Study on Dengue and Dengue Haemorrhagic Fever in Rajasthan, India -

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Date of Commencement: **February, 2003** Duration: **Four Years** Status: **Ongoing**

Objectives (Research)

1. To undertake situation analysis with respect to entomological, virological, epidemiological and serological aspects of dengue /DHF in study areas. Establishment of inter-relation among pupal density of *Aedes* species, naturally infected adult mosquitoes and cases of dengue in a given setting, to develop entomological indicators of disease: Development of predictors and determinates of dengue in Rajasthan.

2. To study quantum of transovarial transmission of virus taking place in nature among generations of susceptible *Aedes* mosquitoes. Study of its epidemiological significance in retention of disease during inter epidemic periods.

3. To study mechanism of DHF in study areas in context to Halstead's hypothesis and role of cytotoxic factor and/or genomic changes: Determination of regional risk factors of DHF.

Objectives (Capacity Building)

1. Creation of a databank to provide knowledge of occurrence and distribution of *Aedes* species in representative paradigms (study areas) of Rajasthan. Development of an updating mechanism of above data base in existing computer soft wares to know status of entomological and virological parameters at a given time for a given setting. Computer simulations of expected dengue prone areas, validation of the simulated results and their ultimate utilization for developing early warning system.

2. Establishment of a Regional Dengue/DHF Reference Centre in the host institute. The proposed laboratory will have its own generated data in the demonstrable form, to guide in developing a suitable control programme. In addition, necessary reference facilities will be initiated in the host institute to help implementing authorities in developing expertise of identifying vector species and their region specific habitats.

Rationale & Observations

To accomplish the research objectives stated in the project, three major research questions were addressed. An account of research questions addressed, work accomplished and interpretations made is mentioned below:

Research question 1: Through study of dengue as a system consisting of *Aedes* vectors, dengue virus and affected human population, in association with regional ecological conditions of a given setting, can we develop predictors and determinants of dengue infection for different settings of Rajasthan so as to workout surveillance design?

Work accomplished: Study has been accomplished in 5 physiographic regions or eco-social settings of Rajasthan, India. Desert region (Area I), Hilly region (Area II), Foot hills region (Area III), Forest & River region (Area IV) and Saline river region (Area V) have been selected. Five villages and one town from each of above settings have been chosen for the present investigations. In all, the observations presented in the report pertain to investigations undertaken in 20 villages and 5 towns, within 6418 houses (1612 urban houses and 4806 rural houses), involving human population of 37,525 inhabitants (8789 urban and 28,736 rural population).

Observations

Adult survey

In study Areas I, II & III (representing desert, hilly and foot hills ecosystems respectively), during pre-rain period (April to June) Adult House Index (AHI) was more in towns than rural areas. Whereas in Area IV & V (representing Forest & Rivers and Saline river ecosystems respectively) more AHI was observed in rural areas than towns. During post-rainy period (September-October), except Area I (desert ecosystem), in all other areas, more AHI was observed among villages than towns. During spring-winter season (December-January) more AHI was observed in urban areas than rural settings (Table 1).

Maximum AHI in urban areas during all the three seasons (24, 20, 25) was observed in desert ecosystem while among rural areas, maximum AHI (18, 89, 10) was observed in ecosystem Forest & River (Area IV) (Table 1).

As a token of presence of a species in a house, total mosquito collected were 1081, out of which 1059 (97.9 %) specimens were *Aedes aegypti* while only 22 (2.0%) specimens of *Aedes vittatus* were collected. While *Ae. aegypti* was observed in all the three seasons, *Ae vittatus* was available only during rains and post-rainy period. No *Aedes albopictus* could be collected from the houses searched during the course of present studies.

Larval survey

Pooled data for all the 5 study regions showed that Breteau Index (BI) during pre-rains period was observed as 13.0 in urban set up while in rural areas it was observed to be 45.2. During post-rain period BI in urban areas was 11.0 and in rural areas it was 74.1 (Table 1). Very low breeding Index of mosquitoes was observed during winter season.

Among urban areas maximum BI was observed (37 & 2) in desert ecosystem (Table 1), while among rural areas maximum BI (94 & 7) was observed in foot hills area (Table1).

Container indices calculated for all the study settings are shown in Tables 2-4. Pooled data suggest that during pre-rains period, among urban areas, container index was maximum (6.0%) in Area I (desert ecosystem). In Area II (Hilly ecosystem) highest container index (3.5) was observed during post-rain period. During winter season urban areas of Area III (Foot hills ecosystem) showed highest (10.2) container index (Tables 2-4).

Table 1. Inter-regional comparison of house hold level adult and larval indices of *Ae. aegypti*

Ecological Area	Pre-rain Adult survey		Larval survey		Post-rain Adult survey		Larval survey		Spring-winter Adult survey		Larval survey	
	Houses searched	AHI	Containers examined	BI	Houses searched	AHI	Containers examined	BI	Houses searched	AHI	Containers examined	BI
Area I												
Urban	100	24.00.0	1079	37	100	20.0	696	5.0	100	25	428	2.8
Rural	288		3833	60	388	0.0	2704	2.5	594	0	1942	0.0
Area II												
Urban	100	13.010.	151	3	100	6.0	454	1663	102	7.8	425	0.2
Rural	200	0	167	9	300	10.3	2032		294	5.7	1172	0.9
Area III												
Urban	100	15.012.	541	15	100	3.0	361	1412	128	23.3	564	10.2
Rural	200	5	1510	94	400	14.5	2453	3	684	7.3	3961	4.4
Area IV												
Urban	100	3.0	491	5.0	100	5.0	464	16	103	11.6	436	1.3
Rural	200	18.5	917	44	37	89.1	1956	85	226	10.1	1087	5.2
Area V												
Urban	100	6.0 9.0	732	5.0	100	1.0	1264	4 97	187	17.6	1101	7.3
Rural	200		2043	19	400	5.5	3180		395	6.8	2326	1.1
Total												
Urban	**500***	**12.2**	**2994**	**13**	**500***	**7.0**	**3239**	**1174**	**620**	**17.0**	**2954**	**4.4**
Rural	**1088***	**8.5**	**8470**	**45.2**	**1525***	**9.3**	**12325**	**.1**	**2193**	**6.0**	**10488**	**2.3**
Pooled	**Houses examined for adult survey 6581 Human population of surveyed houses 37, 525**											
	Containers examined for larval survey 40, 470											

AHI= Adult House Index; BI= Breteau Index

Table 2. Container survey for the breeding of *Aedes aegypti* during pre-rains

PRE RAINS		Cement		Metallic		Clay		Plastic		Underground		Coolers		Others		Total	
Area		Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve
Area I	U	147	12.9	54	5.5	1184	0.05	174	2.87	204	5.88	0	0	0	0	1763	6.06
	R	224	9.37	383	0.52	3960	1.66	473	1.26	691	4.05	0	0	0	0	5731	2.14
Area II	U	42	2.3	6	0	69	0	29	6.89	5	0	0	0	0	0	151	1.98
	R	431	16.4	755	0.13	1746	2.63	375	2.93	125	12	22	4.54	81	3.70	3535	4.18
Area III	U	429	7.92	384	1.04	639	0.46	287	0	92	4.34	64	14.0	12	41.6	1907	2.13
	R	1114	23.3	1149	0.34	2415	0.62	610	0	176	6.25	54	20.3	20	50	5538	3.91
Area IV	U	221	3.16	356	0.56	482	1.03	272	0	19	10.5	96	10.4	0	0	1446	2.21
	R	580	19.3	1211	0.49	1173	1.02	577	1.21	20	0	199	18.0	29	0	3789	4.56
Area V	U	313	4.79	275	0.36	1490	0.06	346	0	175	4	27	0	102	3.92	2728	1.02
	R	920	9.34	1013	2.27	4255	1.17	343	0	551	1.45	27	48.1	93	5.37	7220	2.56

Table 3. Container survey for the breeding of *Aedes aegypti* during post-rains

POST RAINS Area		Cement		Metallic		Clay		Plastic		Underground		Coolers		Others		Total	
		Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve
Area I	U	27	11.1	22	4.54	250	1.6	48	2.08	48	0	0	0	0	0	395	2.27
	R	52	1.92	163	0	846	0.23	125	0	149	1.34	0	0	0	0	1335	0.334
Area II	U	76	9.21	120	0.83	483	2.69	128	4.68	31	9.67	20	0	24	4.16	882	3.51
	R	326	18	713	0.84	1343	2.15	244	1.22	134	8.95	2	100	71	4.2	2833	4.72
Area III	U	187	8.5	174	2.2	271	0.36	133	0	40	0	24	12.5	2	50	831	3
	R	5.6	21.9	499	0.60	1047	0.47	269	0	68	8.82	54	20.4	10	20	2453	5.62
Area IV	U	73	9.58	120	0	148	2.02	84	0	7	0	32	18.7	0	0	464	3.44
	R	282	20.6	675	0.59	611	0.98	283	2.47	13	0	83	12.0	9	0	1956	4.34
Area	U	147	6.12	125	0.8	692	0.14	160	0	83	3.61	11	0	46	8.6	1264	1.42
	R	420	12.8	477	2.30	1885	1.90	167	0	203	2.95	5	20	22	4.54	3179	3.42

Table 4. Container survey for the breeding of *Aedes aegypti* during winter

WINTER Area	Cement		Metallic		Clay		Plastic		Underground		Coolers		Others		Total	
	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve	Ex.	% +Ve
Jaisalmer U	37	16.2	48	0	229	1.74	71	2.81	43	0	0	0	0	0	428	2.80
Jaisalmer R	77	1.29	272	0	1098	0	196	0	299	0	0	0	0	0	1942	0.05
Udaipur U	54	1.85	80	0	193	0	69	0	16	0	1	0	12	0	425	0.23
Udaipur R	153	5.88	364	0.27	459	0.21	114	0	37	0	0	0	47	0	1172	0.93
Jaipur U	146	34.2	118	1.69	186	0.53	86	1.16	26	11.53	0	0	2	50	564	10.28
Jaipur R	580	27.9	718	0.27	1947	0.20	577	0.17	143	4.89	0	0	0	0	3965	4.43
Kota U	70	7.14	135	0	152	0	68	1.47	11	0	0	0	0	0	436	1.37
Kota R	231	22.5	274	0.72	301	0	135	0.74	12	0	33	6.06	2	0	988	5.76
Jalore U	215	8.83	129	6.2	531	8.66	129	5.42	88	0	9	11.1	0	0	1101	7.35
Jalore R	350	4.85	392	0.25	1265	0.55	105	0.95	190	0.52	2	0	22	0	2326	1.16

Virological survey

Among sampled households in rural and urban areas of each study settings, fever survey of current cases was undertaken in all these three seasons to attempt a correlation of cases with simultaneously made entomological observations. Following observations were made:

- During pre-rains, maximum cases were reported from area I (desert) followed by Area II, V and least no. of cases in Area III. No DF case was observed from Area IV (Forest & River) during pre-rains period. During post-rains season maximum cases were observed in Area IV but no cases in Areas I and II (Table 5).

- During pre-rains period sero positivity of cases for dengue was highest (7.4 %) in Area I (Desert Ecosystem) with 21.5% positive sera in urban areas and 2.0% in rural areas. During post-rains period sero-positivity was highest (100%) in Area IV (Forest and River Ecosystem) with all the positive cases occurring in urban areas only. During winter-spring season no sero positive cases of dengue were observed in any of study areas (Table 5).

- Of the 1133 total mosquitoes subjected individually to IFAT, 27 (2.38 %) were found +ve for presence of dengue antigen. Pooled data showed highest mosquito positivity (4.0 %) during winter-spring season, followed by post rains period (1.8 %) and least (1.0 %) during pre-rainy period. During pre-rain period mosquitoes carrying natural infection of dengue were present only in rural areas of Areas III, IV and Area V while none in Areas I and II (Table 6). It was interesting to note that during winter-spring season (December-February), natural infectivity of mosquitoes by dengue virus was highest whereas, in this period no active cases of dengue were recorded from any of study areas (Tables 5-6).

Table 5. Sero-survey of fever cases among sampled houses for dengue antibodies

Area	Pre-rains			Post-rains			Winters		
Zone	**Serum sample Examined**	**Serum +ve**	**No. of +Ve cases / 1000 population**	**Serum sample Examined**	**Serum samples +ve**	**No. of +Ve cases / 1000 population**	**Serum sample Examined**	**Serum samples +ve**	**No. of +Ve cases / 1000 population**
Area I									
Urban	22	11	21.5	0	0	0	0	0	0
Rural	4	1	2.07	4	0	0	0	0	0
Total	**26**	**12**	**21.5**	**0**	**0**	**0**	**0**	**0**	**0**
Area II									
Urban	13	7	15.5	0	0	0	0	0	0
Rural	0	0	0.0	0	0	0	0	0	0
Total	**13**	**7**	**5.3**	**0**	**0**	**0**	**0**	**0**	**0**
Area III									
Urban	7	2	3.01	6	1	1.5	0	0	0
Rural	0	0	0	6	0	0	0	0	0
Total	**7**	**2**	**0.8**	**12**	**1**	**0.2**	**0**	**0**	**0**
Area IV									
Urban	0	0	0		7		0	0	0
Rural	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**7**	**7**	**2.5**	**0**	**0**	**0**
Area V									
Urban	1	1	2.1	13	6	12.7	7	0	0
Rural	0	0	0.7	0	0	0	0	0	0
Total	**1**	**1**	**2.68**	**13**	**6**	**2.5**	**7**	**0**	**0**
Pooled	**47**	**22**	**2.68**	**32**	**14**	**1.04**	**7**	**0**	**0**

Table 6. Area-wise details of mosquitoes carrying natural infection of dengue (IFAT)

Area		Pre Rain			Post Rain			Winter-Spring			Total		
		Ex.	+Ve	%	Ex.	+Ve	%	Ex.	+Ve	%	Ex.	+Ve	%
Area- I	Urban	50	0	0	45	0	0	89	2	2.24	184	2	1.08
	Rural	0	0	0	1	0	0	5	0	0	6	0	0
Area – II	Urban	24	0	0	10	0	0	7	0	0	41	0	0
	Rural	40	1	0	69	0	0	31	1	3.22	140	1	0.71
Area – III	Urban	26	0	0	4	0	0	50	0	0	80	0	0
	Rural	39	1	2.5	120	0	0	74	5	6.75	233	6	2.56
Area – IV	Urban	7	0	0	13	0	0	39	4	10.25	59	4	6.77
	Rural	72	1	1.38	87	6	6.8	36	0	0	195	7	3.58
Area - V	Urban	7	0	0	1	0	0	75	2	2.66	83	2	2.40
	Rural	35	0	0	41	0	0	36	4	11.11	112	5	4.46
Total	Urban	114	0	0	73	0	0	260	8	3.07	447	8	1.78
	Rural	186	3	1.61	258	6	2.32	182	10	5.49	686	19	2.76
Pooled		300	0	1.0	331	6	1.81	442	18	4.07	1133	27	2.38

IFAT= Indirect Fluorescence Antibody Test; Ex.= Examined; +ve= Positive

Inferences

- For developing a surveillance design for dengue for a given area, regional level plans for each socio-ecological area of Rajasthan, India is required which may involve separate rural and urban surveillance schemes. A generalized plan is not likely to be effective. In each of villages and towns, owing to socio-economic and ecological conditions, water storage habits of inhabitants differ and hence domestic vector surveillance has to be based on these criteria of villages/towns.

- For rural areas pre-rains are best periods for adult surveillance and control operations thereof in Desert, Hilly and Foot hills regions of Rajasthan whereas for Forest and Saline river ecosystems, season of post rains is suitable for undertaking adult surveillance.

- For urban areas, in Hilly and Foot hills pre-rains is the better period for mosquito surveillance while for Forest and Saline river regions, post rains is the suitable period.

- Among all the types of containers examined, *Aedes aegypti* emerged as the dominant species and thus it should be a target species for designing control strategy in the Rajasthan.

- In desert and hilly areas, pre-rains is the period of occurrence of disease whereas in Forest, foot hills and Saline river areas, post rain is the preferred time for disease

appearance. This observation forms an important aspect for designing suitable time for disease prevention/ management measures in Rajasthan.

- Table 1 shows that highest Adult House Index (AHI) of *Ae. aegypti* has been encountered during winter (17.0 %) in urban areas, whereas, in rural areas much of seasonal difference with respect to AHI was not observed. However, sero-survey showed (Table 5) no active dengue cases during winters. The data suggest that high AHI does not appear to be the predictor of onset of disease. Table 1 shows high BI during pre-rains and post-rains and these are the periods when maximum dengue cases have been reported. The data suggest that BI could be the strong indicator of disease onset.

Research question 2. Since dengue appears as a seasonal morbidity in community, during inter epidemic periods, where virus remains in nature?

Observations & Interpretations

- The sero survey of fever cases in study population has clearly shown that cases of DF were observed during pre-rains and post-rains period. In winters no case has been reported in any of the towns/villages studied (Table 5).

- However, in winter season, in spite of lowest AHI and BI, maximum percentage of naturally infected mosquitoes has been observed (Table 6). Our observations suggest that in the eco-sociological conditions of Rajasthan, India, winter is the period when virus remain circulating across mosquito generations through vertical route without expressing itself as human morbidity. This appears to be due to low ambient temperature, which does not promote extrinsic virus activity during winters.

- To confirm above aspect we have undertaken an extensive survey of tree hole breeding mosquitoes in a dengue endemic town Jodhpur, Rajasthan. Larvae collected from tree hole were reared into adults and mosquitoes were subjected to IFA to detect vertically transmitted dengue virus. The results are shown in the Table 7.

Research question 3. What are the risk factors of DHF in Rajasthan in context of Halstead's hypothesis, in context of concept of development of cytotoxic factor and/or in context of genomic constitution of affected population?

Contention: According to the widely acceptable theory offered by Halstead, cross infectivity by two dengue strains in a patient, with an interval between two subsequent infections, lead to the stage of DHF. It is being presumed that second dengue strain into an endemic locality is introduced by human infections. However, considering that dengue viruses are highly antigenic and span of virus in transmittable constitution is possible only during short acute stage of fever, we need to work out a persistent source of unchallenged virus responsible for introducing second viral strain into a previously exposed population.

- Data depicted in Table 7 sensitize whether mosquitoes and virus within tree holes can form an independent zoo cycle of dengue with monkeys who live in close association of these tree hole breeding mosquitoes. Since we have observed tree hole breeding *Ae. albopictus* mosquitoes showing positive IFAT and since role of this species has been reported to be more of maintaining type, presence of virus in such niches, may be source of introducing new dengue strain to previously exposed and immune population of endemic or urban DF. More work is required to be done on these aspects.

Table 7. Results of IFAT on tree hole breeding *Aedes* mosquitoes in Jodhpur

Study area	**Indirect Fluorescence Antibody Test**					
	aegypti		*albopictus*		*vittatus*	
	Ex.	+ve	Ex.	+ve	Ex.	+ve
Area A	5	0	0	0	2	0
Area B	18	0	40	4	2	0
Area C	0	0	27	2*	0	0
Area D	0	0	0	0	0	0

Ex. = Examined; IFAT = Indirect Fluorescence Antibody Test
A= Fort, B= City area with garden, C= City area with garden and zoo,
D= Outside city area with garden

Work Remains to be carried out

The research objectives of project included a complete situation analysis of different physiographic region of Rajasthan with respect to entomological, virological, serological and ecological components of Dengue fever. This objective has been accomplished. Since the study is baseline work which is aimed to develop a surveillance design for monitoring magnitude and risk of DF/DHF, at family level, vertical studies, are needed to be made. In addition, an important research issue regarding role of sylvatic viruses in causing DHF, remains to be pursued. Following objectives are proposed to be accomplished:

- Study of Inter-familial and intra-familial transmission dynamics of dengue through confirmation of corelation between vectors, infected vectors and diseased population at family level in a sub sample from selected study areas

- Study of strain characterization of dengue viruses among tree hole breeding *Aedes spp*. and adjacent dengue infected human population to establish evidences of role of sylvatic viruses in amplifying endemic DF and for causing DHF

- Data analysis in GIS and preparation of final project report

Proposed work for Research component strengthening:

- Development of molecular level studies for confirming causes of DHF in the study areas.

- Development of a analytical software for developing surveillance design for dengue vectors and viruses for different settings of Rajasthan, India.

Proposed work for Capacity building strengthening:

- To develop of expertise and technical facilities for epidemiological assessment of risk of DF and DHF in different settings of Rajasthan, India.

- Training school development in institute for Ph.D. and M. Sc. courses on Dengue.
- Service and reference provision for capacity enhancement of institute to diagnose human infections of dengue and identification of vectors.

Development of molecular and genetic markers of virus transmission competence of dengue vector species in Rajasthan- *Vinod Joshi and Manju Singhi*

Date of Commencement: **July, 2005** Duration: **Three Years** Status: **Ongoing**

Objectives

1. Determination of mid-gut proteins responsible for dengue virus transmission (horizontal and vertical) among mosquito vector species, in different ecotypes of Rajasthan.

2. Location of gene controlling the implicated protein and study of frequency of its appearance through gene flow maps.

3. Extrapolation of observations in GIS across different ecotypes of Rajasthan to develop molecular markers of transmission risk of dengue in Rajasthan.

Rationale

Dengue fever associated with Dengue Hemorrhagic Fever (DHF) is an emerging public health problem of India including its north western state, Rajasthan. Presence of vector species of *Aedes* mosquitoes and their abundance in a given area are being used at present as entomological indicators of transmission potential of an area for dengue. However, owing to wide biological variations among mosquitoes in different settings, vector biological indices can not be used as accurate and sustainable markers of risk of disease transmission, in the long run. Through available biotechnological methods, proposed project envisages to develop molecular markers of transmission potential of dengue vectors species *viz*. *Aedes aegypti* and *Ae. albopictus* in different ecotypes of Rajasthan. The protein responsible for imparting virus transmission property to available mosquito species will be implicated and areas wherever such proteins are reported in the state, the area will be marked as dengue risk zones using Geographical Information System (GIS). In addition, the gene controlling appearance of these proteins within wild caught mosquitoes will also be studied for frequency of its occurrence across generations of mosquitoes, to predict seasonality of dengue onset in different settings of Rajasthan. The proposed study is the first of its type in the country where molecular epidemiological indices will be for management of emerging disease such as Dengue and Dengue Hemorrhagic Fever.

Progress of the work

The available species of Aedes mosquitoes in different parts of desert, western Rajasthan, have been collected and reared in laboratory. F1 generation of wild caught mosquitoes were

maintained on sterilized yeast powder as larval food and were kept on glucose solution for survival of laboratory reared adult Aedes. After 2-3 days of emergence into adult mosquitoes, the specimens were dissected in normal saline and the mid-guts of individual mosquitoes were taken out and processed for further studies.

On other hand, head portion of each individual mosquito was processed for the examination of presence of dengue antigen using Indirect Fluorescence Antibody Test (IFAT). Details of test performed is mentioned below:

SDS Poly Acrylamide Gel Electrophoresis (PAGE)

A total number of 545 Aedes mosquitoes were reared in laboratory from field collected larval samples, dissected in normal saline and were subjected to SDS PAGE for their protein assay. Species wise details of assayed mosquitoes is given below:

Table 1.Species-wise details of mosquitoes assayed for SDS PAGE

No. of Mosquitoes assayed	***Ae. aegypti***			***Ae. albopictus***			***Ae. vittatus***		
	No. assayed	**% presence of 200 kDA protein**	**% absence of 200 kDA**	**No. assayed**	**% presence of 200 kDA**	**% absence of 200 kDA**	**No. assayed**	**% prese-nce of 200 kDA**	**% absence of 200 kDA**
545	293	9.55	90.4	135	12.5	87.4	117	100	0.0

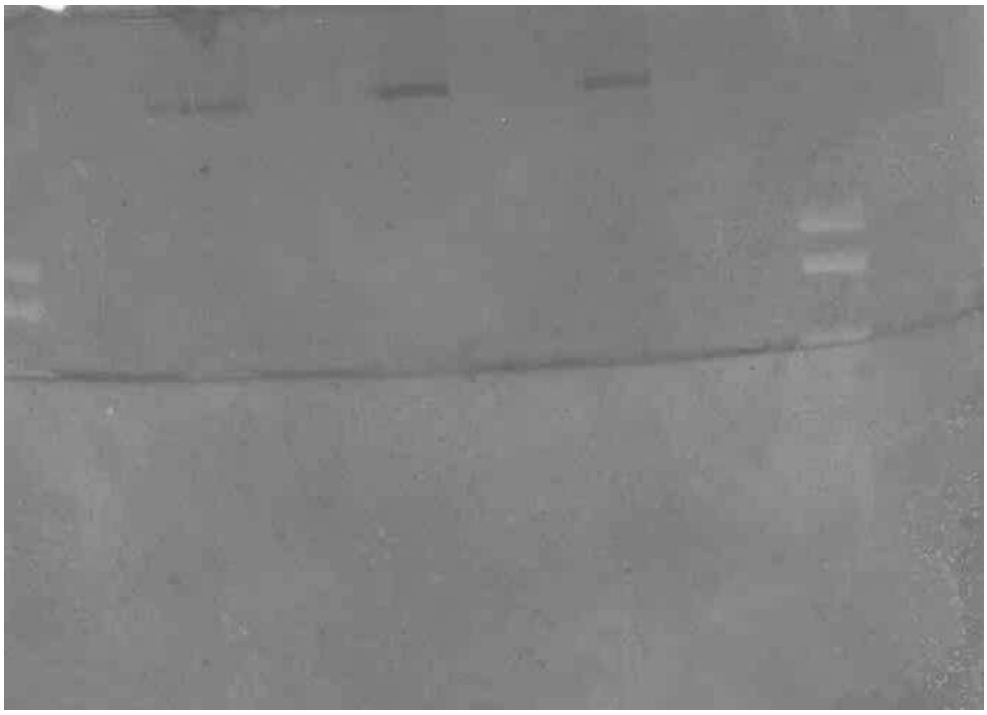


Fig. 1. 200 kDA protein bands of *Aedes vittatus*

Extrinsic replication of dengue virus and present work

The thinking behind present work is that whether surface receptors or intracellular proteins of mid-gut will play a crucial role or not, in penetration competence of dengue virion through inner mid-gut wall of vectors species to designate a mosquito becoming vector or a refractory species respectively? It has therefore, been hypothesized that mid gut proteins of mosquitoes which are likely to play a major role in forming a species a vector or refractory one, should be resolved and related to vector competence of mosquitoes for dengue virus.

Progress of the Work

Proteomics

- Number of field collected as well as laboratory reared *Aedes aegypti* were processed for SDS Poly Acrylamide Gel Electrophoresis (PAGE) for protein assay of their mid guts. In initial assays, no protein bands were emerging from number of individual mosquitoes assayed. However, in few specimens some band of lower molecular weights appeared. In all, 293 *Aedes aegypti* were assayed of which, 90.4% did not shown any high molecular weight proteins (Table 1).

- Another *Aedes* species, *Aedes vittatus*, was then selected to resolve its mid gut proteins. About 117 individual mosquitoes were assayed. It was interesting to observe that in all the specimens of this species (100%) a consistent presence of a High Molecular weight Protein (HMP), about 200 kDA was observed (Table 1, Fig. 1).

- Eggs of *Aedes albopictus* were collected from the tree holes of the zoos/parks in and around Jodhpur and also from other districts of Rajasthan. These were reared in laboratory into adults and specimens were then subjected to SDS PAGE for resolving mid gut proteins. Of the 135 specimens assayed 87.4% showed absence of 200 kDA (Table 2).

Table 2. Association of the absence of 200 kDA protein bands with vector competence of species for TOT

Species	Number of mosquitoes assayed for PAGE	Percentage of presence of 200 kDA protein	Percentage of absence of 200 kDA protein	Percentage of Association of IFA with presence & absence of 200 kDA protein
Aedes vittatus	- 117	- 100.00	- 0.0	- 100.0
Aedes albopictus	- 135	- 12.50	- 87.4	- 71.7
Aedes aegypti	- 293	- 9.55	- 90.4	- 0.5

PAGE = Poly Acrylamide Gel Electrophoresis; IFAT = Indirect Fluorescence Antibody Test

Virus Isolations for Vector competence of TOT

It was perceived that a species acting as vector retaining vertical or horizontal transmission of virus would have successful multiplication of virus within its body so that virus ingested or penetrated in mid gut could reach to salivary glands for inoculation into a host. Presence of virus in the head squashes, inclusive of salivary glands, thus was taken as the criteria of vector competence of a specimen for TOT, in the present study. The Indirect Fluorescence Antibody Test (IFAT)was then employed for the enquiry of virus presence in head squashes of individual mosquitoes tested.

Leads Achieved

Present work has been focused to determine protein markers of vector competence of different Aedes species for vertical as well as horizontal transmission of dengue viruses. So far, following leads have been obtained:

- It has been observed consistently that non-vector or refractory *Aedes* species such as *Aedes vittatus* have shown presence of a High Molecular weight 200 kDA protein in the mid-guts of 117 individual mosquitoes assayed for Electrophoresis.

- Since mid-gut proteins are being pursued as markers of vector competence by few workers as contemporary research, our this finding initiates a new direction of thinking, that is, presence of a protective protein makes a species non-vector or refractory and that absence of this protein makes a species Vector.

- It appears that it is absence of protein which makes a species vulnerable. This needs to be further studied as marker of transmission risk of an area for dengue.

Study of role of zoonotic cycle of dengue virus in maintaining/amplifying endemic DF and causing DHF in different settings of Rajasthan, India -
Vinod Joshi and Manju Singhi

Date of Commencement: **December, 2005** Duration: **Two Years** Status: **New**

Objectives

1. To confirm occurrence of zoonotic cycle (ZC) of Dengue virus among tree hole breeding mosquitoes and inhabiting monkey populations. Study of its occurrence and epidemiological significance in desert settings of Rajasthan.

2. Study of role of Zoonotic cycle in maintaining and/or amplifying endemic cycle of dengue fever.

3. Study of possible role of Zoonotic cycle as factor causing Dengue Hemorrhagic Fever.

4. To undertake experimental studies to confirm monkey- mosquito cycle of dengue in laboratory models of monkeys.

Rationale

Dengue fever (DF) associated with Dengue Hemorrhagic Fever (DHF) is an emerging public health problem in countries of South East Asia and Western Pacific Region. In Rajasthan the epidemics of DF have been reported for number of times in past. In the absence of any chemotherapy or vaccination against DF, prevention of infection is the only tool to save susceptible human population from the disease. With the increasing population and development of rapid means of transportation, exchange of vectors and virus of dengue across different ecotypes of the country has become more pronounced than before. Consequently, dengue is spreading fast and risk of its more severe form i.e. DHF & DSS has increased tremendously.

In the current scenario of available knowledge and expertise it appears essential that reproducible research on developing entomological indices for transmission risk evaluation of an area is undertaken. In addition, studies on mosquito-virus interaction aspects to detect maintenance foci of virus in nature, may also play a key role in understanding aggravation of disease. The virus –mosquito –monkey cycle on trees can serve as one of the maintenance foci of virus. Or extrinsic virus stock being exchanged vertically across mosquito generations within tree holes may serve as such foci. These virus may also contribute to amplify viraemia among towns situated adjacent to these peri-urban niche. In addition, these may also cause DHF.

Progress of the work

Site and Season selection for the study

Present understanding of etiology of Dengue Hemorrhagic Fever (DHF) is based on cross reactivity of two dengue strains appearing in a common host with a gap of few months/years of infectivity from each other. Keeping this in view, we have presumed that endemic dengue has a uniform infectivity by a one DEN strain and that zoonotic or sylvatic foci of virus within tree hole breeding *Aedes albopictus* and monkeys or through vertically transmitted virus within generations of *Aedes albopictus*, may offer another DEN strain to either aggravate or cause DHF/endemic dengue. Thus we have selected following two areas:

1. Umaid Garden with monkeys in zoo

2. Mandore Garden with natural habitats of monkeys

Collection of tree hole breeding *Aedes albopictus* has been made since December, 2005 at fortnightly interval.

Mosquito rearing and Virus isolations

Field work pertaining to collection of breeding stages of *Aedes albopictus* from tree holes has been started from December, 2005 through April, 2006. In all, 10 point collections with fortnightly intervals have been made. A total of 83 samples of adult *Aedes albopictus* mosquitoes have been reared in laboratory form eggs collected from the soil samples of tree holes. The laboratory reared adults have been subjected to Indirect Fluorescence Antibody Test (IFAT) for virus isolations from salivary glands. Mosquito mid-guts of all IFAT processed mosquitoes have been subjected for SDS PAGE for resolving their proteins as the possible molecular basis of vector competence. Details are provided in the Tables 1-2 below:

Table 1. Details of monthly prevalence of tree hole breeding of *Aedes albopictus* and vertically transmitted virus isolations

Period of collection	No. of mosquitoes subjected for IFAT	No. +ve for IFAT	Positive / 1000 mosquitoes
December'05	7	1	140
January'06	12	0	0
February' 06	1	0	0
March' 06	17	4	235
April' 06	46	9	195

IFAT= Indirect Fluorescence Antibody Test

Table 2. Poly Acrylamide Gel Electrophoresis (PAGE) of midguts of *Aedes albopictus* and association with TOT

Period of study	Virus positive/1000	% Absence of 200 kDA protein
December'05	140	86
January'06	0	0
February	0	0
March	235	55
April	195	100

Important Leads:

- Present study aims to establish epidemiological links between extrinsic virus foci and appearance of DHF in the area. The ultimate evidences will be generated through genotyping the viral strains circulating among endemic dengue and sylvatic dengue foci. Work done so far has highlighted an initial lead that a high percentage of mosquito positivity of vertically transmitted dengue virus has been observed among tree hole breeding *Aedes albopictus* species. It is expected that during forthcoming rainy season (July-September) when possible mixing of endemic dengue with sylvatic foci takes place, evidences of mixing of two strains emerging from two foci will be produced more to prove this novel research concept.

- As the present group is also pursuing the contention of absence of 200 kDA proteins of mid gut as possible marker of vector susceptibility, the same issue has been applied in the present project to study the association of virus presence with absence of 200 kDA protein.. Table 2 depicts a strong association of this type.

Confirmation of 'Introduction, Transmission and Aggravation' conceptuality of Desert Malaria: Verification of research undertaken and softwares developed – *Vinod Joshi, Manjeet Singh, Himmat Singh and Praveen Anand*

Date of Commencement: **June, 2005** Duration: **Two Years** Status: **New**

Objectives

1. Study of feasibility and effectiveness of installing check post at sub centre/ village level to check in-migrated natives to prevent introduction of malaria.

2. Testing of malaria transmission prediction module software through prediction and its confirmation in the adopted study villages.

3. Computer programme development using introduction and transmission quantum of malaria in a group of villages to develop epidemic forecasting system.

Rationale

Under influence of desert ecology condition of Rajasthan, malaria has been reduced to its seasonal existence during post monsoonal period of August-October only. The work undertaken so far by our group has shown that in villages of desert region malaria appears every year afresh, it completes its one or two transmission cycles with the help of local vector fauna and then it disappears (Personal discussion with Dr. R. C. Sharma). In certain pockets, outbreaks of disease appear when more imported malaria cases meet with more vector density (DMRC unpublished data). Our earlier research undertaken in 26 villages of irrigated, semi-irrigated and non-irrigated villages of Jaisalmer and Jodhpur districts of Rajasthan had shown that malaria is introduced into desert every year through in-migrated natives. Once introduced through in-migration, the transmission of malaria is controlled by a resultant effect of interaction of mosquito density, human population density, cattle population density and carriers of active infection. The inference which has been drawn on the basis of research undertaken so far is being validated through repeat studies adopting few villages. The whole of concept has been transformed into an equation and the equation has been transformed into a computer software. The description and functionality of software developed has been presented in the present report.

Progress of the work

Four villages have been adopted in Jaisalmer district, Rajasthan, during pre-monsoonal season (June, 2005) and followed up till August, 2005, to accomplish the stated objectives.

The work undertaken in the present project has been focused to address following contentions:

Contention
That malaria in desert conditions is introduced afresh every year otherwise there is no consistent malaria situation in most of the desert villages.

Observations
Only occasional cases of malaria were observed in above adopted villages during months of June-August, 2005.

Table 1. Malaria cases observed in the selected villages during June-August, 2005

Months	Villages	Adult density*		Cattle population	Human population	No. of cases	Predicted status
		An. culicifacies	*An. stephensi*				
June	Tejpala	9(7.01*)	1(0.77)	29000	1151	1**	Sporadic
	Sheikhaser	0(0.0)	0 (0.0)	14000	2200	0	Sporadic
	Bada	20 (20.6)	0(0.0)	11000	1240	3**	Sporadic
	Naga	0(0.0)	0 (0.0)	8000	900	0	Sporadic
July	Tejpala	1(7.5)	0 (0.0)	29000	1151	0	Sporadic
	Sheikhaser	ND	ND	14000	2200	ND	Sporadic
	Bada	2 (12)	0 (0.0)	11000	1240	0	Sporadic
	Naga	0 (0.0)	0 (0.0)	8000	900	3**	Sporadic
August	Tejpala	23 (25.0)	20 (21.8)	29000	1151	0	Sporadic
	Sheikhaser	6 (6.5)	0 (0.0)	14000	2200	0	Sporadic
	Bada	ND	ND	11000	1240	0	Sporadic
	Naga	0 (0.0)	0 (0.0)	8000	900	0	Sporadic

*Average density of month, ** Imported cases

Contention
That this introduction of malaria in desert can be prevented by checking in-migrating natives. The demonstration of the prevention can be shown in adopted villages through introduction of check posts.

Observations
Since there were no cases erupting this step need to be confirmed when disease is witnessed. During the study there were not the cases in rainy season.

Contention
- That once introduced, the prospective transmission of malaria is the resultant interaction of following components:

An. stephensi – Human population density – Active malaria patients

An. culicifacies – Cattle population – Active malaria patients

- That through our epidemiological understanding of above relationship, we can develop a mathematical Equation predictive of malaria transmission in a setting.

Observations

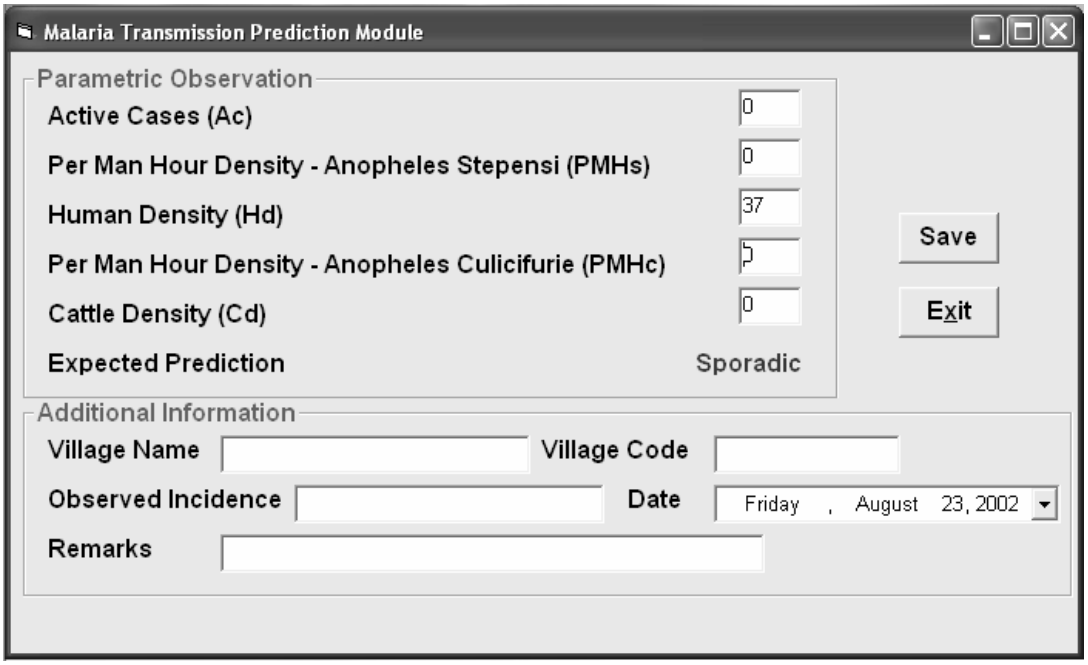
Following equation of quantitative relationship among above parameters has been developed.

TI = Ac (PMHst – Hd + PMHcu - Cd)

Where TI = Transmission Index; Ac = Active Cases; PMHst = density An. *stephensi*; PMHcu = density *An. culicifacies*; Hd = Human density; Cd = Cattle density

Contention

- That we can convert this equation into **A software** for predicting malaria transmission.



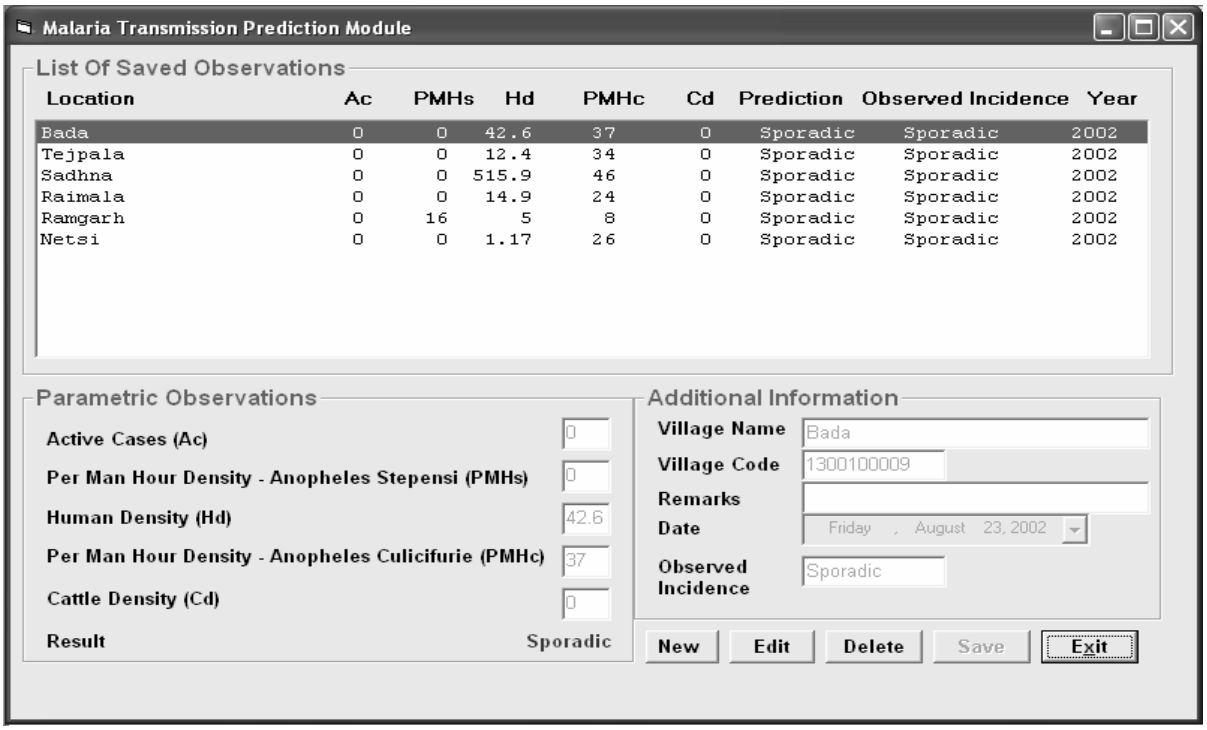
Observations

- A working software has been developed

Contention

- That this **Software could be tested** in field conditions to evaluate its utility.

Observations



Observations

The software developed was used to predict prospective malaria using current data. The expected and observed status of disease (through software) was found same.

Work remains to be undertaken

Developed software will be tested to ensure whether this can predict the prospective disease transmission and testing software through simulated conditions of vector, parasite and disease. During next year attempts will be again made adopting few.

Studies on *Calotropis procera* as larvicide and repellent plant against vectors of Dengue and DHF in Rajasthan, India - *Manju Singhi, Vinod Joshi and P.K. Dam*

Date of Commencement: **July, 2003** Duration: **Two and half years** Status: **Ongoing**

Objectives

1. To study the efficacy of plant as larvicide and repellent against vectors of dengue.
2. To isolate active larvicidal ingradient of latex of *Calotropis procera*
3. To determine optimum dose of larvicide and study mode of action against vectors of dengue.

Rationale

Dengue fever associated with Dengue Haemorrhagic Fever is emerging as one of the major infectious diseases in many parts of India including north -western state, Rajasthan. In the absence of any specific chemotherapy aginst this viral infection and with the confirmed reports of virus being maintained through transovarial transmission among vector fauna of dengue endemic localities, vector control attempting source reduction (larval control) through appropriate means appears most effective method of prevention of disease. *Calotropis procera* is a wildely grown plant of the desert available throughout the year. The plant latex has been observed to contain some constituents which are responsible for the larvicidal efficacy. Preliminary studies accomplished by our group have shown that the latex avilable in *C. procera* has remarkable effect as larvicide. Through proposed project, the attempts of identification of active ingredient of *C. procera* latex responsible for its larvicidal properties against dengue vectors *Ae. aegypti*, will be explored for a bio-larvicide development from indigenous flora. In addition, the optimum dose determination of larvicidal compound will also be made to study feasibility of its use as handy and cost effective biocide in vector control programmes.

Progress of the work

Studies to determine efficacy of *Calotropis procera* latex against two more speciec viz: *An. stephensi* and *Cx. quniquifaciatus* have been undertaken during reported period. Latex from leaves and shoots were collected manually in the month of April-July. Concentrations of crude latex from 0.1-1 % in water have been prepared. Experiments were conducted in summer and rainy season against late 3^{rd} and 4^{th} instar larvae. Controls were kept in normal water to compare the results of experimental exposure with untreated larvae. Corresponding results of zero mortality in controls as shown in Tables 1 and 2 clearly indicate the larvicidal effect of latex as cause of mortality to the exposed larvae. Regression analysis of per cent mortality for different species of mosquitoes during summer and rainy season

showed that value of r= 0.45 or 0.46 which signifies that there is a good corelation between increasing doses of lethal concentration and mortality of larvae.

To resolve chemical compound and identification of the ingradient responsible for larvicidal action, the latex was dissolved in 14 different solvants. The dissolved constituent of latex in each of these solvants was subjected to the dose preparation in the concentration 1000 ppm. Mortality was observed for 24 hours expousre of *Aedes aegypti* larvae to larvicidal preparations . The observation showed that latex dissolved in methyl alcohol and acetonitrile showed highest larvicidal efficacy among all the experimental solvents (Table 3).

The latex of *C.procera* has shown larvicidal efficacy against all three important vector species *viz,*. *Ae. aegypti*, *An. stephensi* and *Cx. quinqefaciatus*, vectors of dengue, malaria and Lymphatic filariasis respectively.

The studies conducted so far necessitate further chemical analysis of latex extracted in methyl alcohol and acetonitrile. The studies are in progress to identify larvicidal compound/ group of *Calotropis procera* through further analysis using spectroscopy and High Performance Liquid Chromatography (HPLC).

Table1. **Larvicidal efficacy of *Calotropis procera* latex against *An. stephensi***

Concentration of Latex (%)	**Percent mortality at different time interval (Hrs.)**									
	24		**48**		**72**		**96**		**120**	
	S	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**R**
Controls	0	0	0	0	0	0	0	0	0	0
0.1	**0**	0	50	40	70	70	90	90	100	100
0.2	30	30	90	80	100	90	100	90	100	100
0.3	40	40	100	80	100	80	100	100	100	100
0.4	70	90	100	100	100	100	100	100	100	100
0.5	80	90	100	100	100	100	100	100	100	100
0.6	80	90	100	100	100	100	100	100	100	100
0.7	90	100	100	100	100	100	100	100	100	100
0.8	100	100	100	100	100	100	100	100	100	100
0.9	100	100	100	100	100	100	100	100	100	100
1.0	100	100	100	100	100	100	100	100	100	100

S- summer, R-rainy

Regression values for Summer season = Y= -7.26+0.54 x, r = 0.45
Regression values for Rainy season = Y= -7.19+0.53 x, r = 0.45

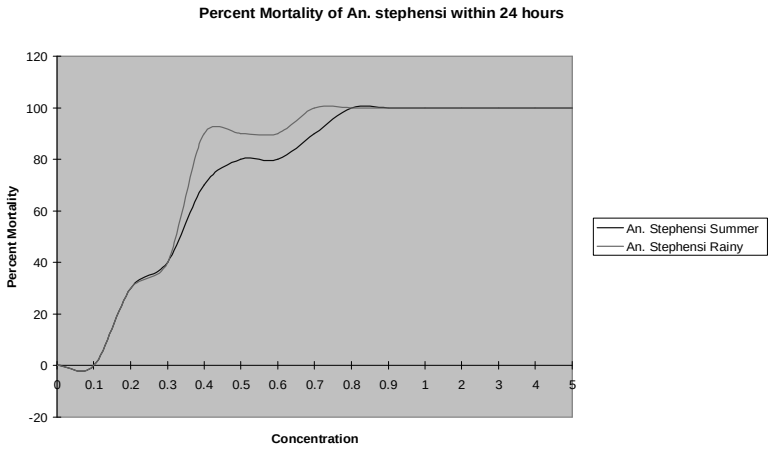


Table 2. Larvicidal efficacy of *Calotropis procera* latex against *Cx. quinquefasciatus.*

Concentration of Latex (%)	Percent Mortality after different time interval (Hrs.)											
	24		48		72		96		120		144	
	S	R	S	R	S	R	S	R	S	R	S	R
Controls	0	0	0l	0	0l	0	0	0	0	0	0	0
0.1	0	60	Nil	60	Nil	60	Nil	80	10	90	20	100
0.2	10	70	30	90	50	100	70	100	100	100	100	100
0.3	10	70	40	80	70	80	80	80	100	80	100	100
0.4	20	80	40	100	80	100	90	100	100	100	100	100
0.5	30	80	50	100	80	100	90	100	100	100	100	100
0.6	50	90	50	100	80	100	100	100	100	100	100	100
0.7	60	100	80	100	100	100	100	100	100	100	100	100
0.8	80	100	70	100	100	100	100	100	100	100	100	100
0.9	80	100	100	100	100	100	100	100	100	100	100	100
1.0	100	100	100	100	100	100	100	100	100	100	100	100

S- summer, R-rainy

Regression values for Summer season = Y= -6.30+0.52x, r = 0.47
Regression values for Rainy season = Y= -6.71+0.52 x, r = 0.46

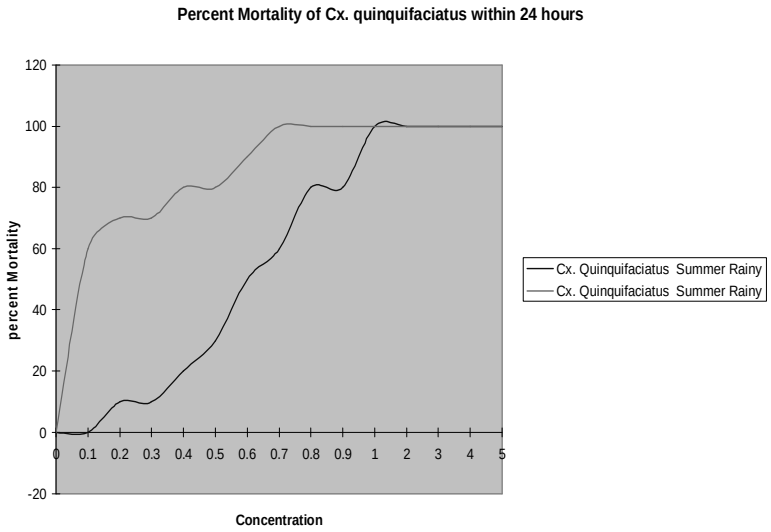


Table 3. Larvicidal efficacy of latex of *C. procera* against larvae of *Aedes aegypti* in Different solvents at 1000 ppm

S.No.	Solvent	Part used	% mortality (24 hours)
1.	Methanol	extract	100
2.	Ethanol	extract	90
3.	Propanol	extract	50
4.	Butanol	residue	80
5.	Diethyl ether	residue	40
6.	Chloroform	extract	10
7.	Pyridine	extract	90
8.	Acetone	extract	90
9.	Aceto nitrile	extract	90
10.	Nitro methane	extract	60
11.	Dimethyl formamide	extract	70
12.	Ethyl acetate	extract	40
13.	Aqueous	extract	10
14.	Hexane	residue	30

Work remains to be carried-out

The methanol and acetonitrile extracts which showed maximum larvicidal efficacy, will be resolved through HPLC, IR, etc. to identify and isolate larvicidal fraction.

Mapping of insecticide resistance in vectors of malaria in Rajasthan - *Karam V. Singh and S. K. Bansal,*

Date of Commencement: **October, 2005** Duration: **Two Years** Status: **New**

Objectives

1. To determine the current status of insecticide susceptibility/ resistance among malaria vectors against conventional and newer compounds in different parts of Rajasthan, and

2. To determine the biochemical mechanisms involved in the development of resistance.

Rationale

Several years of intensive use of organic insecticides to control disease vectors has led to the precipitation of insecticide resistance among them. Resistance management has evolved as a favoured approach to prevent, delay or reduce the impact of insecticide resistance. To develop this new strategy a thorough knowledge of the current status of resistance-developed and the mechanism involved are essential. Factors that induce resistance are numerous and the mechanism adopted by a particular vector species depends on the prevailing pressure and mode of action of insecticide in use. The information collected on the current status of resistance and the mechanism(s) involved would help in formulating probable means for the management of insecticide resistance and state insecticide policy as well.

Progress of the work

The studies have been carried-out in 3 desert districts namely Barmer, Jaisalmer and Jodhpur. These districts have the insecticide spray history of DDT and the synthetic pyrethroids. Two synthetic pyrethroids *viz.* Cyfluthrin and Deltamethrin were introduced as indoor residual spray (IRS) following an epidemic of malaria in 2003 in Barmer and Jaisalmer districts in the epidemic affected villages, whereas, the Jodhpur district is still under DDT spray. In Barmer district the studies were undertaken in village Bhooka Bhagat Singh (PHC-Sindhari), which has insecticide spray history of DDT. In Jaisalmer district the studies were carried-out in two villages of Nachna PHC i.e. Sakaria and Madasar. Both the villages have the past insecticide spray history of synthetic pyrethroids since last two years.

In Jodhpur district all the study villages have past insecticide spray history of DDT. To study the impact of withdrawal of insecticide spray on the insecticide susceptibility status of vector population the villages were selected with the past history of regular spray (Benar), no spray since last one year (Sindhi Nagar), last two years (Vishnui ki Dhani) and >2 years (Bhavi & Ramdeo Colony). The studies were initiated in October, 2005.

During the studies two vector species *viz. Anopheles stephensi* and *An. culicifacies* were tested. Three insecticides i.e. DDT, Malathion and Cyfluthrin (Synthetic Pyrethroid) were used to determine the susceptibility status of these two vector species. In all the districts *An. stephensi* and *An. culicifacies* were prevalent and were tested against the diagnostic doses of the candidate insecticides to determine their susceptibility status in different situations. Besides determining the susceptibility status against the candidate insecticides, the record of the density of the vector species and the proportions of gravid females was also made.

For determining the susceptibility status of vector species dawn collection was made in selected villages using suction tube method. The collected individuals were identified species-wise, abdominal conditions recorded and transported to centre's insectary in Burraud cages for colonization. Then their F-1 generations were tested for susceptibility status using standard WHO method for determining the insecticide susceptibility of adult mosquitoes. The individuals of each species were exposed to the diagnostic doses of DDT (4.0%), Malathion (5.0%) and Deltamethrin (0.05%) for 1.0 hour and the observations were made after 24 hours. The WHO criteria was followed for considering the vector species susceptible (mortality >98 %), resistant (mortality <80 %) and intermediate resistant (mortality 80 – 98 %). Abbott's formula was applied wherever required to correct the observed mortality.

Table 1. Insecticide Susceptibility status of *Anopheles stephensi* in different districts

S. No.	**Candidate Insecticides (Diagnostic doses)**	**Exposure Time** (Hrs.)	**Percent Mortality (%) and Susceptibility Status**				
			Barmer District	**Jaisalmer District**		**Jodhpur District**	
			Bhooka Bhagat (DDT)	**Sankaria** (SP→SP)	**Madasar** (SP→SP)	**Benar** (DDT-Regular.)	**Ramdeo Colony** (DDT >2Yr**)**
1.	DDT	1.0	52.8 **R***	60.0 **R**	25.0 **R**	55.8 **R**	60.0 **R**
2.	Malathion	1.0	73.3 **R**	70.0 **R**	54.5 **R**	77.5 **R**	80.0 **IR**
3.	Deltamethrin	1.0	100.0 **S**	100.0 **S**	100.0 **S**	100.0 **S**	100.0 **S**

***R** – Resistant, **IR** – Intermediate Resistant, **S** – Susceptible.

An. stephensi, the known urban vector of malaria in most of the parts of the country, was prevalent in all the villages selected for the study and tested against DDT, Malathion and Deltamethrin. The results of the susceptibility tests have been given in Table 1. The results revealed that in all the places the species has developed resistance to DDT. Against Malathion also the species exhibited resistance in all the villages except Ramdeo Colony of Jodhpur district, where it has developed intermediate resistance. Against Deltamethrin the species was found totally susceptible. *An. culicifacies*, though was recorded from all the three districts but the susceptibility tests could be conducted only with the individuals collected from Jodhpur district due to the availability of adequate number of individuals (Table 2). The species was found resistant to both DDT and Malathion and susceptible to Deltamethrin.

Table 2. Insecticide Susceptibility status of *Anopheles culicifacies* in Jodhpur district.

S. No.	Candidate Insecticides (Diagnostic doses)	Exposure Time	Percent Mortality (%) and Susceptibility Status	
			Vishnu Ki Dhani (DDT before 2 Yrs.)	**Ramdeo Colony** (DDT >2 Yrs)
1.	DDT	1.0	47.4 **R***	53.3 **R**
2.	Malathion	1.0	-	66.7 **R**
3.	Deltamethrin	1.0	-	100.0 **S**

***R** – Resistant, **S** – Susceptible.

Table 3. Showing mortalities of vector species in the areas having different histories of DDT spray.

S. No.	Vector Species	Percent Mortalities (%) in different backgrounds of DDT Spray			
		Regular Spray	**Before 1.0 Yr.**	**Before 2.0 Yr.**	**>2.0 Yr.**
1.	*An. stephensi*	55.8	55.6	72.5	60.0
2.	*An. culicifacies*	-	-	47.4	53.3

The percent mortalities of *An. stephensi* and *An. culicifacies* against DDT were correlated with the past spray histories in term of duration since last spray (Table 3) and it was observed in case of both the species that with the increased duration the susceptibility status also increases. This observation needs further investigations to establish whether the vector species after the withdrawal of DDT or any other insecticide regains its susceptibility status.

Attempts were also made to correlate the physiological conditions of abdomen of the vector species with different durations since last spray of insecticides, however, no definite trend was observed, which indicated that the durations since last spray do not play any role in determining the proportion of gravid females in the vector population.

Further studies in other parts of the state and determination of biochemical mechanisms involved in the development of insecticide resistance are in progress.

Determination of larvicidal potential of active principle(s) of *Solanum xanthocarpum* against important mosquito vectors - *S. K. Bansal and Karam V. Singh*

Date of commencement: **September,2005** Duration : **Two years** Status: **New**

Objectives

1. Preparation of different solvent extracts from roots, leaves and fruits of *S. xanthocarpum* and isolation of their active constituents.

2. To identify different constituents of the extract and comparison of their larvicidal/repellant properties.

Rationale

Alternate vector control is an essential and effective means for controlling transmission of vector-borne diseases especially in areas where vector has become resistant to the insecticides. Moreover, increasing awareness of the environmental hazards of these synthetic insecticides and development of resistance has forced the scientists to look for other alternatives of vector control. Hence, biologically active plant materials with complex chemical substances of different composition found in various parts of the plants with selective anti-larval and anti-adult properties are being paid attention to replace the synthetic one's. In the process a number of plant species with insecticidal properties have been considered including *Solanum xanthocarpum,* the Indian night shade commonly known as 'baigan kateli' . It is found throughout the country but more abundantly in the arid areas and used widely for a variety of ailments in public health.

During our preliminary studies this plant has exhibited larvicidal properties against *Anopheles stephensi* and *Aedes aegypti*. During the proposed studies different parts of the plant *S. xanthocarpum* will be screened for its active principles, which have yet not been identified for their specific actions. The study will suggest the actual effective constituent(s) of the plant extract which has/have larvicidal/repellent properties and later can be considered for the development of a commercial product.

Progress of the work

Susceptibility tests were carried out with larvae of different mosquito vectors viz. *Anopheles culicifacies, Anopheles stephens*i, *Aedes aegypti* and *Culex quinquefasciatus.* For this

purpose adults and larvae of all the mosquito species were collected from different areas of Jodhpur city and reared in the laboratory for further generations under controlled conditions of temperature (28±2°C) and humidity (75±5%). *S. xanthocarpum* has been selected for undertaking the proposed study. The different parts of this plant differ in their active constituents when extracted in different solvents. Samples of roots, leaves, fruits and seeds of this plant were chopped and shade dried between 30-40°C for 10-15 days. Dried plant material was powdered separately and dissolved in different solvents and stock solutions and duration and serial dilutions were made as per requirement. Third or early fourth instar larvae of these mosquito species were tested as per standard WHO method for determining the baseline data on their susceptibility status. Experiments were carried out in 500 ml beakers containing 249 ml of water by using 20-25 larvae of each mosquito species. Mortality was noted after 24 hr and corrected by using Abbott's formula. Average of four observations was taken and data subjected to log probit regression analysis.

Observations on the results of the larval susceptibility to methanol extracts of fruits are given in Table 1&3. With all the mosquito species mortality was dose dependent i.e. mortality increased with increase in concentration. LC_{50} and LC_{90} values along with their fiducial limits, regression equation and chi-square were calculated. LC_{50} and LC_{90} values as observed for *An. culicifacies*, *An. stephens*i, *Ae. aegypti* and *Cx. quinquefasciatus* were 51.6, 52.2, 118.3 & 157.1 and 159.0, 177.3, 233.1 & 529.4 mg/l respectively. Comparative susceptibility calculated on the basis of LC_{50} value showed that larvae of *An. culicifacies* are 1.01, 2.29 and 3.04 times more susceptible than larvae of *An. stephens*i, *Ae. aegypti* and *Cx. quinquefasciatus* respectively.

Larval susceptibility tests were also carried out with methanol extracts of seeds of this plant with larvae of all the four mosquito species and the results have been given in Table 2&4. With all the mosquito species concentrations tried were 25 to 400 mg/l of the extract and the mortality was again dose dependent. LC_{50} and LC_{90} values as determined for *An. culicifacies, An. stephens*i, *Ae. aegypti* and *Cx. quinquefasciatus* were 66.9, 73.7, 123.8 and 154.9 & 194.2, 241.1,364.0 and 501.2 mg/l respectively which revealed that larvae of *Anophelines* were more susceptible than that of the culicines. Larvae of *An. culicifacies* were found 1.10, 1.85 and 2.32 times more susceptible than *An. stephens*i, *Ae. aegypti* and *Cx. quinquefasciatus* respectively.

Experiments have also been carried out with the methanol extracts of leaves and roots of this plant species which have been given in table 5. Experiments carried out up to 400 mg/l with root extract and from 50 to 400 mg/l of leaves extract show only up to 0-4% mortality indicating that active principle may be present only in the ripe fruit and seeds.

Table 1. Efficacy of methanol extracts of fruits of *S. xanthocarpum* on larvae of different mosquito vectors

Mosquito species/ Concentrations (mg/l)	No. Exposed	No. Dead	Percent Experimental Mortality	Percent Corrected Mortality
An. culicifacies				
Control	80	4	5.0	-
25	80	19	23.7	19.7
50	78	42	53.7	51.3
100	78	59	75.6	74.3
150	79	71	89.9	89.4
200	80	77	96.3	96.1
An. stephensi				
Control	100	7	7.0	-
25	99	29	29.3	24.0
50	98	48	49.0	45.2
100	98	72	73.4	72.5
150	99	87	87.9	87.0
200	100	99	99.0	98.9
Ae. Aegypti				
Control	100	2	2.0	-
50	97	9	9.3	9.3
100	97	31	31.3	31.3
150	97	67	69.1	69.1
200	100	89	89.0	89.0
250	100	98	98.0	98.0
Cx. quinquefasciatus				
Control	99	6	6.1	-
50	99	13	13.1	7.5
100	100	38	38.0	34.0
200	98	57	58.2	55.5
300	99	78	78.8	77.4
400	100	95	95.0	94.7

Table 2. Efficacy of methanol extracts of seeds of *S. xanthocarpum* on larvae of different mosquito vectors

Mosquito species/ Concentrations (mg/l)	No. Exposed	No. Dead	Percent Experimental Mortality	Percent Corrected Mortality
An. culicifacies				
Control	80	5	6.3	-
25	79	12	15.2	9.5
50	79	36	45.6	41.9
100	80	56	70.0	68.0
200	78	67	85.9	85.0
300	77	76	98.7	98.6
An. stephensi				
Control	100	6	6.0	-
25	99	16	16.2	10.9
50	99	41	41.4	37.7
100	98	61	62.2	59.8
200	99	83	83.8	82.8
300	97	95	97.9	97.8
Ae. Aegypti				
Control	89	4	4.5	-
50	88	12	13.6	13.6
100	90	38	42.2	42.2
200	84	55	65.5	65.5
300	83	73	88.0	88.0
400	88	85	96.6	96.6
Cx. quinquefasciatus				
Control	99	5	5.1	-
50	100	18	18.0	14.0
100	98	31	31.6	27.9
200	98	57	58.2	56.0
300	99	81	81.8	80.8
400	99	95	96.9	96.7

Table 3. Log probit regression analysis of the mortality data of larvae of different mosquito vectors to methanol extracts of fruits of *S. xanthocarpum*

Mosquito species	Regression Equation	Chi-Square (DF)	LC_{50} (Fiducial limits)	LC_{90} (Fiducial Limits)
Anopheles culicifacies	Y=2.62x+0.51	0.25 (2)	51.6 (40.1-66.4)	159.0 (93.3-270.6)
Anopheles stephensi	Y=2.41x+0.86	1.26 (2)	52.2 (40.4-67.4)	177.3 (101.6-309.4)
Aedes aegypti	Y=4.35x-4.01	2.69 (2)	118.3 (102.5-136.4)	233.1 (171.4-317.0)
Culex quinquefasciatus	Y =2.43x-0.33	1.42 (2)	157.1 (121.3-203.4)	529.4 (283.1-990.0)

Table 4. Log probit regression analysis of the mortality data of larvae of different mosquito vectors to methanol extracts of seeds of *S. xanthocarpum*

Mosquito species	Regression Equation	Chi-Square (DF)	LC_{50} (Fiducial limits)	LC_{90} (Fiducial Limits)
Anopheles culicifacies	Y=2.77x-0.05	0.95 (2)	66.9 (52.4-85.4)	194.2 (121.0-311.7)
Anopheles stephensi	Y=2.48x+0.35	0.99 (2)	73.7 (58.3-93.3)	241.1 (146.1-397.7)
Aedes aegypti	Y=2.73x-0.72	0.68 (2)	123.8 (98.6-155.4)	364.0 (224.6-590.0)
Culex quinquefasciatus	Y=2.51x-0.50	3.11 (2)	154.9 (122.0-196.7)	501.2 (280.3-896.0)

Table 5. Efficacy of methanol extracts leaves and roots of *S. xanthocarpum* on larvae of different mosquito vectors

Mosquito species/ Conc. (mg/l)	% Mortality with Leaves Extract			% Mortality with Root Extract		
	No. Exposed	No. Dead	% Mortality	No. Exposed	No. Dead	% Mortality
An. culicifacies						
Control	80	00	00	80	00	0.0
50	79	00	00			
100	79	01	1.3			
200	80	01	1.3			
400	80	02	2.5	80	03	3.8
An. stephensi						
Control	97	01	1.0	98	01	1.0
50	98	01	1.0			
100	98	01	1.0			
200	100	03	3.0			
400	100	04	4.0	100	04	4.0
Ae. aegypti						
Control	79	00	0.0	80	00	0.0
50	79	02	2.5			
100	78	01	1.3			
200	80	02	2.5			
400	80	03	3.8	80	02	2.5
Cx. quinquefasciatus						
Control	98	00	0.0	95	01	1.1
50	99	00	0.0			
100	100	02	2.0			
200	99	03	3.0			
400	100	03	3.0	96	02	2.1

A study of the potential interventional variables associated with delay in diagnosis/treatment of pulmonary tuberculosis (PTB) cases in the Thar desert of Rajasthan. *S.P. Yadav and A. K. Dixit*

Date of commencement: **April, 2004** Duration: **Three Years** Status: **On going**

Objectives

1. To measure the time lapse between disease onset and diagnosis/or starting treatment of PTB under DOTS.

2. To find out the causes for delay in diagnosis/treatment for PBT

3. To determine the suitable interventional methods for early case finding and its diagnosis and treatment under DOTS and to find out the cast effectiveness.

Progress of the work

During the report period, 1435 more persons were included in this study who reported at District Tuberculosis Centre (DTC), Jodhpur and PHC, Balesar for medical check up and laboratory investigation for the confirmation of the tuberculosis. The spot sputum samples three times (same day, next day morning and next to next day on spot sample) of all the subjects were examined. Disease history was collected. Sputum slides were prepared and microscopy was done to see presence of *mycobacterium tuberculosis.* Thus, the data of 4142 persons is summarized. About sixty four per cent (63.6%) were new subjects and 36.4% were old. New positive case was defined, whose sputum was first time examined and found positive for *mycobacterium tuberculosis* and old positive case, whose sputum was examined and found positive more than one time at least 8 weeks interval after taking ATT (Table 1).

Table 1. Coverage of study subjects

	Examination Done			**Positive Cases Detected**		
	New	**Old**	**Total**	**New**	**Old**	**Total**
Number	2635	1507	4142	287	72	359
Percentage	63.6	36.4	100.0	79.9	20.1	100.0

About nine per cent (8.7%) were positive for pulmonary tuberculosis. Of these 79.9% were new cases, recurrence cases 10.9%, Irregular cases 5.3% and drop out cases were 3.9%

(Table 2). Further, out of 287 new cases 263(91.6%) cases were delayed in their diagnosis and treatment.

Table 2. Category of study subjects

Category	Number	Percentage
New Cases	287	79.9
Recurrence cases	39	10.9
Irregular cases	19	5.3
Dropout cases	14	3.9
Total	359	100.0

Table 3 depicts socio-demographic characteristics of the study subjects. About eleven percent (10.6%) subjects were < 20 years of age, 24.7% between 20-30 years, 35.7% between 30-39 years, 21.3% between 40-49 years of the age group and 7.6% were > 50 years of age. About Seventy two per cent (71.9%) were male and 28.1% female. About seventy one (70.7%) subjects were Hindu, 29.3% were other than Hindu. Among the Hindus 18.3% were general caste, 34.4% OBC, 47.3% SC/ST, 59.7% Illiterate, 24.0% Literate, 9.5% Primary, 6.8% Middle School and above, 3.4% at home, 10.6% house wife, 14.8% service, 55.5% labour and 15.6% were doing other jobs. Nearly twenty six per cent (26.2%) were living in urban area and 73.8% were belonging to the rural area. About seventy eight per cent (77.6%) were smokers, 37.3% alcoholics and 21.3% opium addicts.

Majority (75.3%) belonged to low socio-economic group, followed by middle income group (19.4%) and high income group (5.3%). Source of referral was one of the important factor for suspected case reporting and treatment. It was found that majority (47.1%) cases were reported to DTC and PHC by own or on the suggestions of the TB patients who had taken experiences of diagnosis and treatment of the disease or by the motivation of their relatives and friends. About one third (33.5%) subjects were referred by government hospitals and 19.4% referred by private practitioners (Table 4).

Table 3. Socio-Demographic characteristics of the study subjects

Characteristics	Number	Percentage
Age		
<20	28	10.6
20-29	65	24.7
30-39	94	35.7
40-49	56	21.3
>50	20	7.6
Sex		
Male	189	71.9
Female	74	28.1
Religion		
Hindu	186	70.7
Other than Hindu	77	29.3
Caste		
General Caste	34	18.3
OBC	64	34.4
SC & ST	88	47.3
Education		
Illiterate	157	59.7
Literate	63	24.0
Primary	25	9.5
Middle School & above	18	6.8
Occupation		
At home	9	3.4
House wife	28	10.6
Service	39	14.8
Labour	146	55.5
Others	41	15.6
Place of Living		
Urban	69	26.2
Rural	194	73.8
Personal Habits		
Smokers	204	77.6
Alcoholics	98	37.3
Opium addicts	56	21.3

Table 4. Distribution of subjects according to economic status and referral

Characteristics	Number	Percentage
Economic Status		
Low Income Group	198	75.3
Middle Income Group	51	19.4
High Income Group	14	5.3
Source of referral		
Self/or suffer/or relatives	124	47.1
Private Practitioners	51	23.2
Government Hospital	88	29.7

Table- 5. Present Complaints of the study subjects

Complaints	Number	Percentage
Fever	142	69.4
Cough with expectoration	159	77.6
Haemoptysis	39	19.0
Loss of appetite	56	27.3
Loss of weight	78	38.0
Chest Pain	125	61.0
Breathlessness	83	40.5

The study subjects (72.2%) were complaining cough with expectoration followed by fever (63.5%), chest pain (58.2%), breathlessness (40.3%), loss of weight (37.3%) and loss of appetite (24.3%) Table5.

Table 6. Period of delay according to category wise

Parameter	<1 Month	1-2 Month	2-3 Month	>3 Month	Total
Sex					
Male	15(7.9)	53(28.0)	45(23.8)	76(40.2)	189(100.0)
Female	7(9.5)	12(16.2)	13(17.6)	42(56.8)	74(100.0)
Educational status					
Illiterate	6(3.8)	9(5.7)	21(13.4)	121(77.1)	157(100.0)
Literate	15(14.2)	52(49.1)	30(28.3)	9(8.5)	106(100.0)
Economic Status					
Low	7(3.5)	40(20.2)	38(19.2)	113(57.1)	198(100.0)
Middle	6(11.8)	24(47.1)	18(35.3)	3(5.9)	51(100.0)
High	10(71.4)	3(21.4)	1(7.1)	0	14(100.0)
Sputum status					
Positive	23(8.7)	62(23.6)	49(18.6)	129(49.1)	263(100.0)
Source of Referral					
Self/Sufferers/relatives	4(2.1)	7(5.6)	11(8.9)	102(82.3)	124(100.0)
Private practitioners	1(2.0)	5(9.8)	31(60.8)	14(27.4)	51(100.0)
Government Hospital	18(20.5)	53(60.2)	11(12.5)	6(6.8)	88(100.0)

Table 6 depicts the period of delay according to category wise. Females as compared to males, illiterate as compared to literate, low income group as compared to high income group were more delay in diagnosis/or treatment.

Table 7. Reasons for delay in diagnosis/treatment

Reasons	**Number**	**Percentage**
Lack of Knowledge	203	77.2
Others	60	22.8
Total	263	100.0

Table 7 shows the causes for the delay in diagnosis/treatment of the tuberculosis patient. Most dominating cause of delay in diagnosis /treatment was lack of awareness among the patients about causation of disease, signs and symptoms of the disease, preventive and curative measures. As a result they failed to recognize symptoms of disease (77.2%) and did not report to the doctors for the diagnosis and treatment.

Inferences

Based on the study undertaken following inferences can be drawn:

- There is a substantial proportion of patients (91.6%) of Pulmonary Tuberculosis (PTB) who delay the diagnosis and treatment of the disease.

- Out of this 91.6% of patients delaying, nearly 92% makes more than 1 month delay, which is a dangerous period of delay for infection such as PTB.

- Lack of awareness was the major cause of delay in 77.2% of patients.

- Socio-Demographic characteristics suggest that patients belonging to illiterate, low income and SC/ST & OBC are vulnerable sets of population.

Work remains to be done

Collection of remaining data from desert area and similar observations from non desert areas in same number and by same methods will be done to compare social determinants of delay in diagnosis and treatment among desert versus non desert population. This will help to plan an intervention.

Important leads/outcomes from the study

The study will reveal the duration of delay in diagnosis/ treatment of the tuberculosis in the desert population of Rajasthan. Further, this study will identify the causes of delay in diagnosis/ treatment. After completion of this study an intervention programme could be planed for the reduction in delay in diagnosis/ treatment in national tuberculosis control programme. Certainly this will be great achievement of this study and as a result decreasing will start in new cases of tuberculosis in the community. The control programme will achieve its goal for early diagnosis and treatment for the tuberculosis control.

Longitudinal studies for disease dynamics in desert ecosystem of Rajasthan: Study of socio-cultural, socio-economic and epidemiological aspects of malaria - *SP Yadav, RK Kalundha, and AK Dixit*

Commencement: **January, 2005** Duration: **Five Years** Status: **On going**

Objectives

1. Study of health seeking behaviour of desert population and determination of socio-economic, socio-cultural and educational basis of behaviour.

2. Study of migration of human population as risk factor for import and spread of desert diseases with special reference to malaria.

3. Study of inter-relationship of sociological, biological and epidemiological components for a disease.

Rationale

Desert forms an exemplary system of peculiar adaptive abilities exhibited by dwelling human population, mosquitoes and other vector species, pathogenic bacteria and viruses. At a glance, it appears as a stable system having acquired its own characteristics for centuries with respect to above aspects of biosphere. To develop a long term and reliable strategy for monitoring and controlling desert diseases, a complete profile study of desert is needed through launching continuous longitudinal studies in its selected representative area. Proposed study has been aimed to generate baseline data needed to understand human and its interaction with environment to maintain viable health status. The basic health relevant information on socio-cultural, socio-economic and education status of human population in desert areas will generate a basis for understanding transition of any disease in desert with special reference to vector born diseases for example malaria.

Progress of the work

During report period total households in all the 60 villages of Ramgarh CHC in Jaisalmer district were covered for base line data. Data entry for analysis is on progress. Data of sub sample of 450 households which was collected in 15 villages by covering 30 households (15 household from LSEG and same number of households from HSEG) in each village were summarized. Majority (75.6%) of the respondents were 20-49 years of age group. About eighty eight per cent (88.4%) were Hindus and among the Hindus 25.7% were SC/ST

followed by 34.4% OBC and 39.9% GC (Table 1). The average family size was 6.2. The background information of malaria collected for these H/H in last five years showed that the incidence of malaria was more common among the low socio-economic group during five consecutive years from 1999 through 2003 for all the study villages. The number of positive cases for malaria was markedly different among subjects of the low socio-economic group as compared to high socio-economic groups of households. In the year 1999, 25(1.8%) cases of malaria were observed in the low socio-economic group (LSEG), while in the high socio-economic group (HSEG) 4(0.3%) cases were reported. In the year 2000, 31(2.2%) among LSEG and 6(0.5%) among HSEG; in 2001 46(3.1%) among LSEG and 9(0.7%) among HSEG; in 2002, 27(1.8%) among LSEG and 7(0.5%) among HSEG and in the year 2003, 26(1.7%) cases in LSEG and 5(0.4%) cases were reported among HSEG. This is an indication of the importance of socio-cultural factors in contributing malaria transmission (Table 2). This indicates that socio-cultural factors are much responsible for transmission of malaria. These include living style, social behaviour, beliefs and practices, social customs, level of education, type of occupation, economic status, and so on. These factors were found influencing the degree of transmission of malaria in both the communities. Surroundings of living area, practices of water stores in the containers, covering practices of water containers through lids, frequency of changing portable water in the containers, use of proper lid on 'tanka', and proper sanitation, were significantly different in the study population groups. Misconceptions about malaria have been found in study population. As a result low socio-economic community was taking double time to avail health facility between the occurrence of the malaria and diagnosis and treatment as compared to high socio-economic community. Distribution pattern of malaria cases among different age groups of inhabitants of two different socio-cultural groups of study population is shown in Table 3. Data indicate clearly that among infants (less than one year) in none of the two communities any malaria case was present. In the age group of 1-5 yr, 30.1% of total cases were present among LSEG, while only 5.4% of cases were observed in HSEG. In the age group of 5-15 yr, 43.5% of cases were reported among LSEG, while only 8.6% of cases were present among HSEG. In the age group of >15 yr least difference of malaria cases LSEG (9.5%) and HSEG (2.7%) was observed as compared to pre school and school going age children. The pre-school and school going children were found to be more vulnerable to malaria. The lower susceptibility in infants could be attributed to two reasons: firstly, the social custom of keeping the infants well clothed and covered by cloth which did not allow the mosquitoes bite. Secondly, infants born of immune mothers were, at least partially protected by maternal antibodies and fetal hemoglobin during the first 3-5 months from the malarial parasite. Similarly, the population, over 15 years of age exposed continuously to malaria developed considerable degree of resistance and awareness about the disease and use preventive measures against mosquitoes bites, thus thereby decreasing the susceptibility in adults. Table 4 depicts status of knowledge between the two socio-cultural groups. The knowledge status about malaria parasite was 9.8% among LSEG as against 63.1% among HSEG. However, other parameters of knowledge about disease causation were not much different as about parasite between the two communities. It also shows status of knowledge about signs and symptoms of malaria between the two communities. It is obvious that important signs and symptoms such as high fever, chills, vomiting, etc., were substantially less known to LSEG as compared to HSEG (Table 4).The human behaviour with regard to the etiology, treatment and prevention of malaria not only fosters the spread of the disease but also results in continuing of the disease

within the community. People seek medical care depending upon the individual perceptions of illness. The concept of illness behaviour under which individual perceptions of ill health are analyzed has been reviewed by many other workers also. Illness behaviour is the ways in which given symptoms may be differentially perceived, evaluated and acted (or not acted) upon by different kinds of persons. It appears from this study also about beliefs and values of the people and the continuance of malaria are not conceptually focused on the illness behaviour' and malaria transmission. The tribal populations identified the perceptions about causation, prevention and treatment of malaria. In general the tribes believed that diseases are caused primarily by the spirits of the dead, anger of the local deities and black magic.

Majority of study population in theses villages could not distinguish malaria from other types of fever and regarded malaria as a mild and self limiting disease. They believed malaria fever was the results of climatic factors. Mosquito bite, were not viewed as harmful to health and treatment were not taken for malaria. Table 5 enumerates details of different preventive measures being adopted by the two different communities in the desert. An interesting observation was that adoption of modern preventive measures such as use of mosquito nets, good night vaporizer, odomos cream etc. were more common among HSEG, while use of traditional or ad hoc preventive measures such as use of oils, smoke of cow-dung, etc. were more common measures among LSEG. Table 6 states the level of knowledge, attitude about malaria vectors and personal prophylaxis among study subjects. Data resolved across different parameters under "knowledge about malaria vectors" show substantial difference in knowledge about vector mosquitoes within the two communities. The attitude regarding expectation of respondents from system (questions such as "Is Health Department not taking good care of malaria patients in your village?") was more pronounced among the LSEG (73.3%) as compared to the HSEG (54.2%). Table 7 depicts the refusal status of the study subjects.

Inferences

This is an indication of the importance of socio-cultural factors in contributing malaria transmission. This also indicates that socio-cultural factors are responsible for giving the environment for transmission of malaria by their living style, social behaviour, beliefs and practices, social customs, level of education, type of occupation, economic status, and so on. These factors were influencing the degree of transmission of malaria in high and low economic group of study population. Surroundings of living area, practices of water stores in the containers, covering practices of water containers through lids, frequency of changing portable water in the containers, use of proper lid on ‘tanka’, and proper sanitation, were significantly different in the study population groups. Misconceptions about malaria have been found in study population. As a result low socio-economic group of population was taking double time to avail health facility between the occurrence of the malaria and diagnosis and treatment as compared to high socio-economic group of population. Distribution pattern of malaria cases among different age groups of inhabitants of two different socio-cultural groups of study population was also found to be different.

Work remains to be done

Collection of remaining data will be done. Determinants emerging need to be confirmed and verified to plan an intervention based on them.

Important leads/outcomes from the study

The study will reveal the importance of socio-cultural factors in contributing malaria transmission. After completion of this study an intervention programme could be planed for malaria control.

Table 1. Socio-demographic characteristics of respondents

Characteristics	LSEG		HSEG		Total	
	No.	%	No.	%	No.	%
Age (yrs)						
<20	19	8.4	15	6.7	34	7.6
20-29	35	15.6	17	7.5	52	11.6
30-39	51	22.7	62	27.6	113	25.1
40-49	89	39.6	86	38.2	175	38.9
>50	31	13.8	45	20.0	76	16.8
Sex						
Male	163	72.4	144	64.0	307	68.2
Female	62	27.6	81	36.0	143	31.8
Religion						
Hindu	197	87.6	191	84.9	398	88.4
Other than Hindu	28	12.4	34	15.1	62	13.8
Caste						
General Caste	93	47.2	66	34.6	159	39.9
OBC	58	29.4	79	41.4	137	34.4
SC&ST	56	28.4	46	24.0	102	25.7
Education						
Illiterate	172	76.4	88	39.1	260	57.9
Literate	31	13.8	61	27.1	92	20.4
Primary	10	4.4	46	20.4	56	12.4
Middle	8	3.6	23	10.2	31	6.9
High School and above	4	1.8	7	3.2	11	2.4
Occupation						
Agriculture	96	42.7	112	49.8	208	46.2
Animal Keeping	55	24.4	51	22.7	106	23.6
Service	5	2.2	32	14.2	37	8.2
Labours	62	27.6	8	3.6	70	15.6
Others	7	3.1	22	9.7	29	6.4

LSEG- Low socio- economic group HSEG- High socio- economic group

Table 2. Incidence of malaria in two different communities from 1999 to 2003

Study parameters	1999		2000		2001		2002		2003	
	LSEG	**HSEG**	**LSEG**	**HSEG**	**LSEG**	**HSEG**	**LSEG**	**HSEG**	**LSEG**	**HSEG**
Population	1396	1215	1440	1234	1483	1257	1529	1276	1571	1298
Family size	6.2	5.4	6.4	5.5	6.6	5.6	6.8	5.7	7.0	5.8
BSC	73	51	85	62	94	70	87	59	76	55
BSE	60	42	72	54	79	59	76	48	63	46
(+)ve cases	25	4	31	6	46	9	27	7	26	5
Pf cases	13	1	19	2	28	4	17	3	12	1
%*Pf*	52.0	25.0	61.3	33.3	60.9	44.4	63.0	42.9	46.2	20.0
ABER	4.3	3.5	5.0	4.4	5.3	4.7	5.0	3.8	4.0	3.5
API	1.8	0.3	2.2	0.5	3.1	0.7	1.8	0.5	1.7	0.4
SPR	41.7	9.5	43.1	11.1	58.2	15.3	35.5	14.6	41.3	0.4
SFR	21.7	2.4	26.4	7.3	35.4	6.8	22.0	6.3	19.0	2.2
Death	00	00	00	00	00	00	00	00	00	00

LSEG- Low socio- economic group HSEG- High socio- economic group

Table 3. Distribution of Malaria Cases according to Age and Sex in two Different Communities

Age Group (Yrs)	LSEG			HSEG			Grand Total		
	M No. (%)	F No. (%)	Total No. (%)	M No. (%)	F No. (%)	Total No. (%)	M No. (%)	F No. (%)	Total No. (%)
0-1	0	0	0	0	0	0	0	0	0
1-5	36 (19.4)	20 (10.8)	56 (30.1)	7 (3.8)	3 (1.6)	10 (5.4)	43 (23.1)	23 (12.4)	66 (35.5)
5-15	50 (26.9)	31 (16.7)	81 (43.5)	11 (5.9)	5 (2.7)	16 (8.6)	61 (32.8)	36 (19.4)	97 (52.2)
>15	11 (5.9)	7 (3.8)	18 (9.7)	3 (1.6)	2 (1.2)	5 (2.7)	14 (7.5)	9 (4.8)	23 (12.4)
Total	97 (52.2)	58 (31.2)	155 (83.3)	21 (11.3)	10 (5.4)	31 (16.7)	118 (63.4)	68 (36.6)	186 (100.0)

LSEG- Low socio- economic group HSEG- High socio- economic group

Table 4. Knowledge about causation and signs and symptoms of malaria in two different communities

Causation	LSEG		HSEG	
	No.	%	No.	%
Malaria parasite	22	9.8	142	63.1
Personal Hygiene	24	10.7	9	4.0
Impure water and edible items	60	26.8	24	10.7
Changing environment	71	31.4	30	13.3
Multiple causes	28	12.4	13	5.8
Don't Know	20	8.9	7	3.1
Total	225	100.0	225	100.0
Signs and Symptoms				
High Fever with chills or sweating on alternate day	75	33.3	120	53.3
Fever with giddiness, vomiting and reddish on the faces	37	16.4	65	28.9
Multiple sign and symptom	64	28.4	31	13.8
Others	49	21.8	9	4.0
Total	225	100.0	225	100.0

LSEG- Low socio- economic group HSEG- High socio- economic group

Table 5. Preventive majors used by two different communities

Preventive majors	LSEG		HSEG	
	No.	%	No.	%
Mosquito net	13	5.8	82	36.4
Odomos cream	5	2.2	36	16.0
Oils	60	26.7	21	9.3
Tortoise coil	6	2.7	25	11.0
Good night vaporizer	2	0.9	14	6.2
Smoke of cow-dung	39	17.3	18	8.0
Smoke of foliage	37	16.4	15	6.7
Nothing	63	28.0	14	6.2
Total	225	100.00	225	100.0

LSEG- Low socio- economic group HSEG- High socio- economic group

Table 6. Knowledge, attitude about biology of malaria vectors and preventive measures of malaria in two different communities

Study parameters	LSEG(n=225)		HSEG(n=225)	
	No.	%	No.	%
(A) Knowledge about malaria vector				
Does *Anopheles* mosquito carry malaria parasite?	47	20.8	159	70.7
Can you identify male/female mosquitoes?	15	6.7	68	30.2
Is the feeding time of malaria mosquitoes before dawn or after the dusk period?	27	12.0	102	45.3
Do you know if *Anopheles* mosquito rest in cool and dark place?	18	8.0	87	38.7
Do you know if *Anopheles* mosquitoes lay eggs in the water?	31	13.8	136	60.4
(B) Personal Prophylaxis				
Do you know *Anopheles* takes 5-6 day to complete lifecycle?	35	15.6	120	53.3
Do you know mosquito- meshes on windows and doors can prevent the entry of mosquitoes in the house?	51	22.7	144	64.0
Do you know that the bed net can prevent the mosquitoes bite in the open field?	63	28.0	161	71.6
Do you know 'tanka', earthen pots, cess pits and stagnant water are the main sources of mosquitoes breeding?	70	31.1	150	66.7
Do you know by covering 'tanks' etc. and by proper drainage, the mosquito breeding can be prevented in the house?	91	40.4	191	84.9
(C) Treatment and other aspects				
Can Malaria take human life?	46	20.4	198	88.0
Can present drug cure the patients?	97	43.1	209	92.9
Whether the malaria control programme will improve the disease condition?	69	30.7	131	58.2
Is health deportment not taking good care of malaria patients in your village?	165	73.3	122	54.2
Would you like to contribute in running Sub-centre, PHC, etc. in your village?	40	17.8	72	32.0
Are present malaria control activities not of much help to malaria patient?	154	68.4	187	83.1
Would you go and get chloroquine tablets from PHC/RH/Sub-centre & etc. if no body came and delivered them regularly at your place?	35	15.6	153	68.8
Would you like to be treated discretely at the nearest PHC/RH/Sub - centre?	123	54.7	162	72.0
Whether health workers are cordial in their dealing with malaria patients?	109	48.4	137	70.2

LSEG- Low socio- economic group HSEG- High socio- economic group

Table 7. Distribution of respondents according to reasons for refusal to household Spraying

Reasons for refusal to household spraying	LSEG		HSEG		Total	
	No. (n=112)	%	No. (n=37)	%	No. (149)	%
Bad odors	77	68.8	12	32.4	89	59.7
Fear of water being poisoned	66	58.9	10	27.0	76	51.0
Fear of food being poisoned	71	63.4	8	7.1	79	53.0
Fear of stored eatable items being poisoned	64	57.1	6	16.2	70	47.0
Fear of killing domestic animals (goats, sheep, dogs, hens & etc.)	59	52.7	3	8.1	62	41.6
In convenience and wastage of time in shifting household goods	48	42.9	2	5.4	50	33.6
More than one or other reasons People were not convinced with the effectiveness of spray	22	19.6	1	2.7	23	15.4

LSEG- Low socio- economic group HSEG- High socio- economic group

Epidemiology of Essential Hypertension in Arid Population of Rajasthan-

K.R. Haldiya, R. Sachdev , M.L. Mathur and J. Lakshminarayana

Date of Commencement: **June, 2004** Duration: **Two Years** Status: **Concluded**

Objectives

1. To identify the risk factors for high prevalence of hypertension in Gachipura village of desert part of Rajasthan.

2. To administer specific lifestyle interventions based on identified risk factors and assess their impact on control of hypertension.

Progress of the Work.

A cross sectional survey has been undertaken in Gachipura and Balarwa village for identifying the risk factors of high prevalence of hypertension in Gachipura. All houses of both villages were covered. House to house survey has been carried out. The members of the households who were above 15 years of age, interviewed and examined for hypertension. The information was recorded about smoking habits, level of physical activity, alcohol consumption and dietary habits particularly intake of salt, oil and ghee at household level. Body weight, height, waist circumference and hip circumference were measured using standard techniques by trained investigators. The blood pressure was measured in supine position after rest for five minutes. The dietary survey was carried out in one fifth of households. The biochemical investigations like blood sugar, cholesterol, creatinine, triglyceride and urine for electrolytes were also carried out in selected subjects. A twelve-lead routine electrocardiogram was performed using proper standardizations in selected individuals. The two health camps were organized for awareness of hypertension in the Gachipura and Balarwa.

A total of 922 households in Gachipura and 742 households in Balarwa village were covered. The total population of the 15 years and above for the Gachipura and Balarwa was 3499 and 2971 respectively. The coverage in Gachipura and Balarwa was 69.4% and 68.7% respectively. The mean age of surveyed population of Gachipura and Balarwa was 39.0±17.4 years and 36.7± 16.9 years. The overall prevalence of hypertension in Gachipura was 20.1% whereas in Balarwa was 10.4% (Table-1). The prevalence of hypertension was increasing with age in both villages. The prevalence of hypertension among sexes was not significantly different in both villages. The subjects of general castes had a significantly higher prevalence of hypertension than subjects of schedule castes. Widows and widowers had a significantly higher prevalence than married subjects. The prevalence of hypertension was significantly higher in illiterates than those with school and higher education. This difference remained significant after adjustment for age and sex.. The labours were significantly less affected in both villages. The tobacco use did not alter the prevalence of

hypertension. The prevalence of hypertension was increased with increasing Body Mass Index (BMI) and those with BMI 25 or more had very high prevalence. The prevalence also increased with increasing waist/hip ratio (WHR), and was very high in those with WHR ratio above 0.9. The prevalence of hypertension reduced with increasing physical activity in routine life style.

Adults involved in agriculture had a higher prevalence of hypertension in Gachipura as compared to those doing house work, while it was not so in Balarwa. It suggests that the factor responsible for high prevalence of hypertension in Gachipura also affects those involved in agriculture. The prevalence of hypertension increased with increasing BMI in both villages but it was above 40% at BMI more than 25 and tapered thereafter in Gachipura while in Balarwa it did not reach that height. The prevalence of hypertension was higher in those consuming alcohol in Gachipura as compared to their counterparts while in Balarwa habit of alcohol consumption did not alter prevalence of hypertension The prevalence of hypertension increased significantly in Gachipura with salt consumption above 8 gm/day but not in Balarwa. Similarly, prevalence of hypertension increased with increasing consumption of edible oil and ghee in Gachipura but not in Balarwa. This suggests the factor responsible for high prevalence of hypertension in Gachipura has synergistic effect with consumption of alcohol, salt and fat. Familial aggregation of cases of hypertension was more pronounced in Gachipura than Balarwa. Chemical analysis of samples of drinking water depicted higher concentration of sodium and fluoride in Gachipura as compared to Balarwa. The biochemical analysis of serum samples depicted higher levels of fasting blood sugar and cholesterol in Gachipura than Balarwa.

Electrocardiographic changes indicating ischemia and left ventricular hypertrophy were more commonly observed in hypertensive patients of Gachipura than Balarwa.

Work remaining to be carried out

The data analyzed so far suggested that there is a factor which has synergistic effects with physical activity, BMI, WHR, consumption of alcohol, salt and fats The detailed analysis is under process to identify the factors for higher prevalence of hypertension in Gachipura village.

Possible outcome and Utilization

The study will help in identifying the risk factors and planning of intervention programme to reduce the high prevalence in this area.

Table 1. Prevalence of Hypertension according to Socio demographic characteristics

Socio demographic characteristics		Gachipura		Balarwa	
		No.	Prevalence of hypertension	No.	Prevalence of hypertension
Total Population Surveyed		2221	20.1	1941	10.4
Average Age (Yrs.)		39.0±17.4		36.7± 16.9	
Sex	Males	779	19.6	870	9.5
	Females	1442	20.4	1071	11.1
Caste	General Caste	852	23.8	261	13.8
	OBC	923	19.2	1134	10.5
	SC/ST	446	15.0	557	8.1
Religion	Hindu	2073	20.4	1896	10.6
Marital Status:	Married	1643	21.1	1527	10.3
	Widower	202	46.0	116	33.6
Education	Illiterate	915	25.5	1051	12.5
	School and higher	967	13.3	663	6.9
Occupation	House work	1395	23.2	1002	12.9
	Agriculture	114	21.1	489	8.6
	Labour	125	12.8	236	5.9
Personal Habits	Alcohol	74	36.5	54	11.1
	Tobacco Users	497	22.9	406	11.1
Diet	Vegetarian diet	1677	20.9	1586	10.6
	Ground Nut oil	644	23.8	1274	10.8
	Mixed oil	1422	18.3	178	11.2
	Pure ghee	1823	20.9	1790	10.8
Drinking Water	Tap water	1762	19.9	637	10.8
	Tube well	99	19.2	1278	10.3
Physical Activity	Sedentary	129	51.9	235	20.9
	Heavy	112	9.8	394	6.6
BMI	<18.0	593	11.0	466	7.1
	25.0-29.9	214	43.5	207	20.8
Waist Hip Ratio	<0.8	633	9.0	455	5.7
	0.9-0.99	450	31.8	438	15.5
Salt Intake/mth.	≤ 240 gm	1717	19.2	1371	10.6
	> 240 gm	504	23.2	570	9.8
Oil intake/month	≤ 500 gm	775	17.4	703	9.2
	> 500 gm	1446	21.7	1238	11.1
Ghee intake/mth	≤ 500 gm	1266	19.3	1307	10.4
	> 500 gm	517	26.5	478	11.7
Total Fat Intake	≤ 900 gm	1284	17.7	1056	9.4
	> 900 gm	937	23.5	885	11.6

Nutrition Monitoring Survey on NNMB pattern in Jodhpur district of Rajasthan - *Madhu B. Singh, J. Lakshminarayana and Ranjana Fotedar*

Date of commencement: **January, 2005** Duration: **Long Term** Status: **Ongoing**

Objectives

1. To develop continuous monitoring service to study the nutritional status, dietary habits, food availability and the effect of changing social and environmental factors on the health status of the population.

2. Comparisons with other states data so as to assess the percentage of variation among them.

Progress of the work

Project preludial activities included working on sampling plan in detail. The similar sampling design and protocol was adopted for the Nutrition Monitoring type of survey for carrying out in Rajasthan, as it is being done in other states where NNMB is in operation. The sampling adopted here was two stages stratified random sampling method in which the villages in selected district formed the first stage units (FSU's), while in the village households (HH's) formed the second stage units. For the study purpose the district has been divided in to different strata in rural areas as per the tehsils with agro-economic regions and based on the population size of the village i.e. <2000 and >=2000 populated villages. In the urban area three wards were selected as per the census classification.

Selection of villages: From each stratum i.e. Tehsil, five villages were chosen randomly for the purpose of the survey in different direction one each from North South East West and central part, to have proper representation of the tehsils in the district. Selection of Households: The households in each village have been selected by adopting cluster sampling procedure for the purpose of the survey. A total of five clusters of four households each will be selected from each village. Generally the households in a village can be divided into natural "groups/areas" by geographical location such as streets/mohallas/areas. The SC/ST population often lives in a separate group/area in the villages. One cluster will be selected from SC/ST group/area while the remaining 4 clusters have been selected by systematic random sampling procedure, probability proportion to size of the group. In each cluster, by selecting a random start, 4 contiguous households will be covered.

Keeping in view the manpower and resources available at the centre, it has been decided to cover only Jodhpur district in the first phase and later on this will be expanded horizontally in other districts of the state in the similar pattern.

During this reported period, a total of 28 villages were covered from six tehsils of Jodhpur district i.e. Jodhpur, Bilara, Osian, Phalodi, Shergarh and Bhopalgarh (five villages from each tehsil), covering 560 households. All the selected households were examined for Socio-demographic and Socio- economic aspects. All the members in the household have been examined for nutritional deficiency signs, anthropometric measurements (Height, weight, arm circumference and FFT), Dietary intake (24 hours recall method) and examination of nutritional morbidities in last 15 days. Information on dietary intakes of the individuals were recorded in alternate houses i.e.10 households from each village were covered.

Project work is being continued. Preliminary analysis of 560 households covering 3301 individuals has been done so far. Table 1 showed age and sex wise distribution of population (1731 males and 1570 females). Analysis revealed that 93.8 percent of population was Hindus and 5.0 percent were Muslims. Nuclear families were more (59.5 %) as compare to joint families i.e. 24.4 percent (Tables 1-2). Table 3 revealed that illiteracy is high in females (53.6 %) than males (29.0 %). Higher education is very low in this area.

Table 1. Age and sex wise distribution of population covered

Age group	Males	%	Females	%	Total	%
0-4	213	12.3	198	12.6	411	12.5
5-9	253	14.6	202	12.9	455	13.7
10-14	237	14.0	204	13.0	441	13.4
15-19	190	11.0	170	10.8	360	10.9
20-29	260	15.0	258	16.4	518	15.7
30-39	190	11.0	187	11.9	377	11.4
40-49	147	8.5	149	9.5	296	9.0
50-59	111	6.4	104	6.6	215	6.5
> 60	130	7.5	98	6.2	228	6.9
Pooled	1731	100.0	1570	100.0	3301	100.0

Table 2. Distribution of households according to type of family

Type of family	N	%
Nuclear	333	59.5
Extended Nuclear	90	16.1
Joint	137	24.4
Pooled	560	100.0

Table 3. Distribution of population according to education status

Educational Status	Males	%	Female	%	Total	%
Illiterate	502	29.0	841	53.6	1343	40.7
Read & Write	26	1.5	21	1.4	47	1.4
1-4 Standard	393	22.7	309	16.7	702	21.3
5-8 Standard	301	17.4	131	8.3	432	13.1
9-12 Standard	252	14.6	54	3.4	306	9.3
College	57	3.3	7	0.4	64	1.9
N. A.	200	11.5	207	13.2	407	12.3
Pooled	1731	100.0	1570	100.0	3301	100.0

Main morbidities observed in population were acute respiratory infection (5.5 %) and fever (4.7 %) followed by diarrhoea (1.1 %). Both the morbidities i.e. acute respiratory infection and fever were higher in females than males (Table 4). Regarding nutritional deficiency signs, it is observed that discoloration and sparseness of hair, a sign of protein calorie malnutrition was observed to be high i.e. 7.1 percent which was higher in females than males. Marasmus was observed only in females (0.2 %). Angular stomatitis, cheliosis and glossitis were ranging from 0.2 to 1.8 percent. Vitamin A deficiency (Bitot Spot) was 0.3 percent, higher in males than females. Dental caries (30.4 %) and dental fluorosis (25.1 %) observed high in this area. Females suffered more from dental caries and dental fluorosis than males (Table 5). Thyroid palpabale and visible were 0.6 percent. Koilonichia, a sign of anemia, was observed higher in females (0.2 %).

Table 4. Distribution of population according to morbidity profile

Morbidity	Males	%	Females	%	Total	%
N.A.D.	1554	89.5	1370	87.2	2924	88.5
Fever	64	4.0	90	5.7	154	4.7
Diarrhoea	21	1.2	15	1.0	36	1.1
Dysentery	1	0.1	0	0.0	1	0.03
Ac. Res. Infec.	89	5.1	92	5.9	181	5.5
Measles	0	0.0	0	0.0	0	0.0

Table 5. Distribution of population according to nutritional deficiency signs

Deficiency Signs	Males N=1731	%	Female N=1570	%	Total N=3301	%
Hair Discoloured	91	5.3	113	7.2	204	6.2
Hair Sparsed	7	0.4	24	1.5	31	0.9
Emaciation	6	0.3	7	0.4	13	0.4
Marasmus	0	0.0	3	0.2	3	0.1
Bitot spots	9	0.5	2	0.1	11	0.3
Angular Stomatitis	3	0.2	2	0.1	5	0.2
Chelosis	28	1.6	30	1.9	58	1.8
Glossitis	10	0.6	9	0.6	19	0.6
Koilonychia	1	0.1	3	0.2	4	0.1
Gums Bleeding	33	1.9	56	3.6	89	2.7
Dental Caries	436	25.2	567	36.1	1003	30.4
Dental Fluorosis	376	21.7	452	28.8	828	25.1
Thyroid Palpable	5	0.3	2	0.1	7	0.2
Thyroid Visible	12	0.7	1	0.1	13	0.4

The weights of pre-school children were expressed as percent of NCHS standards and categorized into different nutritional grades, based on Gomez classification (Tables 6-8). The overall prevalence of under nutrition was very high i.e. 81.0 percent which was higher in Scheduled Castes and Scheduled Tribes communities (85.7 to 88.0 %) in comparison to other communities (74.7 %). The overall prevalence of severe under nutrition was very high i.e. 34.4 percent which needs attention. Under nutrition was higher in nuclear families (82.0 %) than joint families (79.2 %) and observed maximum in semi pucca houses (36.7 %) followed by pucca houses.

Table 6. Distribution of 1-5 years children according to Gomez distribution and community

Community	Nutritional Grades*				
	N	Normal	Mild	Moderate	Severe
ST	21	14.3	38.1	14.3	33.3
SC	117	12.0	26.5	25.2	33.3
BC	139	18.7	31.7	13.6	36.0
Others	150	25.3	29.3	11.4	34.0
Pooled	427	19.0	29.7	16.9	34.4

* NCHS Standards

Table 7. Distribution of 1-5 years children according to Gomez distribution and type of family

Type of Family	N	Nutritional Grades*			
		Normal	Mild	Moderate	Severe
Nuclear	256	18.0	32.4	19.1	30.5
Extended	65	20.0	26.2	13.8	40.0
Joint	106	20.8	25.4	13.2	40.6
Pooled	427	19.0	29.7	16.9	34.4

* NCHS Standards

Table 8. Distribution of 1-5 years children according to Gomez distribution of type of house

Type of House	N	Nutritional Grades*			
		Normal	Mild	Moderate	Severe
Kutcha	89	20.2	30.3	18.0	31.5
Semi Pucca	120	11.6	29.2	22.5	36.7
Pucca	218	22.5	29.8	13.3	34.4

* NCHS Standards

The distribution of adults according to BMI grades have been shown in Tables 9-11. At the aggregate level, 44.5 percent had normal BMI (18.5-25.0), while 55.5 percent had chronic energy deficiency. Severe chronic energy deficiency was observed highest in scheduled castes and scheduled tribes (23.7 & 18.4 %) communities followed by backward and other communities. Severe chronic energy deficiency was higher in extended nuclear families (18.2 %) than nuclear and joint families (14.5 %) and maximum in Semi pucca houses (18.7 %).

Table 9. Distribution of adults (>=18 years) according to BMI classification and community

Community	Nutritional Grades				
	N	Normal	Mild	Moderate	Severe
ST	38	50.0	13.2	18.4	18.4
SC	215	31.2	23.3	21.8	23.7
BC	356	50.3	21.3	16.9	11.5
Others	463	45.8	19.4	19.4	15.3
Pooled	1072	44.5	20.5	19.1	15.9

Table 10. Distribution of adults (>=18 years) according to BMI classification and type of family

Type of Family	N	Nutritional Grades			
		Normal	Mild	Moderate	Severe
Nuclear	559	42.8	19.7	21.8	15.7
Extended	208	43.3	23.6	14.9	18.2
Joint	305	48.5	20.3	16.7	14.5
Pooled	1072	44.5	20.5	19.1	15.9

Table 11. Distribution of adults (>=18 years) according to BMI classification and type of house

Type of House	N	Nutritional Grades			
		Normal	Mild	Moderate	Severe
Kutcha	166	40.4	25.3	21.7	12.6
Semi Pucca	251	40.2	19.5	21.6	18.7
Pucca	655	47.2	19.8	17.4	15.6

Project work is being continued and detailed analysis is under process. Dietary schedules are also in process of analysis. Data remains to be collected from 40 households from Shergarh tehsil of Jodhpur district. Data will again be collected from 30 villages of Jodhpur district in view to develop continuous monitoring service to study the nutritional status, dietary habits, food availability and the effect of changing social and environmental factors on the health status of the population.

Important leads/ outcomes

The results of such a study carried out on representative segment of the population in desert areas as well as non desert areas would provide information and useful guidelines not only for food policies but also to assess the impact of the nutritional programs currently in progress and for future planning in the state of Rajasthan.

Nutritional Status along with micronutrient deficiency disorders and morbidity in pregnant and lactating women in desert areas of Rajasthan -

Madhu B. Singh, Ranjana Fotedar and J. Lakshminarayana

Date of commencement: **July, 2004** Duration: **2 years** Status: **Ongoing**

Objectives

1. To what extent the micronutrients deficiency disorders i.e. Iron deficiency anemia, Vitamin A deficiency disorder and Iodine deficiency disorder are prevalent in pregnant and lactating women

2. To assess the nutritional status of pregnant and lactating women by means of anthropometry, dietary intake as well as through clinical examination

3. To study the morbidity profile of diseases among the rural pregnant and lactating women of the desert areas of Rajasthan and

4. To develop nutrition package for pregnant and lactating women of the desert areas based on the findings of the study during the second phase.

Progress of the work

Project preludial activities included development of protocol, formulation of sampling design in detail and the preliminary field visits to the studied area. As per suggestions/recommendations made by SAC member, one panchayat samithi is to be selected in Jodhpur district. In Jodhpur district, there are six tehsils as per the census book (1991) i.e. Phalodi, Osian, Bhopalgarh, Shergarh, Jodhpur and Bilara. These tehsils are distributed in Nine panchayat Samithis in the rural area i.e. Luni (32), Bilara (30), Phalodi (24), Bap (18), Bhopalgarh (32), Shergarh (21), Osian (41), Balesar (22) and Mandore (20). In these panchayat Samithis there are different Panchayats mentioned in the parenthesis and villages are distributed in these panchayats. In the present study one tehsil i.e. Jodhpur tehsil is being selected and from Jodhpur tehsil one panchayat samithi i.e. Luni Panchayat samithi is being selected by Random sampling technique which represents desert area of Jodhpur which have 32 Panchayats. In these 32 panchayats, there are 15 villages with more than 3000 population. The criteria for selecting bigger villages is to get the adequate number of pregnant and lactating mother. Out of these 15 villages, nine villages have been selected based on Simple Random Sampling technique using tippets random number tables. The selected villages will be completely surveyed i.e. complete enumeration of the village will be done and all the Pregnant and lactating mothers found in these villages will be covered for the present study (If required sample size could not be achieved in these 9 villages, than the target population will be completed from adjacent villages). Data

had been collected from five villages belonging to Luni Panchayat samithi of Jodhpur tehsil, Jodhpur district

During this reported period, data have been collected from twelve villages belonging to Luni Panchayat samithi of Jodhpur tehsil, Jodhpur district. A total of 933 households have been covered. At each household level information for demographic and socio-economic aspects have been collected. Pregnant and lactating women found in these villages along with control group of non pregnant and non lactating women have been interviewed / examined for the nutritional deficiency signs, dietary pattern (24 hours recall method) along with morbidity survey (Data will be collected by the standard technique as followed by NIN (ICMR), Hyderabad) and Micronutrient deficiency disorders i.e. Anemia, Iodine and Vitamin A. Anemia have been assessed by clinical signs (platinichia and koilonichia). Hemoglobin levels have been estimated using Cyanmethaemoglobin technique and classified according to WHO classification. Iodine deficiency disorders have been assessed by clinical examination of thyroid gland using the standard method as recommended by the joint WHO / UNICEF / ICCIDD consultation. A casual urine sample was collected for estimation of Urinary Iodine Excretion (UIE) levels to assess the Iodine nutriture status. Iodine was determined by WET digestion method using standard laboratory technique. UIE level less than 100 mcg/l have been considered as indicator of iodine deficient nutriture. 25 to 30 percent of women selected randomly had been requested to bring sample of 20 gm. salt consumed in their families in autoseal LDPE pouches. Iodine content of salt sample have been estimated using standard iodometric titration method. Salt samples having iodine content less then 15 ppm classified as with inadequate iodine. Vitamin A deficiency was assessed by administering pretested semi structured questionnaire on the presence of symptoms of night blindness. The women were asked specific questions regarding their sight at the time of sunset and later in dim light, had any problems in cooking during dusk period due to lack of proper vision and any change in their activity pattern due to vision problems in the dusk. The subjects with positive response to these questions have been classified as suffering from VAD.

Project is continuing. Preliminary analysis of 793 individuals have been done so far out of which 175 were pregnant, 286 lactating women and 332 NPNL (control) women. (The inclusion criteria for the pregnant mothers were those mothers whose pregnancy was more than 24 weeks of gestation period as suggested by SAC members. Those mothers were not registered / excluded whose gestation period was less than 24 weeks and with null pregnancy. The inclusion criteria for the lactating mothers were those mothers who were breast feeding their child and the cut off level for breast feeding was up to 6 months period. The inclusion criteria for the control group was those who were 15 years and above women (unmarried) or mothers who are more than 15 years, just married living together not attained their family status by becoming pregnant because till this age, the girls were not being sent to stay with husband even though they were married much earlier).

Table 1 showed distribution of women according to anemia on the basis of haemoglobin estimation. Preliminary trend showed that anemia was observed to be maximum among pregnant women and lactating women and least in control group. Severe anemia

observed higher in pregnant and lactating women (2.9 to 3.3 %) in comparison to control group (1.1 %).

Table- 1. Distribution women according to anemia (Haemoglobin Estimation)

Women	**Non Anemic**		**Anemic**					
	Normal		**Mild**		**Moderate**		**Severe**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Pregnant* N = 169	29	3.8	25	3.3	93	12.1	22	2.9
Lactating** N = 278	34	4.4	98	12.8	121	15.8	25	3.3
Controls** (NPNL) N=319	75	9.8	143	18.7	92	12.0	9	1.1
Total N=766	138	18.0	266	34.8	306	39.9	56	7.3

* Cut off values for Normal: (≥11g/dl) ** Cut off values for Normal: (≥12g/dl)

Caste, education and income observed to play important role in distribution of anemia (Table 2-4). OBC (11.0 to 19.7 %) and SC (6.4 to 11.5 %) suffered more from anemia than general caste in all three groups. Anemia declined as education and income rose.

Table- 2. Caste wise distribution of anemia (Haemoglobin Estimation)

Haemoglobin Estimation	Pregnant		Lactating		Controls	
	Anemic N = 140		Anemic N = 244		Anemic N = 244	
	N	%	N	%	N	%
General	24	3.8	36	5.7	64	10.2
OBC	69	11.0	124	19.7	105	16.7
SC	40	6.4	72	11.5	68	10.8
ST	7	1.1	12	1.9	7	1.1

Table- 3. Education wise distribution of anemia (Haemoglobin Estimation)

Haemoglobin Estimation	Pregnant		Lactating		Controls	
	Anemic N = 140		Anemic N = 244		Anemic N = 244	
	N	%	N	%	N	%
Illiterates	106	16.9	192	30.6	87	13.8
Primary	23	3.7	39	6.2	47	7.5
Middle	9	1.4	12	1.9	45	7.2
Secondary & above	2	0.3	1	0.1	65	10.4

Table- 4. Income wise distribution of anemia (Haemoglobin Estimation)

Haemoglobin Estimation / Income	Pregnant		Lactating		Controls	
	Anemic N = 140		Anemic N = 244		Anemic N = 244	
	N	%	N	%	N	%
Low Income Group	51	8.1	95	15.1	91	14.5
Middle Income Group	45	7.2	79	12.6	54	8.6
High Income Group	44	7.0	70	11.1	99	15.8

Consumption of iron folic acid tablets by anemic pregnant and lactating women observed to be very low (15.4 to 22.1 %). Abortions, child deaths, still births and premature births observed to be higher in anemic pregnant and lactating women in comparison to normal women (Table 5).

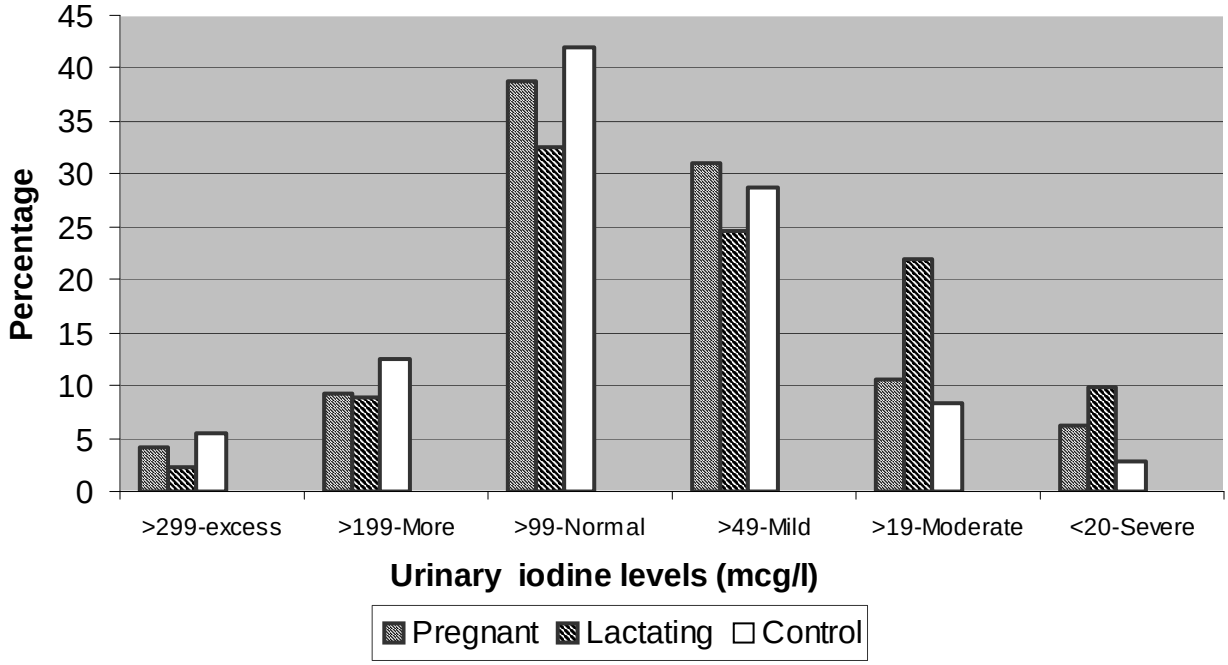
Table- 5. Distribution of women according to anemia (Hemoglobin Estimation) & Obstetric history

Hemoglobin Estimation (N=447) / Obstetric History	Pregnant (169)				Lactating (278)			
	Normal		Anemic		Normal		Anemic	
	N=29	%	N=140	%	N=34	%	N=244	%
Abortions	1	0.2	13	2.9	5	1.1	22	4.9
Premature Births	0	0.0	4	0.9	0	0.0	6	1.3
Still Births	1	0.2	5	1.1	0	0.0	16	3.6
Child Deaths	2	0.4	10	2.2	5	1.1	24	5.4

Epidemiological criteria, as prescribed by WHO, for assessing iodine nutrition is based on median urinary iodine concentrations / levels as shown in figure 1. Analysis of 640 urine samples have been done so far. Preliminary trend showed that the median urinary iodine values were observed less in lactating women (75 mcg/l) according to WHO cut off points (100 mcg/l) where as pregnant and control observed to be just on the marginal values. Nearly 48 to 56 percent pregnant and lactating women suffered from mild to moderate iodine deficiency disorder whereas in control group it was only 40.1 percent. Severe iodine deficiency disorder was observed higher in lactating (9.8 %) and pregnant women than control group (2.9 %). Iodine deficiency disorders (UIE levels) showed increasing trend with decline of income and educational status. OBC (45.6 to 71.8 %) and SC

women suffered significantly higher from IDD than general caste women (15.9 to 38.2 %).

Fig. 1 Distribution of Women according to UIE level



Iodine content of 474 salt samples have been estimated using standard iodometric titration method (Table 6). Overall high proportion of women (83.0 %) consume salt having inadequate iodine content i.e. less then 15 ppm. This proportion observed to be higher in OBC (43 to 47 %) and SC women (29.8 to 33.8 %), than general caste women (15.2 to 22.2 %). Initial trends revealed that consumption of salt deficient in iodine content observed higher in low income (39.1 to 41.4 %) and illiterate women (nearly 80 %) than high income and higher educated women.

Table- 6. Iodine content in salt intake of women in different physiological groups

Iodine content in salt→ Women (N=474)↓	Normal >=15 ppm		Mild 10 - <15 ppm		Moderate 5- <10 ppm		Severe < 5 ppm	
	N	%	N	%	N	%	N	%
Pregnant N=120	21	4.5	11	2.4	36	7.8	52	11.2
Lactating N=163	18	3.9	19	4.1	43	9.3	83	17.9
Controls N=191	40	8.6	25	5.4	50	10.8	76	16.4
Total	79	17.0	55	11.9	129	27.8	211	45.5

Sickness at the time of survey was highest in lactating women (12.2 %) followed pregnant (8.0 %) and least in controls (3.9 %). Main morbidities observed to be aches (4.5 %) and gastroenterological complaints (3.4 %). Vitamin A deficiency based on Night blindness observed higher in pregnant women (4.6 %) than controls (0.9 %). Study is ongoing and data remains to be collected from 267 women belonging to selected villages of Luni Panchayat samithi of Jodhpur tehsil, Jodhpur district.

Important leads/ outcomes from the study

Results will help in developing the database on nutritional status along with micronutrient deficiency disorders and morbidity in pregnant and lactating women in desert areas. The results of the first phase of the present study will be helpful in assessing the magnitude and distribution of three micronutrients deficiency disorders i.e. Iron, Vitamin A and Iodine along with the nature and type of nutritional deficiencies and their morbidities. These results will be helpful in formulating nutritional intervention packages for this region by introducing the adequacy i.e. bioavailability - of iron, and vitamin A etc. in usual diets which can be improved by altering meal pattern to favour enhancers and lower inhibitors or both during the second phase of the study. According to WHO, at present, Iron and Vitamin A supplementation are the most common strategy currently used to control these deficiencies in developing countries for the time being. This is likely to remain the case until either significant improvements are made in the diets of entire populations or food fortification is achieved. Second phase of the study will try to achieve this aim.

Occurrence and burden of disease across the districts of Rajasthan: A Study of the year 2000 - *A.K. Dixit, P.K. Anand and M.S. Chalga*

Date of commencement**: March, 2005** Duration: **Two Years** Status: **Ongoing**

Objectives

1. To Study the pattern of disease occurrence and associated burden across the districts in Rajasthan

2. Mapping of epidemiological association of diseases with the districts and ecological zones in the state

Rationale

Occurrence and burden of diseases studied at state level attracted for disease burden analysis across the individual district of the state to look for the variations and/or concentration of diseases across the districts. On the recommendation of SAC held last, this study is undertaken. The data obtained from Directorate of health, Govt. of Rajasthan was analyzed for the 32 districts of the state and for 158 reported diseases from the following perspectives:

1. **Distribution of district wise diseases occurrence and burden**

This was obtained by summing up the disease occurrence of all diseases and similarly their burden against each district.

2. **Distribution of disease wise occurrence and burden**

For each disease; its occurrence and computed burden was summed across all the districts. We thus obtained the distribution of disease wise occurrence and burden, disease-wise.

3. **Top variant diseases**

For each disease, we computed variance of its occurrence and burden, across the districts and ranked them as per the CV, so obtained. Set of diseases with low CV show the nature of local health problems.

4. **Disease wise epidemiological association of districts**

We computed odd ratio (OR) with respect to occurrence and burden of each disease for each district. OR so obtained, shows the strength of epidemiological association of a disease with a chosen district was used to get disease wise mapping of the districts.

5. **Zone wise mapping of the diseases**

Districts were clubbed in to six ecological zones of the state. Zone wise epidemiological association was then worked out for each disease to look for zone wise association of the diseases.

Observations

From percentage distribution of district wise occurrence and burden of all diseases, given in table 1 (a) and 1 (b) respectively; we may note the districts amounting for 50% of all disease occurrence in the state. While, Jaipur tops the list with respect to disease occurrence, Jodhpur carries top disease burden.

Table 2(a) and 2(b) give the percentage distribution of disease wise occurrence and burden. Non-infectious diseases dominate in each case. Accidents are at top. Certain diseases, which are of importance e.g. anemia, pneumonia, PTB, hypertensive heart diseases etc, could be located only through disease burden analysis (table 2b), which shows pertinence of disease burden analysis.

Table 3(a) and 3(b) depict top diseases which showed maximum variance with respect to their occurrence and burden across the districts. This listing of diseases identifies the local health problems, e.g. leishmaniasis, which tops the list as per its CV, occurrence wise is indicative of its high nature of local problem; i.e. occurrence of it is confined to certain districts. Similarly we observe from table 3 (b) that burden associated with certain diseases like cataract, malignant neoplasm of pancreas are also specific in nature.

Table 4(a) and 4 (b) are the outcome of our concept of considering strength of association of a disease with a district in terms of its occurrence and burden. The OR values given in these tables depict the strength of association of a disease with a district in comparison of other diseases and districts. For each disease, we have worked out such epidemiological associations. These tables depict an example of the same for some diseases. We note, for example that occurrence of acute poliomyelitis is more prone in district Nagaur (OR= 12.38) than in district Dhaulpur (OR= 5.86). Similarly, from table 4 (b) burden of atherosclerosis is likely to be least in Tonk.

Our attempts then have been to see such association of diseases with six ecological zones of the state. As an example, table 5, depicts association of diseases (for whom OR value exceeded 5) with zone 1. Here we find that this zone harbors much of malignancies.

Conclusion

The exercise has been very interesting in studying the distribution of disease occurrence and their burden across the districts in the state. We have been able to identity districts which carry more than 50% of disease burden. The top diseases according to their occurrence and burden are also identified. To look in to variations of diseases across the districts helped in identifying local health problems. The concept of mapping of diseases and districts alerts us in terms of management of diseases at district level. Zone wise mapping raises research questions in terms of association of certain diseases with a specific ecological type.

Table 1(a). Percentage distribution of District-wise occurrence of diseases (All)

Districts	Total Occurrence	Percent Occurrence	Cumulative Total
Jaipur	83135.94	5.53	5.53
Kota	79739.19	5.30	10.83
Ajmer	68564.74	4.56	15.38
Pali	66475.61	4.42	19.80
Baran	65666.64	4.36	24.17
Bhilwara	65390.87	4.35	28.51
Tonk	57618.03	3.83	32.34
Jodhpur	53329.71	3.54	35.89
Udaipur	52839.06	3.51	39.40
Rajsamand	52186.07	3.47	42.87
Chittorgarh	50997.47	3.39	46.26
Bundi	50675.62	3.37	49.62
Sirohi	49866.59	3.31	52.94

Table 1(b). Percentage distribution of District-wise burden of diseases (All)

Districts	Total Burden	Percent Burden	Cumulative Total
Jodhpur	17814.87	11.20	11.20
Kota	14635.74	9.20	20.40
Jaipur	13289.93	8.36	28.76
Ajmer	12681.23	7.97	36.73
Udaipur	8120.81	5.11	41.84
Hanumangarh	7490.89	4.71	46.55
Jhalawad	6675.07	4.20	50.74

Table 2(a). Percentage distribution of disease-wise occurrence

Disease Name	Is Inf.?	Total Occurrence	Percent Occurrence	Cumm Total
Accidents-(E970-E999)	n	295356.10	19.63	19.63
Chronic disease of tonsils and adenoids-(474)	n	140302.00	9.33	28.96
Acute-bronchitis and bronchiolitis-(466)	y	117369.10	7.80	36.76
Diseases of skin & subcutaneous tissue-(680-707)	n	80693.17	5.36	42.12
Open wounds and injuries to blood vessels-(870-904)	n	73873.04	4.91	47.03
Anaemias-(280-285)	n	70869.14	4.71	51.74

Table- 2(b). Percentage distribution of disease - wise burden

Disease Name	Is Inf.?	Total Burden	Percent Burden	Cumm Total
Accidents -(E970-E999)	n	23446.80	14.74	14.74
Anaemias-(280-285)	n	9586.13	6.03	20.77
Bronchitis, chronic and unspecified,emphysema and Asthma-(490-493)	n	7268.89	4.57	25.34
Acute Myocardial infection-(410)	n	7011.05	4.41	29.75
Pneumonia-(480-486)	y	6860.61	4.31	34.06
Leishmaniasis-(085)	y	6815.07	4.28	38.35
Pulmonary tuberculosis-(011)	y	6724.63	4.23	42.57
Acute-bronchitis and bronchiolitis-(466)	y	6285.05	3.95	46.53
Hypertensive Heart Diseases-(402-410)	n	5928.01	3.73	50.25

Table- 3(a). Top ten variant diseases (occurrence wise)

Disease Name	Is Inf.?	CV (Occurrence)	CV %	Cumm CV%
Leishmaniasis-(085)	y	532.66	2.17	2.17
Misadventure during medical care abnormal reactions,late complications-(E870-E879)	n	483.15	1.97	4.14
Air and space Transport accidents-(E840-E845)	n	444.65	1.81	5.96
Malignant neoplasm of Larynx-(161)	n	418.33	1.71	7.66
Congenital anomalies of heart and circulatory system-(745-747)	n	408.88	1.67	9.33
Late effect of acute poliomyelitis-(138)	n	376.93	1.54	10.87
Carcinoma in Situ-(230-234)	n	374.08	1.53	12.40
Major puerperium-(670)	n	367.58	1.50	13.89
Mental retardation-(317-319)	n	367.12	1.50	15.39
Water Transport Accidents-(E830-E838)	n	348.86	1.42	16.82

Table 3(b). Top ten variant diseases (Burden-wise)

Disease Name	Is Inf.?	CV (Burden)	CV %	Cumm CV%
Cataract-(366)	n	214.60	8.83	8.83
Malignant neoplasm of bones-(170)	n	130.52	5.37	14.21
Acute poliomyelitis-(045)	y	120.98	4.98	19.19
Tuberculosis of bones&joints-(015)	y	109.92	4.52	23.71
Malignant Neoplasm of colon-(153)	n	85.66	3.53	27.24
Late effect of acute poliomyelitis-(138)	n	77.77	3.20	30.44
Water Transport Accidents-(E830-E838)	n	72.92	3.00	33.44
Tuberculosis of genito urinary system-(016)	y	68.96	2.84	36.28
Benign Neoplasm of uterus-(212-219)	n	64.34	2.65	38.93
Salpingitis and Cophoritis-(641-641.2)	n	63.02	2.59	41.53

Table 4(a). Disease-wise epidemiological association of districts (as per Occurrence)

Disease	Is Inf.?	Districts with OR values		
Malignant Neoplasm of stomach-(151)	n	Bikaner (15.79)	Jaipur (5)	Udaipur (7.16)
Tuberculosis of intestines,peritoneum &mesenteric glands-(014)	y	Bhilwara (5.62)	Bikaner (8.21)	Shriganganagar (5.76)
Acute poliomyelitis-(045)	y	Bikaner (8.64)	Dhaulpur (5.86)	Nagaur (12.38)

Table 4(b). Disease-wise epidemiological association of districts (as per Burden)

Disease	Is Inf.?	Districts with OR values			
Athoroselerosis-(440)	n	Dausa (10.05)	Jalore (11.27)	Sawaimadhopur (6.99)	Tonk (5.8)
Chronic disease of tonsils and adenoids-(474)	n	Barmer (11.81)	Shriganganagar (8)	Jalore (11.42)	Tonk (31.22)
Dislocations,Sprains&Strains-(830-848)	n	Banswara (8.41)	Bharatpur (9.71)	Shriganganagar (35.17)	Sirohi (6.38)

Table 5. Zone -wise mapping with respect to diseases (occurrence)

Zone	Disease Name	Is Inf.?	OR Value
Zone 1 (Comprises of Desert region)	Leishmaniasis-(085)	y	162.37
	Carcinoma in Situ-(230-234)	n	25.43
	Arthropod-borne Haemorrhaegic fever-(065)	y	18.11
	Malignant neoplasm of Larynx-(161)	n	15.84
	Major puerperium-(670)	n	13.16
	Malignant Neoplasm of pancress-(157)	n	6.09
	Malignant Neoplasm of colon-(153)	n	5.95
	Malignant Neoplasam of cervix uteri-(180)	n	5.55
	Malingnant Neoplasm of Lip oral cavity and Pharynx-(140-149)	n	5.51
	Homicide and injury purposely inflicted by other persons-(E960-E969)	n	5.46
	Multiple Seleros-(340)	n	5.15

Household distribution of disease burden in community health Management: A study in desert – *A.K. Dixit and P.K. Anand*

Date of commencement**: October, 2004** Duration: **Two Years** Status: **Ongoing**

Objectives

1. Identification of distribution of disease burden at household level
2. Locating the pockets of population needing prioritized health care attention
3. Identification of household level risk factors of disease burden

Progress of the work done

At the recommendation of the SAC, this project was undertaken in district Jodhpur. 30 villages were proportionally selected from 7 tehsils of the district as per PPS sampling procedure. From each village, 30 household (H/H) were selected giving due representation to major castes in the village. In all, data on H/H characteristics were recorded for 900 H/H on structured H/H schedule. A village schedule recorded the village level characteristics. Persons present in a H/H at the time of visit of that H/H were examined clinically and their health details recorded on a carefully designed health schedule. Mortality, if any occurred in last one year was also recorded with probable cause of death as discussed with the respondent by the physician. This data was then used to calculate total disease burden (sum of the burden of all individuals in the H/H) at house hold as well as at individual level. We computed at individual level, age and sex wise distribution of disease burden and at household level, the distribution of disease burden of households and disease burden distribution as per the number of persons in the H/H. From village schedule, we classified H/H level distribution of disease burden as per village level characteristics.

Observations

We observe from table 1 that availability of health facility decreases the disease burden load at the village. One allopathic facility (a sub centre) reduces it by 42.37% and one additional health facility (ayurvedic) reduces it to 75.67% . Location of health facility is also important. We observe from table 2, that if facility is outside village, there is heavy increase in disease burden (by136.47%)

Table 3 depicts the association of availability of education facility with disease burden. Just from primary level to provision of secondary level education, there is decrease in disease burden by 64.82%

Migration also affects the village level disease burden. Infact, it increased disease burden percentage by 64.34%. Even the developmental activities play vital role in reducing village level burden, as is evident from table 5. Disease burden in reduced by 71.78%, if there is road; electricity, drinking water and bus stand in a village.
The association of village characteristics with disease burden helps us in identifying the type of villages carrying more disease burden.

The age and sex wise distribution of disease burden given in table 6, clearly shows the increasing trend of disease burden with age. However at each age class, females are better off than male. It is also understood from table 7 that family size also influences the disease burden. For family size being more than 5, there is around 300% increase in burden, which is worth considerable. We observe from table 8 that 90% of H/H share 20% of disease burden i.e. there are much less H/H sharing more amount of disease burden. This entails the identification of such households.

Work remaining to be done

We need to correlate H/H level characteristics with disease burden at household in order to identify household level practices affecting disease burden. This will also help in identifying the pockets of people carrying bigger disease burden load.

Table 1. Distribution of village level disease burden as per the type of available health Facilities

Type of health facility available	No. of villages	% DB per village	Drop %
No. facility	4	54.96	-
only Allo.	20	31.67	42.37
Only Ayur.	-	-	-
Allo.+ Ayur	6	13.37	75.67
Total	30	100	

Table 2. Distribution of village level disease burden according to location of health facility

Location of health facility	No. of villages	% DB per village	Increase %
With in village	25	29.72	-
Outside village	5	70.28	36.47
Total	30	100	

Table 3. Distribution of village level disease burden according to highest level of education facility

Highest education facility available	No. of villages	% DB per village	Drop %
up to primary	3	52.45	-
up to Secondary	22	29.10	44.52
up to Sr. Secondary	5	18.45	64.82
Total	30	100	

Table 4. Distribution of village level disease burden according to migration

Migration	No. of villages	% DB per village	Increase %
No migration	17	37.83	
Migration	13	62.17	64.34
Total	30	100	

Table 5. Distribution of village level disease burden according to available amenities

Amenities available	No. of villages	% DB per village	Drop %
No facility	1	54.76	-
Road , Elect., Water	8	29.79	45.59
Road, Elect. Water, Bus stand	21	15.45	71.78
Total	30	100	

Table 6. Distribution of disease burden according to age and sex

Age	Male		Female	
	Persons	DB%	Persons	DB%
0-5	337	1.47	296	.09
5-15	808	11.77	736	4.76
15-45	1075	23.14	960	11.93
45-60	262	18.54	260	24.95
60+	170	45.08	160	58.27
Total	2652	100	2412	100

Table 7. Distribution of disease burden according to size of family

Family size	%DB	Increase %
up to 5	18.37	-
More than 5	81.63	344.3 6

Table 8. Distribution of H/H according to disease burden percentage

Disease burden %	No. of H/H	%	Cum %
< 10	>66	85.11	85.11
10-20	61	6.78	91.89
20-30	27	3.00	94.89
30-40	15	1.67	96.56
40-50	10	1.11	97.67
50-60	8	.89	98.56
60+	13	1.44	100.00
Total	100		

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-Balasamand	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 asses the magnitude of air pollution. The parameters RSPM, SPM, NO_2, SO_2, NH_3 and O_3 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
SiteIII- 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.

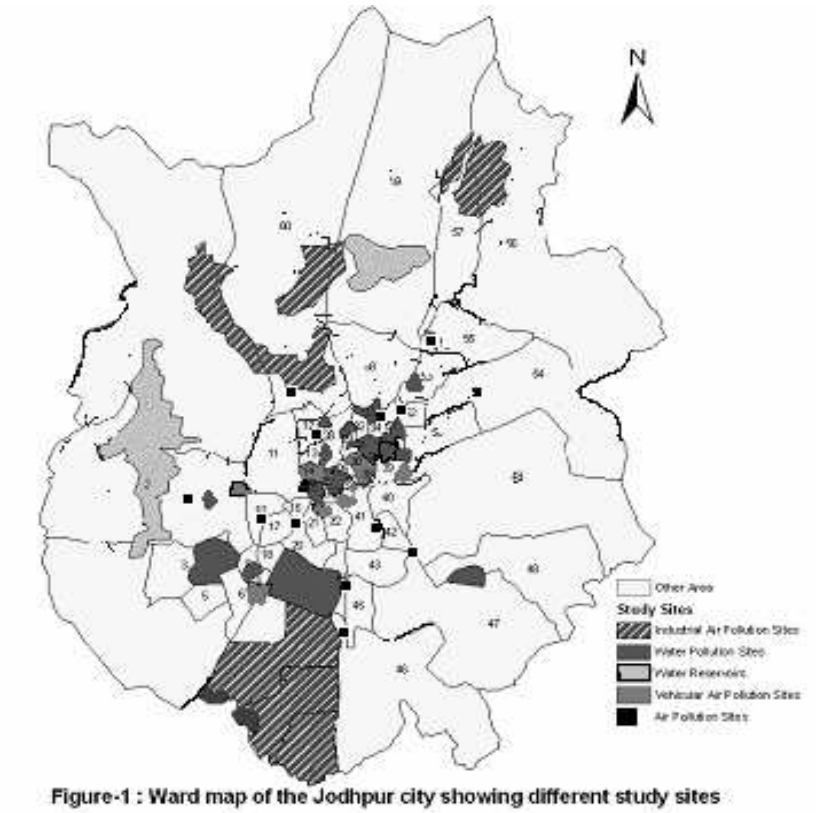


Figure-1 : Ward map of the Jodhpur city showing different study sites

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, NOx, SO_2, NH_3 and O_3.

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 NOx, SO_2, NH_3 and O_3 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).

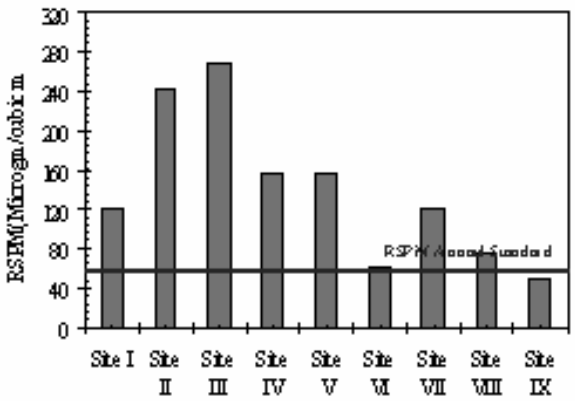


Figure-4: Annual average of RSPM at Traffic intersection Sites (2004-05)

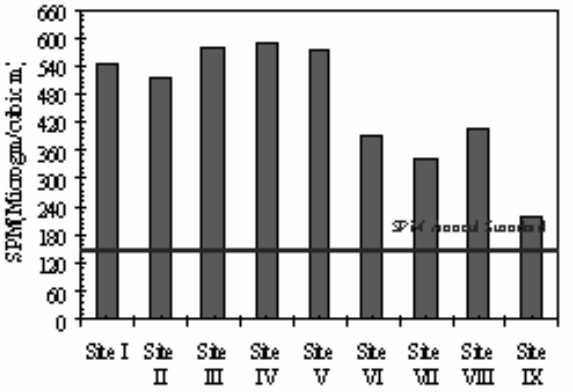


Figure-5: Annual average of SPM at Commercial Sites (2004-05)

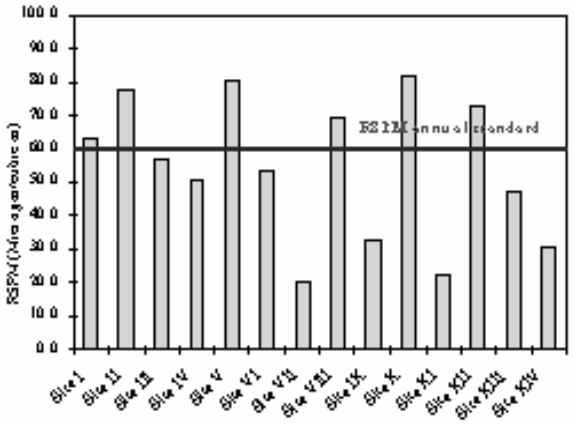


Figure-6: Annual average of RSPM at Residential Sites (2005-06)

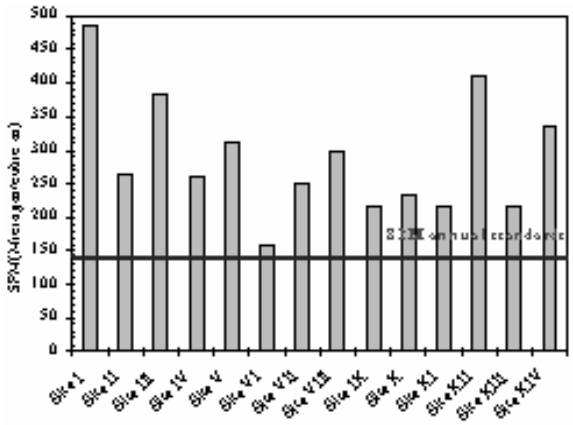


Figure-7: Annual average of SPM at Residential Sites (2005-06)

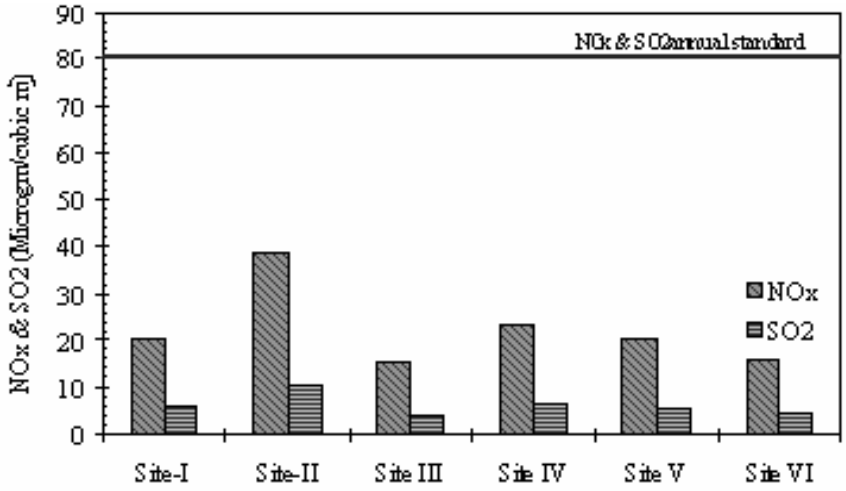


Figure-8: Annual average of NOx and SO2 at Industrial Sites (2004-05)

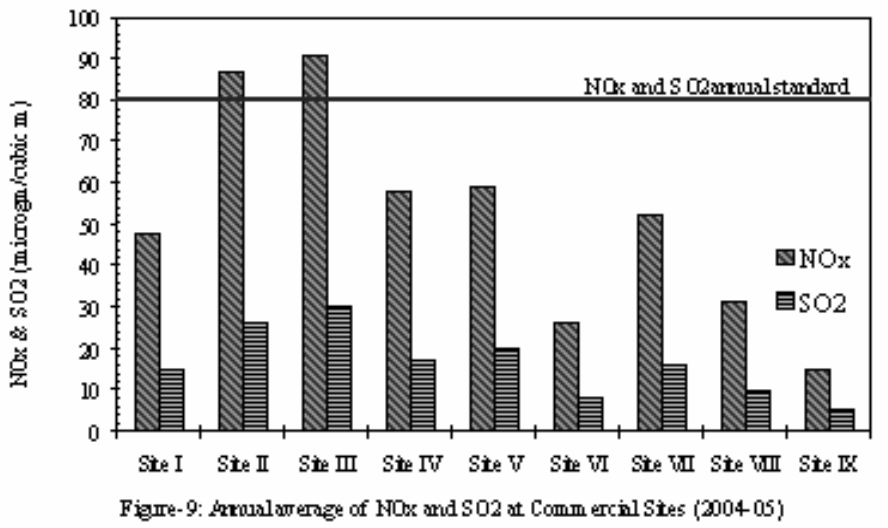


Figure-9: Annual average of NOx and SO2 at Commercial Sites (2004-05)

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

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

*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	Para-meters	RSPM (µg/m3)	EF	SPM (µg/m3)	EF	N
Site I	Range	60.9-273.75		350.4-942.875		
	Mean	120.0±70.9	2.0	544.2±230.8	3.9	7
Site II	Range	165.0-282.3		336.2-989.5		
	Mean	241.7±38.2	4.0	513.1±225.0	3.7	7
Site III	Range	213.8-367.7		318.7-1165.02		
	Mean	267.7±55.5	4.5	579.9±275.7	4.1	7
Site IV	Range	77.1-196.25		340.2-1091.75		
	Mean	155.5±47.8	2.6	588.2±279.0	4.2	7
Site V	Range	85.5-345.0		343.6-1150.7		
	Mean	156.2±109.3	2.6	571.4±328.3	4.1	5
Site VI	Range	33.6-98.6		257.6-608.9		
	Mean	60.8±26.5	1.0	391.9±127.1	2.8	6
Site VII	Range	47.1-223.03		185.3-609.96		
	Mean	121.3±63.6	2.0	338.2±151.7	2.4	6
Site VIII	Range	45.5-108.86		275.0-641.5		
	Mean	73.9±22.9	1.2	409.0±125.9	2.9	6
Site IX	Range	30.8-70.0		163.5-254.7		
	Mean	48.7±16.4	0.8	217.4±33.9	1.6	5
All sites	Range	30.8-367.7		163.5-1165.0		
	Mean	143.8±90.0	2.4	470.6±234.5	3.4	56
* Annual Standard		60 µg/m^3		140 µg/m^3		

*National Ambient Air Quality Standards

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

Sites	RSPM(µg/m3)			SPM(µg/m3)			
	Range	Ann avg	EF	Range	Ann avg	EF	N
Site I	32.8-90.9	63.0±19.7	1.1	332.7-706.05	486.4±166.8	3.5	6
Site II	34.0-125.0	78.1±35.2	1.3	139.0-368.0	265.7±94.6	1.9	6
Site III	18.3-88.0	57.0±27.2	1.0	210.9-502.8	384.9±132.2	2.7	6
Site IV	32.3-79.23	50.6±18.3	0.8	134.1-462.4	258.7±156.9	1.8	6
Site V	50.0-120.9	80.6±25.8	1.3	188.7-548.4	311.0±145.7	2.2	6
Site VI	27.8-75.0	53.2±16.1	0.9	122.6-194.5	156.7±23.4	1.1	6
Site VII	11.2-37.6	20.7±9.9	0.3	166.0-329.9	250.5±68.5	1.8	6
Site VIII	51.1-100.0	69.5±17.1	1.2	225.5-398.6	300.3±58.8	2.1	6
Site IX	12.7-51.4	32.9±13.0	0.5	154.7-280.9	216.3±48.9	1.5	6
Site X	54.8-130.0	81.6±26.6	1.4	197.8-295.8	234.8±38.3	1.7	6
Site XI	13.4-38.57	22.3±9.2	0.4	154.6-278.65	215.6±52.2	1.5	6
Site XII	42.6-110.15	73.2±24.4	1.2	318.3-498.6	412.9±74.4	2.9	6
Site XIII	20.5-81.4	47.3±21.5	0.8	167.1-284.1	216.6±44.6	1.5	6
Site XIV	18.0-51.6	30.5±12.0	0.5	231.5-472.17	335.8±107.3	2.4	6
All sites	11.2-130.0	54.3± 28.3	0.9	122.6-706.1	291.4±129.6	2.1	84
* Annual Standard	60 µg/m^3			140 µg/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	Para-meters	NO_2 (ug/m^3)	EF	SO_2 ($\mu g/m^3$)	EF	NH_3 ($\mu g/m^3$)	EF	O_3 ($\mu g/m^3$)	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	
* Annual Standard		60 $\mu g/m^3$		60 $\mu g/m^3$		100 $\mu g/ m^3$		120$\mu g/m^3$		

*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 1sample, 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 outsides 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. (ºC)		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					
			COPD/ Asthma	Pneumonia	Silicosis	TB	URI	TOTAL
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
ll 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.

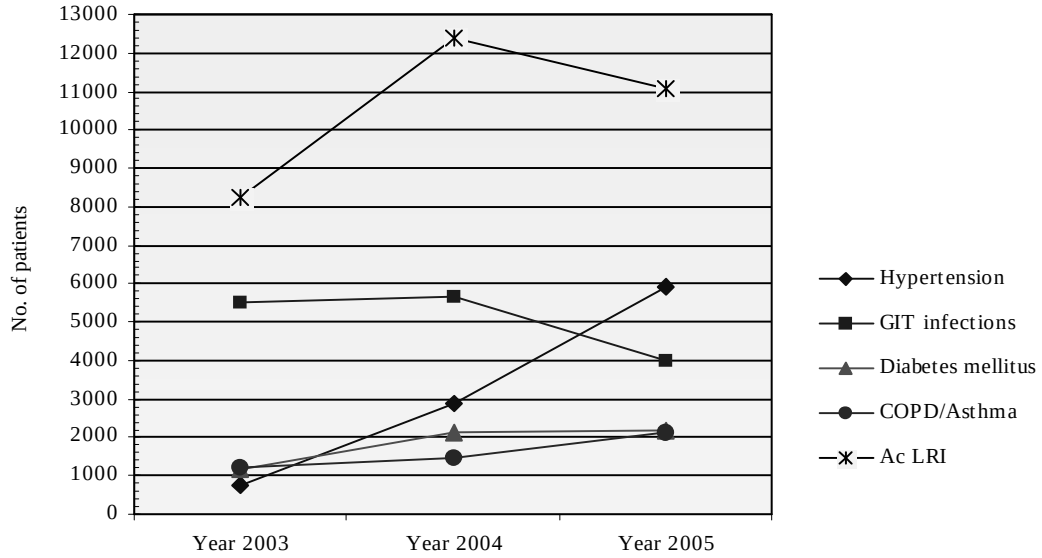


Figure 10. Number of cases of environment related diseases at seven dispensaries.

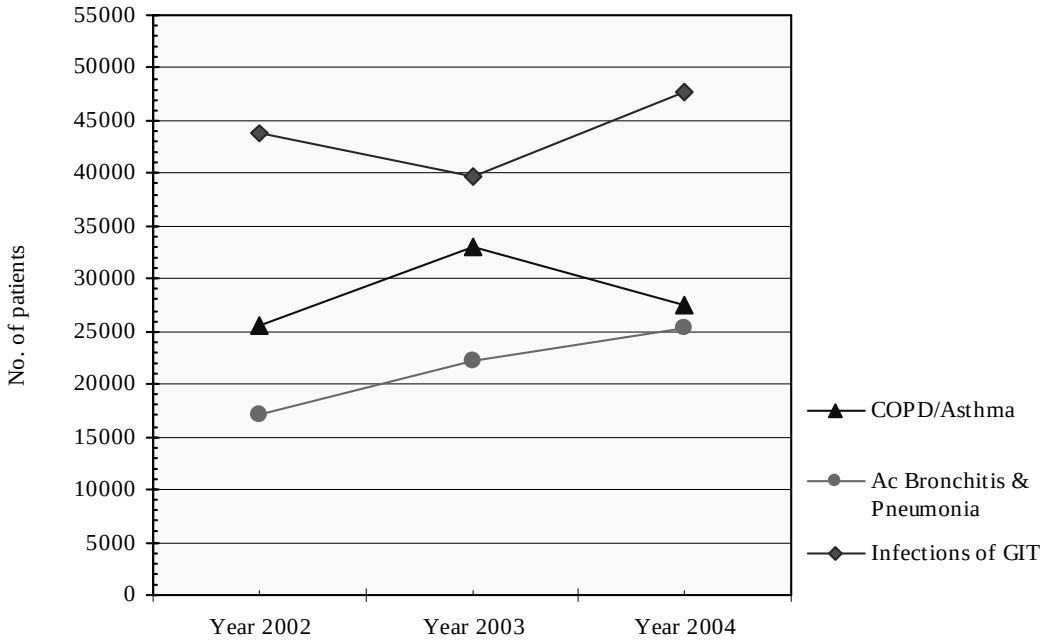


Figure 11. Number of patients of Respiratory Diseases and infections of GIT at teaching Hospitals.

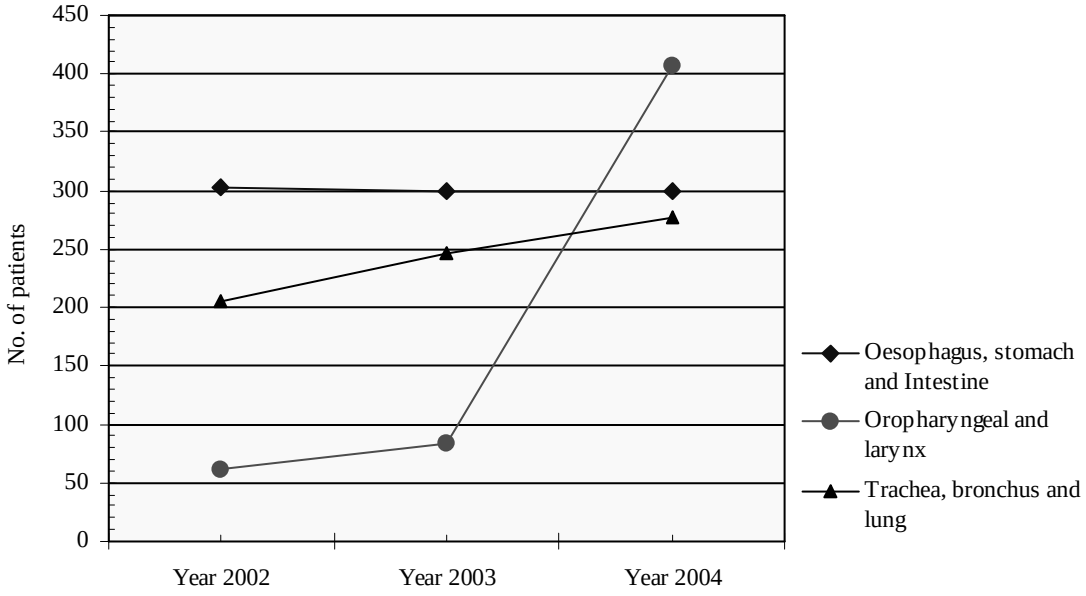


Figure-12. Cancers of respiratory and gastrointestinal tract at teaching hospitals.

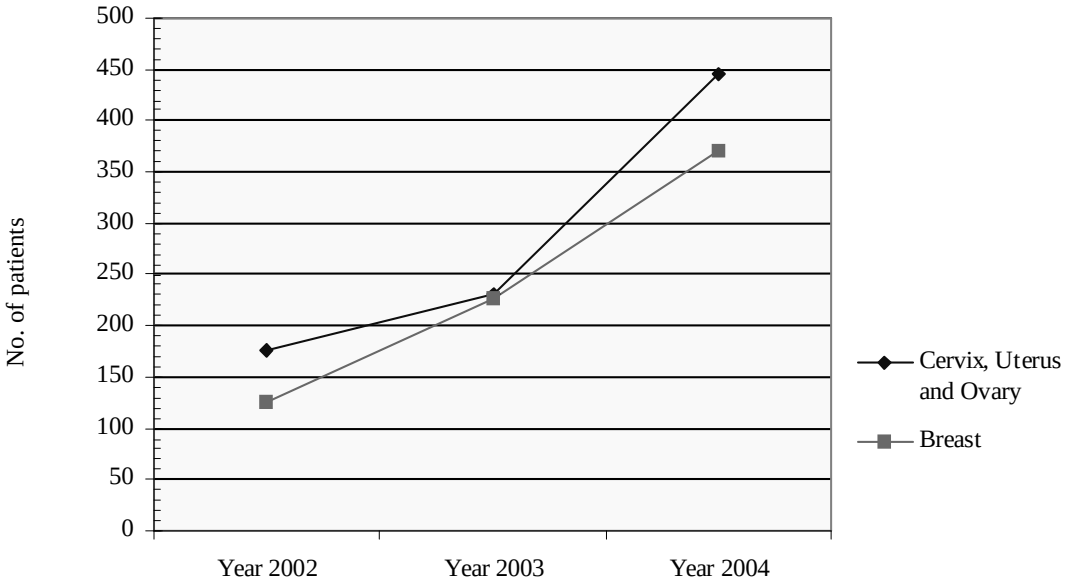


Figure-13. Cancers of breast, uterus and ovary at teaching hospitals.

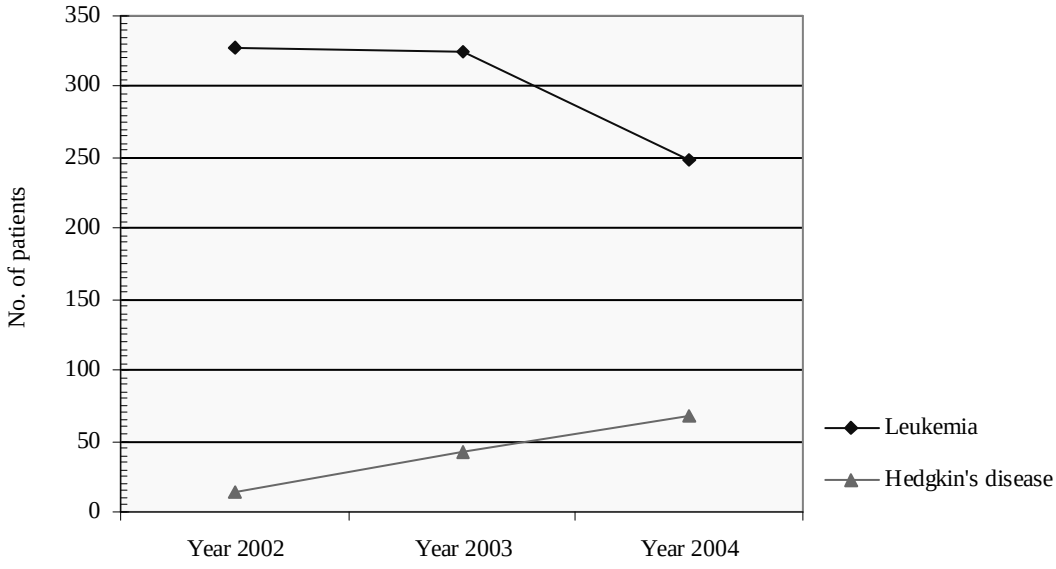


Figure-14. Cases of leukemia and Hodgekin's disease at teaching hospitals.

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.

5. Papers published/accepted

Published

1. Haldiya KR, Mathur ML, Sachdev R and Saiyed HN. Risk of high blood pressure in salt workers working near salt milling plants: a cross sectional and interventional study. *BMC Environ Health*, 4:13 (2005).

2. Haldiya KR, Sachdev R, Mathur ML and Saiyed HN. Knowledge, Attitude and Practices about Occupational Health Problems among Salt Workers working in Desert of Rajasthan, India. *J Occup Health*, 47: 85-88 (2005).

3. Joshi V, Sharma RC, Singhi Manju, Sharma K, Sharma, Y and Adha, S. Entomological studies on malaria in irrigated and non-irrigated areas of Thar desert, Rajasthan, India. *J Vec Borne Dis.,* 42: 25-29 (2005).

4. Mathur ML. Pattern and Predictors of Mortality in Sandstone Quarry workers. *Ind J Occup Env Med*, 9:80-85 (2005).

5. Singh Madhu B, Fotedar R and Lakshminarayana J. Occupational morbidities and their association with nutrition and environmental factors among textile workers of desert areas of Rajasthan, India. *Jour Occupational Health*, 47: 371–377 (2005).

6. Singhi Manju, Joshi V,Sharma RC, Adha Sandeep and Dixit AK. Larvicidal efficacy of *Calotropis procera* against vectors of dengue, malaria and lymphetic filariasis in Arid zone of Rajasthan. *Annals of Arid Zone*, 44: 185-189 (2005).

7. Yadav SP and Mathur ML. Knowledge and practices about malaria among the sandstone quarry workers in Jodhpur district, Rajasthan. *Annals of Arid Zone*, 44: 65-70 (2005).

8. Yadav SP, Sharma RC and Joshi V. Study of social determinants of malaria in desert parts of Rajasthan, India. *J Vec Borne Dis.,* 42: 141-146 (2005).

9. Bansal SK and Singh Karam V. Laboratory evaluation for comparative insecticidal activity of some synthetic pyrethroids against vector mosquitoes in arid region. *Journal of Environmental Biology*, 27: 251-255 (2006).

10. Joshi Vinod, Sharma RC, Adha Sandeep, Sharma Keerti, Singh Himmat, Purohit Anil and Singhi Manju. Importance of Socio-economic status and tree holes in distribution of Aedes mosquitoes (Diptera: Culicide) in Jodhpur, Rajasthan, India. *J Med Entomol.,* 43: 330-336 (2006).

11. Mathur ML. Potential utility of Mycobacterium w vaccine in control of tuberculosis. *Current Respiratory Medicine Reviews,* 2: 183-188 (2006).

Accepted

12. Mathur ML, Haldiya KR, Sachadev R and Saiyed HN. Risk of pterygium in salt workers. *Int Ophthalmol,* (2005).

13. Purohit SD, Purohit V and Mathur ML. A Clinical scoring system as useful as FNAC in diagnosis of tuberculous lymphadenitis in HIV positive patients. *Curr HIV Res*, (2006).

14. Singh Madhu B, Fotedar R, Lakshminarayana J and Anand PK. Studies on the nutritional status of under five children in drought affected desert area of Western Rajasthan, India. *Pub Health Nutrition,* 9: 961-67 (2006).

15. Yadav SP, Mathur ML and Dixit AK. Knowledge and attitude towards tuberculosis among the sandstone quarry workers in desert part of Rajasthan, India. *Ind J Tub* (2006).

6. Workshops/Conferences/ Symposia/ Scientific meetings attended/ participated/ organized by scientists

Dr. R. C. Sharma, Deputy Director (SG) & Officer in charge

- Scientific Advisory Group (SAG) meeting of the Division of NCD, 10th & 11th May, 2005 at ICMR Hqrs., New Delhi.
- Task Force Study on Sub-Clinical Vitamin-A deficiency among children of Rajasthan, 9th & 10th June, 2005 at ICMR Hqrs. New Delhi
- Attended Executive Committee meeting of the Indian Society for Malaria and other Communicable Disease held on 12th July, 2005 at NICD, Delhi.
- ICMR Forum for epidemiology, 25th July, 2005 at NIE, Chennai
- ICMR-WHO workshop on NCD Prevention & Control, 29th & 30th August, 2005 at Jaipur
- Performance Appraisal Board meeting, 8th to 10th Septemeber, 2005 at ICMR Hqrs. New Delhi.
- Global Forum for Health Research, 12th to 16th September, 2005 at Mumbai.
- International Conference on Malaria, 4th to 6th November, 2005 at NIMR, Delhi
- Indo-US workshop on "Practical Methods for Silica Dust Control" held on 18th Janaury, 2006 at Beawar.
- Annual Conference of Indian Society for Malaria and Other Communicable Diseases held on 11th to 13th February, 2006 at Agra.
- National Consultative Workshop on National Vector Borne Disease Control Programme, 21st March, 2006.

Dr. K.R. Haldiya, Deputy Director (SG)

- Attended the Annual Meeting of Health Forum 9 held at Mumbai from 11th September to 17th September 2005 which was organized by Global Forum for health Research, Geneva.
- Participated in Expert Working Group on 'National Programme for Control and treatment of Occupational Diseases' (Ninth five year Plan) on 28th September 2005 at NIOH, Ahmedabad.

- Attended XVI RAJ APICON to held at Dr. S.N. Medical College, Jodhpur on 15th to 16th October, 2005 and chaired a session.

- Participated in International workshop on Research Ethics at Chennai from 6th to 10th February, 2006 as member secretary of Ethics Committee of the center.

Dr. Murli L. Mathur, Deputy Director

- Attended a Workshop on 'Capacity building of young scientists for Nutrition Research', jointly organized by ICMR, Delhi & NIPCCD, Assam & Micronutrients Initiative, Delhi, from 25th to 28th October, 2005 at National Institute of Public Cooperation and Child Development (NIPCCD), Guwahati and delivered a lecture on 'Role of Vitamin A and zinc in tuberculosis'.

- Attended WHO-NIV Workshop on 'Molecular Surveillance network for Measles in India', from 17th to 18th October, 2005, at Pune and made presentation on 'Measles in Rajasthan'.

- Attended ICMR-WHO workshop on 'Prevention and Control of Non-communicable Diseases in India', from 29th to 30th August, 2005, at Jaipur.

Dr. Karam V. Singh, Deputy Director

- Attended an 'International Conference of Malaria', organized by Malaria Research Centre, Delhi, from 4th to 6th November, 2006, at National Agriculture Science Complex, New Delhi.

- Attended a 'Meeting of Entomological Forum', at Vector Control Research Centre, Pondicherry, on 9th November, 2005, as nominee of the centre.

- Attended a training on 'Biochemical assays for determining insecticide resistance in Mosquitoes', at National Institute of Malaria Research, Delhi, from 12th to 16th December, 2005.

- Attended '6th Joint Annual Conference of Indian Society for Malaria and Other Communicable Diseases (ISMOCD) & Indian Association of epidemiologists (IAE)', at National JALMA Institute for Leprosy & Other Mycobacterial Diseases, Agra, from 11th to 13th February, 2006 and presented a paper on 'Feasibility assessment of different types of ovitraps for the surveillance and control of Aedes aegypti in arid areas'.

Dr. S.K. Bansal, Deputy Director

- Attended the ICMR – MIHR workshop on 'Intellectual property and Technology management in health' at Indian Council of Medical Research (ICMR), New Delhi on 23rd January, 2006.

- Attended '6th Joint Annual Conference of Indian Society for Malaria and Other Communicable Diseases (ISMOCD) & Indian Association of epidemiologists (IAE)', at National JALMA Institute for Leprosy & Other Mycobacterial Diseases, Agra, from 11th to 13th February, 2006 and presented a paper entitled 'Larvicidal potential of active principle(s) of *Solanum xanthocarpum* against important mosquito vectors in the arid region.'

Dr. S.P. Yadav, Assistant Director

- Attended an 'International Conference of Malaria', organized by Malaria Research Centre, Delhi, from 4th to 6th November, 2006, at National Agriculture Science Complex, New Delhi and presented a paper entitled 'Role of population movement in transmission of malaria in desert part of Rajasthan, India'.

- Attended '6th Joint Annual Conference of Indian Society for Malaria and Other Communicable Diseases (ISMOCD) & Indian Association of epidemiologists (IAE)', at National JALMA Institute for Leprosy & Other Mycobacterial Diseases, Agra, from 11th to 13th February, 2006 and presented a paper entitled 'A study of some socio-cultural factors associated with malaria transmission in desert part of Rajasthan, India'.

- Attended 'National Workshop on health problems and health care systems among the tribes of India', at Andhra University, Visakhapatnam, from 8th to10th February, 2006 and presented a paper entitled 'Awareness and practices about silicosis among tribes of sandstone quarry workers in Jodhpur district of Rajasthan'.

Dr. Madhu B. Singh, Assistant Director

- Attended a Workshop on 'Capacity building of young scientists for Nutrition Research', jointly organized by ICMR, Delhi & NIPCCD, Assam & Micronutrients Initiative, Delhi, from 25th to 28th October, 2005 at National Institute of Public Cooperation and Child Development (NIPCCD), Guwahati and delivered a lecture on 'Nutritional status of preschool children of drought affected areas of Jodhpur, desert district of Western Rajasthan, India'..

- Attended National Workshop on 'Development of Guidelines for Effective Home Based Care and Treatment of Children Suffering from Acute Severe Under

Nutrition', organized by Department of Human Nutrition, AIIMS, New Delhi, from 11th to 13th November, 2005, at AIIMS, New Delhi.

- Attended '6th Joint Annual Conference of Indian Society for Malaria and Other Communicable Diseases (ISMOCD) & Indian Association of epidemiologists (IAE)', at National JALMA Institute for Leprosy & Other Mycobacterial Diseases, Agra, from 11th to 13th February, 2006 and presented a paper entitled 'Childhood illnesses and malnutrition in under five children in drought affected desert area of western Rajasthan, India'.

Dr. J. Lakshminarayana, Assistant Director

- Attended '23rd Annual Conference of Indian Society for Medical Statistics (ISMS)' held at KLE's-Jawaharlal Nehru Medical College (JNMC), Belgaum, Karnataka during January 20-22nd , 2006 and presented a paper on 'Estimating and Adjusting for Publication Bias of Vitamin A deficiency (VAD) in Meta Analysis'.

- Attended '6th Joint Annual Conference of Indian Society for Malaria and Other Communicable Diseases (ISMOCD) & Indian Association of epidemiologists (IAE)', at National JALMA Institute for Leprosy & Other Mycobacterial Diseases, Agra, from 11th to 13th February, 2006 and presented a paper entitled 'A Systematic Review and Meta Analysis of Prospective Intervention Studies on Malaria'

Dr. Manju Singhi, Research Officer

- Attended a Regional Workshop on challenges in forestery research extention', organized by AFRI, Jodhpur from 18th to 19th October, 2005 and presented a paper entitled 'Development of scientific rationale for distribution and abundance of medicinal plants of desert Rajasthan'.

- Attended Medical Development Congress, 2005 on " Drugs and pharmaceutical infectious diseases" on 23-24 January 2006 , organized by ICMR, New Delhi .

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   PGI
   Chandigarh – 160 012

6. Dr. G. C. Mishra — Member
   Director
   National Centre for Cell Science
   Pune – 411 007

7. Dr. Bela Shah — Member
   Senior Deputy Director-General &
   Chief, Division of NCD
   Indian Council of Medical Research
   Ansari Nagar
   New Delhi – 110 029

8. Shri P. D. Seth — Member
   Financial Adviser
   Indian Council of Medical Research
   V. Ramalingaswami Bhawan
   Ansari Nagar
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9. Shri Mohinder Singh — Member
   Sr. Deputy Director-General (Admn.)
   Indian Council of Medical Research
   Ansari Nagar
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10. Shri A. K. Shrivastava — Member
    Executive Engineer
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11. Dr. R. C. Sharma — Member Secretary
    Officer-in-Charge
    Desert Medicine Research Centre
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    Jodhpur – 342 005

10. *Scientists & Staff*

Officer-in-Charge

Dr. R. C. Sharma, M.Sc., D.Sc.

A. SCIENTISTS

1. Dr. K. R. Haldiya, M.D., Deputy Director (S.G)
3. Dr. Vinod Joshi, M. Sc., Ph.D., Deputy Director
4. Dr. M. L. Mathur, M.D., Deputy Director
5. Dr. Raman Sachdev, M.D., Deputy Director
6. Dr. Karam V. Singh, M. Sc., Ph.D., Deputy Director
7. Dr. S. K. Bansal, M. Sc., Ph.D., Deputy Director
8. Dr. S. P. Yadav, M. A., Ph.D., Assistant Director
9. Dr. Madhu B. Singh, M. Sc., Ph.D., Assistant Director
10. Dr. A. K. Dixit, M. Sc., Ph.D., Assistant Director
11. Dr. J. Lakshminarayana, M. Sc., Ph.D., Assistant Director
12. Dr. Ranjana Fotedar, M.B.B.S., Senior Research Officer
13. Dr. Manju Singhi, M. Sc., Ph.D., Research Officer
14. Dr. P. K. Anand, M.B.B.S., Research Officer

B.TECHNICAL STAFF

1. Dr. P. K. Dam, M. Sc., Ph.D., Technical Officer
2. Sh. Raj Kumar Kalunda, M.A., Technical Officer
3. Sh. Manjeet Singh, AMIE, Technical Officer
4. Dr.Himmat Singh, M. Sc., Ph.D., Research Assistant
5. Sh. Anil Purohit, M. A., Research Assistant
6. Sh. M. S. Khan, Laboratory Technician
7. Sh. Rajneesh Kumar, Laboratory Technician
8. Sh. S. K. Dhawal, Laboratory Technician
9. Sh.Ramesh Chandra, Laboratory Technician
10. Sh. Pooranmal Meena, Laboratory Technician
11. Sh.Colvin Sunil Singh, Laboratory Technician
12. Sh.Rohit Prasad Joshi, Laboratory Assistant
13. Sh.Rajendra Chouhan, Laboratory Assistant

.

C. MINISTERIAL STAFF

1. Sh. Anup Sarin, Accounts Officer
2. Sh. S. K. Lotan, Section Officer
3. Sh. Narender Bajaj, Section Officer
4. **Smt**. Neelam Devi, Assistant

5. Sh. Dharam Pal, Assistant
6. Sh. Rajendra Singh, Assistant
7. Sh. Shamshad Ali, Upper Division Clerk
8 Smt. Chandra Kala, Upper Division Clerk
9 Sh. Mahesh Chand Pargi, Upper Division Clerk
10. Sh. Yesh Pal Singh, Upper Division Clerk
11. Sh. Ram Niwas, Lower Division Clerk
12. Sh. Nand Kishore, Lower Division Clerk
13. Smt. Kanchan Bala, Jr.Hindi Translator
14. Sh. Joginder Singh, Stenographer

D. SUPPORTING STAFF

1. Sh. Babu Lal, Driver
2. Sh. Mangu Singh, Driver
3. Sh. Raghunath Singh, Driver
4. Sh. Mohammed Gaffar, Driver
5. Sh. Ishwar Khetani, Driver
6. Sh. Manoher Singh, Driver
7. Sh. Banwari Lal, Lab.Attendant
8. Sh. Shridhar Bohra, Lab,Attendant
9. Sh. Lal Chand Bandra. Lab.Attendant
10 Sh. Raghunath Bisht,Animal Attendant
11 Sh. Babu Lal Bunker, Animal Attendant
12 Sh. Mahaveer Prasad, Animal Attendant
13 Sh. Satya Prakash , Animal Attendant
14 Sh. Mahesh Chand Sharma, Attendant
15 Smt. Laxmikanta, Attendant
16 Sh. Khushal Singh, Attendant
17. Sh. Jodha Ram, Attendant
18. Sh. Ram Lal , Peon
19 Sh. Ladu Ram, Peon
20. Smt. Sohni Devi, Peon
21. Smt. Sua Devi, Sweeper.

PROJECT STAFF

Dengue & dengue hemorrhagic fever in Rajasthan

1. Sh. Sandeep Adha – SRF
2. Ms. Keerti Sharma – JRF
3. Sh. Narender Sharma – Technician
4. Ms. Prabha Joshi – Lab. Investigator
5. Ms. Benit Angel – Lab. Investigator
6. Sh. Sonu Sharma – Driver

2. Epidemiology of essential hypertension in arid population of Rajasthan

1. Mrs. Sunita Dankiya – Field Investigator
2. Sh. Ram Naresh – Field Investigation
3. Sh. Vinod Kumar – Attendant

3. Environmental Health Studies in Jodhpur

1. Dr. Harcharan Singh Rumana, Research Associate
2. Mrs. Alka Sharma, JRF
3. Ms. Pallavi Bohra, JRF
4. Sh. Achlesh Kumar Sharma, Lab. Cum-Field Assistant