Pradesh mainly in Gwalior. Air pollution is a serious environmental concern. With the strength of industrialization, urbanization coupled with fast growing population has resulted the environmental degradation. The dangerous pollutants NO2, SO2, SPM, RSPM, are emitted and still go beyond the WHO guidelines. Particulate and gaseous pollutants from auto exhaust and industrialization are responsible for the respiratory problems.

The present study reveals that SPM is above the permissible limits at all study sites with maximum limit at commercial area in summer (535ug/cu-m), winter (493 ug/cu-m), monsoon (448 ug/cu-m), and post monsoon (338 ug/ cu-m). The SPM is also higher in residential area with maximum value in summer (423ug/cu-m) and minimum at industrial area with maximum limit in summer (597 ug/cu-m) higher than the permissible limit (500 ug/cu-m). The RSPM is higher during summer in industrial area (309 ug/cu-m) and least in residential area during monsoon while the highest level in commercial area is determined during summer (248 ug/cu-m). High particulate concentration is due to the heavy transport activity in the study area apart from industrial emissions, dust from paved roads and conventional fuel from domestic purposes. Air pollutants were found high during winter and summer than monsoon and post monsoon.

The air quality has depreciated in most of the Indian cities. The efforts taken by the government is not enough. It is must that the society should make an obvious impact with the decrease of contamination. The public authorities should be encouraged repeatedly with the utilization of communal transport requirements to make sure that vehicles are discharging gases within allowable limits. People are required to be made knowledgeable to stop their vehicles when come at traffic intersections. Regular monitoring for adequacy of pollution control equipments installed at various industries should be undertaken to check emissions from industrial process. In addition to above public awareness for environmental protection and green plantation along highways and within industries should be encouraged.

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