

Environmental health study in Jodhpur- *R.C. Sharma, Murli L. Mathur, H.S. Rumana, Alka Sharma, and Pallavi Bohra.*

Date of Commencement: **April, 2004**

Duration: **Two years**

Status: **Concluded**

Objectives

1. To assess the magnitude of environmental pollution analyzing air, water and solid waste pollutants by seasonal and periodic sampling.
2. To collect information on incidence and prevalence rates for specific health end points such as respiratory ailments, infectious diseases, cardiovascular diseases and cancer.
3. To formulate a design for rational mitigation strategies for the environmental management for the area based on the health risks assessment, economic costs and community perceptions.

Rationale

Environmental pollution is a growing problem with its impact on human health. According to World Health Organization air pollution leads to 8,00,000 premature deaths from lung cancer, cardiovascular and respiratory diseases worldwide, in addition to increased incidence of chronic bronchitis, acute respiratory illness, exacerbation of asthma and coronary disease, and impairment of lung function. Worldwide approximately 1.1 billion people do not have access to safe water and 2.4 billion lack basic sanitary facilities. In India the magnitude of the problem is high. It is estimated that the hazardous wastes generated in India is about 4.4 million tons per annum. The most polluting of them are the city sewage and industrial waste. The problem varies across the states.

In Rajasthan, particularly in western region, which include the part of the Thar Desert, the situation becomes grimmer due to sandy storms. Jodhpur is second largest city in the state. It had 21% decadal population growth as per census 2001. It has more than 3 lakh of registered vehicles and more than 10000 industrial units, which are likely to contribute to air pollution. The city has a sewerage system, which does not cover entire city and also needs frequent repairs. This may cause the problem of water pollution. Magnitude of environmental pollution and its impact on human health in the city remained largely unknown due to lack of studies on the problem. Therefore, the present study was carried out to assess the problem of environmental pollution and related diseases in Jodhpur city.

Progress of Work

For assessment of environmental pollution on human health, the Jodhpur city, which has 60 wards, is divisible into different zones with respect to different types of pollution i.e. air, water and solid wastes. Study sites from within zones are selected to represent entire Jodhpur city. The air, water and solid waste/soil samples were collected from the above selected sites of Jodhpur city. The sampling of air, water and soil/ solid hazardous waste was timed as to capture the seasonal variations of winter, summer and rainy seasons. These samples were analyzed using standard methods.

Different study sites were selected for assessment of commercial/vehicular, industrial and residential air pollution. Level of air pollution was separately studied for these categories because acceptable limits for each of them are different and are separately given by Central Pollution Control Board, Government of India. The study sites selected for air pollution are described below.

Industrial air pollution: There are about 10 000 industries in Jodhpur city. The city has Boranada, Basni, Bhagat ki kothi and Mandore industrial areas. In addition, the quarrying of sandstones in Soorsagar and Mandore area are the other major sources, contributing to the city's air pollution. The types of industries in the city are related to dyes, textiles, timber and furniture, handicrafts, metals and chemicals. Other industries include rolling mills, guar gum, pulses and oil mills. We have selected central location of each industrial area representing their development.

Site I - Basni phase-I

Site II - Basni phase-II

Site III - Light Industrial Area

Site IV - Heavy Industrial Area

Site V - Boranada Industrial Area

Site VI - Mandore Industrial Area

Vehicular/commercial air pollution: The vehicular load in the city of Jodhpur has increased from 238880 to 366399 in last six years. For the purpose of vehicular air pollution assessment, the city was first divided into two categories i.e. old walled city area and the outer new city areas. Different study sites of traffic intersection were selected. These are representing residential, commercial and sensitive areas of Jodhpur city. The selected study sites were described as follows:

Category 1. Congested commercial sites with heavy vehicular load (Old City Area): The most congested markets as well as the old residential areas are mainly located at the following points-

Site I -Jalori gate.

Site II - Khanda Phalsa.

Site III - Katla Bajar.

Site IV - Sojati gate

Category 2. Less congested sites with moderate to heavy vehicular load (New city area): Here the roads are wide but less congested. Vehicular load here also includes heavy motor vehicles. State and national high ways pass through this area. Big commercial complexes are developed along the wide roads.

Site V -Nai Sadak Circle

Site VI -Paota circle

Site VII - Pal link road

Site VIII -Akalia circle

Residential areas air pollution: Samples have been collected from the residential areas selected from different parts of the city:-

Site I - Siwanchi gate	Site II - High court colony/ratanada
Site III - BJS Colony	Site IV - Mandore
Site V - AFRI Campus	Site VI - Massooria
Site VII - Chopasni Housing Board	Site VIII- Mahamandir
Site IX- Ratanada, Bhati Circle	Site X - Bhakat Ki Kothi
Site XI- Chandpole	Site XII- Soorsagar
Site XIII-Balagamand	Site XIV-Rawan Ka Chabutra

Ambient Air Quality Monitoring: Air quality monitoring at major 6 industrial sites, 9 traffic sites and 14 residential sites on 8 hourly average bases were carried out during three seasons, covering winter, summer and rains (monsoon) of the year 2004-05 at Jodhpur city to assess the magnitude of air pollution. The parameters RSPM, SPM, NO₂, SO₂, NH₃ and O₃ were monitored on all working days at all selected study sites. A total of 45 samples from the industrial sites, 72 samples from the commercial/traffic intersection sites and 86 samples from the residential sites were collected during winter (2004-05), summer (2005), rains (2005) and winters (05-06) respectively. These samples were analyzed by using standard methods as described below. The monitoring of Ambient Air Quality was carried out as per standard procedures.

Water pollution assessment

There are three main reservoirs of raw water in the city viz. Kailana, Takhat sagar, and Balsamand. All these reservoirs receive water continuously from Rajiv Gandhi canal and rains. Public Health Engineering Department treats this water in filter houses and then supplies to the city for drinking purpose. The inhabitants mostly use tap water but a few also use groundwater from open wells/hand pumps in some parts of the city. In present study water samples were collected from following major categories of sites and were analyzed using standard methods:

Category 1: Drinking Water samples: These samples were collected from water stored by the households for drinking purpose. Mostly its source was the tap water supplied by PHED. Samples were collected from all residential colonies in all three seasons. In all 123 drinking water samples were collected, 47 samples in winter 2004-05 (December 2004 to February 2005), 40 samples in summer 2005 (April to June 2005) and 36 samples in rainy season of 2005 (July to September 2005).

Site I - Kolari Mohalla	Site II - Umaid Chowk
Site III - Bhim ji Ka Mohalla	Site IV - Jalap mohalla
Site V - Hathiram ka Odha	Site VI - Jalorion ka Vas
Site VII - Jalori gate	Site VIII - Merti gate
Site IX - Shashtri nagar:	Site X - Chaupasani Housing Board
Site-XI - Pabupura basti slum areas	Site XII- Bhadasia slum area

Category 2: Samples from open well/step wells and hand pumps: In all thirty-one water samples were collected one in each of three seasons from following ten sites. In all 9 samples from open well/ step wells and 23 samples from hand pumps and bore wells were collected.

Site I - Kolari Mohalla	Site II- Bhimji Ka Mohalla
Site III- Jalap Mohalla	Site IV - Jalori gate
Site V - Sojati gate	Site VI - Merti gate
Site VII - Hathi Ram Ka Oda	Site VIII- Jalorion ka Vas
Site IX - Umaid chowk	Site X - Bhadasia
Site XI – Balsamand	Site XII – Ratanada

Category 3: Large water reservoirs: In all 9 representative samples were collected from the main raw water sources with one sample from each during winter, summer, and rainy seasons.

Site I - Rajiv Gandhi canal	Site II - Kaylana lake
Site III - Balsamand lake	

Category 4: Filter Houses: The main filter house for drinking water supply to the city is setup near Kaylana lake, Chopasani Road. The other filter house is near Balsamand lake, which supplies water to a very small population of the city in its north side. One representative sample in each season from each filter house was brought to the laboratory and analyzed.

Site I – Water being supplied from Chopasani water filter plant to the city.
 Site II - Water being supplied from Balsamand filter plant to some part of the city

Health Status Assessment

A population based cross sectional health survey was carried out covering all wards of the city. A sample size of 10000 was calculated to find out prevalence of morbidity conditions with prevalence of 1% or more, keeping standard error of 10%. Assuming at least six members in a household, it was decided to survey 1600 households from the city. The sample was distributed to all sixty wards of Jodhpur city depending on the population of the ward. The information about environment related health problems at household level were collected in a pretested schedule provided by Ministry of Environment and Forests. The information about number of patients treated at OPD or indoors at seven selected Govt. Dispensaries cancer, hypertension, gastrointestinal diseases, respiratory diseases, cardiovascular diseases were collected from Office of Chief Medical and Health Officer, Jodhpur. Similar information about patients treated at OPD and wards of four teaching hospitals of Jodhpur was collected from Office of Principal Dr. S. N. Medical College, Jodhpur. Detailed analysis of data about health and diseases and their association with different environmental parameters has been carried out using software Epi- Info 2000.

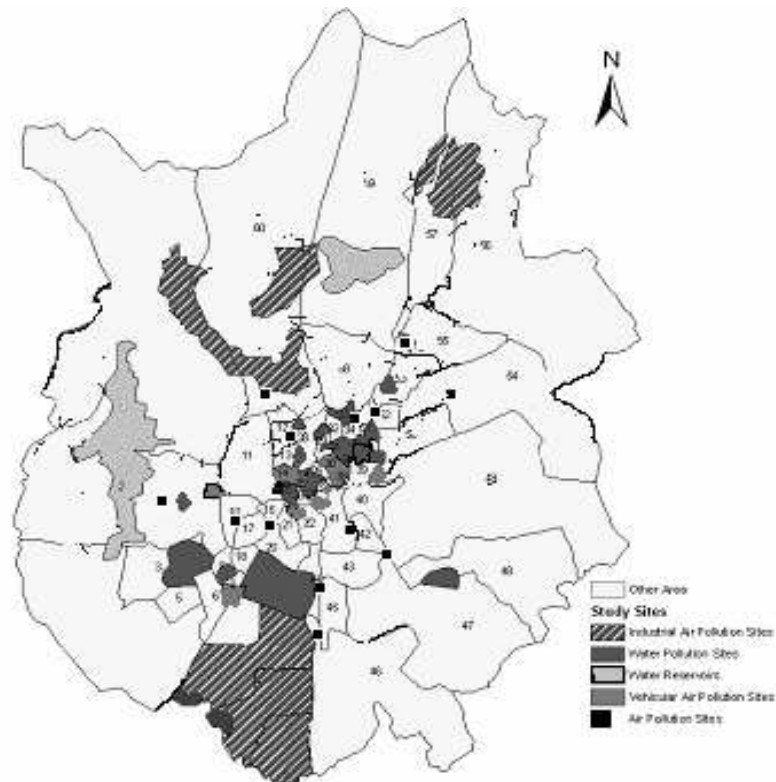


Figure-1 : Ward map of the Jodhpur city showing different study sites

Observations

Air quality monitoring at major industrial sites, traffic intersections/commercial sites and residential areas on 8 hourly basis were carried out during three seasons covering winter, summer and rains of 2004-05 and 2005-06 at Jodhpur city to assess the magnitude of air pollution. The parameters monitored were RSPM, SPM, NO_x, SO₂, NH₃ and O₃.

The annual range, mean and standard deviation of suspended particulate matter up to size 10 microns (SPM), respirable suspended particulate matter up to size 2.5 microns (RSPM) and gases NO_x, SO₂, NH₃ and O₃ of all selected sites for the industrial, commercial and residential air pollution are given in table 1-5 and depicted in Figures 2-9.

Central Pollution Control Board defines the Exceedance Factor (EF) as Observed Annual Mean Concentration of a Criterion Pollutant / Annual Standard for the Respective Pollutant and Area Class. They use this index (EF) for further categorizing level of air pollution as follows:

- Critical Pollution (C): When EF is more than 1.5
- High Pollution (H): When EF is between 1.0 - 1.5
- Moderate Pollution (M): When EF is between 0.5 - 1.0
- Low Pollution (L): When the EF is less than 0.5

The EF for different sites has also been calculated and shown in the table 1-5. The annual mean values of RSPM and SPM were found within permissible limits of annual standards

except for the site II. Their annual means of all sites for SPM and RSPM were within the acceptable standards. The results shown in the table 1 also indicate that the concentration of both parameters were found higher than the acceptable standards once or twice in a year indicating their seasonal effect and that was reported high during winters only.

Fifty six samples were collected from the major traffic intersection sites to assess the vehicular air pollution in the city. These intersections being the main centers of commercial activities have nearby residential areas as well. It has been observed that the annual averages of RSPM and SPM at different sites were above the national ambient air quality standards (Figure 4-5). The annual average of RSPM and SPM in all sites were reported 2-3 times higher than the annual standards as given in the Table-2.

RSPM and SPM level were also measured in the residential areas of the city. The results are depicted in table-3 and figure 6-7. The RSPM at all sites were found within limits of the national ambient air quality standards (Fig.6). The concentrations of SPM in all study sites were found about higher than the annual standards (Fig. 7).

The observations of gaseous air pollution in the industrial areas and in traffic intersections/commercial sites are shown in the Table 4-5 (Fig. 8-9). The annual average values in all the industrial sites were found within the national ambient air quality standards. Similarly the annual averages of gaseous air pollution at vehicular/commercial sites of the city were found within the permissible limits except during winter season when the average values of pollutants were high (Table 5, Fig. 9).

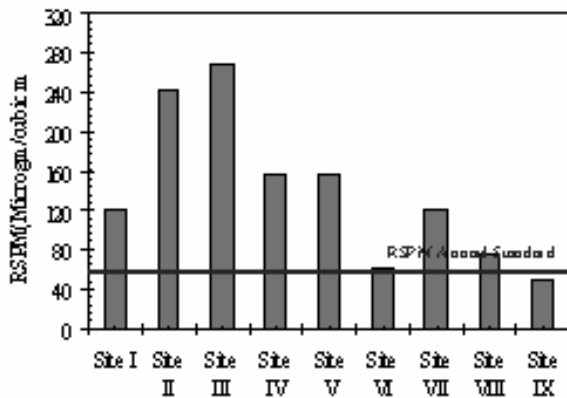


Figure-4: Annual average of RSPM at Traffic intersection Sites (2004-05)

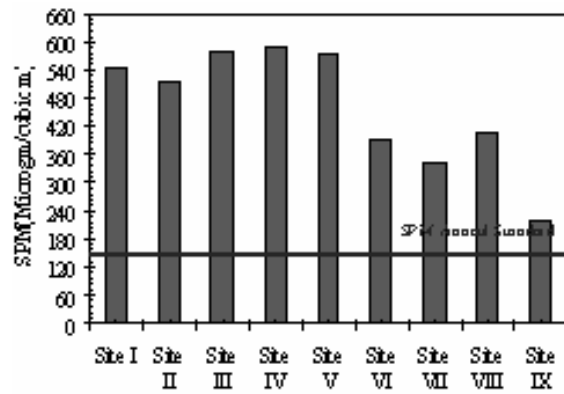


Figure-5: Annual average of SPM at Commercial Sites (2004-05)

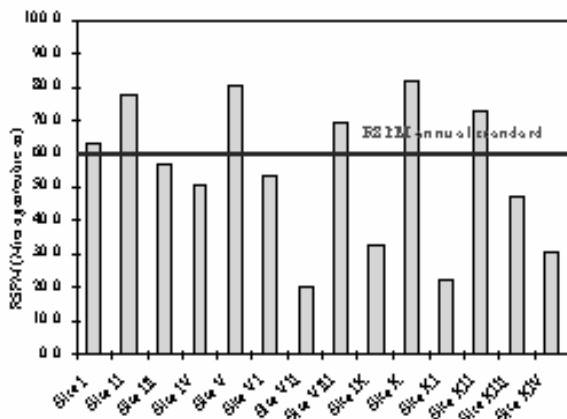


Figure-6: Annual average of RSPM at Residential Sites (2005-06)

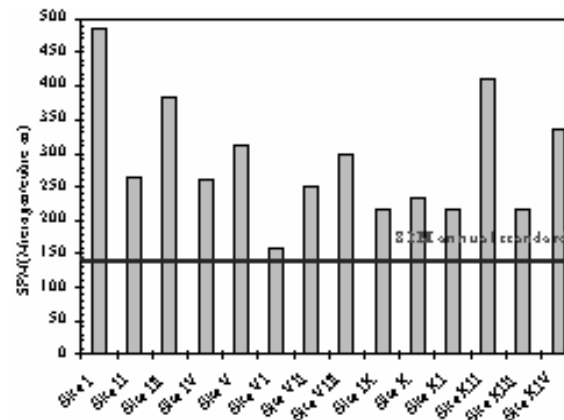


Figure-7: Annual average of SPM at Residential Sites (2005-06)

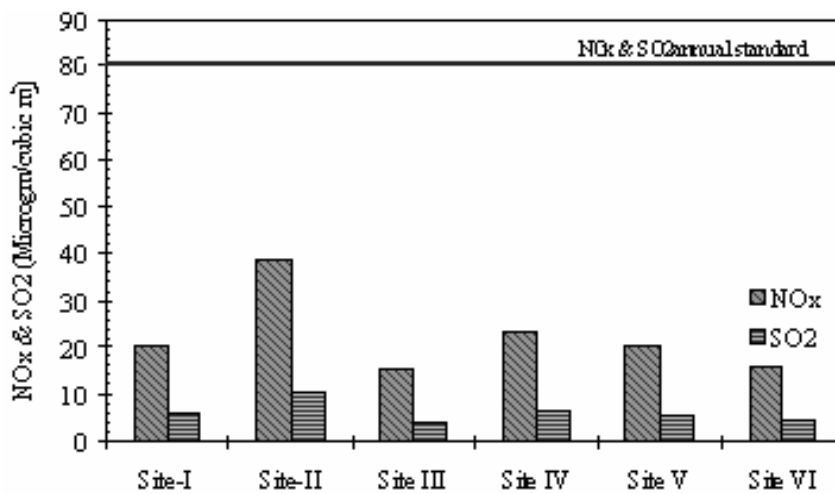


Figure-8: Annual average of NOx and SO2 at Industrial Sites (2004-05)

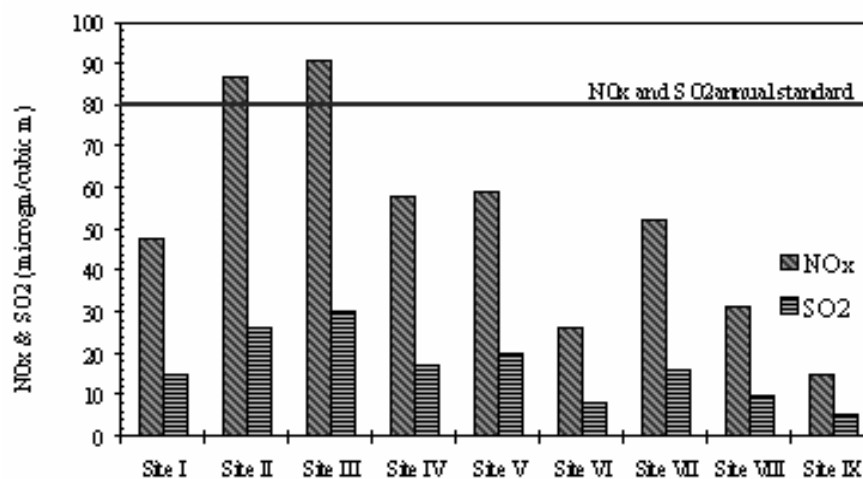


Figure-9: Annual average of NOx and SO2 at Commercial Sites (2004-05)

Table1. Annual levels of RSPM and SPM at Industrial sites during 2004-05

Study sites	Variables	RSPM ($\mu\text{g}/\text{m}^3$)	EF	SPM ($\mu\text{g}/\text{m}^3$)	EF	N
Site I	Range	19.7-163.8		152.3-536.4		
	Mean	60.9 \pm 50.6	0.5	262.6 \pm 179.1	0.7	7
Site II	Range	26.3-390.2		183.3-886		
	Mean	139.2 \pm 144.8	1.2	400.0 \pm 260.9	1.1	9
Site III	Range	18.7-86.25		153.5-582.77		
	Mean	42.7 \pm 21.9	0.4	235.7 \pm 150.3	0.7	8
Site IV	Range	28.9-140.1		192.6-884.3		
	Mean	66.7 \pm 48.1	0.6	397.9 \pm 314.4	1.1	7
Site V	Range	25.5-116.3		179.7-613.97		
	Mean	58.1 \pm 34.0	0.5	339.4 \pm 250.5	0.9	7
Site VI	Range	20.3-98.75		156.7-859.5		
	Mean	45.6 \pm 26.4	0.4	295.1 \pm 259.6	0.8	7
All sites	Range	18.7-390.2		152.3-886.3		
	Mean	71.4 \pm 77.8	0.6	323.4 \pm 236.2	0.9	45
* Annual Standard		120 $\mu\text{g}/\text{m}^3$		360 $\mu\text{g}/\text{m}^3$		

*National Ambient Air Quality Standards described by CPCB, India

Table 2. Annual Average values of SPM and RSPM at traffic intersections/commercial sites during 2004-05

Study Sites	Parameters	RSPM ($\mu\text{g}/\text{m}^3$)	EF	SPM ($\mu\text{g}/\text{m}^3$)	EF	N
Site I	Range	60.9-273.75		350.4-942.875		
	Mean	120.0 \pm 70.9	2.0	544.2 \pm 230.8	3.9	7
Site II	Range	165.0-282.3		336.2-989.5		
	Mean	241.7 \pm 38.2	4.0	513.1 \pm 225.0	3.7	7
Site III	Range	213.8-367.7		318.7-1165.02		
	Mean	267.7 \pm 55.5	4.5	579.9 \pm 275.7	4.1	7
Site IV	Range	77.1-196.25		340.2-1091.75		
	Mean	155.5 \pm 47.8	2.6	588.2 \pm 279.0	4.2	7
Site V	Range	85.5-345.0		343.6-1150.7		
	Mean	156.2 \pm 109.3	2.6	571.4 \pm 328.3	4.1	5
Site VI	Range	33.6-98.6		257.6-608.9		
	Mean	60.8 \pm 26.5	1.0	391.9 \pm 127.1	2.8	6
Site VII	Range	47.1-223.03		185.3-609.96		
	Mean	121.3 \pm 63.6	2.0	338.2 \pm 151.7	2.4	6
Site VIII	Range	45.5-108.86		275.0-641.5		
	Mean	73.9 \pm 22.9	1.2	409.0 \pm 125.9	2.9	6
Site IX	Range	30.8-70.0		163.5-254.7		
	Mean	48.7 \pm 16.4	0.8	217.4 \pm 33.9	1.6	5
All sites	Range	30.8-367.7		163.5-1165.0		
	Mean	143.8 \pm 90.0	2.4	470.6 \pm 234.5	3.4	56
* Annual Standard		60 $\mu\text{g}/\text{m}^3$		140 $\mu\text{g}/\text{m}^3$		

*National Ambient Air Quality Standards

Table 3. Annual average of RSPM and SPM values in residential areas during 2005-06.

Sites	RSPM($\mu\text{g}/\text{m}^3$)			SPM($\mu\text{g}/\text{m}^3$)			N
	Range	Ann avg	EF	Range	Ann avg	EF	
Site I	32.8-90.9	63.0 \pm 19.7	1.1	332.7-706.05	486.4 \pm 166.8	3.5	6
Site II	34.0-125.0	78.1 \pm 35.2	1.3	139.0-368.0	265.7 \pm 94.6	1.9	6
Site III	18.3-88.0	57.0 \pm 27.2	1.0	210.9-502.8	384.9 \pm 132.2	2.7	6
Site IV	32.3-79.23	50.6 \pm 18.3	0.8	134.1-462.4	258.7 \pm 156.9	1.8	6
Site V	50.0-120.9	80.6 \pm 25.8	1.3	188.7-548.4	311.0 \pm 145.7	2.2	6
Site VI	27.8-75.0	53.2 \pm 16.1	0.9	122.6-194.5	156.7 \pm 23.4	1.1	6
Site VII	11.2-37.6	20.7 \pm 9.9	0.3	166.0-329.9	250.5 \pm 68.5	1.8	6
Site VIII	51.1-100.0	69.5 \pm 17.1	1.2	225.5-398.6	300.3 \pm 58.8	2.1	6
Site IX	12.7-51.4	32.9 \pm 13.0	0.5	154.7-280.9	216.3 \pm 48.9	1.5	6
Site X	54.8-130.0	81.6 \pm 26.6	1.4	197.8-295.8	234.8 \pm 38.3	1.7	6
Site XI	13.4-38.57	22.3 \pm 9.2	0.4	154.6-278.65	215.6 \pm 52.2	1.5	6
Site XII	42.6-110.15	73.2 \pm 24.4	1.2	318.3-498.6	412.9 \pm 74.4	2.9	6
Site XIII	20.5-81.4	47.3 \pm 21.5	0.8	167.1-284.1	216.6 \pm 44.6	1.5	6
Site XIV	18.0-51.6	30.5 \pm 12.0	0.5	231.5-472.17	335.8 \pm 107.3	2.4	6
All sites	11.2-130.0	54.3 \pm 28.3	0.9	122.6-706.1	291.4 \pm 129.6	2.1	84
* Annual Standard	60 $\mu\text{g}/\text{m}^3$			140 $\mu\text{g}/\text{m}^3$			

*National Ambient Air Quality Standards CPCB

Table 4. Annual average and range of gaseous air pollution at Industrial sites (2004-05)

Sites	Parameters	NO ₂ (µg/m ³)	EF	SO ₂ (µg/m ³)	EF	NH ₃ (µg/m ³)	EF	O ₃ (µg/m ³)	EF	N
Site-I	Mean	20.5±15.4	0.3	5.9±4.8	0.1	23.6±21.1	0.2	31.3±25.5	0.3	6
	Range	7.6-48.3		1.8-14.5		5.8-61.5		7.6-78.1		
Site-II	Mean	38.3±34.2	0.5	10.1±9.0	0.1	43.6±42.4	0.4	48.5±38.1	0.4	9
	Range	9.9-96.6		2.6-23.8		7.7-110.7		10.6-102.1		
Site III	Mean	15.2±7.6	0.2	3.9±2.2	0.0	16.3±9.9	0.2	21.9±11.6	0.2	6
	Range	6.8-26.4		1.7-7.5		6.8-34.0		8.0-41.1		
Site IV	Mean	23.4±15.0	0.3	6.2±5.0	0.1	26.3±20.9	0.3	34.4±22.9	0.3	6
	Range	10.6-44.3		1.8-14.3		8.5-55.2		12.2-65.9		
Site V	Mean	20.0±10.1	0.3	5.2±3.7	0.1	22.9±15.3	0.2	29.9±16.0	0.2	6
	Range	9.8-34.9		1.5-11.5		7.9-46.8		9.9-53.5		
Site VI	Mean	15.9±8.0	0.2	4.6±2.8	0.1	17.0±10.1	0.2	22.5±12.6	0.2	6
	Range	8.3-29.1		1.9-9.4		6.9-34.9		7.9-45.1		
All sites	Ann. mean	23.44±20.3	0.3	6.3±5.64	0.1	26.4±25.59	0.3	32.7±25.06	0.3	39
	Range	6.7-96.6		1.5-23.8		5.8-110.7		7.6-102.1		
* Annual Standard		80 µg/m ³		80 µg/m ³		100 µg/m ³		120µg/m ³		

*National Ambient Air Quality Standards

Table 5. Annual average and range of gaseous air pollution at vehicular/ commercial sites (2004-05)

Sites	Parameters	NO ₂ (ug/m ³)	EF	SO ₂ (ug/m ³)	EF	NH ₃ (ug/m ³)	EF	O ₃ (ug/m ³)	EF	N
Site I	Range	19.3-89.5		4.7-32.6		21.1-124.0		35.9-180.5		5
	Ann.avg	47.5±29.2	0.8	14.8±11.1	0.2	56.8±39.4	0.6	79.3±59.1	0.7	
Site II	Range	62.2-118.7		18.3-36.8		68.7-119.1		106.4-156.7		5
	Ann.avg	86.6±26.8	1.4	25.9±7.4	0.4	99.4±21.8	1.0	134.3±19.0	1.1	
Site III	Range	48.1-145.5		16.7-49.7		86.7-142.6		115.8-210.9		5
	Ann.avg	90.7±40.5	1.5	30.2±13.6	0.5	117.8±24.2	1.2	155.9±45.5	1.3	
Site IV	Range	19.7-93.1		5.8-25.8		33.5-84.6		42.2-134.7		6
	Ann.avg	58.0±30.8	1.0	17.4±9.0	0.3	61.1±19.6	0.6	93.5±38.6	0.8	
Site V	Range	23.1-113.9		6.7-44.6		41.9-131.1		49.8-219.0		5
	Ann.avg	58.7±38.3	1.0	19.9±15.2	0.3	66.3±37.4	0.7	95.9±71.4	0.8	
Site VI	Range	10.8-48.9		3.5-12.9		17.0-82.8		19.9-81.8		5
	Ann.avg	26.4±16.1	0.4	8.2±4.5	0.1	35.5±27.5	0.4	40.2±27.6	0.3	
Site VII	Range	14.6-89.2		6.6-27.2		28.4-145.8		29.8-156.0		5
	Ann.avg	52.3±33.1	0.9	16.2±9.3	0.3	64.0±47.8	0.6	76.1±50.6	0.6	
Site VIII	Range	11.2-58.7		4.0-15.8		22.3-53.7		24.9-69.0		5
	Ann.avg	31.1±18.8	0.5	9.7±4.9	0.2	33.6±13.3	0.3	45.3±19.9	0.4	
Site IX	Range	6.5-23.7		2.4-7.8		9.3-21.6		13.9-36.5		5
	Ann.avg	15.1±7.4	0.3	5.1±2.5	0.1	16.5±5.3	0.2	23.5±9.1	0.2	
All sites	Range	6.5-145.5		2.4-49.7		9.3-145.8		13.9-219.0		46
	Ann.avg	52.0±35.5	0.9	16.4±11.5	0.3	61.2±39.9	0.6	82.9±56.2	0.7	
* Standard	Annual	60 ug/m ³		60 ug/m ³		100 ug/ m ³		120ug/m ³		

*National Ambient Air Quality Standards

The results of 123 drinking water samples collected from tap water of the household were illustrated in table-4. The observations revealed that pH in 10 samples, turbidity in 1 sample, conductivity in 4 samples, total dissolved solids (TDS) in 1 sample, nitrates in 2 samples, alkalinity in 1 sample, BOD in 2 samples and dissolved oxygen in almost all samples were reported outside the acceptable limits of Indian standards of drinking waters. The bacteriological examination of these household drinking water samples shows that total coliform (TC) in 107 samples, faecal coliform (FC) in 69 sample and faecal streptococci (FS) in 51 samples were present outside the acceptable limits of drinking water standards described as it should be nil. This may be due to contamination of water pipelines lying close to sewer lines. The presence of total coliform in a small number was also observed even in the filter house water samples. This underlines need of residual chlorine.

The results of physical, chemical and bacteriological characteristics of water samples collected from filter house, raw water sources, open/step well and hand pumps/bore wells are shown in the table-7. It was observed that the annual averages of conductivity, total dissolved solids (TDS), total hardness, dissolved oxygen, nitrates, sulfates, alkalinity and chlorides of hand pumps/ bore well and open / step well waters were outside the limits of drinking water standards, whereas most of the parameters in tap water samples of household drinking water samples were within acceptable limits. The presence of total coliform, faecal coliform and faecal streptococci were also observed in all water samples collected from different water sources.

Table 6. Showing average values of physical-chemical & biological parameters of drinking water samples collected from households, as compared sample from filter house (2004-05).

Para-meters	Acceptable limits	Winter n=47		Summer n=40		Monsoon n=36		Mean of all seasons n=123		Chb.Filter house n=3	
		Avg.	Samples outside accept. limits	Avg.	Samples outside accept. limits	Avg.	Samples outside accept. limits	Annual average	Samples outside accept. limits	Ann. avg.	Samples outside accept. limits
pH	6.5-8.5	7.4±0.37	0	7.8±0.25	8	7.6±0.26	2	7.6±0.34	10	7.2±0.15	0
Turb. (NTU)	<5.0	1.1±0.54	0	0.5±0.37	0	2.0±1.16	1	1.2±0.93	1	0.6±0.23	0
Cond. (µs/cm)	<600	274.3±163.24	2	265.1±94.96	2	224.1±48.51	0	256.6±118.58	4	229.0±21.66	0
TDS	<500	146.4±83.66	1	131.3±47.42	0	140.9±20.42	0	139.9±59.31	1	147.0±14.73	0
Hardness	<300	85.6±28.29	0	101.6±15.61	0	100.4±13.39	0	95.2±22.12	0	104.7±11.02	0
Res.Cl	<0.20	0.0±0.05	0	0.1±0.00	0	0.1±0.00	0	0.1±0.04	0	0.3±0.12	0
Temp. (°C)		16.2±2.51	0	33.1±2.00	0	27.9±1.63	0	25.1±7.62	0	23.6±2.45	0
Cl	<250	35.7±9.90	0	34.5±4.00	0	26.9±6.35	0	32.7±8.24	0	27.4±2.68	0
F	<1.0	0.2±0.08	0	0.1±0.12	0	0.1±0.11	0	0.1±0.10	0	0.2±0.13	0
NO ₃	<45	12.2±15.95	2	5.7±6.44	0	9.5±9.27	0	9.3±11.89	2	4.1±2.51	0
SO ₄	<200	61.1±37.27	0	25.0±5.35	0	28.4±8.74	0	39.8±29.01	0	31.3±4.04	0
Alkalinity	<200	131.0±35.03	1	105.0±12.70	0	44.8±27.00	0	97.3±44.70	1	55.8±40.55	0
DO	>7.5	5.1±0.93	47	6.6±0.28	40	6.6±0.65	36	6.0±1.01	123	5.2±0.66	0
BOD	<2.0	1.2±0.48	1	0.8±0.33	0	0.9±0.63	1	1.0±0.51	2	0.8±0.69	0
Pb*	<0.05	0.0±0.00	0	0.0±0.00	0	0.0±0.00	0	0.0±0.00	0	0.0±0.00	0
Fe	<0.30	0.1±0.04	0	0.1±0.09	0	0.2±0.05	0	0.1±0.08	0	0.1±0.03	0
Cd	<0.01	0.0±0.00	0	0.0±0.01	1	0.1±0.08	9	0.0±0.05	10	0.0±0.00	0
TC	0	1306.2±3246.9	34	790.4±2034.6	38	1715.1±3205.8	35	1351.6±3062.3	107	132.3±125.6	3
FC	0	75.4±244.54	18	29.1±94.91	25	65.2±87.86	26	57.4±167.47	69	0.0±0.00	0
FS	0	6.5±22.13	14	10.7±25.62	16	25.4±43.12	21	13.4±31.48	51	0.0±0.00	0

*Pb – 0.0 means Pb <0.19 ppm (Sensitivity of Perkin Elmer AAS Model 2380).

Values of all parameters are in mg/L. Bacterial colonies as counts per 100 ml.

Table 7. Annual average values of physico-chemical and bacteriological characteristics of different water sources (2004-05)

Parameters	Acceptable limit	Drinking water (Household)	Chopasani Filter House	Bal. Filter House	Reservoirs	Wells	Hand pumps/ Bore well
		n=123	n=3	n=3	n=9	n=9	n=23
pH	6.5-8.5	7.6±0.34	7.2±0.15	7.6±0.2	7.6±0.26	7.6±0.23	7.5±0.3
Turb. (NTU)	<5.0	1.2±0.93	0.6±0.23	2.7±1.6	18.4±14.4	0.8±1.05	3.3±3.9
Cond. µs/cm	<600	256.6±118.58	229.0±21.66	672.3±283.0	425.3±267.17	1079.1±341.61	1820.2±988.9
TDS	<500	139.9±59.31	147.0±14.73	159.0±26.5	207.1±69.6	702.1±196.28	1256.8±670.9
Hardness	<300	95.2±22.12	104.7±11.02	160.3±15.0	143.9±52.6	270.8±43.35	393.2±230.6
Res.Cl	<0.20	0.1±0.04	0.3±0.12	0.1±0	0.1±0.04	0.1±0.03	0.1±0.0
Temp. (°C)		25.1±7.62	23.6±2.45	25.8±7.3	24.6±6.89	25.1±2.21	25.1±2.0
Cl	<250	32.7±8.24	27.4±2.68	52.3±31.0	43.8±49.52	93.9±38.08	209.5±110.8
F	<1.0	0.1±0.10	0.2±0.13	1.2±0.3	0.7±0.58	0.2±0.12	0.7±0.4
NO ₃	<45	9.3±11.89	4.1±2.51	6.0±3.3	6.4±4.09	124.6±57.72	296.1±167.9
SO ₄	<200	39.8±29.01	31.3±4.04	66.7±17.1	73.2±35.37	146.3±69.67	202.3±127.4
Alkalinity	<200	97.3±44.70	55.8±40.55	120.0±10.0	132.1±39.80	272.2±102.67	302.6±124.5
DO	>7.5	6.0±1.01	5.2±0.66	5.8±0.9	5.3±0.77	4.4±2.02	4.5±1.8
BOD	<2.0	1.0±0.51	0.8±0.69	0.9±0.6	1.0±0.97	1.1±0.75	1.1±0.6
Pb*	<0.05	0.0±0.00	0.0±0.00	0.0±0.0	0.0±0.00	0.0±0.00	0.0±0.0
Fe	<0.30	0.1±0.08	0.1±0.03	0.3±0.1	0.2±0.09	0.2±0.21	0.2±0.2
Cd	<0.01	0.0±0.05	0.0±0.00	0.0±0.0	0.0±0.00	0.0±0.00	0.0±0.0
TC	0	1351.6±3062.3	132.3±125.6	149.7±93.3	11725.4±11757.6	1129.0±2037.98	2761.9±4641.3
FC	0	57.4±167.47	0.0±0.00	2.0±3.5	79.0±80.03	124.0±146.81	722.6±1617.9
FS	0	13.4±31.48	0.0±0.00	1.3±2.3	108.1±157.3	132.3±216.67	98.4±213.8

*Pb – 0.0 means Pb <0.19 ppm (Sensitivity of Perkin Elmer AAS Model 2380).

Values of all parameters are in mg/L. Bacterial colonies as counts per 100 ml.

For human health assessment 1600 houses were surveyed in the city, which included 9287 individuals (46.2% females and 53.8% males). Our observations indicated sex ratio of 860.0 females per thousand males. As per census 2001, sex ratio was 877.8 females per thousand males in Jodhpur city.

Out of 9287 individuals, 81.1% were Hindus, 18.2% were Muslims and 0.2% were Christian, 0.5% were Sikh, and. As for as their economic status concerned, of all individuals, 3% were in high income group, 47.3% in middle income group, 46.7% in low income group and 2.9% were slum dwellers (lowest income group). Age sex and educational status of the population studied is depicted in Table 8. It shows 24.0% population (17.4% males and 31.7% females) were illiterate. Of all individuals, 3.1% (3.0% male, 0.1% female) were smokers, 3.0 % (2.1% males, 0.9% females) used oral tobacco (zarda) and 5.9% (4.3% males, 1.6% females) consumed gutka; whereas 88.0% of population was not addicted to such habits. Only 2.0% consumed alcohol.

About 73.1% population solely used LPG as fuel in the households, where as about 14.1 % solely used biomass (wood, burada, chaine etc.) and about 3% depended on combination of kerosene/biomass/LPG.

Majority (71.3%) of heads of households told that their family was exposed to medium level of vehicular traffic pollution, followed by 17.6% to low level and 11.1 percent of high vehicular pollution. Similarly 25.5% of the population (23.4% houses) felt indoor smoke problems, where as about 8.9% of the population had the industrial air pollution in their surroundings (3.6% mines, and 5.6% other industries) and 0.3% had air pollution due to solid wastes.

Most houses (97%) did not have any garbage disposal facility and garbage from these houses was dumped on roadsides or open plots. It was found that toilets were not available in 5.9% houses and these residents practiced open field defecation, where as 0.1% individuals depended on common toilets meant for a group of families, 1.3% on dry pits and 3.3% on public toilets. In all 10.6% houses in the city did not have easy access to sanitary facilities.

Tap water supply was available to 85.6 % population and the remaining 14.4% population (10.2% house) depended on public taps / tankers, hand pumps, reservoirs, bore wells and open wells.

The percent prevalence of different environmental related diseases such as respiratory diseases, gastrointestinal diseases, diabetes mellitus, cardiovascular disease, eye diseases and skin diseases are described in Table 9-13. The prevalence of the respiratory disease was 6.7%. It was higher in males (7.7%) than females (5.6%). Prevalence of upper respiratory tract infections was 2.2%, asthma/COPD (Chronic obstructive pulmonary diseases) was 3.4%, and pulmonary tuberculosis was 0.7%. Occupational silicosis was observed in 0.3% males of 45-59 years age. History of diseases diabetes mellitus was given by 2.1 % males and 2.2% females (Table 10).

Percentage prevalence of cardiovascular diseases reported in males was 3.2 %, females 3.9% (Table 11). History of disease hypertension, coronary heart disease with hypertension, and coronary heart diseases without hypertensions was given by 2.7%, 0.8% and 0.1 % subjects (Mutually exclusive). Prevalence of hypertension was higher in females (3.3 %) than the males (2.1%), whereas CHD with hypertension was higher in males (0.9%), than females (0.6%). Coronary heart disease without hypertension was reported only by males (0.2%). Maximum prevalence of cardiovascular diseases was observed in the age group of 45-59 years (10.1%) and 60 years and above (16.4%).

Prevalence of redness of eyes was 1.2%. Another 0.4% and 0.2% subjects complained of irritation of eyes and watery discharge from eyes respectively (Table 12). These prevalences were higher in males.

Percent prevalence of skin diseases was 4.1% (Table 13). Prevalences of various skin diseases such as allergic manifestation, boils, fungal infections, dermatitis, leucoderma and patch of discolouration were 1.3%, 1.1 %, 0.3 %, 0.8 %, 0.2 % and 0.3 % respectively.

The prevalence of gastrointestinal infections was 5.0 % (Table 14). It was 4.9 % in males and 4.7 % in females. Of all 1.2 % had abdominal pain, 0.4 % loss of appetite, 0.8% hyperacidity, 0.3% diarrhoea, 0.3 % dysentery, 0.7% gastritis, 0.3 % hepatitis, 0.6 % jaundice and 0.4 % had typhoid.

Table 8. Educational status in surveyed population of the city

Age-group	Sex	Number examined (n)	Percentage of Education							
			IL	L	M	P	PG	S	SS	G
<5	M	347	83.6	3.5	0.0	13.0	0.0	0.0	0.0	0.0
	F	289	80.3	4.1	0.0	15.6	0.0	0.0	0.0	0.0
5—14	M	967	14.0	16.1	15.4	51.1	0.0	3.1	0.3	0.0
	F	802	12.3	18.1	16.1	48.0	0.0	4.7	0.5	0.2
15-44	M	2581	8.3	3.4	20.7	8.6	5.7	22.8	15.0	15.5
	F	2226	22.4	5.7	17.7	10.5	4.6	17.4	10.7	11.0
45--59	M	695	15.5	5.0	16.0	5.8	7.3	17.0	12.1	21.3
	F	561	44.4	8.6	14.6	8.6	2.7	10.0	5.0	6.2
60+	M	403	31.0	8.4	12.7	8.7	5.2	10.9	9.4	13.6
	F	416	68.8	5.8	8.7	9.1	1.0	2.4	2.2	2.2
All Ages	M	4993	17.4	6.5	16.9	16.8	4.4	15.6	10.3	12.1
	F	4294	31.7	8.3	15.0	17.5	2.8	11.5	6.5	6.8
	Both Sexes	9287	24.0	7.3	16.0	17.1	3.7	13.7	8.5	9.7

Table 9. Percent prevalence of respiratory diseases in Jodhpur city

Age (Completed years)	Sex	Number examined (n)	Percent prevalence of					TOTAL
			COPD/ Asthma	Pneumonia	Silicosis	TB	URI	
0-1	M	42	0.0	0.0	0.0	0.0	0.0	0.0
	F	31	0.0	0.0	0.0	0.0	0.0	0.0
	Both sexes	73	0.0	0.0	0.0	0.0	0.0	0.0
1-4	M	305	2.3	2.6	0.0	0.3	0.7	5.9
	F	258	1.6	1.9	0.0	0.4	2.3	6.2
	Both sexes	563	2.0	2.3	0.0	0.4	1.4	6.0
5-14	M	967	1.6	0.8	0.0	0.0	1.3	3.8
	F	802	1.4	0.2	0.0	0.1	1.0	2.9
	Both sexes	1769	1.6	0.6	0.0	0.1	1.2	3.4
15-44	M	2581	2.5	0.2	0.0	1.1	2.3	6.1
	F	2226	1.8	0.0	0.0	0.7	1.8	4.4
	Both sexes	4807	2.2	0.1	0.0	0.9	2.1	5.3
45-59	M	695	8.5	0.4	0.3	0.7	4.2	14.1
	F	561	5.3	0.0	0.0	1.1	2.9	9.3
	Both sexes	1256	7.1	0.2	0.2	0.9	3.6	11.9
60+	M	403	10.2	0.5	0.0	1.7	4.5	16.9
	F	416	7.7	0.0	0.0	1.0	3.8	12.5
	Both sexes	819	8.9	0.2	0.0	1.3	4.2	14.7
All Ages	M	4993	3.8	0.6	0.1	0.8	2.4	7.7
	F	4294	2.8	0.2	0.0	0.6	2.0	5.6
	Both Sexes	9287	3.4	0.4	0.05	0.7	2.2	6.7

Table 10. Percent prevalence of known diabetics in Jodhpur city

Age-group	Sex	Number Examined (n)	Percent prevalence of	
			Diabetes	Total
0-1	M	42	0.0	0.0
	F	31	0.0	0.0
	Both sexes	73	0.0	0.0
1--5	M	305	0.0	0.0
	F	258	0.0	0.0
	Both sexes	563	0.0	0.0
5--14	M	967	0.1	0.1
	F	802	0.1	0.1
	Both sexes	1769	0.1	0.1
15-44	M	2581	0.6	0.6
	F	2226	0.7	0.7
	Both sexes	4807	0.6	0.6
45--59	M	695	5.6	5.6
	F	561	5.7	5.7
	Both sexes	1256	5.7	5.7
60+	M	403	12.4	12.4
	F	416	11.3	11.3
	Both sexes	819	11.8	11.8
All Ages	M	4993	2.1	2.1
	F	4294	2.2	2.2
	Both Sexes	9287	2.2	2.2

Table 11. Percent prevalence of known cardiovascular diseases in Jodhpur city

Age-group	Sex	Number examined (n)	Percent prevalence of			
			Hypertension	CHD With Hypertension	CHD without Hypertension	Total
0-1	M	42	0.0	0.0	0.0	0.0
	F	31	0.0	0.0	0.0	0.0
	Both sexes	73	0.0	0.0	0.0	0.0
1--5	M	305	0.0	0.0	0.0	0.0
	F	258	0.0	0.0	0.0	0.0
	Both sexes	563	0.0	0.0	0.0	0.0
5--14	M	967	0.0	0.0	0.0	0.0
	F	802	0.1	0.0	0.0	0.1
	Both sexes	1769	0.1	0.0	0.0	0.1
15-44	M	2581	0.8	0.2	0.1	1.1
	F	2226	1.6	0.2	0.0	1.9
	Both sexes	4807	1.1	0.2	0.1	1.4
45--59	M	695	5.9	3.2	0.4	9.6
	F	561	8.0	2.5	0.2	10.7
	Both sexes	1256	6.8	2.9	0.3	10.1
60+	M	403	10.7	4.7	0.5	15.9
	F	416	14.9	2.2	0.0	17.1
	Both sexes	819	12.8	3.4	0.2	16.4
All Ages	M	4993	2.1	0.9	0.2	3.2
	F	4294	3.3	0.6	0.0	3.9
	Both Sexes	9287	2.7	0.8	0.1	3.6

Table 12. Percent prevalence of Ophthalmological diseases in Jodhpur city

Age-group	Sex	Number examined (n)	Percent prevalence of				
			Cataract	Redness	Irritation	Watery discharge	Total
0-1	M	42	0.0	0.0	0.0	0.0	0.0
	F	31	0.0	0.0	0.0	0.0	0.0
	Both sexes	73	0.0	0.0	0.0	0.0	0.0
1--5	M	305	0.0	0.3	0.3	0.0	0.6
	F	258	0.0	0.4	0.8	0.0	1.2
	Both sexes	563	0.0	0.4	0.5	0.0	0.9
5--14	M	967	0.0	0.8	0.6	0.2	1.6
	F	802	0.0	0.4	0.0	0.1	0.5
	Both sexes	1769	0.0	0.6	0.3	0.2	1.1
15-44	M	2581	0.1	1.9	0.7	0.2	2.9
	F	2226	0.2	0.8	0.0	0.2	1.2
	Both sexes	4807	0.1	1.4	0.4	0.2	2.1
45--59	M	695	1.4	2.4	1.2	0.3	5.3
	F	561	2.3	1.2	0.0	0.2	3.7
	Both sexes	1256	1.8	1.9	0.6	0.2	4.5
60+	M	403	5.0	1.2	1.2	1.0	8.4
	F	416	6.5	1.4	0.0	0.7	8.6
	Both sexes	819	5.7	1.3	0.6	0.9	8.6
II Ages	M	4993	0.6	1.6	0.7	0.2	3.1
	F	4294	1.0	0.8	0.1	0.2	1.2
	Both Sexes	9287	0.8	1.2	0.4	0.2	2.6

Table 13. Percent prevalence of Skin diseases in Jodhpur city

Age-group	Sex	Number examined (n)	Percent prevalence of							
			Allergy	Boils	Redness/ Itching	Fungal Infections	Dermatitis	Leuco-derma	Patch Dicolouration	TOTAL
0-1	M	42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	F	31	0.0	0.0	0.0	0.0	3.2	0.0	0.0	3.2
	Both sexes	73	0.0	0.0	0.0	0.0	1.4	0.0	0.0	1.4
1--5	M	305	0.7	1.0	0.3	0.3	0.3	0.0	0.0	2.6
	F	258	0.4	2.7	0.4	0.4	0.0	0.0	0.0	3.9
	Both sexes	563	0.5	1.8	0.4	0.4	0.2	0.0	0.0	3.3
5--14	M	967	1.1	1.3	0.2	0.4	0.4	0.0	0.1	3.5
	F	802	0.7	3.1	0.6	0.0	0.2	0.2	0.0	4.8
	Both sexes	1769	1.0	2.1	0.4	0.2	0.3	0.1	0.1	4.2
15-44	M	2581	1.4	0.8	0.4	0.3	0.3	0.1	0.4	3.7
	F	2226	1.3	0.7	0.5	0.4	0.4	0.2	0.4	3.9
	Both sexes	4807	1.3	0.7	0.4	0.3	0.4	0.1	0.4	3.6
45--59	M	695	1.9	1.0	0.7	0.3	0.0	0.0	0.9	4.8
	F	561	2.1	0.5	0.7	0.9	0.2	0.2	0.5	5.1
	Both sexes	1256	2.0	0.8	0.7	0.5	0.1	0.1	0.7	4.9
60+	M	403	2.0	0.2	1.7	0.2	0.2	0.0	0.2	4.5
	F	416	1.4	1.0	0.5	0.0	0.5	1.2	0.0	4.6
	Both sexes	819	1.7	0.6	1.1	0.1	0.4	0.6	0.1	4.6
All Ages	M	4993	1.4	0.9	0.5	0.3	0.3	0.0	0.4	3.8
	F	4294	1.3	1.3	0.5	0.3	0.3	0.3	0.3	4.3
	Both Sexes	9287	1.3	1.1	0.6	0.3	0.3	0.2	0.3	4.1

Table 14. Percent prevalence of Gastrointestinal (GIT) diseases in Jodhpur city

Age-group	Sex	Number examined (n)	Percent prevalence of									
			Abd. pain	Loss of appetite	Hyper-acidity	Diarrhoea	Dysentery	Gastritis	Hepatitis	Jaundice	Typhoid	Total
0-1	M	42	2.4	0.0	0.0	2.4	0.0	0.0	0.0	2.4	0.0	7.2
	F	31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Both sexes	73	1.4	0.0	0.0	1.4	0.0	0.0	0.0	1.4	0.0	4.2
1--5	M	305	0.3	0.7	0.0	2.3	1.0	2.3	0.0	1.3	0.0	7.9
	F	258	0.4	0.0	0.4	1.2	0.8	1.6	0.0	0.8	0.4	5.6
	Both sexes	563	0.4	0.4	0.2	1.8	0.9	2.0	0.0	1.1	0.2	7.0
5--14	M	967	1.4	0.3	0.2	0.4	0.7	0.6	0.1	1.0	0.4	5.1
	F	802	2.1	0.4	0.0	0.4	0.5	0.6	0.2	0.5	0.6	5.3
	Both sexes	1769	2.0	0.3	0.1	0.4	0.6	0.6	0.2	0.8	0.5	5.5
15-44	M	2581	0.9	0.2	0.6	0.1	0.3	0.7	0.3	0.8	0.4	4.3
	F	2226	1.1	0.6	0.9	0.2	0.1	0.4	0.3	0.2	0.4	4.2
	Both sexes	4807	1.0	0.4	0.7	0.1	0.2	0.6	0.3	0.5	0.4	4.2
45--59	M	695	0.7	0.3	1.7	0.0	0.4	0.8	0.6	0.3	0.4	5.2
	F	561	2.0	0.4	3.2	0.2	0.0	0.4	0.2	0.4	0.4	7.2
	Both sexes	1256	1.3	0.3	2.4	0.1	0.2	0.7	0.4	0.3	0.4	6.1
60+	M	403	0.0	1.2	0.2	0.0	0.2	0.7	1.0	0.2	0.0	3.5
	F	416	1.0	0.0	1.7	1.0	0.5	0.0	0.2	0.2	0.0	4.6
	Both sexes	819	0.6	0.6	1.0	0.5	0.4	0.4	0.6	0.2	0.0	4.3
All Ages	M	4993	0.9	0.4	0.6	0.3	0.4	0.8	0.3	0.8	0.4	4.9
	F	4294	1.4	0.4	1.0	0.3	0.2	0.5	0.2	0.3	0.4	4.7
	Both Sexes	9287	1.2	0.4	0.8	0.3	0.3	0.7	0.3	0.6	0.4	5.0

Secondary data was also collected from Seven Government Dispensaries out of total 23 dispensaries in the city, from the year 2003-2005. These dispensaries were Basni, Police line (Ratanada), Mahilabag, Sardarpura, Chopasni housing board, Chandpole and Udai mandir. The results are depicted in Figure 10 and Table 15. An increasing temporal trend from year 2003 to 2005 has been observed from these data for hypertension, diabetes mellitus, COPD/asthma and acute lower respiratory infections (Ac.LRI). However a declining trend was observed in number of patients of gastrointestinal infections seen at these dispensaries.

There is only one Medical College in Jodhpur (Dr. S. N. Medical College, Jodhpur). Secondary data regarding respiratory diseases, gastrointestinal diseases and cancers were also collected from all its teaching hospitals viz. M. G. Hospital, Umaid Hospital, Mathuradas Mathur Hospital and Kamla Nehru Chest Hospital. The numbers of cases of these diseases seen at these hospitals from 2002 to 2004 are depicted in Figures 11-14 and Tables 16-17. Number of cases of respiratory disease and gastrointestinal infection seen at these hospitals showed increasing temporal trend (Fig. 11). Number of cases of malignancies of breast, body uterus, cervix, oral cavity, pharynx, larynx, trachea, bronchus and lungs and Hodgkin's disease showed increasing temporal trend from 2002 to 2004 as illustrated in Figure 12-14. However gastrointestinal malignancies and leukemia did not show increasing trend.

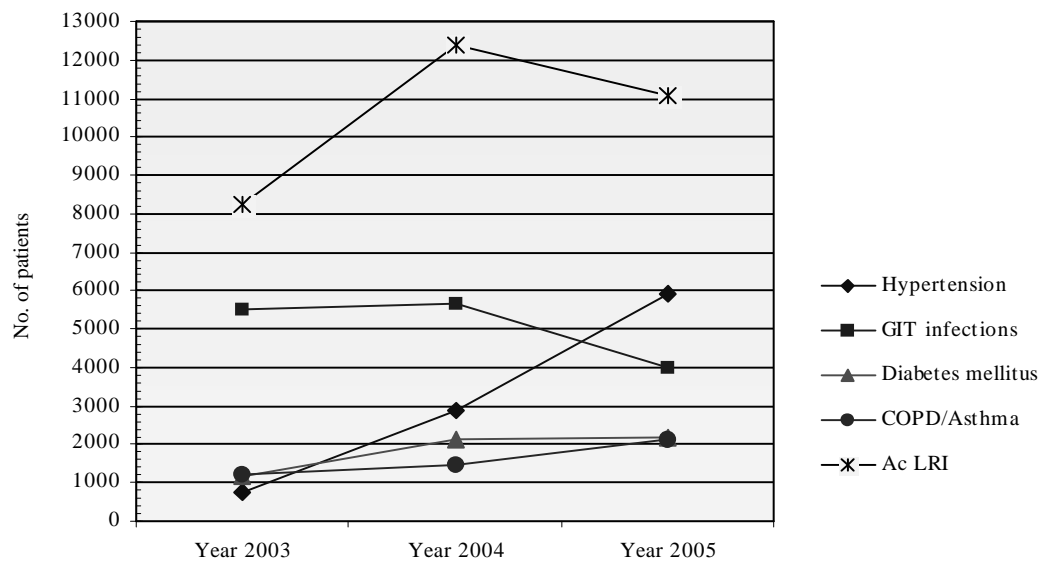


Figure 10. Number of cases of environment related diseases at seven dispensaries.

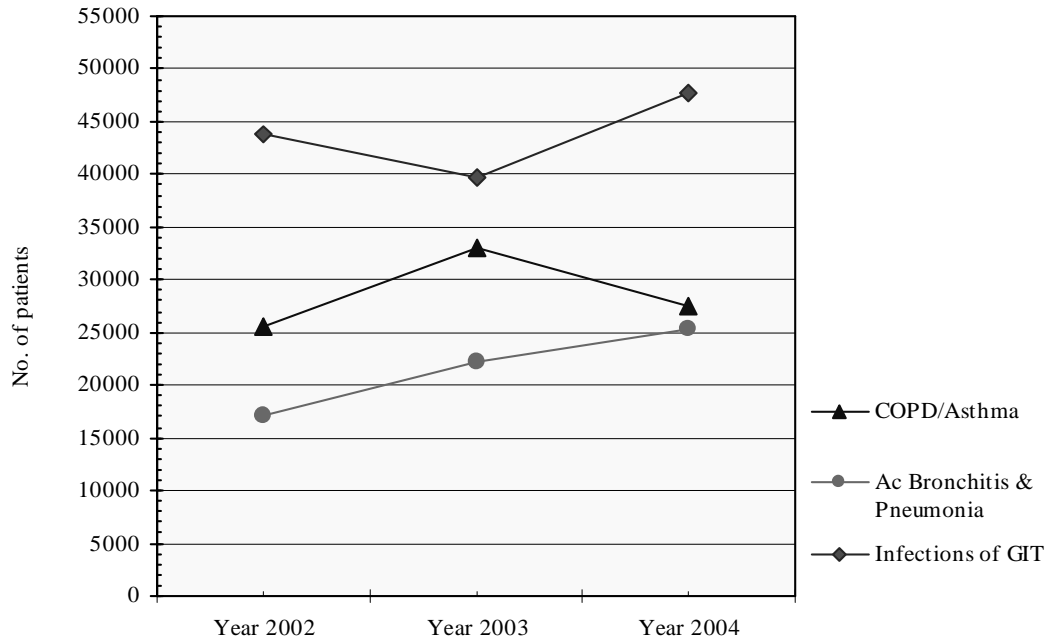


Figure 11. Number of patients of Respiratory Diseases and infections of GIT at teaching Hospitals.

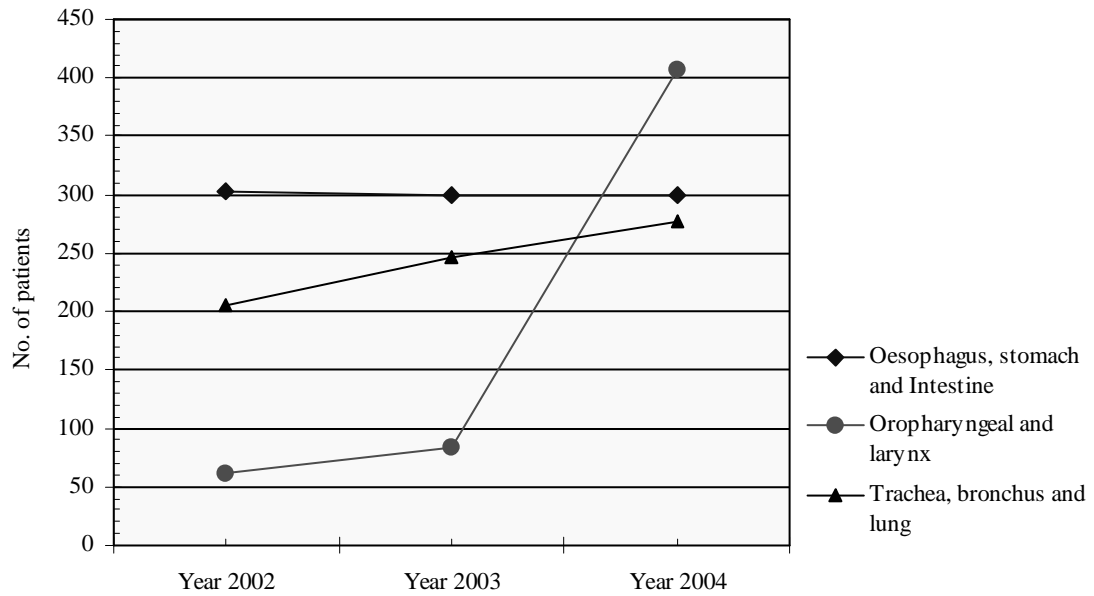


Figure-12. Cancers of respiratory and gastrointestinal tract at teaching hospitals.

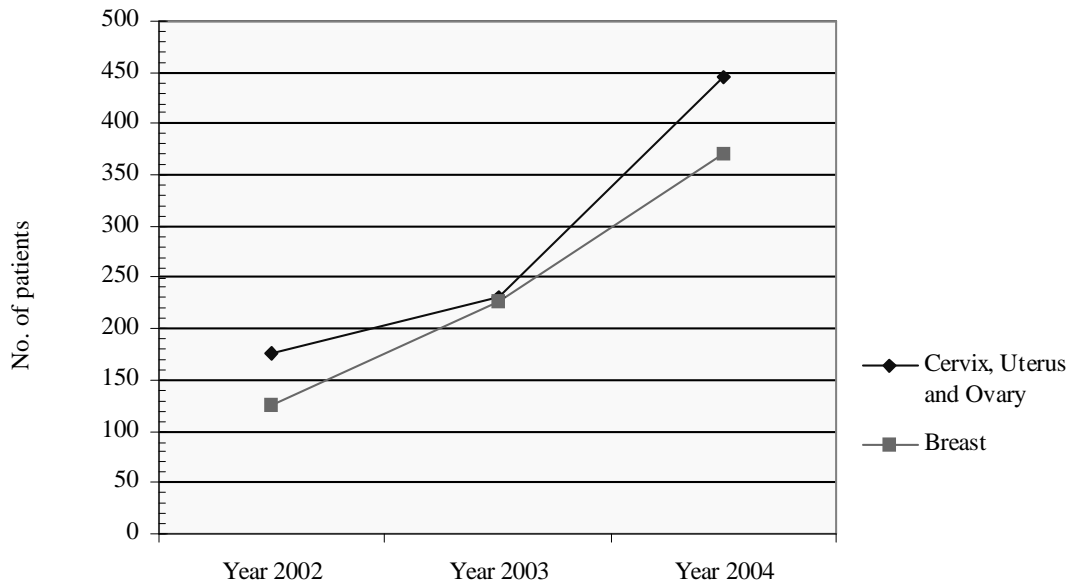


Figure-13. Cancers of breast, uterus and ovary at teaching hospitals.

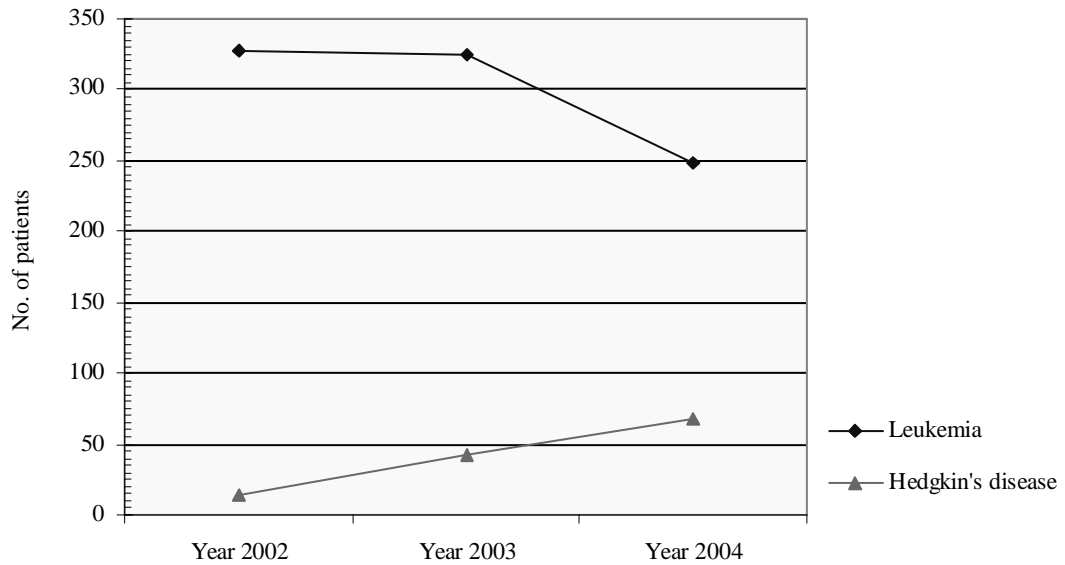


Figure-14. Cases of leukemia and Hodgekin's disease at teaching hospitals.

Table 15. Number of cases of environment related diseases seen at seven selected dispensaries.

Diseases	Year		
	2003	2004	2005
Hypertension	757	2892	5933
GIT infections	5518	5677	3973
Diabetes mellitus	1153	2107	2166
COPD/Asthma	1225	1455	2118
Ac LRI	8269	12404	11088

Table 16. Number of cases of Respiratory and Gastroenteritis diseases at teaching hospitals.

Diseases	Year		
	2002	2003	2004
COPD/Asthma	25506	32950	27408
Ac Bronchitis & Pneumonia	17166	22177	25427
Infections of GIT	43813	39740	47700

Table 17. Number of Cancer patients at teaching hospitals during 2002-04

Site of Malignancy	Year		
	2002	2003	2004
Oesophagus, stomach or Intestine	302	300	300
Oral cavity, pharynx or larynx	62	83	408
Trachea, bronchus or lung	205	246	277
Cervix, Body uterus or Ovary	176	230	446
Breast	126	227	370
Leukemia	327	325	248
Hodgkin's disease	14	43	68

Important Leads and Outcome

The results of present study revealed that annual average of RSPM were above national ambient air quality standards at all traffic intersections/commercial sites and six of fourteen residential sites, while it was higher at only one of six industrial sites. The annual averages of SPM were above national ambient air quality standards at all traffic intersections/commercial sites and all of fourteen residential sites, while it was higher at only two of six industrial sites. The particulate matter may be natural dust, industrial dust or automobile exhausts. The

other dusts deposited on road sites are also made air born by movement of vehicles. Higher levels of SPM and RSPM in residential areas indicate that major cause of air pollution in Jodhpur city may be increasing number of vehicles. The number of cases of respiratory diseases including malignancies also showed increasing temporal trend in the city. The bacteriological examination of 123 household drinking water samples showed faecal coliform (FC) in 69 samples and faecal streptococci (FS) in 51 samples above the acceptable limits of drinking water standards. However prevalence of gastrointestinal infections was not alarming though it showed an increasing trend in cases seen at teaching hospitals.

The project is completed and has yielded general information about state of pollution and occurrence of environment related diseases in Jodhpur but study of specific environmental health problems caused by specific pollutants needs further in depth work. Detailed chemical analyses of heavy metals like lead, cadmium, arsenic, nickel and chromium in air samples, water samples, soil samples and human blood samples remains to be done. Levels of chlorinated byproducts in drinking water samples also need to be measured. Surveillance of morbidity and mortality due to specific diseases needs to be carried out. The strategies to keep the levels of pollution under control also remain to be developed for the city.