TRIBAL HEALTH IN RETROSPECT

EXPERIENCES FROM MULTIDISCIPLINARY RESEARCH ACTIVITIES AT RMRCT

REGIONAL MEDICAL RESEARCH CENTRE FOR TRIBALS
(Indian Council of Medical Research)
Nagpur Road, P.O. Garha
Jabalpur - 482 003 (MP) INDIA

Moving with a Vision

to empower the health status of
the tribal communities
by doing action oriented quality research

TRIBAL HEALTH IN RETROSPECT

EXPERIENCES FROM MULTIDISCIPLINARY RESEARCH ACTIVITIES AT RMRCT

REGIONAL MEDICAL RESEARCH CENTRE FOR TRIBALS
(Indian Council of Medical Research)
Nagpur Road, P.O. Garha
Jabalpur - 482 003 (MP) INDIA

TRIBAL HEALTH IN RETROSPECT

EXPERIENCES FROM MULTIDISCIPLINARY RESEARCH ACTIVITIES AT RMRCT

SILVER JUBILEE CELEBRATION OF RMRCT, JABALPUR

(1984-2009)

Published by:
Director
Regional Medical Research Centre for Tribals
(Indian Council of Medical Research)
Nagpur Road, P.O.Garha, Jabalpur-482 003
Madhya Pradesh, India
Tel: +91-761-2370800, 2370818; Fax: +91-761-2672835
E-mail: rmrctjabalpur@rediffmail.com
Website: www.rmrct.org, www.icmr.nic.in

Contributors to this Volume

Planning and Technical Editing	Dr. Neeru Singh	Scientist G & Director
Scientific Contribution	Scientists of the Centre	
Compilation and Technical Editing	Dr. R.S. Balgir	Scientist F
	Dr. Kalyan B. Saha	Scientist C
	Dr. Jyothi Bhat	Scientist B
	Dr. Ravendra K. Sharma	Scientist B
	Dr. Jyotirmoy Roy	Research Assistant
	Dr. Arvind Verma	Research Assistant
Cover Page Design	Dr. Rakesh C. Mishra	Sr. Artist Cum Photographer

सत्यमेव जयते

डॉ विश्व मोहन कटोच
एम डी, एफ एन ए एससी, एफ ए एम एस, एफ ए एससी, एफ एन ए
सचिव, भारत सरकार
(स्वास्थ्य अनुसंधान विभाग)
स्वास्थ्य एवं परिवार कल्याण मंत्रालय एवं
महानिदेशक, आई सी एम आर
Dr. Vishwa Mohan Katoch
MD, FNASc, FAMS, FASc, FNA
Secretary to the Government of India
(Department of Health Research)
Ministry of Health & Family Welfare &
Director-General, ICMR

भारतीय आयुर्विज्ञान अनुसंधान परिषद
(स्वास्थ्य अनुसंधान विभाग)
स्वास्थ्य एवं परिवार कल्याण मंत्रालय
वी. रामलिंगस्वामी भवन, अंसारी नगर
नई दिल्ली - 110 029 (भारत)

Indian Council of Medical Research
(Department of Health Research)
Ministry of Health & Family Welfare
V. Ramalingaswami Bhawan, Ansari Nagar
New Delhi - 110 029 (INDIA)

MESSAGE

I am indeed pleased to learn that Regional Medical Research Centre for Tribals, Jabalpur has successfully completed 25 years of its inception. The Centre dedicated to tribal health has established its relevance in important area.

India has a large number of tribal populations. Each tribe has different health problems owing to the variability in their habitat, socio economic development, cultural practices and lack of education and health facilities. RMRCT is the only ICMR centre working extensively on tribal health in remote areas under all odds and through its in-depth research it brings to light the correlates and causal factors of morbidity and distinctly the health needs of the tribal. It is worth mentioning its contribution particularly in the field of haemoglobinopathies, fluorosis, malaria and other vector borne and communicable diseases. The centre also helped State Government investigating and evaluating many outbreaks/national programmes such as Malaria outbreak in Betul, Yaws Eradication Programme in Bastar, Universal Sanitation Programme in Rewa, etc. Over the period the centre has consolidated its research activities from mere prevalence studies to technology driven molecular studies. It has also remarkably extended its net work of collaborative work with both national and international research agencies of repute. The centre is also recognized by many national and international universities for pursuing M.Sc dissertation and also Ph.D programme because of the expertise and interest of the scientists.

This document is the reflection of research activities carried out at RMRCT over the period and will be very useful for any body working on health particularly among the ethnic population.

I express my best wishes and congratulate Director, all scientists and staff of RMRCT for this achievement.

(V.M. Katoch)

Tele. : (Off.) +91-11-26588204, 26589620; Fax (Off.) : +91-11-26588662, E-mail : secydhr@icmr.org.in; dg@icmr.org.in

आचार्य एन.के. गांगुली
सलाहकार, केन्द्रीय स्वास्थ्य एवं परिवार
कल्याण मंत्री एवं पूर्व महानिदेशक
भारतीय आयुर्विज्ञान अनुसंधान परिषद
अलंकृत - पद्म भूषण, 2008

Prof. N.K. GANGULY
MD, D.Sc (hc), FMedSci (London), FRC Path. (London), FAMS, FNA, FASc, FNASc, FTWAS (Italy), FIACS (Canada), FIMSA
Adviser to Union Health & Family Welfare Minister
and former Director-General, ICMR
Awarded Padma Bhushan, 2008

स्वास्थ्य अनुसंधान विभाग
(स्वास्थ्य एवं परिवार कल्याण मंत्रालय)
भारतीय आयुर्विज्ञान अनुसंधान परिषद
वी. रामलिंगस्वामी भवन, अंसारी नगर,
पोस्ट बॉक्स 4911, नई दिल्ली–110 029

Department of Health Research
(Ministry of Health & Family Welfare)
Indian Council of Medical Research
V. Ramalingaswami Bhawan, Ansari Nagar,
Post Box 4911, New Delhi - 110 029

MESSAGE

It gives me immense pleasure to express my best wises on successful completion of 25 years of Regional Medical Research Centre for Tribals.

During this period the centre has consolidated its position day by day by strengthening its scientific activities starting from modernization of its laboratories to publication in high impact factor journals. This is only ICMR centre exclusively working on tribal health and is instrumental in exploring the disease profile of the primitive tribe in details for which such informations are either partially or not available. The centre has build up a wide network not only at national level but also with international scientific community for transfer of technology and carrying out some very challenging studies at the heart of the country. Mention may be made of its success stories in controlling the diseases particularly on haemoglobinopathies, fluorosis and malaria in Madhya Pradesh. The national and international symposiums and regular training workshops conducted by the centre particularly on malaria, HIV/AIDS and fluorosis is worth mentioning for its effort in developing human resource not only in the central region, but throughout the country and abroad. The establishment of a mega site for vaccine trial pertaining to malaria is a significant achievement of the centre and the same may be used by any research agency for multiple research endeavour. The centre's extensive work under all odds on tribal health particularly on haemoglobinopathies, sickle cell disease, fluorosis, tuberculosis, malaria and other vector borne and communicable diseases which takes hundreds of life every year has helped to develope its brilliance and established itself as a valid source of research support and monitoring and evaluation of the activities for the Ministry of Tribal Affairs, Government of India. Considering the RMRCT's achievements, Rani Durgawati Vishwavidyalaya, Jabalpur has recently recognized the centre for pursuing Ph.D work, which has added a fillip to it's cap.I congratulate Dr. Neeru Singh, her team of all the scientists and staff of RMRCT for their hard work and valuable contributions.

This book is the out come of its research activities and will be a valuable reference for any body working on health and particularly related to tribal health.

Nirmal Kr. Ganguly
(Prof. N. K. Ganguly)

Tele. : 26588204(Off.); PABX : 26589334, 26589335, 26589336, 26588707 Extn. : 264 (Res.) : 26493145, 26493045
Fax : 91 - 11 - 26588662, 26589492, 26589647, 26589258; E- mail : gangulynk@icmr.org.in; gangulynk41@yahoo.co.in; gangulynk@gmail.com (personal)
Permanent Residence : 701, Gayatri Apartments, GH-6, Sector-45, Faridabad-121003; Telefax : 0129-2439998

CONTENTS

PREFACE

It is my pleasure to present the research achievements of RMRCT on successful completion of its 25 years of its establishment. The centre was established on 1st march 1984 with an objective to carry out research and identify the regional health problems, identification of specific health problems and health needs of the tribal. It also works in close with the Government machineries in planning, executing and on developing human resources on different aspects of health.

This long journey of 25 years is not an easy passage for the centre and it has witnessed many ups and downs in different sphere. From the year 2000 onwards the centre is consolidating the initial achievements and diversifying into advanced research on genetic disorder and infectious diseases, using molecular tools.

The centre also excelled in infrastructural development during the period. Most of the laboratories at the centre established since inception were either renovated or modernized. New laboratories equipped with higher technology based equipments particularly in the field of malaria, tuberculosis and other infectious diseases were also established. There were significant improvements on the human resource development at the centre. Several students have enrolled for undertaking their MD/M.Sc./Ph.D. dissertation work with financial support from UGC/CSIR/ICMR and also from international agencies such as Liverpool School of Tropical Medicine (LSTM), UK, Boston School of Public Health (BSPH), USA and Centre for Disease Control (CDC), USA. Some residential quarters were also used as hostels for the students. The construction of an international hostel is in progress. The centre also established linkages for collaborative research and received extramural funds from some of the agencies like MP Council of Science and Technology, CDC, UNICEF, NACO, WHO-SEARO, LSTM, Liverpool School of Tropical Medicine and Hygiene, National Institute of Health, BSPH, Morehouse School of Medicine, ICMR, etc.

Over the period more and more scientists and the technical staff of the centre

participated in different national and international conferences in India and abroad and also build up a wide net work with the scientific community for future collaborative work. I expect a quantum jump in generating more extramural funds as well as quality publications in the years to come.

It is worth mentioning here that the centre provides forum in the form workshop/symposium from time to time for intellectual and brain storming interactions. Beside regional and state level workshops, the centre also organized national and international symposium. Recently Rani Durgawati Vishwavidyalaya, Jabalpur has recognized the centre for pursuing research work leading to Ph.D degree.

In achieving what we are today on the 25th year of its inception, I sincerely acknowledge the hard work and continuous support by all the scientists, members and staff of RMRCT. I feel privileged to be a part of the team and congratulate all of them on this occasion of Silver Jubilee.

I place on record my sincere thanks and gratitude to all the former Directors of the RMRCT.

Needless to mention the name of Prof. N.K.Ganguly, former Director General of Indian Council of Medical Research for his constant support to the centre, innovative ideas and vision.

I also acknowledge and thank the different Scientific Advisory Committees of the centre, its all chairman and members for their interest and support which helped us building Excellence in Science.

This book is an outcome of selected studies compiled out of the vast scientific research activities carried out in the centre at different point of time. I believe this will be an immense help for the planners, academicians, scholars, and any other researcher who endeavour to work on health and particularly among the tribal.

(Neeru Singh)

Director

INTRODUCTION

Origin of Regional Medical Research Centre for Tribals, Jabalpur

Tribes of India are socially and economically backward and hence the constitution of India has special provisions for upliftment of these communities. They mostly live in forests and hilly terrains isolated from the other elite communities. They have their own way of living and different socio-cultural settings. Lack of proper health and education facilities, faulty feeding habits, certain irrational belief systems and special tribal chores are likely to aggravate their health and nutritional status. Their health problems need special attention in the context of primarily for two reasons, firstly, many of the tribal communities are backward and, thus, deserve special attention, and secondly, the growth of the tribal communities is very uneven. In few communities, there is a definite decline threatening their very existence. This decline may not be due to low level of fertility but rather high level of mortality.

The usual concept about diseases in tribal society is that they are caused by the breach of some taboo or by hostile spirits or the ghosts of the dead. Accordingly, the tribal have more faith in magico-religious treatment of the diseases and second line of treatment is to utilize modern medical facilities available to them. These tribal differ from one another in population size, literacy and socio-cultural aspects. Their geographical distribution also vastly differs from plains to dense forests and hilly terrains. Therefore, each tribe has different health problems owing to the variability, i.e. geographical, socio-economic development, cultural characteristics, etc. Hence, it is necessary to investigate the magnitude of the problem, inter-relationship with their socio-cultural habits, and to plan suitable intervention programs for each tribe.

Tribal population of India constitutes about 8% of the total population of India. There exist tremendous amount of heterogeneity in the tribal population. The Central part of India comprising the states of Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, and Rajasthan harbor the majority of these indigenous or aboriginal folks. There are some tribal communities which are still at pre-

agricultural level of technology, having low literacy, with stagnant population and some of them even facing the danger of slow extinction.

The state of Madhya Pradesh (undivided) has the largest proportion of tribal communities (23%) in the country. There are 46 scheduled tribes and sub-tribes in the state. Gonds, Bhils are the two numerically predominant tribes (Census 1991). In the year 2000 Madhya Pradesh has been divided in to two states of Madhya Pradesh and Chhattisgarh. A look into Census 2001 reveals that the scheduled tribe population of the state of Madhya Pradesh was 20.3 % of the total population of the state while same for Chhattisgarh was 32 %. Madhya Pradesh holds 1st rank among all the states/ UTs in terms of ST population and 12th rank in respect of the proportion of ST population to total population. The growth of the ST population during 1991-2001 has been 26.4 % which is 2.1 % higher than the over all growth of total population (24.3 %). The scheduled tribe population is overwhelmingly rural, with 93.6 % residing in rural areas. At district level, STs have retained the highest proportion in Jhabua district (86.8 %) followed by Barwani (67 %), Dindori (64.5 %) and Mandla (57.2 %). Bhind district preceeded by Morena and Datia has the lowest proportion of STs (0.5%). The overall sex ratios of the ST population in Madhya Pradesh is 975 females per 1000 males which is lower than the national level of 978 for all STs. The overall literacy rate of the STs of Madhya Pradesh has increased from 18.4 % at 1991 census to 41.2 % at 2001 census but still this figure is lower if compared with that of all STs at the national level (47.1 %). Bhil is the most populous tribe contributing 37.7 % of the total ST population of the state. Gond is the second largest with 25.6 %. Four other STs in their descending order are Kol, Korku, Sahariya and Baiga. As regard fertility is concerned, the mean number of children ever born per ever married ST women (45-49 years) was 5 which is higher than the total STs at national level (4).

The tribes of Madhya Pradesh are shifting cultivators, forest dwellers, artisans, land-owner and landless communities of depleted resources and other communities mainly dependent on forest for their sustenance facing various problems. Their life style

is peculiar because of their social and cultural habits, which makes them distinct. The ecological conditions are also different from the general population. Their primitive economy and dependence on natural resources also make them vulnerable to on slaughter of the Nature. Because of lack of communication and proper education, the tribal have not been able to utilize the health services and facilities of the health posts. Efforts are being made to bring them in the main stream of the society for development through various general upliftment programs operating in the rural areas of the state. However, it is believed that these have had little effect because they were not geared towards their specific needs/requirements. Therefore, they continued to depend on their traditional health practices. No significant health impact on them is expected from the conventional health care services.

Map showing the State of Madhya Pradesh and Jabalpur

During the 6th Five Year Plan of the Country, the Indian Council of Medical Research, New Delhi had established the Regional Medical Research Centre for Tribals at Jabalpur in March 1984 with the focus to tackle the regional health problems of the tribal population in the central region of the country. Initially, the research emphasis of this Centre was on:

- epidemiology of communicable diseases
- epidemiology of non-communicable diseases
- operational research for improving efficiency of the health care services to the population
- education and training to the personnel working in the tribal areas to improve the intersectoral developmental programs
- incorporating health as a part of package of need-based services, and
- finally to develop and strengthen the local expertise in the biomedical research.

The centre is consolidating the initial achievements and diversifying into advanced research on genetic disorders and infectious diseases by using molecular tools. The broad objectives of the Centre are:

- To plan, conduct and coordinate research in order to bring out the solutions to specific health problems/needs of the tribal.
- To conduct epidemiological studies on communicable diseases and non communicable diseases among the tribal.
- To conduct studies on haemoglobinopathies.
- To assist the Government in planning, executing and training of health functionaries for specified tribal health programs.

At present, the Centre has the following disciplines for carrying out the research:

Medical Microbiology	Genetics
Bio-chemistry	Community Health & Epidemiology
Vector control	Anthropology
Biostatistics	Demography
Health Economics	

Difficulties in Tribal Areas and Health Problems of Primitive Tribes

There are seven Primitive Tribes, namely, Abujhmarias, Baigas, Birhors, Bharias, Hill Korwas, Kamars, and Saharias which are categorized based on their use of level of technology, education level, low growth rate, high morbidity and mortality, health and hygienic conditions, and their standard of living in the undivided state of Madhya Pradesh.

Problems of working in tribal areas

Unlike the established research institutes where the scientists are working in air-conditioned laboratories with sophisticated equipments, this centre is engaged primarily in field based action oriented research programs among the tribes located in far flung and inaccessible hills and forests. Thus, inherent nature of the centre's work is such that its performance can not be truly assessed if not seen through the constraints and impediments which may not similarly affect the functioning of other laboratories. Despite the resource crunch, internal infrastructural constraints, transfer of staff and ban on creation of new posts, the centre faced a number of problems. However, despite impediments and limited resources, the centre has much to be proud of its achievements. It is not the bulging sail but the subtle breeze behind it that moved the ship.

In tribal realm, the social acceptance of existing scientific knowledge is more important than doing new science itself. Moreover, it is not the virulence of causative agents alone to be investigated but the determinants like environment, customs, education, socio-economics and religious hindrance, which decide the fate of an individual victim.

A scientific institution is not only known by its building and by other glitters but through the work and contributions made by its constituent scientists. Fortunately, the centre possessed a dedicated band of young scientists, who came forward with an additional spurt of energy, whenever the situation demanded and thus, despite a

number of constraints during the course of history, the centre has lived upto the trust placed on it. The scientific staff of the centre, unmindful of the inconveniences and risks, continued the march for achieving the targeted goals with zeal and commitment. Research records straight forwardly speak of the credibility.

Health problems of the primitive tribes

There are some identified morbidities and certain causal factors which aggravate the health problems among the primitive tribes and are mentioned below:

The morbidities includes-

- High prevalence of hemoglobinopathies i.e. Sickle Cell Anemia and G-6-PD deficiency.
- The tribal population are exposed to the risk of infection by the vector borne diseases particularly the malaria.
- Nutritional deficiency, High prevalence of Anemia, Vitamin-A deficiency, Scabies and Upper Respiratory Tract Infections (URI).
- Most of the population had intestinal worm infestation. It reflects extensive feco-oral transmission due to poor environmental sanitation.

Initial Functioning of the Centre and Research Studies

The Centre started with an Administrative Cell located in the Medical College, Jabalpur in April, 1984. The main activities upto March 1985 were acquisition of land from the Government of Madhya Pradesh for construction of the Centre. A total of 14,760 Hectares of land was acquired and fenced. In the beginning, on the scientific front the scientists belonging to the Social Sciences, Human Genetics and Medical Entomology were recruited in 1985-86. Procurement of sophisticated equipments was done for standard laboratories.

A view of RMRCT building

Initial studies were carried out on the following fronts:

Health seeking behaviour among the Bhil and Gond tribes of Madhya Pradesh

A study on the health seeking behavior among the two major tribes, namely, Bhils and Gonds in Dhar and Bastar districts, respectively, the largest tribal groups in Madhya Pradesh was initiated. An anthropological case study was carried out to understand their health behavior. This helped in knowing the appropriateness of the existing health care services and also threw light on areas which need an in depth probing for formulation of need based health care and services.

Personal hygiene and sanitary habits of Bhil and Bhilala of Madhya Pradesh

A questionnaire based study was carried out in five villages of Bagh block and two villages of Kukshi block in Dhar district to know their habits of personal hygiene and sanitation covering a total of 734 households of Bhilalas and 128 households of Bhils. Defecation in the open fields was reported by almost all the households. The use of soap for washing hands after defecation was reported in a negligible (2%) proportion of the households. About half of them were washing their hands with plain water, while other 41 % used mud for this purpose.

Most of the households (87%) cleaned their teeth everyday. The main source of water in two thirds of the households was an open in sanitary well. The remaining one-third of them had an access to safe drinking water from the hand-pumps. About one-third of the households did not take bath daily. The habits were found to be associated with the availability of the water in the area. Where ever the water was available in abundance and close to the households it was used for bathing and washing of clothes everyday.

Cattle-sheds were found inside the main dwelling in two-thirds of the households. Sewage and refuse disposal were usually done in the open around the

house. However, between the two tribes, the personal hygiene, daily bathing habits, and sanitation of the households, cattle sheds and environment around the house was relatively better in the Bhilalas.

Prevalence of sickle hemoglobin and glucose-6-phosphate dehydrogenase deficiency in Bhils of Madhya Pradesh

Some studies on the Bhils of Rajasthan and Gujarat have shown a high prevalence of sickle hemoglobin (Hb S) and G-6-PD deficiency. In view of their potential health risks, a study of the frequency of Hb S and G-6-PD deficiency was carried out among the Bhils of Dhar district, which constitute about 53% of the district's population.

Studies on malaria and its vector biology in Mandla district

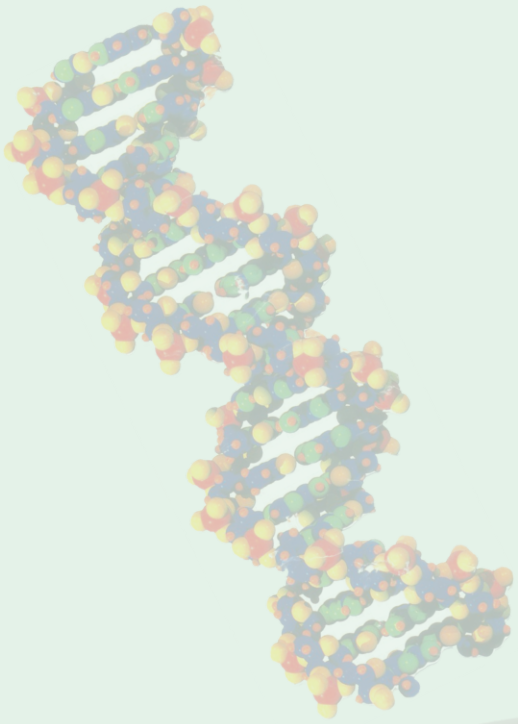
Malaria is a major public health problem in our country. The surveillance activities under the National Malaria Eradication Program (NMEP) revealed that some tribal pockets of Madhya Pradesh are endemic for *Plasmodium falciparum* infection. This is a potentially dangerous infection causing cerebral malaria and multiple organ failure, resulting in high fatality in the affected population. In view of this, studies were initiated in collaboration with the Malaria Research Centre (ICMR), New Delhi on mosquito's fauna, vector susceptibility to commonly used insecticides and malariometric survey.

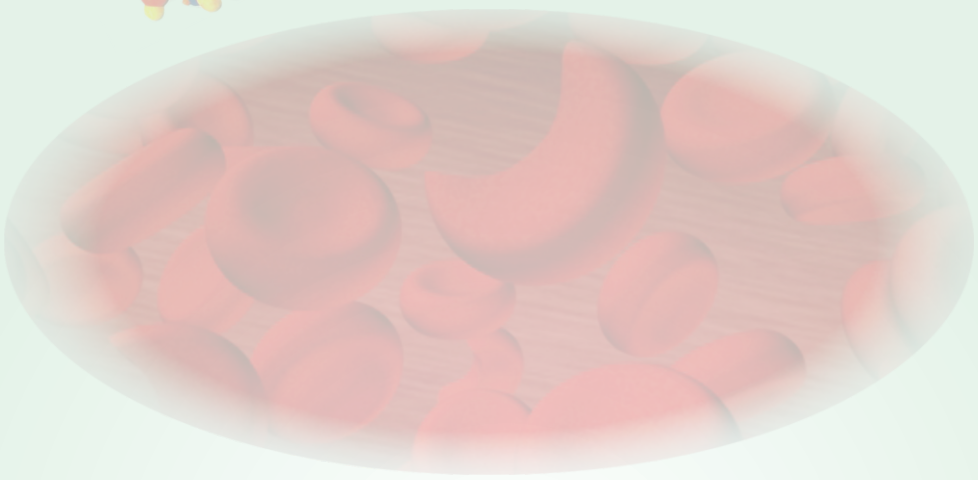
The findings indicated that malaria due to *P. falciparum* was a major health problem in the tribal areas of Mandla. *P. malariae* was identified for the first time in the region. The commonest vector of malaria was found to be *Anopheles culicifacies*, which were resistant to commonly used insecticides like DDT and Dieldrin. Hence, there was a need to develop alternative strategies for the control of vector species to eradicate malaria in this region.

Under the coordination of the Malaria Research Centre, Delhi, a project on Integrated Disease Vector Control (IDVC) was initiated by this Centre in areas around Jabalpur. The main emphasis was to reduce the source through biological control of the

vector species by improving the environmental sanitation, through active community participation, health education and active surveillance. This approach was expected to pay greater dividends in the eradication of not only malaria but also other vector borne communicable diseases besides a healthy and clean environment.

Some more scientific, technical, and administrative staff joined the Centre in the latter part of the year 1985-86. A number of community and hospital based studies fulfilling the objectives of the Centre were initiated in 1986-87.





GENETIC DISORDERS

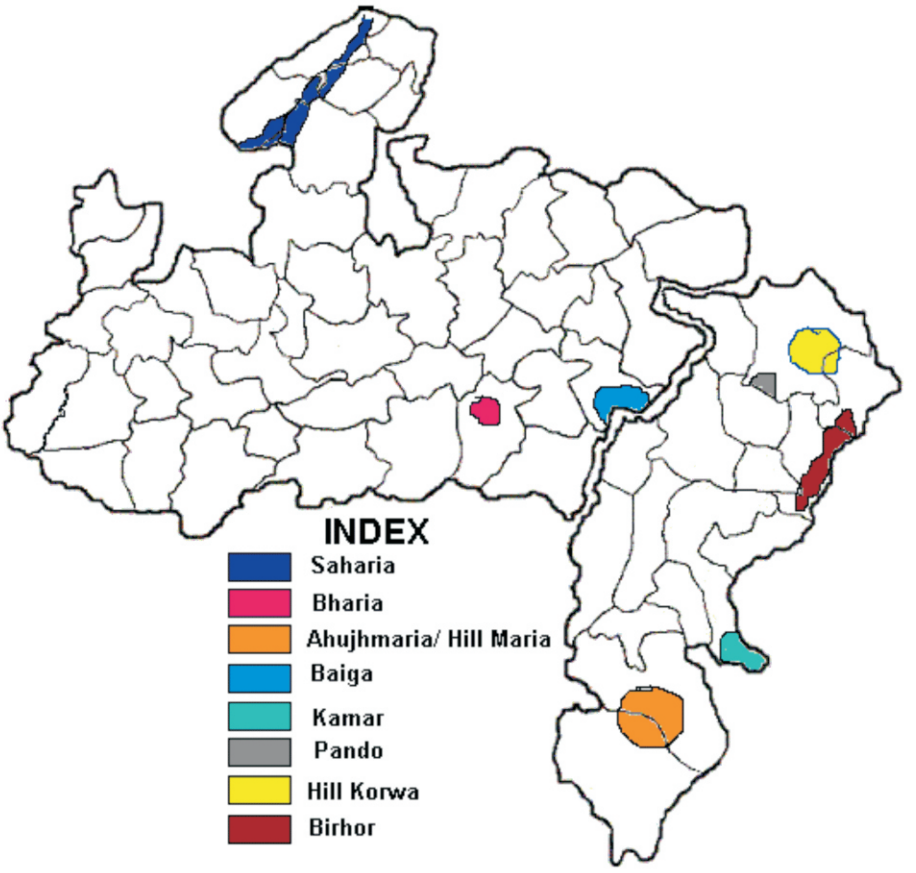
Red Cell Genetic Disorders in Primitive Tribes of Madhya Pradesh and Chhattisgarh 1986-1996

Saharias of Gwalior division; Baigas of Baigachak area of district Dindori; Bharias of Patalkot area of district Chhindwara; Hill Maria of Abhujhmarh area of district Bastar; Kamar of district Mahasamund / Raipur, Birhor of districts of Jashpur and Raigarh and Hill Korwa of district Surguja are the primitive tribes with the areas of their major concentration. Another tribe i.e. Pando of district Surguja was considered as priority accord group based on parameters considered for classification of primitiveness. The distribution of these tribes are shown in the map. The population size of these primitive tribes varies a lot e.g. Bharia of Patalkot valley are only 2000 in number whereas Saharias are a few lacs. All these tribes have a distinct life style and live in inaccessible area covered with thick forest. All these tribes follow the tribe endogamy strictly. The status of common red cell genetic disorders in these primitive tribes was not known prior to this study.

Table 1: Red Cell genetic disorders in primitive tribes of Madhya Pradesh and Chhattisgarh

Population	Year of Study	Area	HbAS (%)	HbSS (%)	G6PD DEF. (%)	-Thal. Trait (%)	UNST. Hb
Hill Marias	1988	Abhujmarh, Bastar	22.5	0	3.6	ND	ND
Hill korwas	1991	Surjuja	0	0	1.7	10.4	3.2
Kamars	1992	Raipur	0.9	0	1.6	6.6	ND
Birhors	1994	Raigarh	0	0	ND	2.2	ND
Bharia	1989	Patalkot, Chhindwara	1.7	0	8.3	8.5	ND
Baiga	1986	Baigachak, Mandla	18.4	1.1	9.5	3.6	ND
Saharia	1992	Gwalior Division	0	0	1.6	6.1	ND
Pando	1996	Surguja	1.1	0	1.1	0.4	ND

Primitive tribes of Madhya Pradesh and Chhattisgarh



The table 1 shows that sickle hemoglobin is common in primitives tribes of central Madhya Pradesh i.e. Baiga and Bharia and southern Chhattisgarh i.e. Abhujhmaria. Sickle hemoglobin was absent or near absent in primitive tribes of northern and eastern Chhattisgarh i.e. Hill korwa, Birhor and Kamar and northern Madhya Pradesh, i.e. Saharia. Further it was found that there exists a negative relationship in the prevalence of sickle hemoglobin and -thalasaemia in the primitive tribes. The tribes with the absence of sickle hemoglobin tend to have high prevalence of -thalassemia trait. G-6-PD deficiency is common in all the primitive tribes, but Baiga and Bharia are having high prevalence of the deficiency of this enzyme.

Red Cell Genetic Disorders in Other Tribes of Madhya Pradesh 1989-2006

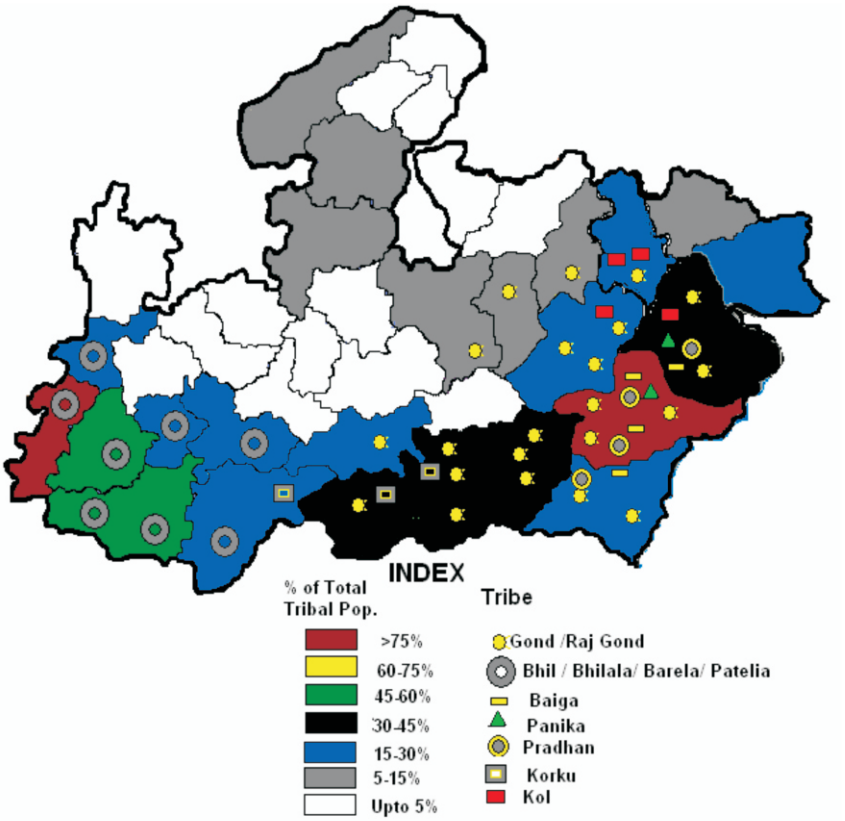
About 20 % of the over 60 million population of Madhya Pradesh belong to various tribal groups numbering over forty. All these tribes are strictly endogamous and have short marital distances hence share a gene pool restricted to a small geographical area. Thus these tribes are having large genetic diversities and need to be studied at micro level. Broadly these tribes can be divided into two main groups i.e. Gond group of tribes. This group includes the tribes of Gond, Raj Gond, Pradhan, Baiga. The Gond groups of tribes occupy the central, eastern and southern parts of the state. The other group is called Bhil group of tribes. This group includes following tribes - Bhil, Bhilala, Barela, and Patelia and occupy western part of the state. There are other tribes i.e.Kol in the districts of Katni, Satna and Sidhi and Korku tribe in the districts of Chhindwara, Betul, Hoshangabad and Khandwa districts. Distribution of the tribes in the state is uneven. There are many districts, for example Vidisha, Ujjain, Bhopal and Narsimhapur, in which tribal population constitute 3 - 5 % only. In other districts the tribal population contributes more than 50 % of the district population. These districts are Jhabua, Dhar, Barwani, Dindori and Mandla. The distribution of the Scheduled tribes are shown in the map follows. Similarly the distribution of Scheduled caste population in the state is uneven. The highest concentration of Scheduled caste population is in Datia district which is one fourth of the district population and the least is in Jhabua district i.e. 2.8 % of the district population. The red cell genetic disorders were studied in the tribes and scheduled caste population of the district / area. There are numerous scheduled caste groups in the state but in the present study few groups which are common in the given area were studied. These caste groups are Jharia, Basod, Mehra, Chaudhary, and Balai. The prevalence of the sickle haemoglobin, G-6-PD deficiency and -thalasaemia trait is given in the Table 2.

Table 2: Prevalence of red cell genetic disorders in the Scheduled tribes and Scheduled caste of Madhya Pradesh

Population	Year of Study	Area	HbAS (%)	HbSS (%)	G6PD DEF. (%)	Thal. Trait (%)	UNST Hb
Gond	1989	Patalkot	15.82	2.53	3.1	ND	ND
Kol	1995	Satna	4.1	0	3.8	5.9	2.1
Pradhan	1995	Dindori	28.3	1.8	4.9	0	0.4
Gond	1996	Kundam	20.0	0.7	ND	ND	ND
Sindhi	1998	Jabalpur	0	0	ND	9.1	ND
General	1998	Jabalpur	1.6	0.2	ND	4.1	ND
Gond	2000	Seoni	18.5	0.4	1.7	1.0	ND
Mehra (SC)	2000	Seoni	21.3	0.5	1.8	1.4	ND
Gond	2001	Balaghat	14.8	0.6	1.3	2.2	ND
Mehra (SC)	2001	Balaghat	17.3	0.9	1.4	0	ND
Korku	1999	Betul	13.8	0.7	2.7	3.9	ND
Gond	1999	Betul	11.4	0.7	3.0	1.0	ND
Mehra (SC)	2001	Betul	32.4	2.0	2.0	0.3	3.7
Basod (SC)	2001	Betul	19.5	0	2.4	0	0.8
Baiga	2003	Dindori	18.4	1.1	3.4	3.6	ND
Gond	2002	Chindwara	4.3	0	3.7	2.9	ND
Korku	2002	Chindwara	17.2	1.2	5.6	4.8	ND
Katiya (SC)	2003	Chindwara	24.9	2.2	3.9	1.1	ND
Mehra (SC)	2003	Chindwara	19.8	3.4	2.6	5.2	ND
Basod (SC)	2003	Chindwara	22.0	0	0	4.0	ND
OBC	2003	Chindwara	12.1	1.7	6.9	8.6	ND
Gond	2004	Panna	6.7	0	2.3	ND	ND
Panika	2004	Shahdol	28.6	3.3	2.8	2.0	2.8
Baiga	2004	Shahdol	10.5	0	1.8	1.6	1.8
Gond	2004	Shahdol	13.1	1.2	3.2	4.6	3.6
Choudhary(SC)	2004	Shahdol	5.1	0	2.6	3.8	3.6
Korku	2004	Nimar	16.9	0.7	1.3	2.3	7.6
Bhil	2004	Nimar	14.2	0	3.4	1.0	3.7
Barela	2005	Nimar	27.2	0.3	5.7	1.3	3.5
Bhilala	2005	Nimar	18.4	0.3	4.3	1.3	8.1
Balai (SC)	2005	Nimar	13.4	0.6	1.0	2.2	5.4
Preg.women	2004	Jabalpur	6.2	0	-	2.2	-
Choudhary(SC)	2006	Damoh	18.0	1.0	6.0	9.0	-
Gond	2006	Damoh	33.0	1.0	30.0	10.0	-
Gond	1996	Jabalpur	11.5	0	ND	2.35	ND
OBC	1994	Jabalpur	22.3	-	ND	ND	ND

Note: (SC) refers to Scheduled caste

Distribution of Tribes of Madhya Pradesh



The table 2 reveals that sickle hemoglobin is the main form of hemoglobinopathies from clinical point of view in almost all the tribes of Madhya Pradesh with variable prevalence rate ranging from 5 to 28 %. Some tribes like Pradhan, Panika and Barela has very high (25-30%) prevalence of sickle haemoglobin. Sickle hemoglobin is common in both the sub-groups of Gond tribe but with a high prevalence (15 - 20%) in Kishan Gond than Raj Gond (4 -10%) of central Madhya Pradesh i.e. in districts of Chhindwara and Damoh. In Bhil group of tribes the sickle haemoglobin ranges from 14- 27 %. - thalassaemia trait which varies from 1 to 4 % is common in Gond tribe including both of its sub-groups in Madhya Pradesh. In Bhil group of tribes the prevalence of - thalassaemia is low i.e. about 1 %. G-6-PD deficiency varies from 1- 5 % in all the tribes of Gond and Bhil groups. But in some tribes i.e. Raj Gond of Damoh and Gonds of Patalkot valley has high prevalence (about 9%) of G-6-PD deficiency. There are large

variations (5- 32%) in the prevalence of sickle hemoglobin in the different SC population of various districts. The highest prevalence (32%) of sickle hemoglobin was in Mehra (Neo-Buddhist) of Betul and Chhindwara districts and lowest (5%) was in Chaudhary of Shahdol and Damoh districts. Mehra community was followed by Jharia community i.e. Jharia, Dahariya, Dahiya etc. of Jabalpur and Mandla districts where HbS prevalence was 30 %. In various SC communities of different parts of state the prevalence of -thalassaemia and G-6-PD deficiency varied from 0- 5 %. Unstable hemoglobin could be studied only among few tribes residing in Betul, Shahdol, Damoh and Chhindwara districts. The prevalence varied from 0.8% (Basod of Betul) to 8.1 % in Balai of Nimar area. In tribal population, Korku has high prevalence (7.6%) of unstable haemoglobin.

Red Cell Genetic Disorders in Other Tribes of Chhattisgarh 1987-1998

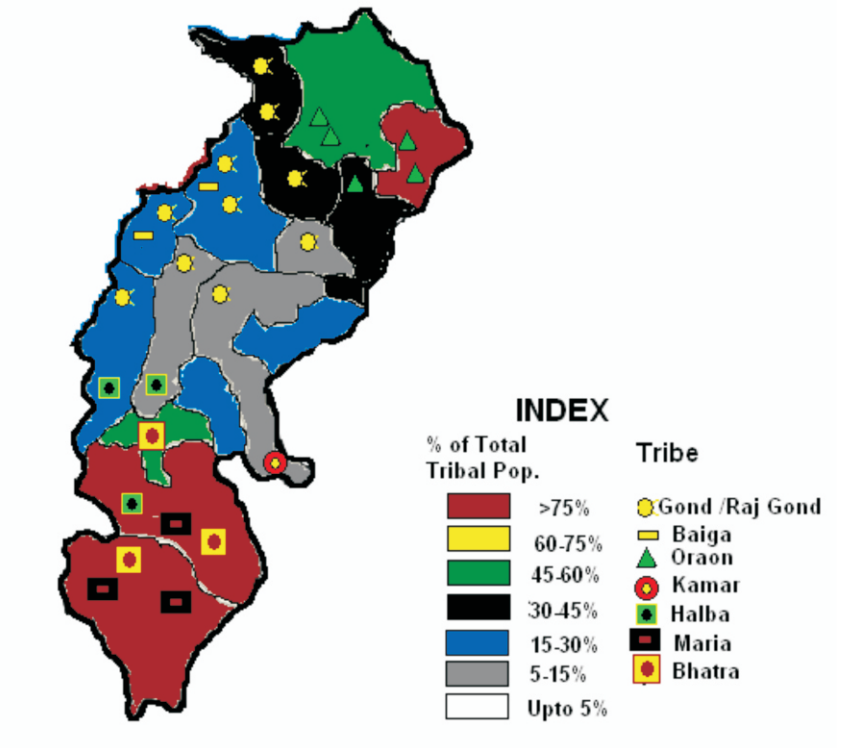
Tribes constitute about 32 % population of Chhattisgarh which is about 6.6 millions as per Census 2001 and Scheduled caste population contributes 11.1 % of the population of the state. Broadly these tribes, other than primitive tribes can be divided into two main groups i.e. Gond group and Oraon group of tribes. Gond group includes the tribes of Gond, Raj Gond, Halba, Muria, Maria, Baiga, Bhatra etc. The Gond and its groups occupy the central and southern parts of the state. The other group is Oraon group of tribes. The groups includes Oaron and Kanwar / Kawar and occupy eastern part of the state. These tribes are unevenly distributed in the state. The districts of Raipur, Janjgir-Champa, and Durg has low concentration of tribal population i.e. 11- 12.5 %. In other districts /areas, the tribes constitutes over 50 % of the population of the district. These districts are Bastar, Dantewada, Surguja, Kanker and Jashpur. The tribal distributions in the state are shown in map follows. The highest concentration of Scheduled caste population is in Janjgir Champa. The red cell genetic disorders were studied in the tribes and Scheduled caste population of the different districts / areas. The prevalence of the

sickle haemoglobin, G-6-PD deficiency and -thalassaemia trait is given in the table 3.

Table 3: Prevalence of red cell genetic markers in tribes of Chhattisgarh

Population	Year of Study	Area	HbAS (%)	HbSS (%)	G-6-PD DEF. (%)	-Thal. Trait (%)	UNST Hb
Maria	1988	Bastar	13.9	0	13.9	ND	ND
Halba	1996	Bastar	18.9	1.05	3.6	ND	ND
Bhatra	1987	Bastar	13.1	0	ND	ND	ND
Oraons	1996	Raigarh and Surguja	0	0	ND	1.9	ND
Halba	1998	Rajnandgaon, Durg	15.6	0.3	1.1	2.4	6.0

Distribution of Tribes in Chhattisgarh



The table 3 reveals that sickle haemoglobin is the common and only abnormal haemoglobin important from public health point of view. Its prevalence varies from 15 to

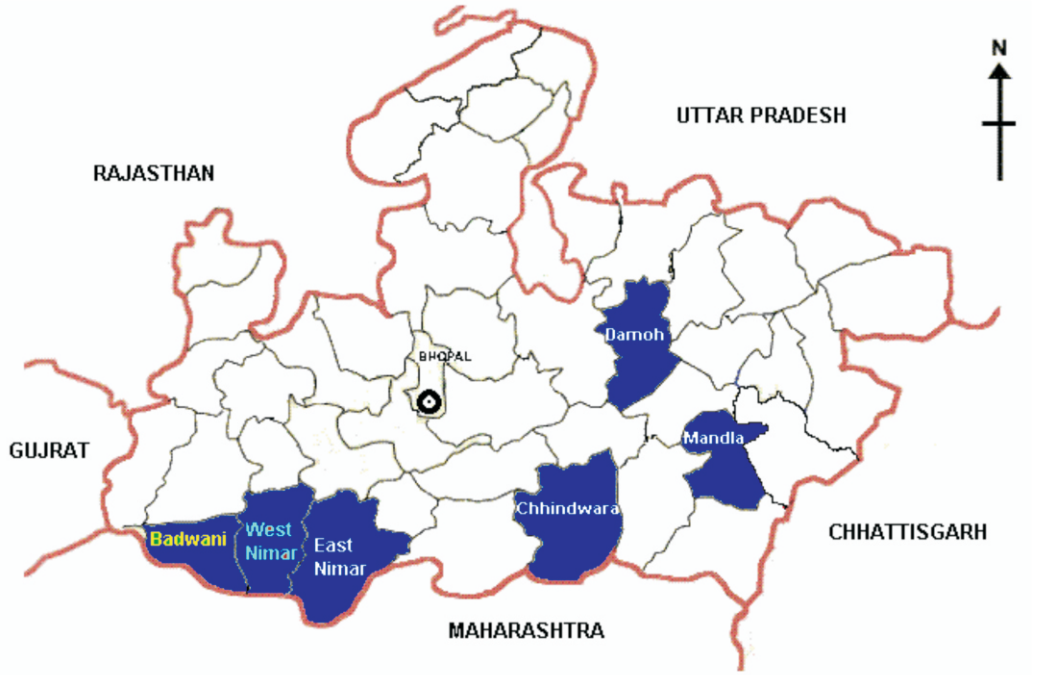
20 % in all the Gond group of tribes i.e. Muria, Maria, Bhatra and Halba of central and southern Chhattisgarh. In Oraon group of tribe i.e. Oraon and Kawar it is almost absent. G-6-PD deficiency is very high i.e. 14 % in Maria tribe.

Prevalence of alpha thalassemia type II in Some tribes of Madhya Pradesh 2003-2007

Hemoglobinopathies are commonest genetic disorders in the world. In late eighties, alpha thalassemia type II was reported in high frequency (about 80%) from a small island population of Pacific Ocean. Later, similar high prevalence of -thalassemia type II were reported from Tharu population in Tarai area of Nepal. Both the studies reported that such a high proportion of genetic disorder in a small population is due to its advantageous selection against malaria. The later study also gave indirect evidences in support of its hypothesis. Few more studies were undertaken in course of time. Study undertaken among the Kachari of Assam and another among the heterogenous population of Orissa, reported prevalence of -thalassaemia type II but the prevalence were lower than reported earlier. In 1991, studies undertaken by RMRCT reported high prevalence of -thalassaemia type II from a Gond population of district Mandla of Madhya Pradesh, in similar proportion that of Tharu people of Nepal and Vantunu population of New Papua New Guinea. Later we investigated few more tribes for the prevalence of -thalassaemia type II. In all the above stated populations, the determinants of -thalassaemia were small deletions in the $_2$-gene region of -gene cluster. These mutations were caused by 3.7 and 4.2 kb deletion of $_2$-gene.

The study was carried out in the Bhil group of tribes of Nimar area, Gond group of tribes of districts of Damoh, Mandla and Bharia and Gond of Patalkot valley of Chhindwara district and are shown in the map. A Scheduled caste community Chowdhary is also covered in the study.

Study area of -thalassaemia type II in Madhya Pradesh



The findings are shown in table 4. The table shows that the prevalence of -thalassemia type II is very high (ranging from 60% to 85%) in the tribes of Bhil, Bhilala, Korku and Barela of Nimar area and Gond of Damoh districts and Bharia of Patalkot valley of Chhindwara district. Alpha thalassemia type II caused by - $^{3.7}$ mutation was quite common, whereas, - $^{4.2}$ allele was almost low or absent. However, - $^{4.2}$ allele is relatively more common in Scheduled caste population and Gond and Bharia tribes of Patalkot valley of Chhindwara district. The homozygosity of -thalassemia type II was prevalent significantly in higher proportion as per Hardy Weinberg's Law in all the tribe studied. The high prevalence of homozygous form of -thalassemia type II in tribal population indicates the selection process in favour of -thalassemia type II and need further investigation. The presence of -thalassemia type II caused mild anemia with reduction in MCV value and increased in RBC count.

Table 4: Prevalence of alpha thalassemia in some tribes and Scheduled caste populations of Madhya Pradesh

Population	Year	/	/-$^{3.7}$	/-$^{4.2}$	-$^{3.7}$ /-$^{3.7}$	-$^{3.7}$ /-$^{4.2}$
		In percentage				
Korku (Nimar)	2003	23.1	15.4	23.1	38.5	0
Bhil (Nimar)	2003	27.8	18.5	0	53.7	0
Barela (Nimar)	2004	38.1	11.3	0	50.5	0
Bhilala (Nimar)	2004	38.9	15.6	0.6	44.8	0
Balai (Nimar)	2004	71.1	14.4	4.1	10.3	0
Raj Gond (Damoh)	2005	22.1	39.7	17.6	20.2	0.4
Chowdhary (Damoh)	2006	92.2	0	3.6	4.2	0
Gond (Patalkot)	2007	19.6	47.1	17.0	16.3	0
Bharia(Patalkot)	2007	18.2	54.5	14.5	12.7	0

Molecular studies in hemoglobinopathies in central India 2002-2008

The study area was tribal predominant areas of districts of Mandla and Jabalpur of Madhya Pradesh. The objectives of the study are to identify the haplotype of sickle hemoglobin, -thalassaemia type II and molecular characterization of -thalassaemia in tribal predominant areas. The study also examines the interaction of sickle hemoglobin with -thalassaemia.

Some of the important findings are mentioned below-

- The haplotype of sickle hemoglobin is highly linked (>95%) with Arab-India haplotype i.e. haplotype No. 31.

- -thalassaemia type II is very high (gene frequency, = 0.6) is mainly caused by - $^{3.7}$ and - $^{4.2}$ kb deletion of $_{2}$ gene and by some point mutations.
- There was a novel mutation of $_{1}$ gene i.e. IVS1-116 (GA) and Hb Koya Dora leading to -thalassaemia type II.
- There was no triplication of alpha gene.
- The frequency of gene was lower (0.32) in individual with -thalassaemia trait.
- Five common -thalassaemia mutations in central India were: IVS 1-5 (GC), IVS1-1(GT), Cd8/9(+G), Cd 41/42 (-CTTT), and 619 bp deletion.
- Two new mutation were found for the first time in Indian population i.e. Cd30 (GC) and IVS 1-1(GA). These are common mutation in African population.
- HbF is generally high but variable (HbF 5%-42%) with high expression of G .
- Persons with homozygous for -thalassaemia had lower values for Hb, MCV, MCH and lower level of HbF.
- -gene bearing sickle hemoglobin mutation had altered sequence at -530 resembling with lower expression of -gene.
- A rare case of Hb Hofu ($_{2}$ $_{2}$ 126 ValGlu) was found in a 26 years old female. It causes mild unstable hemoglobin and anemia.

Morbidity profile of sickle cell disease in central India 2002-2008

The study area is Jabalpur and its surrounding area of Madhya Pradesh. The patients visiting various clinics and hospital of Jabalpur and its surrounding area and suspected to have hemolytic anemia were referred to Regional Medical Research Centre for Tribals, Jabalpur for investigations of hemoglobinopathies. The patients who were diagnosed as sickle cell disease were requested to attend the sickle cell clinic. The clinic

is operative twice a week. The patients and / or their parents were counselled regarding the transmission and variable presentation of the disease were requested to avoid disease precipitating factors like stress, extreme physical labour, acidity, exposure to extreme climate. They were also advised to take adequate hydration and seek quick medical intervention whenever fall sick. The patients were given folic acid, to be taken daily, and antipyretic and anti-inflammatory drugs to be taken, if need arises. If the patients were sick at the time of presentation, they were given symptomatic treatment. The patients were requested to attend the clinic, after every three months even in healthy state. The patients were examined as per structured proforma. Till date 439 patients of sickle cell disease have been registered in the clinic. A total of 243 patients have attended the clinic in the follow-up schedule for more than two years.

Table 5: Age and sex distribution of sickle cell disease patients (N=439)

Age group (Years)	Total	Male (%)	Female (%)
0—5	109	71.6	28.4
5-10	103	72.8	27.2
10-15	107	72.9	27.1
15-20	52	75.0	25.0
20-25	32	53.1	46.9
25-30	19	68.4	31.6
30+	17	70.6	29.4

The distribution of age and sex composition of sickle cell patients are shown in table 5. The median age of the patients was 10.4 years. About three-fourths of the patients are below 15 years of age. It is to mention here that many patients die young. The registration of higher proportion of males may be due to male biased attitude for treatment.

Table 6: Caste/tribe wise distribution of sickle cell patients

Age group (Years)	N	Percentage distribution			
		SC	ST	OBC	General
0-5	109	55.1	11.0	27.5	6.4
5-10	103	46.6	17.5	24.3	11.6
10-15	107	38.3	21.5	32.7	7.5
15-20	52	40.4	9.6	28.8	21.2
20-25	32	46.9	12.5	25.0	15.6
25-30	19	42.1	21.0	15.9	21.0
30+	17	23.5	23.5	35.3	17.6
Total	439	44.9	15.9	27.8	11.4

The caste/tribe wise distribution of the sickle cell patients are shown in table 6. It is evident from the table that about 45 % of the patients are from scheduled caste community suggesting that the problem of sickle cell disease is enormous in this section of population. Other backward class community also has sickle cell disease in sizable proportion. A small proportion of the patients from general caste (forward community, Muslim and Christian) suggest that every community of central India is at risk for sickle cell disease.

The table 7 shows the distribution of spleen size according to the age of the sickle cell patients. It is found that about 30 % of patients, of all age groups were not having palpable spleen. The proportion of not palpable spleen size increases slightly after age of 5 years onwards suggesting increase in non-functioning of spleen.

Table 7: Distribution of spleen size according to age of the sickle cell disease patients

Age group (Years)	N	Spleen size (in cm.)					Splenectomy
		Not Palpable	1-3	3-6	6-9	>9	
		In percentage					
0-5	109	29.4	40.4	25.7	3.7	0.9	0
5-10	103	21.4	34.0	34.0	5.8	3.9	0.9
10-15	107	28.0	32.7	23.4	7.5	5.6	2.8
15-20	52	30.8	34.6	25.0	5.8	1.9	1.9
20-25	32	46.9	40.6	6.2	3.1	0	3.1
25-30	19	36.8	21.1	15.8	15.8	5.3	5.3
30+	17	47.1	11.7	35.3	5.9	0	0
Total	439	29.6	34.4	25.5	5.9	3.0	1.6

Table 8: Common signs and symptoms among the sickle cell disease patients (N=439)

Findings	No. of cases (%)
Joint pain	68.6
Fever	62.9
Abdominal pain	30.1
General weakness, fatigue & giddiness	27.6
Joint swelling	17.1
Chest pain	14.8
Body pain	14.1
Bony pain	59.4
Pallor	92.0
Icterus	75.8
Hospitalization	48.1
No complaints	14.1

Pallor and icterus are the commonest signs as evident (75- 92%). Joint pain, bony pains and fever are the commonest (60- 68%) symptoms reported. Leg ulcer and priapism are

not seen in the Indian patients which are common in African patients (Table 8).

Table 9: Frequency of blood transfusion in SCD patients

Age group (Years)	N	No. of Blood Transfusion						
		0	1	2	3	4-6	7-10	10+
		In percentage						
0-5	109	46.8	46.8	4.6	0.9	0.9	0	0
5-10	103	45.6	43.7	5.8	3.9	0.9	0	0
10-15	107	43.9	41.1	8.4	3.7	0.9	1.8	0
15-20	52	25.0	36.5	15.4	15.4	5.7	0	1.9
20-25	32	56.2	28.1	3.1	9.4	3.1	0	0
25-30	19	21.0	68.4	0	5.3	0	0	5.3
30+	17	23.5	58.8	5.9	5.9	5.9	0	0
Total	439	41.9	43.5	6.8	5.0	1.8	0.5	0.5

Further about 42 % of patients did not receive any blood transfusion. Two percent of patients had multiple blood transfusion (Table 9). No guidelines, except presence of clinical anemia or as therapeutic treatment for crisis were followed for blood transfusion.

It is evident from the table 10 that fetal hemoglobin was generally high in all the age group persons. Average values of MCV and MCH are low suggesting that anemia

Table 10: Hematological profile of sickle cell disease patients (N=391)

Group	N	Hb (g/dl)	PCV (%)	TRBC ($10X^{12}$/l)	MCV (fl)	MCH (pg)	MCHC (g/dl)	HbF (%)	HbA_2 (%)
Male	103	8.2 2.5	24.6 7.1	3.2 1.0	78.8 12.3	26.5 5.2	33.6 3.4	13.3 6.1	2.9 1.4
Female	46	7.9 2.2	23.5 6.3	3.0 0.8	79.6 10.7	26.7 4.9	33.4 3.5	13.5 5.5	2.7 1.4
Children	242	7.2 1.9	21.8 5.8	2.9 0.9	78.6 13.2	26.2 5.0	33.2 4.6	12.9 5.5	2.6 1.0

Table 11: Distribution of patients according to age at onset of the disease

Age (in Years) at first appearance of SCD	Patients (%)
0-3	48.5
3-6	24.8
6-9	8.9
9+	17.8
Total	439 (100.0)

The age onsets of the disease among the patients are shown in table 11. It is evident that about half of the patients had symptoms i.e. hand-foot syndrome or recurrent fever in early stage of childhood. Nearly one-sixth of the patients showed late appearance of sickle cell disease signs and symptoms. Patients who showed early appearance of symptoms generally had severe form of disease.

Table 12: Comparative findings of severity index of the sickle cell disease patients before and after intervention (N=243)

Severity	Before intervention	After intervention
Mild	36.6	54.7
Moderate	54.3	40.7
Severe	9.1	4.5

The table 12 shows that simple intervention, like health awareness, avoiding disease precipitating factors, quick medical intervention upon sickness, folic acid intervention and quick intake of antipyretic or anti-inflammatory on SOS basis, has reduced the severity of sickle cell disease significantly.

VECTOR BORNE DISEASES

Malaria outbreak in Kundam Block of Jabalpur District 1987-1988 & 1998-2000

Malaria is major vector borne disease. Every year under National Vector Borne Disease Control Program, around 2 million cases are being reported. About 30% of malaria cases, 60 % of *P. falciparum* cases and 50% malaria related deaths are reported from ethnic tribal groups. Tribals are the most downtrodden section of the society, living under varied geo-climatic conditions, and constitute only 8% of the total population of the country. Control/containment of the disease is extremely difficult because of technical, administrative reasons and superstitions (witchcrafts) prevalent among tribals.

During the year 1987 there was an unusual increase in fever cases and deaths were reported from some villages of Kundam block of Jabalpur district. Govt. of Madhya Pradesh requested RMRCT to investigate the unusual rise in morbidity and mortality in this tribal block. Records available at Kundam PHC revealed very low prevalence of malaria in the area in the preceding three years with API of 1 and less. The area was under HCH spray and from 1984-1986 coverage was almost 100%. In 1987 because of low API in preceding years only about 30% population were covered under HCH spray.

Rapid fever survey was undertaken from October 1987 in 21 villages. These villages were divided in two groups i.e. sprayed villages (14 villages) and un-sprayed (7) villages. Presumptive treatment as per the NMEP (Now NVBDCP) was given to all the fever cases at the time of preparation of smear. Slide positivity rate (SPR) in these sets of villages were 73.7 and 70.4% respectively. Proportion of *P. falciparum* malaria was 75.9 and 59.2% respectively. Poor surveillance system, withdrawal of insecticide spray, and deficient and delayed rain fall in 1987 were seems to be the associated factors leading to epidemic of malaria. Based on the results of survey of RMRCT, following measures were taken by the state government to check the spread of disease.

- Surveillance machinery was strengthened. 12 additional surveillance workers and supervisors were posted. Five mobile team headed by medical officer were also deputed in the area.

- Fever and mass radical treatment were given in the affected villages and adjoining areas.
- One additional round of HCH spray was undertaken in entire Kundam block in the month of November 1987. Regular spray of insecticide was also started as per the schedule in 1988.
- Health camps were organized and health education material was distributed in the villages.
- The block was declared as restricted zone under the communicable disease act 1987 under section 2(3) to prevent the dissemination of disease due to population movement.

Follow up fever survey from January 1988 to May 1988 revealed that prevalence of malaria remain static in January. Proportion of *P. falciparum* infection was also increased to 90 % in both sets of villages. From February month SPR started reducing till the month of May 1988 and the reduction in *P. falciparum* infection was drastic (reduced to 30%). Results of epidemiological survey were communicated to district malaria officer within 24 hours for further action.

To assess the impact of intervention, a longitudinal epidemiological study was carried out in 7 villages of Kundam block. These villages were located adjacent to Bizadandi block of Mandla district, where activities of a mission project- integrated disease and vector control (IDVC) were in progress. Fortnightly epidemiological and entomological data were collected from August 1987 to July 1988. Overall SPR in these villages were 57.6 which vary from month to month from 36.4 to 71.6%. In children (1-10Yrs) SPR was 67.9 which was higher than higher age group (11+). The difference was not statistically significant. Further 46-50% children in age group of 2-10 years had enlarged spleen in 5 villages. High SPR particularly in infants and children which was recorded in all the months of the year (August 87-Jul 88) shows that transmission was perennial in this area and active transmission of malaria was going on with in villages despite the fact that all the possible control measures were taken up to control the transmission of disease including the imposition of restricted area act. The steps taken

by the Health dept. were though sufficient but unable to control the disease effectively. In view of epidemic of malaria and perennial transmission of disease following additional measures were suggested to state government .

- Release of larvivorous fishes in all water bodies.
- Source reduction- all the unwanted ditches and pools be filled and converted to fruit bearing gardens through community participation.
- Radical treatment to all the malaria infected persons preferably within 24 hours from the preparation of slide.

Entomological monitoring showed the presence of two well known vectors in the area i.e. *An. culicifacies* and *An. fluviatilis*. MHD *An. culicifacies* remains very high throughout the year (70.3-225.8). The density of other vector remained very low (0-1.25) throughout the study period.

Follow up survey (1998-2000)

In 1998 the entire Kundam block was covered under Enhanced Malaria Control Programme (EMCP) with the assistance of World Bank. Under the enhanced program emphasis was given to early diagnosis and prompt treatment by the introduction of malaria link volunteer in each selected village and rapid diagnostic tests. Laboratory services were strengthened with new modern microscope and conventional insecticides were replaced by Syntheic pyrethroids for indoor residual spray.

During 2000 rapid fever survey was carried out in 18 villages to assess the impact of intervention measures. Over all 271 blood smears were collected and slide positivity rate of 4.8% was recorded. *P.falciparum* proportion was 76.9%. MHD of vector, particularly of *An. culicifacies* was also very less (25.7) as compared to 1988-1989 when the density hovers around 125.The survey showed that there was no increase in malaria cases because of intensive control measures undertaken under EMCP by the health department.

Malaria outbreak in Lamta PHC, District Balaghat 1995

Following a request from State Govt. regarding some unusual mortality in the villages coming under PHC Lamta of Balaghat district, a rapid fever survey was carried out to ascertain whether the rise in morbidity and mortality was due to malaria and if the malaria was on rise then to suggest remedial measures to control the epidemic.

Nine villages of PHC Lamta were surveyed. Paddy was the main crop of the area and villages were surrounded by thick forest. Among these villages, five had focal spray of DDT in the month of October 1995 because of high fever rate and unusual deaths.

Active fever survey was carried out during the second week of December, 1995. Blood slides from all the fever cases and history of fever in the last 15 days were prepared by finger prick method. A total of 846 blood slides were prepared. Overall 68.3 percent SPR was recorded in surveyed villages which varied from village to village (40-88%). Proportion of *P. falciparum* infection was 89%. No significant difference was found in SPR in sprayed and unsprayed villages. In mass blood survey carried out in a small hamlet of a village, SPR was 53.5% in normal individuals.

Vector composition reveals the presence of *Anopheles culicifacies* which was the predominant species (62%) followed by *An. annularis* (29%). Proportion and density of *An. fluviatilis* was very less.

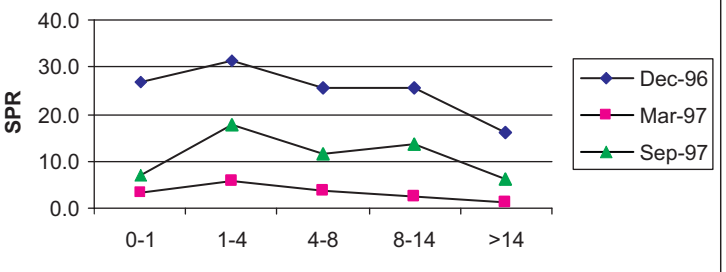
Because of the very high slide positivity rate in febrile and non febrile individuals and the predominance of *P. falciparum* infection, it was concluded that the high morbidity was due to epidemic of malaria in the area. Remedial measures such as strengthening of surveillance system, prompt radical treatment of all the parasite positive cases and indoor spraying of residual insecticide in entire PHC was suggested to health department, Govt of MP, which was implemented.

Epidemiology of Malaria in tribal groups of Surguja District 1996-1999

The study was carried out to determine malaria load and malaria vector composition in Pando and Kodaku tribe of the district. Both these tribes were considered to be the most backward tribes of Madhya Pradesh.

Three mass blood surveys were carried out in the Pando tribe dominated villages and 1142, 1130 and 1069 blood slides were collected. Overall slide positivity rate was 11.01 % and slide falciparum rate was 9.00%. SPR and SFR were highest during December month (20.92 and 18.12%) followed by September (9.35 and 7.1%) and in March month it was lowest (2.56 and 1.6%). Only about 27, 39 and 13% *P.falciparum* cases had gametocyte in the blood stream during December, March and September surveys respectively. Among *P. falciparum* cases, majority of them were asymptomatic (83.6% in December, 83.3% in March and 81.6% in September). Age group wise analysis reveals, peak SPR in children in the age group of 1-4 years and lowest in adult age group (14+ yrs age). The pattern was similar in all the three surveys (Fig.1). Presence of parasitaemia among infants in all the seasons indicates that the transmission takes place within the villages itself. Results showed the presence of very high proportion of asymptomatic *P.falciparum* infection in the community, which indicate high acquired immunity in Pando community. Such cases go undetected in routine surveillance and act as parasite reservoir. From these cases infection keeps on spreading and some time cause epidemics under the appropriate meteorological condition.

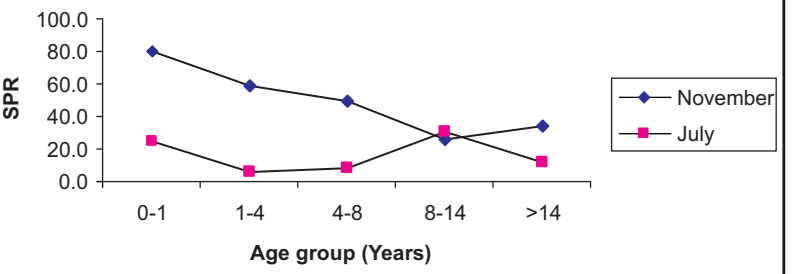
Fig.1: Age group wise slide positivity rate (SPR) in mass blood survey in Pando tribe



Anopheline fauna survey reveals the presence of 15 Anopheline species from indoor resting collection. *An. culicifacies* was predominant in all the three surveys followed by *An. fluviatilis* during December, *An. annularis* and *An. subpictus* during March and September respectively. Density of *An. fluviatilis* was quite high in December month (6.55) as compared to September (0.7) and March month (0.55)

Two mass blood surveys were carried out in Kodaku dominated villages in the month of July 1999 & November 1999 and 858 & 824 blood slides were collected. Among examined persons 201(24%) and 427 (52%) were having fever or history of fever at the time of survey. Overall SPR was 4.5 and 29.0% respectively. Proportion of *P. falciparum* infection was 92.3 and 78.7%. Among *P. falciparum* positive cases, proportion of asymptomatic infection was 27.8 and 30.9% respectively in Jul. & Nov. months. Among fever cases SPR was 13 and & 39.8%. Age group wise SPR in fever cases is shown in fig.2.

Fig.2: Age group wise slide positivity rate(SPR) in fever cases of Kodaku tribe



Malaria in Tamia block of Chindwara District 1997-1999

The primitive Bharia tribe of Patalkot in Tamia block, district Chhindwara was surveyed during 1997-98. Patalkot valley is a unique deep depression of the earth ranging from 1200 ft to 1700 ft deep, surrounded by hills and hillocks commonly called as Kanat. There are 12 villages in the valley spread over in about 500 square Km. No communication was available. The area was not sprayed during 1996 and 1997.

Analysis of secondary data collected from PHC shows very low API from 1986 to 1993 (between 0.84 and 1.6) except for the year 1992 when it was 6.91. From 1994 till 1996 there has been considerable increase in the API from 3.06 to 7.45. Village wise secondary data (last 10 years) for Patalkot valley indicated that except a few villages which are easily approachable, no slide collection was carried out in the area.

Mass blood survey was carried out and 946 blood slides were collected during the month of August 1997. Only 4 were found positive for malaria parasite. All were *P.falciparum* (SPR0.42%). In the month of January 1998, 757 blood slides were collected during the mass survey and 186 were found positive (SPR 23.25%). SPR in febrile cases was 42.6% with Pf proportion of 81.4%. The malaria situation became so worsen that pyrethrum space spray was carried out in the entire villages of Patalkot valley. Majority of the *P.falciparum* cases were asymptomatic during both the surveys (75 and 77.3%). In the follow up survey after first round of DDT spray in July 1998, SPR of 24.6% was recorded in mass blood survey from 413 persons and 34.5% among fever cases. SPR further increased to 46.3% in rapid fever survey in the month of December but overall fever rate was very less as compared to earlier surveys.

Anopheline fauna survey revealed the presence of 14 Anopheline species from indoor resting collections. *An. culicifacies* was the predominant species in all the surveys. Per man hour density of Anophlines were 33.2. Density of *An. culicifacies* was 26.6 and of *An. fluviatilis* 0.55 in the month of August.

Studies on Malaria in Baigas of Baiga Chak - A Primitive Tribe in Dindori District 1999-2007

The district Dindori is highly malarious as it constitutes 0.96% of the state's population, whereas it accounts for 11 % of malaria and 8 % of *P.falciparum* cases of the state in 1999-2000. The study was undertaken to determine prevalence of Malaria in Baiga Chak dominated by primitive tribe Baigas and to study vector composition and their role in transmission of disease.

Fever survey: Cross sectional fever survey in 12 villages of Baiga chak was carried out in the month of November 1999, January, May, August and November 2000. Overall slide positivity rate (SPR) and slide falciparum rate (SFR) was 24.84 and 19.77%, respectively. Overall *P.falciparum* (79.6%) predominates over *P.vivax*.

The overall SPR and SFR was more among the children than the adults. The difference was statistically significant. In all, 26 *P.falciparum* positive cases (out of 281) were having gametocyte. Among the gametocyte carriers 15 were children and 11 were adults.

Infant parasite rate: A total of 230 infants were examined in all the 5 surveys. Overall SPR and SFR was 20% and 11.7% respectiely. Among all the 27 *P. falciparum* cases, only 3 had gametocytes.

Man hour density (MHD) and species composition: Mosquitoes were collected from cattle shed and human dwellings over a fixed period of time. Overall man hour density of *An. culicifacies* and *An. fluviatilis* was 2.9 and 0.7. Except in rainy month (August) MHD of *An. culicifacies* remained low in all the seasons. MHD of *An. fluviatialis* remained below 1 except in the month of January. A total of 617 anopheline specimens were collected in all the surveys. Overall *An. culcifacies* was the predominant species (59.2%) followed by *An. fluvitialis* (14.3%). During the month of January *An. fluviatilis* predominate over all other anopheline species.

Effect of insecticide treated bed nets on the malarial morbidity and vectors in Baiga Chak area 2001-2002

In a co-ordination committee of different departments of Government of Madhya Pradesh held on 16 Feb 2001 in which Director RMRCT also participated, concern was expressed regarding malaria situation in six districts including Dindori and state Government asked the centre to demonstrate prevention of malaria on pilot basis in one of the highly malarious area. Therefore a pilot study was carried out to evaluate the effect of deltametherin impregnated nets in the control of malaria transmission.

Three villages were selected for distribution of bed nets and monitoring of malaria incidence & vector density (Experimental villages). Besides these three villages another two villages with similar topography were selected as control villages where regular monitoring of malaria incidence and vector density was carried out. The population of experimental villages was 1782 consisting of 875 men and 907 women residing in about 370 houses. The population has been divided in to groups i.e. < 10 years (525), and > 10 Years (1257). On an average two bed nets were given in each house. Villagers were involved in impregnation of nets with deltamethrine @25 mg /m^2. In order to generate awareness about malaria and bed nets, health meetings and health camps were organized in study villages. The monitoring of use of bed nets was carried out during wee hours. About sixty eight percent households were found using the bed nets.

Slide positivity rate (SPR) and slide falciparum rate (SFR) was 20 and 10.8% before launch of intervention (August October) in study villages which reduced to 9.4 and 8.7% respectively after distribution of impregnated bed-nets (NovemberMay).The reduction was statistically significant ($p<0.001$). Further in the experimental villages, malaria infection was not found among the infants and children after intervention. In control villages very less reduction was recorded in corresponding period which was not statistically significant ($p>0.5$).

Transmission dynamics of malaria in Baiga Chak of Dindori district and Kanha of Mandla district 2004-2008

From January 2004 a longitudinal study was carried out in Baiga Chak (Dindori district) and Kanha (Mandla district) areas. These two districts contribute 29% of the MP state's malaria and 40% of *P. falciparum* infection while their population was only 2.5% of the state's population when the study was initiated.

Five villages were selected in each of these areas with a population of about 2900 and 2000 in Baiga Chak and Kanha respectively. Gonds are the predominant tribe

at Kanha while Baigas are the main tribal group at Baiga Chak. Kanha is a world famous National park known for Tigers and Baiga Chak for dense forest of Saal (Shorea robusta). Only 15 and 33% houses have electricity connection at Baiga Chak and Kanha respectively. No transport system exists in these areas.

Entomological monitoring was carried out on monthly basis. Four villages at each site were selected for determining vector density. In each village four catching stations (two human dwellings and two cattle sheds) were fixed for mosquito collection. Mosquitoes were collected between 6:00 AM to 8:00 AM from these catching stations as well as from equal number of randomly selected catching stations. To study the biting rhythm of vector and other anopheline species and to study the composition and prevalence of anopheline species that are exophilic and exophagic in nature, whole night mosquito collection between 6:00 PM to 6:00 AM, using animal bait, which was tethered around the premises of a house, light trap collection indoor and out door and human landing collections were made. In each area two villages were selected for whole night collection. Light trap was installed at a fixed place for collection. The abdominal condition of all the wild caught specimens of *An. culicifacies* and *An. fluviatilis* from indoor resting collection was recorded for determining gonotrophic cycle and to determine the resting and feeding behavior of the vector species. Sibling species identification of vectors was done using cytotaxonomic techniques and allele specific PCR assay technique. Vector incrimination was done using ELISA techniques. Monoclonal antibodies (PV247, PV210 and PF) were supplied by CDC Atlanta, USA and standard protocol of Wirtz *et al*., 1985 & 87 was followed.

Door to door active fever surveys were carried out in selected villages fortnightly since May 2004 to understand the transmission pattern of malaria. Blood smears of all the individuals having fever at the time of visit of RMRC officials or history of fever between the two consecutive visits were prepared using finger prick method. Thick smears were examined for the presence of malaria parasite and *Plasmodium* species were confirmed by examining thin smear. Radical treatment was given to all the positive cases as per the NVBDCP criteria.

Parasites were counted in thick smear against 200 White Blood Cell (WBC) count presuming average 8000 WBC count per microlitre of blood in an average person.

Drug sensitivity of *P. falciparum* infection against chloroquine was determined using WHO standard method. To study the socio-culture practices and knowledge, attitude and practices (KAP), structured and semi structured schedules were used. Schedules were pre tested before launch of study. Information regarding type of house, roof and floor, source of drinking water, knowledge about malaria, its causes and treatment seeking behavior were collected.

Anopheline species composition revealed the presence of 15 and 16 anopheline species in Baiga Chak and Kanha respectively in indoor resting collections. *An. subpictus* (47.8%) was the predominant species followed by *An. culicifacies* (34.1%) and *An. fluviatilis* was 4.8% at Baiga Chak while the proportions of these species respectively were 38.2%, 40.6% and 1.1% in Kanha. During the whole night catches (all type) 18 anopheline species were recorded in Baiga Chak area and 19 species in Kanha. Proportion of *An. culicifacies* was 5.3 and 15.6% at Baiga Chak and Kanha while the proportion of *An. fluviatilis* was 23.5 & 2.9% respectively. The proportion of *An. fluviatilis* in light trap (out door) collections was 32% in Baiga Chak while it was 2.6% in Kanha.

Overall MHD of anophelines and *An. culicifacies* was significantly more in Kanha than in Baiga Chak (t- 3.3 and 4.1 $p<0.01$) while the density of *An. fluviatilis* was more in Baiga Chak (t-2.6 $p< 0.05$). *An. culicifacies* was dominant (>90%) in monsoon months only in Baiga Chak while in Kanha the species was prevalent in all the seasons.

In all 73 whole night collections covering all the seasons were carried out in Baiga Chak and 81 in Kanha areas. Per night per bait catches of *An. culicifacies* were more in Kanha (7.12) than in Baiga Chak (1.1). In light trap, per night catches of *An. culicifacies* were also more in Kanha (3.0) than in Baiga Chak (0.2). All the anopheline species identified and *An. culicifacies* was found biting throughout the night. Peak biting activity was recorded between 7:00 P.M. and 10:00 P.M for *An. culicifacies* at Kanha while no clear cut trend was seen in Baiga Chak. On the contrary all night, light trap catches of *An.fluviatilis* were more in Baiga Chak (2.5) than in Kanha (1.0). About 50% of the total *An. fluviatilis* that were caught during the whole night catches were those that collected between 6:00 P.M. and 10:00 P.M. at both the places, and the corresponding

figure for *An. culicifacies* was around 42 %.

An. culicifacies sibling species composition based on polytene chromosome examination showed the predominance of species C (90%) at both the sites. Species D was recorded from Baiga Chak only. Both these species are established vectors of *P. vivax* and *P. falciparum* malaria.

Specimens of *An. fluviatilis* collected during monsoon and post monsoon months from Baiga Chak and Kanha were identified for sibling species composition using PCR technique. Species S and T were found sympatric in the two areas. Species S constituted 17% and species T 83% in Baiga Chak collections while in Kanha collections only one specimen was identified as S and the rest were T.

Specimens of *An. culicifacies* and *An. fluviatilis* were tested for sporozoite antigen positivity using ELISA. Only a few specimens of *An. culicifacies* (Three) were found positive for *P. falciparum* infection from Baiga Chak and Kanha.

Insecticide susceptibility test conducted against DDT revealed only 15% corrected mortality after 24 hours of recovery period which indicated that *An. culicifacies* is highly resistant to DDT while the species was found 100% susceptible to pyrethroids as per the WHO standard procedure. DDT was replaced with Synthetic pyrethroids (Alpha cypermethrine) on the basis of our recommendations.

During cross sectional fever surveys, 4681 and 1902 blood slides were collected respectively from Baiga Chak and Kanha from fever cases and cases with history of fever. Prevalence of malaria varied from year to year (Table 1). Overall slide positive rate (SPR) was significantly more in Baiga Chak (28.3%) than in Kanha villages (9.6%) (^{2} 287.9 $p<0.00001$, OR 4.13). *P. falciparum* was predominant at both the sites, which was around 90% of all the malaria cases. Age group wise analysis revealed highest SPR in >1- 4 years of age in Baiga Chak followed by >4-8 years age group. In Kanha highest SPR was recorded in >4-8 years age group. Parasite count (per microlitre of blood) of *P. falciparum* positive cases revealed slightly less parasite density in Baiga Chak (6870 parasites/µl) than in Kanha (7901 parasites/µl). Age group wise analysis of parasite count shows lowest parasite density in infants and highest in children of >1-4 year age group. The difference was highly significant ($p<0.01$). The trend was similar at

both the sites.

A gradual declining trend in malaria prevalence was recorded due to intensive intervention measures. Number of malaria cases in study villages reduced significantly from 616 in 2004 to 154 in 2007 in Baiga Chak. The reducing trend was linear for Baigas (^{2} 90.0 p<0.00001) while no trend was seen in Kanha from 2004-07. Drug sensitivity studies revealed 53% treatment failure in Baiga Chak (Table 2) and as such Drug policy in this area has been changed to Artesunate combination therapy (ACT)

Frequency distribution of malaria positive cases: In Baiga Chak 4681 blood slides were collected from fever cases, of which records for 4444 cases were available. These slides belonged to 2046 persons. In the study villages1146 persons never had malaria during the study period of 3 years and 6 months though they developed fever. Among malaria positive cases, fifty nine persons had only *P.vivax* infection while 787 had only *P.falciparum* infection. Among *P.vivax* positive cases, only 7% had infection twice or more. Only 54 persons had infection with *P. vivax* at one time and *P.falciparum* infection at other time. Among 787, those who had only *P.falciparum* infection during the study period, 24.6% had infection twice and 7.3% thrice. Less than 2% of positive cases had infection four or more times.

Table 1: Slide positivity rate in study area (2004-2007)

Area	Year	BS coll	Pos	SPR	SFR
Baiga Chak	2004	1710	616	36	33
	2005	1233	336	27.3	23.8
	2006	920	216	21.3	21.3
	2007	818	154	18.8	16.7
Total		4681	1322	28.2	25.4
Kanha	2004	555	82	14.5	14.6
	2005	567	8	1.4	1.1
	2006	442	54	12.2	10.6
	2007	338	39	11.5	8.3
Total		1902	183	9.6	8.5

Table 2: Base line characteristics and treatment response of uncomplicated *P. falciparum* patients to chloroquine

Variables	Treatment response Number (%)
Age (years) †	
Under 5	17 (21.0)
5 – 15	47 (59.0)
Adults	16 (20)
Sex	
Male	41 (51)
Female	39 (49)
Axillary†† temperature	37.7 (36.2 – 40.1)
*P. falciparum*** (asexual) density per µl of blood	1480 (1000 – 49880)
Patients† withdraw/loss to follow up	2 (2.5)
CQ treatment response	
ETF†	20 (26)‡
LCF†	6 (8) ‡
LPF†	15 (19)‡
ACPR†	37 (47)‡

† n (%); †† Mean axillary temperature at day zero in °C;
** Median value (range); ‡ Denominator exclude 2 cases lost to followup

About 50% houses had bed nets in Baigas and 10% in Kanha area. In Baiga Chak all the nets were provided by the govt. agency while in Kanha, villagers purchased the nets from market. Only 48 and 58% respondents reported that they used net last night. About 88% respondents recognized cold (shivering) followed by fever (68%) as malaria fever. The difference in response at both sites was insignificant. Mosquito bite was responded as cause of malaria (Baiga Chak-30%, Kanha-29.6%). Eighty seven and 97% respectively responds tablet/ injection or both as the treatment of malaria. Knowledge regarding the diagnosis is better as about 72% responds blood test for the diagnosis of malaria. Except guarding crops during winter season i.e. December and January ranging from few days to a month, no other major outdoor activities during the night was

observed in tribals of both the areas.

We conclude that pattern of malaria and prevailing vectors are different in Baiga Chak when compared to Kanha. We have recorded high chloroquine failure against *P. falciparum* in Baiga Chak. The findings were communicated to NVBDCP. The program responded immediately and the line of treatment was changed to Artesunate Combination Therapy (ACT). Because of systematic intensive intervention measures carried out by state health department, malaria reduced drastically in Baiga Chak. On the contrary malaria could not be controlled because of lack of intensive intervention measures in Kanha.

Malaria in team members engaged in data collection: During the course of study five of our team member suffered from malaria. All of them developed fever 12-45 days after their visit to Baiga chak. Four of them were involved in whole night collection and fifth one slept in Baiga Chak (Chada) guest house for one day. One insect collector developed malaria twice. Among the sufferers, Scientist and Research fellow developed severe complications and had to admitted in hospital while rest were treated by giving appropriate treatment.

Malaria Control in Betul Using Existing Tools 2001-2005

Betul, a forested district (Pop. 1395175, 45% ethnic tribe) is accounted for 10% of all malaria cases in MP, although the same harbored less than 1% of the states population. The reported annual incidence of malaria in Betul district as per National Vector Borne Disease Control Programme (NVBDCP) has increased gradually from 0.43 per 1000 in 1990 to 11.37 per 1000 in 2000. The malaria in Betul is not responsive to control measures by NVBDCP indicating the need for change in control strategies and better intervention tools. On the request of Govt. of Madhya Pradesh, the RMRCT team investigated the malaria situation and recommended specialized intervention approaches i.e. enhanced surveillance activities and intensified antivector intervention.

The objective was to develop a programme to prevent and control malaria using existing tools.

A programme of malaria control was started in Betul from January 2001 in accordance with national guidelines on the recommendation of research centre at Jabalpur. The district malaria officer and his staff directed the local malaria intervention activities. Repeated cross-sectional surveys were undertaken by the centre throughout the 5 year period following the introduction of specialized intervention measures. The study reports the results of an assessment of the effectiveness of this combined intervention approach carried out in an ethnic minority in Betul using a longitudinal follow-up.

Interventions: To control malaria in Betul, the intervention included intensive surveillance for early detection and prompt treatment (EDPT) using Fansidar (sulphadoxine-pyrimethamine) and two rounds of indoor residual spray (IRS). Residual house spraying with pyrethroid was introduced by replacing DDT as perusal of record from 1992 to 2000 provided no clear evidence of an effect of DDT on prevalence of malaria. In remote and inaccessible areas rapid diagnostic test (RDTs) were used for on the spot diagnosis and treatment. All positive cases were treated in accordance with national guidelines as follows. *P. falciparum* malaria with single dose Fansidar (sulfadoxine pyrimethamine, 1500 mg) and primaquine (PQ) 45 mg or *P. vivax* infections with chloroquine (CQ) 1500 mg for 3 days and PQ (75 mg) for 5 days. Fansidar (SP) was administered under close supervision of the staff. The villagers were asked about possible side effects of the drug. During each surveys questions were asked about health and complaints. Serious patients were referred to PHC for I/V quinine. The larvivorous fish (Gambusia spp) were introduced into large and small ponds that were identified as breeding places of vectors. Additionally, fish have been maintained in stock ponds in each PHC.

Monitoring of malariometric indices: Parasitological cross-sectional surveys (two pre intervention and 13 post intervention) were carried out in 40 villages of same 3

PHCs chosen for entomological monitoring.

The age specific (= 10 and > 10 years) and species specific parasite rates before and during the intervention period are presented in Table 3. In 2000, before the initiation of special intervention measures, 2821 persons were examined of which 1437 (50.94%) were found infected with malaria with >90% *P.falciparum*. Prevalence of malaria was very high even in infants (data not shown separately). Further analysis revealed that significantly more malaria cases were recorded in children (= 10 years) as compared to older age groups (β -0.286, SE 0.055, *P*<0.0001, 95% CI 0.674-0.836). *P. falciparum* was accounting for more than 90% of the infection in both the age groups. *P. falciparum* gametocytes were also detected in both age groups though not significant statistically. Post intervention results revealed that there was a highly significant reduction in malaria cases after initiation of intervention (*P*<0.0001). The estimated malaria parasitaemic cases decrease in log odds for each year is β -0.972, SE 0.037, *P*<0.0001, 95% CI 0.352-0.407. From 2002 onward, parasitaemia was not detected among infants. Prevalence of gametocytes of *P.falciparum* were relatively more in post intervention phase and the differences in the prevalence of gametocyte carriage between pre and post intervention phase was significant (^{2} 12.33 *P*<0.0005).

The spleen rate was > 70% before intervention (Table 4), with average enlarged spleen indices (AES) was around 1.92. After initiation of intervention measures the spleen rate dropped steadily to 4 in 2005 (^{2} for trend 1495.34 *P*<0.00001). Similarly, the number of malaria infections in enlarged spleen cases declined steadily from 64% in 2000 to 4% in 2005 (^{2} for trend 223.41 *P*<0.00001).

Monitoring of entomological data during preintervention phase revealed (Table 5) that only seven species were prevalent in indoor resting collection (Mean MHD 21.23 ± 8.01), of which *An. culicifacies* was the most dominant species (16.77 ± 7.02). The other species found in small numbers were *An. subpictus*, *An. annularis*, *An. fluviatilis*, *An. vagus*, *An. splendidus* and *An. theobaldi*. After initiation of intervention measures, both *Anopheles* and *An. culicifacies* mean density declined significantly (4.17±3.09 and

3.31±2.82 respectively) as compared to pre intervention period (P<0.0001).

Fish of the Gambusia sp were introduced into several identified *An. culicifacies* breeding sites in 2001, 2002, 2003 and 2004. Insecticide susceptibility tests showed that mortality of *An.culicifacies* to DDT was 10% and to malathion 41.8%. Cent percent mortality was recorded with Deltamethrin.

Although the interventions have jointly contributed to the control of malaria, it is hard to quantify which is most efficient tool and similarly, hard to presume which should be given priority for resource allocation. EDPT is important to prevent severe and potentially fatal malaria. However, it is not easy to simultaneously cover a large population with EDPT and proper surveillance for a sufficient period of time. IRS with pyrethroid insecticide have shown benefits but logistics, high costs and the need of recurrent spraying are disadvantages. The efficacy of this combined approach is demonstrated in Betul but question about costs, sustainability and possible increases in disease and mortality after withdrawal of specialized intervention measure remain to be seen.

Table 3: Age wise malaria situation in study villages of district Betul before intervention and after intervention (2000-2005)

Year	Age Groups													
	≤ 10 Years							>10 Years						
	BSE*	*P.v*	*P.f*	SPR†	SfR‡	Pf%§	PfG%¶	BSE	*P.v*	*P.f*	SPR	SfR	Pf%	PfG%
Pre Intervention														
2000	1002	51	522	57.2	52.1	91.1	6.5	1819	54	810	47.5	44.5	93.7	5.8
Post Intervention														
2001	896	64	137	22.4	15.3	68.2	7.3	1957	169	248	21.3	12.7	59.5	9.3
2002	446	29	56	19.1	12.6	65.9	21.4	589	60	54	19.3	9.2	47.4	18.5
2003	160	2	1	1.9	0.6	33.3	0	193	0	1	0.5	0.5	100.0	0
2004	119	0	4	3.4	3.4	100.0	0	117	1	6	6.0	5.1	85.7	16.7
2005	36	0	0	0	0	0	0	77	0	1	1.3	1.3	100	0

*BSE: Blood Slide Examined; †SPR: Slide Positivity rate; ‡SfR: Slide falciparum Rate; §Pf%: *P.falciparum* Percentage; ¶PfG%: *P.falciparum* Gametocyte Percentage

Table 4: Results of spleen examination in children (2-9 yrs) in Betul (2000-2005)

Month	Children Examined	Enlarged spleen	Spleen rate (%)	Odd Ratio	AES*	BSE†	*P.v*	*P.f*	Mixed‡	SPR§	Odd Ratio
Pre intervention											
Autumn, 2000	696	504	72	1.00	1.92	504	23	295	5	64.09	1.00
Post intervention											
Summer, 2001	399	230	58	0.52	2.08	230	35	53	2	39.13	0.61
Autumn. 2002	945	237	25	0.13	1.72	237	28	50	5	35.02	0.55
Summer, 2003	1107	133	12	0.05	1.65	133	3	9	0	9.02	0.14
Autumn, 2004	1533	94	6	0.02	1.08	94	1	3	0	4.26	0.07
Summer, 2005	680	28	4	0.02	1.8	28	0	1	0	3.57	0.06

*AES: Average Enlarged Spleen; †BSE: Blood Smear Examined; ‡Mixed: *P.vivax* + *P.falciparum*; §SPR: Slide Positivity Rate

Table 5: Indoor resting density (MHD) of total *Anopheles* species and *Anopheles culicifacies* in study villages before intervention and after intervention in Betul (2000-2005)

	Month	*Anopheles* (mean±SD)	*An.culicifacies* (mean±SD)
Pre intervention	Oct, 2000	32.17±4.5	25.83±2.02
	Dec, 2000	17.12±3.9	13.38±4.57
Post intervention	Mar, 2001	10.6±1.8	4.3±1.2
	May, 2001	0.5±0.9	0.3±0.45
	Jun, 2001	9.14±9.7	5.27±6.9
	Sep, 2001	11.1±3.7	9.4±3.1
	Dec, 2001	2.0±3.4	2.0±3.4
	Apr, 2002	2.5±2.5	2.07±2.1
	Jul, 2002	11.5±3.3	10.5±3.1
	Oct, 2002	13.8±8.25	11.7±6.29
	Mar, 2003	0.0	0.0
	Sep, 2003	18.0±11.8	12.0±6.56
	May, 2004	0.0	0.0
	Dec, 2004	0.0	0.0
	May, 2005	0.17±0.29	0.0

The Usefulness of a New Rapid Diagnostic Test, First Response® Combo Malaria Ag (pLDH/HRP2) Card Test for Malaria Diagnosis in Forested Belt of Central India 2007

Malaria is a major public health problem in tribal belt of Central India where only two plasmodium species, i.e. *Plasmodium falciparum* and *P. vivax* are prevalent. The ethnic tribe that live in these areas often travel several hours or days to reach the nearest Primary Health Centre (PHC). In such areas laboratory facilities for diagnosis of malaria are often not available and the clinical signs alone can not identify patients with malaria. Diagnosis of malaria made on the basis of clinical symptoms are at best 50% accurate. Further, PHC's clinics examining blood smears from a large number of clinically suspected patients are often limited by one or two trained microscopists resulting in misleading interpretation and underestimation of malaria parasites. Consequently, a considerable proportion of drugs have been wasted on patients with non malarial disease due to lack of prompt and accurate laboratory diagnosis. Presumptive treatment of malaria encourage the development and spread of drug resistant *P. falciparum* parasites. Early diagnosis and prompt treatment of malaria with efficient drugs is required for effective malaria control.

Several rapid diagnostic test (RDTs) kits for malaria exist for situations in which reliable microscopy may not be available. Recently another rapid test First Response® Combo Malaria Ag (pLDH/HRP2) card test was developed in India for differential diagnosis between *Plasmodium falciparum* and the other plasmodium species. To determine the usefulness of new rapid test in low endemic area where both *P. falciparum* and *P. vivax* are prevalent, we compared the diagnostic capacity of First Response® Combo Malaria Ag (pLDH/HRP2) card test (Premier Medical Corporation Ltd., Mumbai, India) with that of expert microcopy, the gold standard. Additionally, the ease of use and accuracy of the test was also assessed.

This study was carried out in Bargi PHC located in forest 45 km from Jabalpur

where a longitudinal study on malaria is ongoing. Make shift field clinic were established where persons of all ages visit for checkup, thus permitting performance of the RDT in all persons suspected to have malaria, whatever their history (recent malaria attack or with a history of malaria in the previous 15 days), clinical status (high or low grade fever, severe or mild symptoms) and other factors that may affect the sensitivity and the specificity of the RDT. A patient form was filled with basic clinical and demographic information after taking verbal consent. The RDT kits were opened only after the patient had been selected and interviewed by the medical staff. Blood was obtained by finger prick for the First Response® combo Malaria Ag (pLDH/HRP2) card test and thick smear before patients received treatment. We saved each RDT as documentation for future reference. An independent staff re-read the saved tests after two months and matched with that original interpretation of results without knowing the result of the previous reader or of the blood film. The RDTs were stored properly (temperature 4 - 30°C) and used within shelf life.

In all 291 patients with fever were suspected of having malaria. The ratio of male to female patients was 1:1.15 and the mean age was 20 year(age <1-60 years). The mean duration of fever is 4 days (1 - 20 days) and mean temperature is 100.5±1.0 (98.6 - 103º F) while in malaria infected persons mean temperature is 100.9±1.1 (99 -103º F). Out of 291, 113 (39%) were found malaria infected, 41 with *P.vivax* (14%), 72 with *P. falciparum* which also include one mixed infection (25%). Table 6 shows a breakdown of malaria cases in different age groups.

The results of parasite detection by microscopy and RDTs were compared in Table 7. Microscopically confirmed *P. falciparum* were 72 of which RDTs detected 69 matching positives. The asexual parasitaemias ranged from 80--111920 parasites/µl (8010.5 ± 21595.2). Only 3 subjects were found as false negatives and 12 as false positives. The sensitivity and specificity of the test for *P. falciparum* was 96% and 95% respectively. The PPV and NPV were 85% and 99% respectively. The accuracy was 95% and J index was 0.84 (Table 8). Only two subjects positive for *P. falciparum* by

microscopy with very low parasite density (120 parasites/µl) were tested positive as non falciparum malaria by RDT.

Out of 41 non falciparum infections, RDTs detected 34 matching positives, 7 false negatives and 15 false positives. The asexual parasitaemias ranged from 200--14800 parasites/µl (1871.58 ± 3364.43). The sensitivity of the test for non falciparum malaria was 83% which was significantly lower when compared with *P. falciparum* (=0.05). However, specificity (94%), accuracy (92%), PPV (69%) and NPV (97%) were not significantly different from the corresponding values for *P. falciparum*.

Overall (pooled *P. falciparum* and non falciparum infections), the sensitivity and specificity were 93% and 85% respectively with a PPV of 79% and a NPV of 95%. A comparison of parasitaemia versus RDTs sensitivity showed that with parasitaemia of =120 parasites/µl, RDT was 98% sensitive for *P. falciparum.* The only exception was one subject with the parasite count of 840 parasites/µl which was negative by RDT. For non falciparum infections, the RDT did not identify 7 subjects out of 41, some of these, but not all had low parasitaemia (=500 parasites/µl) and one subject with a parasite count of 4480 parasites/µl.

The test was evaluated as very easy to perform, as the sampling pipette provided with the test kit made it very easy to measure exact 5 µl of blood to be dispensed onto the sample well. The cassettes were simpler to use and this affect test accuracy. The results did not change after the 20 minutes. These RDTs were reread after two months. The results were matched with that of original results.

In conclusion, the test is reliable and simple to interpret. The test is a potential alternative to microscopy in places where the facility for microscopy are poor. Therefore, it is reasonable to consider future use of RDTs as an epidemiological tool for the rapid screening of malaria.

First Response® Combo Malaria Ag (pLDH/HRP2) card test

Table 6: Age group-wise prevalence of malaria among symptomatic patients (August - September 2007)

Age Groups (yrs)	BSE*	Positive	*P. vivax*	*P. falciparum*	SPR†	SfR‡	Pf%§
1	7	2	1	1	28.6	14.3	50.0
>1 through 4	26	8	6	2	30.8	7.7	25.0
>4 through 8	44	25	10	15	56.8	34.1	60.0
>8 through 14	57	19	8	11	33.3	19.3	57.9
>14	157	59	16	43	37.6	27.4	72.9
Total	291	113	41	72	38.8	24.7	63.7

* Blood Slide Examined
† Slide Positivity Rate (number of parasitaemic cases per 100 examined slides)
‡ Slide falciparum Rate (number of falciparum cases per 100 examined slides)
§ *Plasmodium falciparum* percentage (number of falciparum cases per 100 parasitaemic cases)

Table 7: Diagnostic performance of First Response® Malaria Ag (pLDH/HRP2) card test Vs Light Microscopy as reference standard

Microscopy		First Response® Malaria Ag (pLDH/HRP2) card test		
Results	**N (%)**	**Negative**	***P. falciparum***	**Non *P. falciparum***
Negative	178 (61.2)	153	12	13
P. falciparum	72 (24.7)	1	69	2
Non-*P. falciparum*	41 (14.1)	7	0	34

Table 8: Sensitivity, specificity and accuracy of First Response® Malaria Ag (pLDH/HRP2) card test by Light Microscopy

Indices	Overall	*P. falciparum*	Non-*P. falciparum* species
True Positive	103	69	34
True Negative	153	207	235
False Positive	27	12	15
False Negative	8	3	7
Sensitivity (95% CI)	93 (86-96)	96 (88-99)	83 (69-91)
Specificity (95% CI)	85 (79-89)	95 (91-97)	94 (90-96)
PPV (95% CI)	79 (71-85)	85 (76-91)	69 (55-80)
NPV (95% CI)	95 (91-97)	99 (96-99)	97 (94-99)
Accuracy (95% CI)	88 (83-91)	95 (92-97)	92 (87-95)
J-index	0.74	0.84	0.67

Preparation of a field site for Malaria vaccine trial in and around Jabalpur, Madhya Pradesh 2005-2008

The overall objective of the study is to develop a well-characterized site, where the epidemiology of the disease, immune responses to malarial antigens, diversity of parasite genes, malaria paradigm changes and vector characteristics are well understood. This site would be useful for testing of any tools for the control and prevention of malaria, such as antimalarial vaccines and diagnostic reagents.

The study has four arms

(A) Epidemiology

(B) Immuno Epidemiology

(C) Molecular Epidemiology

(D) Entomology

The progress of work done under each component is as under-

(A) Progress of Epidemiology Component:

Enrollments: Seventeen hundred pregnant women (PW) with or without fever were enrolled in the community cohort after obtaining written informed consent. At the time of enrollment 21.1% PW were having fever or history of fever of which 3.2% were found positive for malaria (0.52% *Pv* and 2.7% *Pf*). During the follow up, before delivery 1.3% PW were found malaria infected (0.42% *Pv*, 0.92% *Pf*). After delivery, 2% mothers were malaria positive (0.66% *Pv* and 1.15%*Pf*). At enrollment, mean hemoglobin of these PW was 10.09±1.63 gm%. Thirty percent were having normal range of haemoglobin. Mild anemia was recorded in 65.5%, moderate anemia in 7.5% and severe anemia in 0.5% of the subjects. Sickle cell heterozygote and G6PD deficiency were found in 11.5% and 1.7% of women respectively in all the enrolled subjects. Four G6PD deficient subjects were malaria positive (2*Pv* and 2 *Pf*).

So far 724 infants with or without clinical symptoms were enrolled for immunological studies of which 0.4% neonate were found positive for malaria (all *Pf*). During subsequent follow up 1.5% infants were malaria positive (0.88% *Pv* and 0.61% *Pf*). All of them were symptomatic. A total 588 fathers and 378 siblings were also enrolled of which 1% fathers (0.5% *Pv* and 0.5% *Pf*) and 3.2% siblings (1.3%*Pv* and 1.9% *Pf*) were found positive for malaria at enrollment. Follow up was done when developed clinical symptoms in which 5% fathers (1.33% *Pv* and 3.66% *Pf*) and 17.14% siblings (12.3% *Pv* and 4.76% *Pf*) were positive. At the time of enrollment, subjects were also tested for sickle cell hemoglobin and G6PD a detail of which has been given in table 9.

Table 9: G6PD and Sickle Cell Profile (study cohort)

Subjects	G6PD Deficient	Sickle Cell	
		Normal (AA)	Heterozygotes (AS)
Pregnant Women (n=1401)	15** (1.1%)	1280 (91.4%)	121* (8.6%)
Father (n=588)	9 (1.5%)	553 (94%)	35 (6%)
Sibling (n=378)	6 (1.6%)	364 (96.3%)	14 (3.7%)
Infants (n=724)	0	709 (98%)	15 (2.1%)

Note: One family (Father, Sibling & Pregnant women) were heterozygotes for sickle cell.
*One PW having Pf infection parasite density (5680/µl).
**Four G6PD deficient subjects were malaria positive (2*Pv* and 2 *Pf*)

Fever Survey: During fever survey 30266 blood smears were collected and examined of which 3275 were malaria positive (53% *Pf*, 47% *Pv*). Overall SPR was 10.82 and *Pf*% was 53.01 (Fig 3). Three year data collection reflects that *P falciparum* remain dominant species from monsoon to winter season i.e., September to February whereas *P vivax* is dominant in summer and monsoon i.e., April to August. Overall trend showed increase in malaria prevalence from age group <1 year to 8-14 years (older children) then showed decline in adults (Fig 4).

Fig. 3: Malaria Prevalence in Cohort Area (2006-2008)

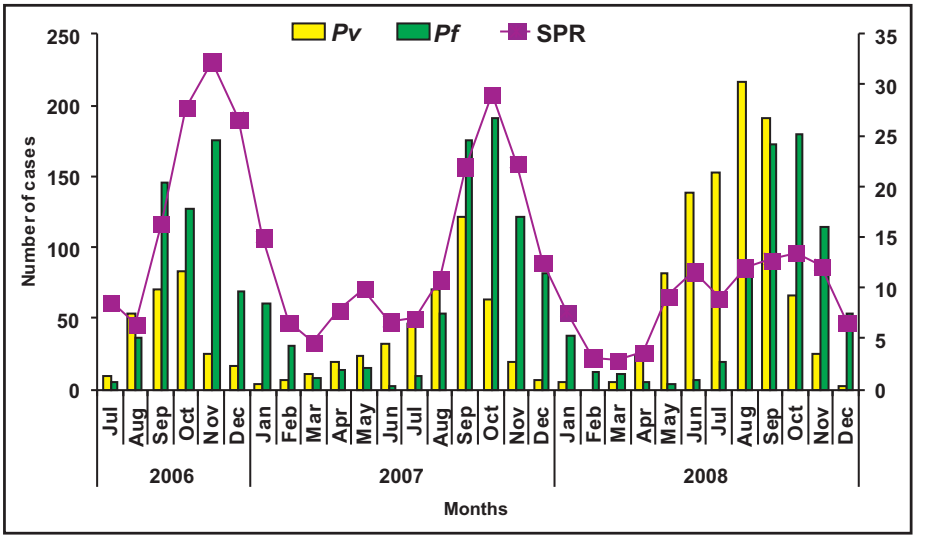
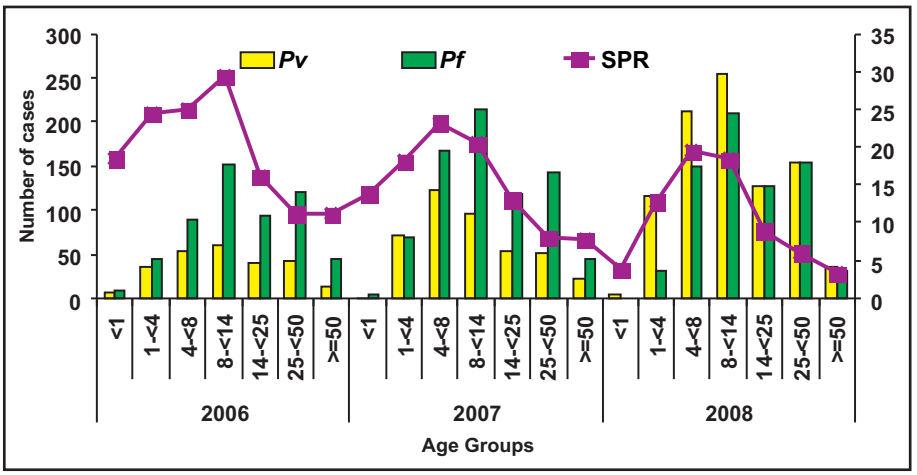


Fig. 4: Malaria prevalence by age groups in cohort area (2006- 2008)



Out of total 1255 deliveries, 11.5% were taken place at hospitals with surgical facility, 47.1% were at Primary health centers and rests were at home or elsewhere. Further analysis revealed that 96% were live births and 2% were still birth. 1.71% neonates died immediately after delivery.

(B) Immunology Component:

Overall young children showed low antibody responses against most of the antigens. The adults who developed naturally acquired immunity to both types of malaria had high antibody levels to CSP, MSP2 and AMA1 (Fig.5&6). Seroprevalence in the pregnant women were also found high in the CSP and MSP2 peptide. The antimalarial IgG profile in mothers at the time of delivery was low and same response has been observed in respective infants. Overall maternal antibody levels were higher than cord antibody levels. Longitudinal immune response was withdrawn in subset of infants (N =277) who were followed up (N=90) at 4 month interval. This data is still to be analyzed.

Antibody levels were assayed for FALVAC 1A among different malaria exposed hospital subjects (N=104) as well as community cohort (N=45) and healthy controls (N=20). Antibody levels were also assessed for 8 different FALVACs provided by CDC Atlanta among 137 different malaria groups and 29 healthy controls. Results revealed that patient with different degree of malaria severity showed significantly higher sero-

positivity than healthy controls although no significant difference is found between different malaria groups.

Fig.5: Responder Frequeny to *P. falciparum* Antigens

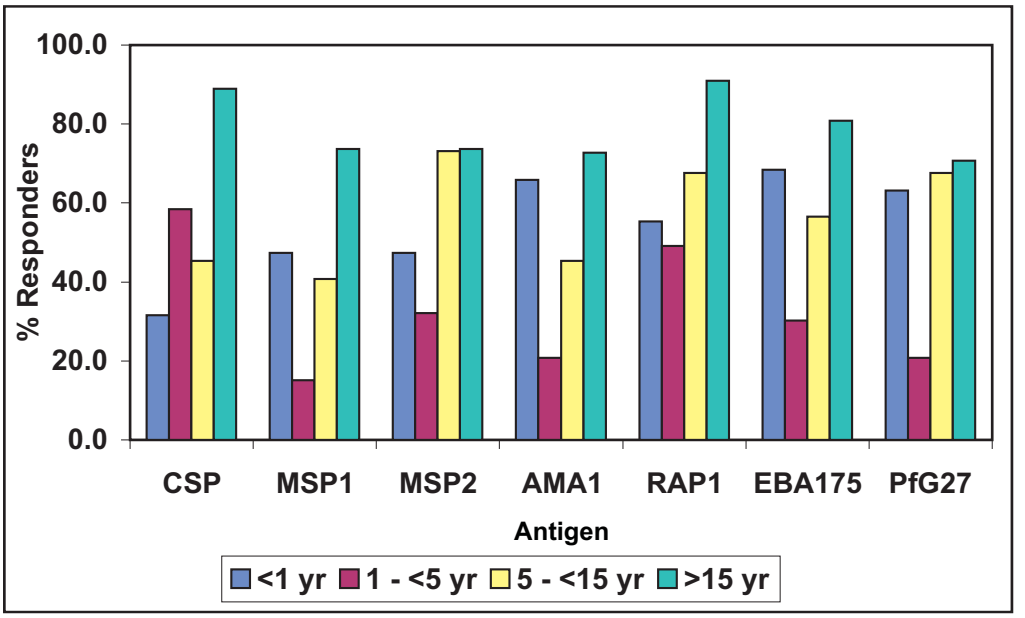
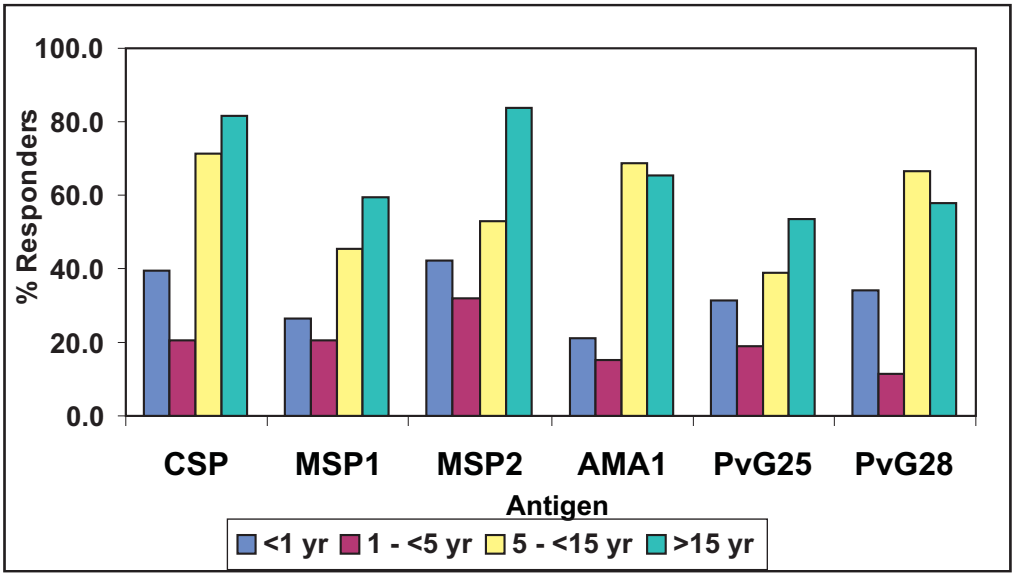


Fig.6: Responder Frequency to *P. vivax* Antigens



Lymphocyte proliferation assay: Lymphocyte transformation assay were done in 90 samples. Out of which 57 were *Pf* primed cases and 33 were *Pv* primed cases. For *P. falciparum* MSP-19, MSP-42, MSP-83 and CSP were selected to determine cell mediated immune response. Among *P. vivax* primed cases CSP, MSP1, AMA, Pvg25

and Pvg28 were selected. Two different FALVACS (856 and 890) were also tested in Pf cases. Candidate vaccine FALVAC 1A (Bharat biotech) was also tested among 35 Pf primed cases. Synthetic peptides/antigens were used at final concentration of 10 g/ml whereas recombinants were in 1 g/ml. Five-day culture supernatants from individual lymphocyte samples were assayed by sandwich ELISA for IL-4 and IFN-γ using anti-human IL-4 and IFN-γ antibodies. For Pf primed cases amongst recombinant peptides MSP-83 gave maximum stimulation index followed by MSP-42 and MSP-19. CSP at 10 ug/ml gave more antigenecity than MSP variant peptide. Cytokine response in cell soup indicated dominant TH1 response by IFN-y than IL-4. Compared to media control IL4 and IFN-g were significantly elevated in presence of antigenic peptides whereas among peptides MSP-42 and MSP-83 stimulated more IFN- y and IL-4 than other antigens. In *Pv* primed cases MSP1, AMA1 and Pvg 25 had higher stimulation index than CSP and Pvg 28. In cell soup analysis of *Pv* cases IFN-y was predominant than IL-4. Further no difference is found in IFN-y levels among different peptides in comparison to media control however IL-4 was higher in CSP, AMA-1 and Pvg25 than media control.

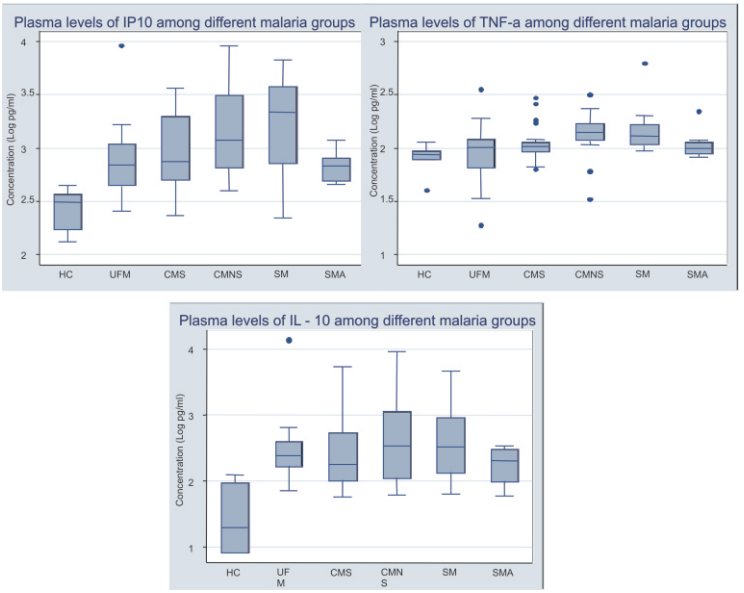
Cytokines estimation among patients of different malaria groups: Cytokines (IL-4, IL-10, IP-10, IFN-γ and TNF-a) levels were estimated using commercially developed two-site ELISA assay in the patients plasma (N=360) of uncomplicated *P falciparum* malaria (UFM), cerebral malaria (CM), severe malaria anemia (SMA), moderate malaria anemia and (MdMA) severe malaria (SM) cases with other complications and healthy controls (HC). Results revealed that IP-10, which is a proinflammatory chemokine, progressively increased with the disease severity but was low in SMA group (Fig. 7). The levels of TNF-a and IFN-γ (both proinflammatory) were also increased with the severity of disease. Anti-inflammatory cytokine IL-4 began rising in plasma during acute falciparum malaria and increased maximum among CM cases but in SM and SMA, IL-4 level was comparatively lower than CM.

(C) Molecular Epidemiology component

The report is describing the genetic polymorphisms in the various vaccine candidate antigens as well as drug resistance loci. In this report we present the data on *P. falciparum* isolates obtained from the hospital-based project. Here, presence of genetic polymorphism in the vaccine candidate antigen genes (MSP1, MSP2, TRAP, RAP1,

CSP, EBA-175 as well as AMA1) and drug resistance genes (*pfcrt*, *pfdhfr* and *pfdhps*) were studied. Table-10 and Table-11 illustrates the total number of isolates sequenced till now for vaccine candidate antigens and drug resistance genes respectively.

Fig. 7: Cytokines Assay (N= 360) Hospital surveillance



A. Polymorphism in Vaccine candidate antigens:

1. Merozoite surface protein 1 (MSP1): MSP1 gene was successfully amplified and sequenced. Among 85 isolates sequenced, percentage distribution of MAD20-type (42.76 %) was higher followed by K1-type (36.05 %) alleles, while RO33 type alleles were observed in only 21.22 % isolates (Fig. 8). A total of 10 MAD20 allelic variants (MI-MX) were found. In addition a total of 14 K1 allelic variants (KI to KXIV) were found. Three variants of RO33 type alleles were observed among the isolates studied so far.

2. Merozoite surface protein 2 (MSP2): A total of 81 *P. falciparum* isolates were sequenced for MSP2 gene. Majority (73 %) of the isolates showed FC27-type allele, while remaining 27% isolates showed 3D7-type alleles (Fig. 9). Fifteen FC27 allelic variants were found (FC27-I to FC27-XV. Six variants of 3D7 alleles (3D7I to 3D7VI) were found.

3. Merozoite surface protein 3 (MSP3): MSP3 gene was successfully amplified and sequenced from 32 isolates. Majority (44%) of the isolates had K1-type allele while,

22% isolates showed 3D7-type MSP3 alleles. Remaining 34% isolates were showing FC27-type alleles (Fig. 10). Two variants each in K1 allele (K1-a and K1-b) and 3D7 alleles (3D7-a and 3D7-b) were found. No allelic variants were found in FC27 type allele.

Fig. 8: Distribution of MSP1 alleles of *P. falciparum* isolates

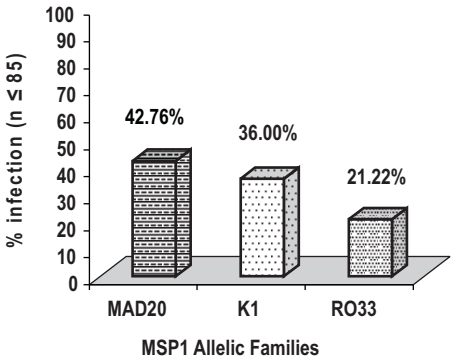
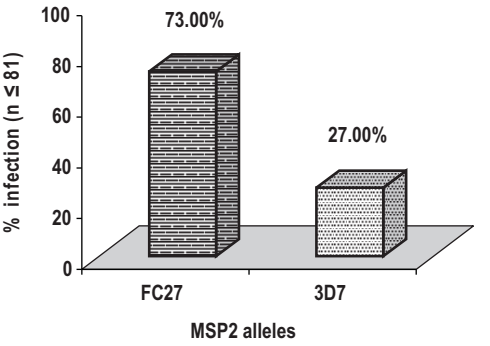


Fig. 9: Distribution of MSP2 alleles of *P. falciparum* isolates



4. Thrombospondin-Related Adhesive Protein (TRAP): TRAP gene was successfully amplified and sequenced from 96 *P. falciparum* isolates. Twenty three allelic variants (G1 to G23) of the TRAP gene were found. Majority (46%) of the isolates belong to the G3 alleles (Fig. 11). All other alleles were found in one, two or few isolates only.

Fig. 10: Diagram showing distribution of MSP3 alleles

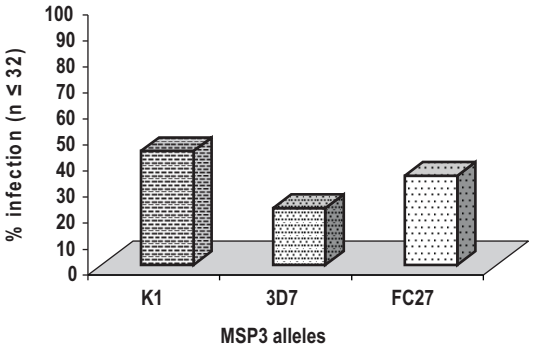
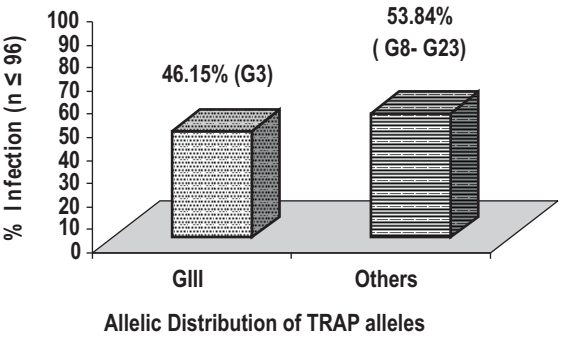


Fig.11: Distribution of TRAP alleles of *P. falciparum* isolates



5. Rhoptry Associated Protein 1 (RAP1): The region from amino acid residues 24-366 were sequenced among 47 *P. falciparum* isolates. A total of 11 RAP1 allelic variants (GI to GXI) were found. The alleles GIII (36.17%), GII (23.4%) and GV (10.63%) were predominant among these isolates (Fig. 12).

6. Erythrocyte Binding Antigen 175 (EBA-175): The region from amino acid residues 478-765 (Region-II) were sequenced among 31 *P. falciparum* isolates. A total of 10 allelic variants (GI to GX) were found. The alleles GIII (38.7%), GVIII (22.5%) were predominant among these isolates (Fig. 13).

7. Apical Membrane Antigen (AMA1): The domain I (amino acid residue 149-302) of the AMA1 gene sequence from 90 *P. falciparum* isolates were sequenced. They were classified into ten different alleles (GI to GX) according to their amino acid sequences.

Fig. 12: Distribution of RAP1 Genotypes of *P. falciparum* isolates

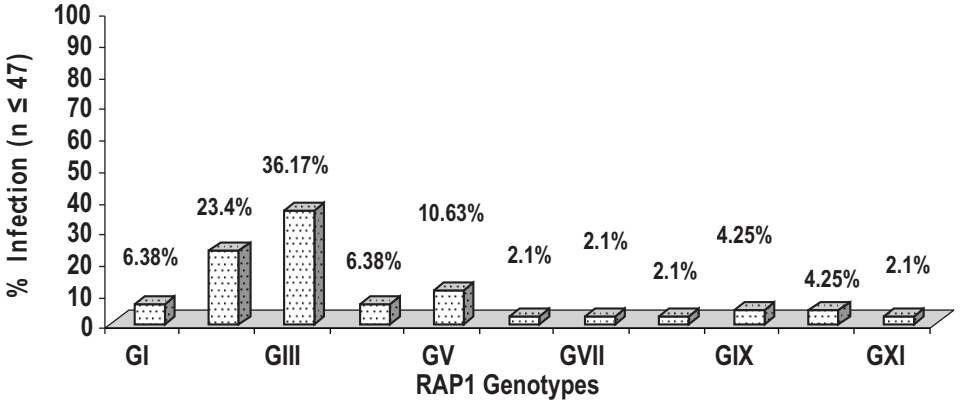
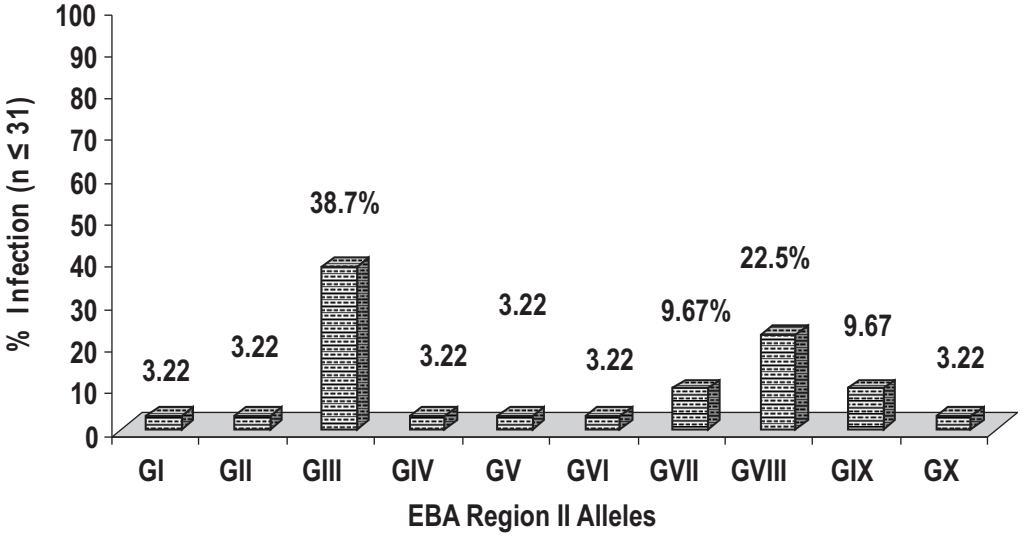


Fig. 13: Distribution of EBA-175 Region-II alleles of *P. falciparum* isolates



8. Circumsporozoite Protein (CSP): Both B-cell epitope region (containing NANP repeat polymorphisms) as well as T-cell epitope region of the CSP gene was successfully amplified and sequenced from 30 isolates. Based on the B-cell epitope polymorphisms, these 30 isolates were divided into 27 different alleles (CSP-1 to CSP-27).

B. Polymorphism in Drug resistance loci:

1. Dihydropteroate synthetase (DHPS): We had sequenced *dhps* codon polymorphisms among 127 *P. falciparum* isolates. Majority (92%) of the isolates showed SAKAA (wild type) genotypes at the codons 436, 437, 540, 581 and 613 respectively (Fig. 14). S**G**KAA (single mutant) genotype was found in 6% isolates at these codons while only 2% isolate was having SA/**E**KAA (mixed) genotype. Percentage distribution wild-type and drug-resistant allele in both group of isolates were found almost equal.

2. Dihydrofolate Reductase (DHFR): A total of 134 *P. falciparum* isolates were sequenced for *dhfr* gene. Majority (56.64%) of the isolates showed AN**RN**I (double mutant) genotypes at the codons 50, 51, 59, 108 and 164 respectively. While 15.49% isolates had ANC**N**I (single mutant) and 5.91% isolates was having ANCSI (wild type) genotype (Fig. 15).

Fig. 14: Distribution of DHPS alleles of *P. falciparum* isolates

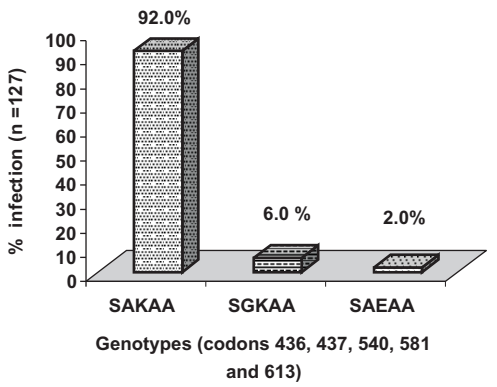
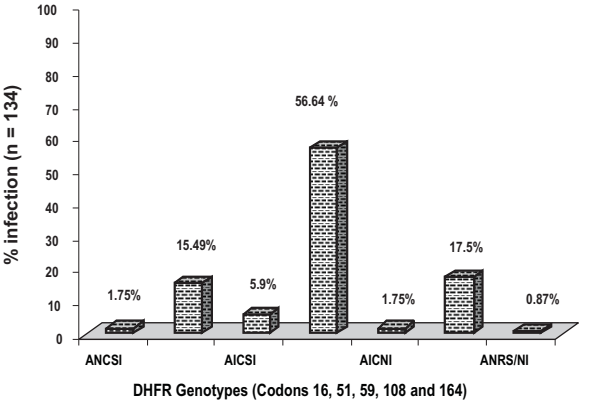


Fig. 15: Distribution of DHFR alleles of *P. falciparum* isolates



3. *Plasmodium falciparum* Chloroquine Resistance Transporter (Pfcrt): A total of 101 *P. falciparum* isolates were sequenced for *pfcrt* gene (codon 72-76) where all isolates were showing triple mutant (SVMNT) genotype. We present data on additional 43 isolates, where 98% of them showed (SVMNT) genotype while 2% had wild type (CVMNK) genotypes (Fig. 16).

Fig. 16: Distribution of Pfcrt alleles of *P. falciparum* isolates

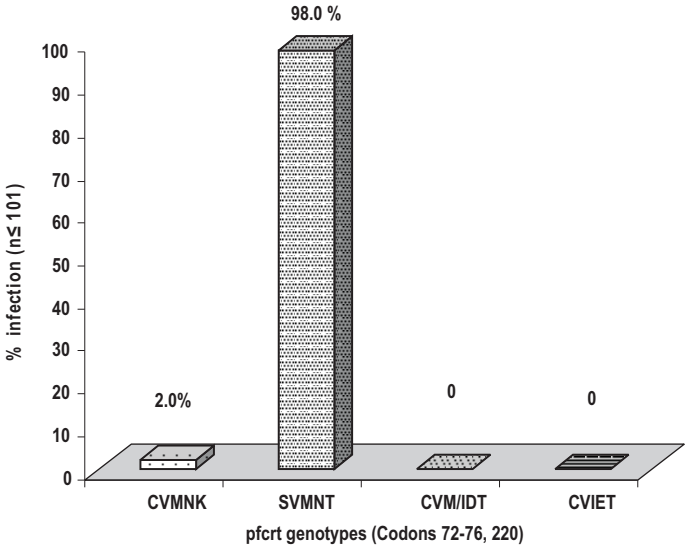


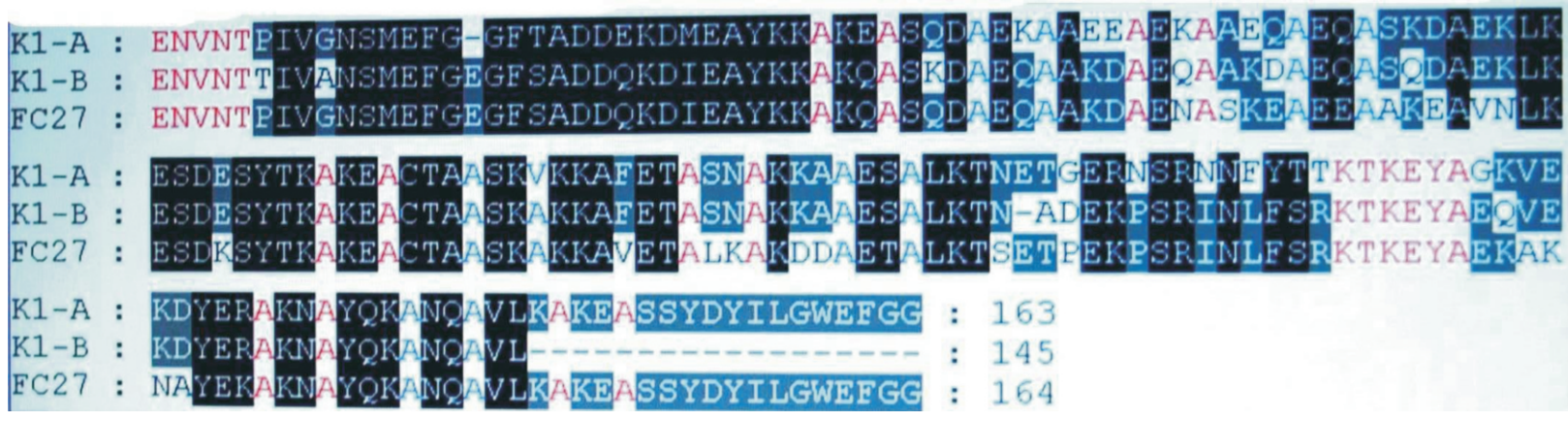
Table 10: Details of the number of isolates sequenced for vaccine candidate antigens

Vaccine Antigens	Total *P. falciparum* isolates sequenced till now	Nucleotides (in base pairs) sequenced for each isolates
MSP-1	85	555
MSP-2	81	634
MSP-3	32	550
TRAP	96	757
RAP-1	47	1133
EBA-175 (REGION II)	31	1100
EBA-175 (REGION III)	60	600
CSP	30	1000 plus 450
AMA-1	90	540

Table 11: Details of the number of isolates sequenced for drug resistance loci

Drug resistance loci	Total No. of *P. falciparum* Isolates sequenced till now	Nucleotides (in base pairs) sequenced for each isolates
Pfdhps	127	653
Pfdhfr	134	542
Pfcrt	101	582 plus 232

Amino acid sequence alignment of Merozoite surface protein 1 (MSP1) of *P.falciparum*.



Electrophograme of MSP1 gene of *P.falciparum*

(D) Entomology component:

Indoor resting mosquito collections: The average per man hour density (MHD) of *Anopheles* mosquitoes was 48.4 (Range-12.4 in May to 165.8 in August), of which 54.3% were *Anopheles culicifacies* (MHD-26.3, Range- 7.75 in May to 87.5 in August). The density of *An.fluviatilis* was 0.51 of which the density in forested villages was 1.2 which is significantly higher as compared to that in villages located at plain area and near dam site ($F=32.5; P<0.0001$). While total anopheline density was highest in the dam site villages as compared to that in villages located at plain area and forested area but the difference is not statistically significant (Table 12).

Human landing collections: The results revealed that the average human landing of total *Anopheles* was 1.24 per man per night in indoors and 1.14 in outdoors (Table 4). *An.culicifacies* was the most common species in both sites with 0.77 per man per night landing in indoors and 0.72 in outdoors. *An. fluviatilis* landing was low (0.01 in indoors and outdoors both). The landing rate of all anophelines in both sites was almost equal in villages located at plain, forest and dam sites. Further analysis revealed that significantly more *An.culicifacies* landed between 7-11 PM than other remaining hours ($t=4.67; p<0.0001$).

Determination of sporozoite rate: A total of 2355 *An.culicifacies* and 265 *An.fluviatilis* collected from different localities were assayed for sporozoite ELISA technique of which 10 *An.culicifacies* were found positive in the months of March, April, May, July and September for the presence of sporozoites (2 for Pf and 8 for Pv strain). The sporozoite rate was 0.42. Four *An.fluviatilis* were also found positive for sporozoites (two for Pf strain and two for Pv strain, sporozoite rate 1.5). Out of 10 sporozoite positive *culicifacies*, 5 were from plain villages, 4 from forest villages and 1 from village near dam site. Two *fluviatilis* were positive from plain village and 2 from forest village. Further analysis revealed that more *culicifacies* were found positive in summer months (six) as compared to those in rains. All four *fluviatilis* were positive in the months of September and October.

Sibling species determination: The *An.culicifacies* were further identified into the sibling species using cytotaxonomy and *An.fluviatilis* by using Polymerase chain reaction (PCR) techniques. Results revealed that the majority of the *An.culicifacies* tested was of sibling species 'C' (70%) followed by species 'D' (24.3%) and species 'B' (5.4%). The percent of B, C and D was almost similar in plain, forest and dam site villages. Sporozoite positive *culicifacies* was detected as sibling species D. All 126 *An.fluviatilis* collected including 4 sporozoite positive were of sibling species 'T'.

Table 12: Results of mosquito collection in plain, forest and dam site villages

Village type	Man hour density			Human landing Indoor			Human landing Outdoor		
	An. culicifacies	*An. fluviatilis*	Total *Anopheles*	*An. culicifacies*	*An. fluviatilis*	Total *Anopheles*	*An. culicifacies*	*An. fluviatilis*	Total *Anopheles*
Plain	20.6	0.4	47.2	0.7	0.01	1.3	0.67	0.02	1.19
Forest	31.2	1.2	46.7	1.02	0.05	1.44	0.78	0.02	1.03
Dam Site	34.1	0.13	52.7	0.73	0.0	1.1	0.71	0.0	1.12
Average	26.3	0.51	48.4	0.77	0.01	1.24	0.72	0.01	1.14

Epidemiology of Filariasis in Panna District, Madhya Pradesh 1991-1993 & 2002

Lymphatic filaria is a major public health problem in tropical countries. Over 90 million people are infected throughout the world of which India alone contributes one third of filaria cases. 22 Indian states are endemic for filariasis and about 411 million populations are at risk, of which three-fourth lives in rural areas. In Madhya Pradesh (including Chattisgarh) 12 districts are endemic. Panna district is one of the endemic districts in Madhya Pradesh where a unit of National Filaria Control Program is functioning but its activities are mainly focused on urban areas. Sizable population of the district is tribal and it constitutes 14% of the district's population which varies from tehsil to tehsil. Information on prevalence of microfilaria in rural and tribal population was also lacking which is expected to be different from non tribal population. With this

background the study was carried out with the objective- to determine the prevalence of rural lymphatic filariasis and its clinical spectrum and to determine microfilaria rate in tribal and non tribal population,to detect the immune responses of individuals with different clinical spectrum of filariasis against *W.bancrofti* microfilaria and to detect monoclonal antibodies specific against *W.bancrofti* microfilarial antigens.

Initially 10 villages of Ajaygarh Tehsil of Panna District were surveyed. The population covered was about 3000. From each village, 50-60 households were covered randomly. A door to door survey was carried out to collect blood smear between 8.00 p.m. to 11.00 p.m. About 20 µl of blood was taken by finger prick method and thick smear was prepared. Clinical examination was done to detect adenolymphangitis, scarring, chyluria, hydrocele and elephantiasis etc.

A total of 2842 persons were examined clinically (sampled population) and 1730 blood slides were collected from persons who gave consent. One hundred one slides were found positive for microfilaria. Overall microfilaria rate was 5.84. Among 101 carriers, 61 were male and 40 were female. Microfilaria rate was higher among children of the age group of 10-14(29.5%) and lowest in the age group of 50 and above (4.9%). Similar trends was observed in the females with mf rate of 32.5% and 2.5% respectively.

In the sampled population 46 diseased cases were detected (disease rate 1.61%), of them 26 were males and 20 were females. Highest frequency of disease was observed in the age group of 35-40 years and lowest in the age group of 5-9 years in both sexes. Majority of the males were suffering from hydrocele (15 out of 26). Among 46 diseased cases, 13 were in acute stage (28.3%), 22 in chronic stage (47.8%) and 11 were having acute as well as chronic clinical manifestations (23.9%).

The study revealed that overall prevalence of filariasis was of 7.5% (including disease rate). Majority of the clinical cases were found in chronic stage and hydrocele was found as major clinical manifestation. Improper and poor drainage of sewerage and man made open pits for collection of waste water which is the ideal breeding site for vector *Culex quinquifasciatus* seems to be the associated factors making the area

conducive for filariasis.

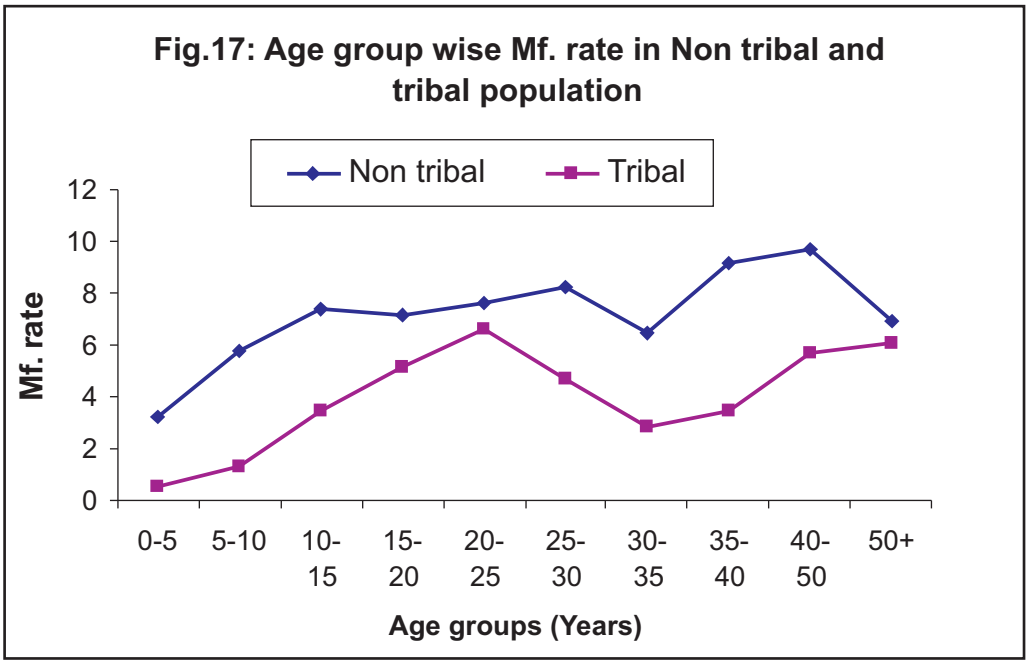
In 1992 -93 all the three tehsils were surveyed to study the spatial distribution of microfilaria and to study its epidemiological, immunological and entomological aspects in tribal and non-tribal population of the district.

Parasitological Aspects: In all 4856 blood slides were collected including 1990 blood slides from tribal population. Two hundred two and 96 sides were positive for microfilaria from non tribal and tribal population. All the microfilaria positive persons were given DEC @ 6 mg. per kg body weight. Avil 25 mg. was also given to all the mf carrier as safe guard against the possible side effect of DEC.

(i) Overall the microfilaria (mf) rate in Panna district was 5.72%. The mf rate was lower for tribal population (3.8%) as compared to the non-tribal population (7.04%) of the district. The difference was highly significant (^{2} - 9.7 $p < 0.001$). Distribution of microfilaria was not uniform in the district and varies with the proportion of tribal population. Highest microfilaria rate was recorded in Ajaygarh (9.20) and lowest in Panna tehsil (2.16) where proportion of tribal population is higher (12.0) than Ajaygarh tehsil. In Pawai tehsil, where tribal concentration was 19.8, the mf rate was 3.5 (Table 13). Low mf rates in Panna tehsil was probably because of availability of filaria clinic and people were of the habit of availing the facilities of the clinic as the approachability was easy. Age group wise analysis revealed that Mf. rate increases with advancement of age and peak mf rate was recorded in 20-25 years of age in tribal population while in non tribal population highest mf rate was found in 35-50 years age group (Fig.17).

Table 13: Microfilaria rate in nontribal and tribal population in different Tehsils of Panna district

Tehsil (No. of villages)	Tribal (%)	Person examined		Mf. rate		
		Non tribal	Tribal	Non tribal	Tribal	Total
Ajay garh (5)	8.0	1303	659	10.5	7.1	9.2
Panna (4)	12.0	457	515	1.1	3.1	2.2
Pawai (9)	19.8	1106	816	5.4	0.3	3.5
Total (18)	14.0	2866	1990	7.0	3.81	5.7



(ii) Micro filaria rate was more among males (6.3) than females (4.9).The difference was statistically significant (^{2}- 4.02 p<0.05).

(iii) The mean filarial count (mfc) was also higher for the non tribal (1.25) than the tribal population (0.28). Gender wise, males had higher mfc (1.09) than the females (0.53). The mfc for non-tribal males was higher (1.58) than the tribal males (0.40) & mfc for non-tribal females was higher (0.81) than non tribal females (0.11).

(B) Entomological Aspects:

(i) Overall man hour density (MHD) of vector *Culex quinquifasciatus* was 21.4. MHD varies among the tehsils from 14. 6 to 25.5

(ii) The infection rate and the infectivity rate of vector *Cx. quinquifasciatus* in the district was 4.4% and 1.4 %, respectively.

(iii) The infection rate in the non tribal villages was slightly lower (4.2%) than the tribal villages (4.9%). However infectivity rate in non-tribal villages was higher (1.5%) than tribal areas (1.0%)

(C) Clinical aspects:

A total number of 2833 persons could be examined clinically which revealed that-

(i) percentage of population showing disease symptoms was 11.2 %. The prevalence among tribals was lower (9.6%) than non-tribals (11.8%).

(ii) Among the tribal population, 98.5% of cases were in acute stage while in non-tribal, the percentage of acute cases was lower (56.4%).

(iii) In non tribals disease symptoms were more among the age group of 20+ years (15.5%) as compared to that in younger age group (8.3%). It may be mentioned that the percentage of chronic cases in the tribal population in age group of above 20 years was significantly lower (2.7%) compared to the non tribals of the same age group (56.6%).

(iv) The percentage of symptomatic filariasis among the males is higher as compared to the females. The non-tribal males had a higher rate of symptomatic manifestations of the disease than the tribal males.

(D) Immunological Aspects:

(i) All the mf carriers were negative for anti sheath antibody. Only 21% endemic normal had anti sheath antibodies, whereas, 48% of acute and 31% of chronic patients had anti-sheath antibody. Only one tribal patient out of 6, had anti-sheath antibody with having acute symptoms.

(ii) Non-endemic normals had very low titre of IgG4 antibodies against microfilarial somatic antigens, whereas, mf carriers and acute & chronic patients had similar levels of titre. Endemic normal had higher titre than other groups but their number examined was less. The tribal showed similar response.

(iii) IgG4 antibody was detected against Setaria cerci adult antigens by ELISA. Mf carrier showed higher response but there was quite variation in the response among mf carriers groups. Other groups responded in a similar way.

(v) Eosinophil count was not found to be very high (maximum up to 19%). No correlation was found between eosinophil count and parasite count.

(E) Socio-Cultural and Economic Aspects:

For socio-cultural study, 61 persons suffering from filariasis and 60 normal persons

were interviewed. For economic study, 73 households having at least one manifested filarial patients were studied, besides 5 case studies. Majority of the patients were literate (57.3%) and married (77.0%). The study revealed that-

Seventy-two percent patients had the disease since more than a year, 9.3% diseased patients did not undertake any treatment, majority of the patients were treated by the private doctors (77.3%), and on an average a sick person has to spend Rs.759/- in a year for the treatment. Most of the patients studied had knowledge of infection of the disease and reported that disease is caused by biting of the mosquitoes (47%). About two third respondents replied that the disease was curable and can be cured by the allopathic medicines (78%), by local herbs (14.6%) and by ayurvedic medicines (7.3%). The disease can be detected by testing the blood (60.6%).

Follow up Study: Follow up study was undertaken after a gap of 11 years in rural areas of Ajaygarh tehsil in 2002, covering a sample of 550 individual showed that microfilaria rate has increased significantly from 5.83 to 19% and filarial disease rate from 1.61 to 22% over a decade, which suggest that there is an urgent need to strengthen the control measures in the area. Health dept. of Govt. of MP has been informed with the latest situation for the necessary intervention measures.

Prevalence of Dengue vector *Aedes aegypti* and Dengue infection in Jabalpur city 2004-2006

Among vector borne diseases dengue fever (DF) is one of the re-emerging vector borne disease and its severe forms dengue hemorrhagic fever (DHF) / dengue shock syndrome (DSS) cause considerable morbidity & mortality. During the last 50 years incidence of dengue has increased 30 folds. India has been categorized in “B” category under a stratification of WHO/SEARO. World wide it is estimated that approximately 2 billion people are under threat of DF/ DHF/DSS epidemics residing in over 110 countries and 50-100 million persons are affected annually of which India contributes about 7-16 thousand cases with case fatality rate (CFR) of 0.05-3.30. During the last 30 years the country has witnessed epidemics of dengue almost every year. The year of 1996 has

been the worst when CFR was 3.3 and in Delhi alone the CFR was 4.1. An outbreak of dengue in Jabalpur city was reported way back in 1965 and a small town Chirimiri in district Surguja also observed dengue outbreak. Breeding source reduction of vector is the only known method to control the disease. *Aedes aegypt*i the vector of dengue is a domestic mosquito and container breeder. Therefore entomological surveillance is important to predict the out break and to target the most important habitats. With this background the study was carried out in four areas of Jabalpur city selected randomly and covering all direction and all socio-economic groups. Every fourth house in each area was searched for water holding containers and presence of *Aedes* larvae in those using flashlight. Larvae from these containers were collected and reared separately to adult stage for identification up to species level and its breeding preferences. *Stegomyia* indices like House index (HI) Container index (CI) and Breteau index (BI) were calculated. Wild caught and laboratory emerged specimens of *Ae. aegypti* were analysed for dengue infection by ELISA technique.

In all 6422 household were surveyed in different months and 25300 water holding containers were checked. Overall HI, CI and BI were 8.7, 2.42, and 9.6 respectively which varied from season to season. Overall *Ae. aegypti* infestations were higher than threshold level of $\geq$5% of HI and below threshold level of BI (>20%). Entomological indices were higher in Gwari Ghat area compared to other three areas which is statistically significant ($p < 0.05$) and lowest in SBI colony. Breteau index is higher in Gwari Ghat than the threshold level. *Aedes* infestation was recoded in all the seasons and in all the areas. Higher values were recorded in monsoon months followed by post monsoon months. (The trend was not uniform in all the areas. CI was significantly less during summer season (^{2} 24.2 P=<0.000001)

***Aedes aegypti* breeding habitat:** Surveyed breeding habitats belong to 18 categories. Except Plastic over head tank Aedes breeding was recorded in all type of containers. Highest positivity for Aedes infestation was recorded for cement tank followed by under ground tank, ceramic drum and cement cistern. The associations between negative and positive containers are highly significant (^{2} 118.1 $p<0.001$). Among positive containers mud pot constitutes over 28% of the total positive containers followed by cement tank. About 50% of the total collected pupae were from cement tank followed by mudpot, ceramic drum and under ground tank. Together these containers yield more than 85 % of the total pupal crop. Coincidently these containers form similar proportion of total

positive containers.

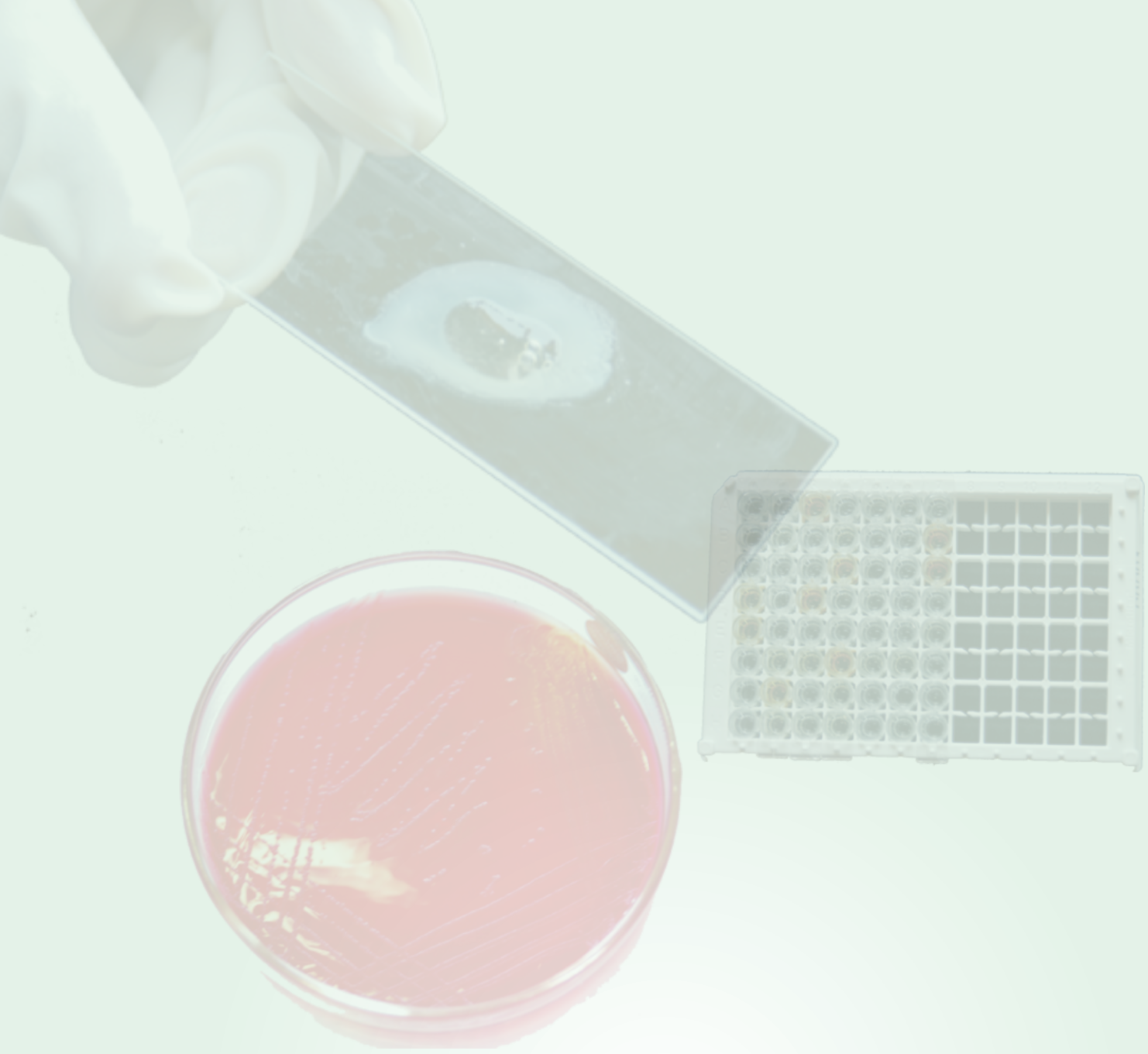
Species composition: A total of 1848 specimens of *Aedes* genera were emerged. *Ae. aegypti* was the predominant species in all the months sharing 96.7 and rest was *Ae. albopictus* and one specimen of *Ae. vittatus.*

Indoor resting density: Limited efforts were made to collect adult *Aedes* mosquito to determine MHD and species composition. Overall MHD of *Ae.aegypti* and *Ae. albopictus* was 1.7 and 0.02 respectively. Highest density was recorded during summer (3.0) followed by monsoon season (1.6).MHD of *Ae. aegypti* was directly proportional to pupal yield which is about 50 % in summer followed by monsoon (25%).total *Ae. aegypti* constitute 98% of *Aedes* genera.

Vector incrimination: A total of 70 wild caught specimens of *Ae. aegypti* and 140 specimens emerged from field collected larvae in the laboratory, during the year 2004-05 were analyzed using Elisa Technique at CRME Madurai in 17 pools. None was found positive for dengue infection.

No unusual rise in fever cases were observed during the entire study. No report of dengue cases was heard from any govt. or private hospital between 2004 and 2006. High entomological indices and higher pupal density in all part of the city suggest that the area is conducive for out break of dengue/ chikangunya.

Dengue out break in Jabalpur (2007): ***First case of dengue was detected while testing the efficacy of Pan Bio ELISA kit in the last week of August 2007.*** There after reports started coming regarding the unusual rise in fever cases and dengue from private hospitals and neighbouring areas. Following the unusual reporting of fever cases in private hospitals, in the month of October a door to door surveillance was carried out in three areas to collect blood samples from febrile cases or cases with the history of fever during last four days. Thirty seven IV blood samples were collected from three areas. Dengue IgM antibody were detected using Pan Bio ELISA Kit. Fifteen samples (40%) were found positive for Dengue anti body. Although dengue cases were recorded from all parts of the city, worst hit areas was the Gwari ghat where stegomyia indices were relatively high for the last several months. Among positive cases only three (20%) were children below the age of 14 years and rest all were in their higher age. Apart from this active case detection, 10 more samples which were received were tested. Five were found positive for dengue.



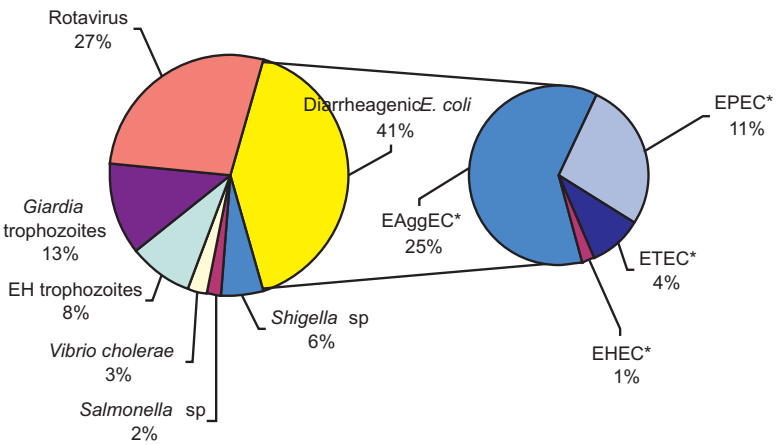
COMMUNICABLE DISEASES

Studies on Etiology of Diarrhea in Tribal Areas 2004-2005

The study was conducted in eight tribal villages of Jabalpur district. Purposive sampling method was adopted for selection of the villages. Stool samples were collected from children having diarrhoea and also collected from children (n=450) when they did not have diarrhea. The samples were processed in the laboratory for microscopy and culture by standard methodology. Rotavirus was detected by using ELISA (Pathfinder Rotavirus direct antigen detection system, BioRad, Japan). Detection of diarrheagenic *E. coli* was done *by PCR.* Multiplex PCR was performed elt, est, stx1, stx2, ipaH, eae, eagg, bfpA, east and eaf genes.

During May 2004 to April 2005, 1236 episodes of diarrhoea were recorded in 580 children, giving an incidence of 2.13 episodes of diarrhea per child per year. Stool samples could be collected during 772 episodes. Classical enteropathogens were isolated from 26 children. *Shigella* sp was isolated from 14 samples, *Vibrio cholerae* from 7 and *Salmonella* sp from 5 samples. Rotavirus was detected in 72 samples. *Giardia* trophozoites were seen in 32 samples and *Entamoeba histolytica* in 21 samples (Fig.1). In an earlier study conducted by RMRCT in hospital attending children at Jabalpur Enteropathogenic *E.Coli* (20.1%) was the most prevalent pathogen followed by Rotavirus (16.9%) and Shigella (13.4%) (Annual Report RMRCT, 1988-89).

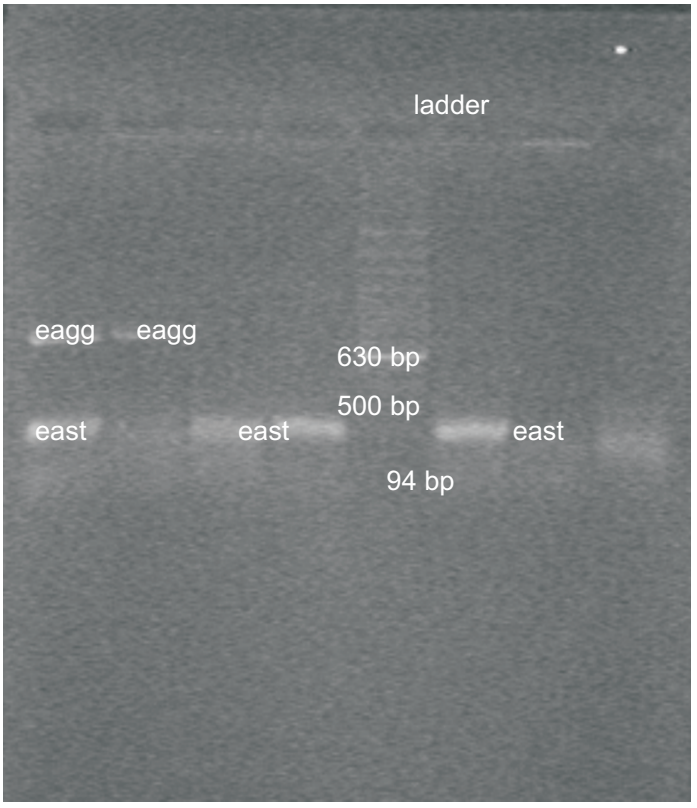
Fig. 1: Etiology of diarrhea in tribal preschool children (n=780)**



Enteroaggregative *E. coli* was isolated from 64, Enterotoxigenic *E. coli* from 10 and Enteropathogenic *E. coli* (EPEC) from 27 samples. Mixed infections of diarrheagenic *E. coli* with classical pathogens was not observed. However, mixed infection of various diarrheagenic *E. coli* was observed. (Fig. 1) More than half of the *E.coli* related diarrhoea cases occurred in the age group of 6 months to 2 years *and* were equally seen in both male and female children. EAggEC diarrhoea was associated with high fever in 11 children and that due to ETEC with two. Two children with EAggEC infection presented with bloody diarrhea. (Table 1).

Of the 450 non diarrhoeal stool samples tested, EAggEC could be detected in 6 samples. Other diarrheagenic *E. coli* or classical enteropathogens were not isolated. Thus, diarrheagenic *E. coli* were detected in 1.33% control samples. This was much less than that in diarrheal stool samples (13.2%). The difference was significant (^{2}=49.798, P=0.001). *Giardia* trophozoites were seen in 2 children.

PCR for detection of genes of EAggEC



Antimicrobial susceptibility pattern showed that more than 60% of diarrhoeagenic E. coli strains showed susceptibility to antibiotics like nitrofurantoin, furazolidone and chloramphenicol. The study population belongs to the tribal area and has limited access to the health delivery system. This could be the reason for less consumption of antibiotics and, in turn, the susceptibility to common antibiotics in our study. At the same time, more than 40% of strains of EAggEC showed resistance to seven antibiotics. The resistance was more in case of EAggEC as compared with other diarrhoeagenic *E. coli* (Table 1).

Table 1: Clinical profile of children with diarrhea caused by diarrheagenic *E. coli*

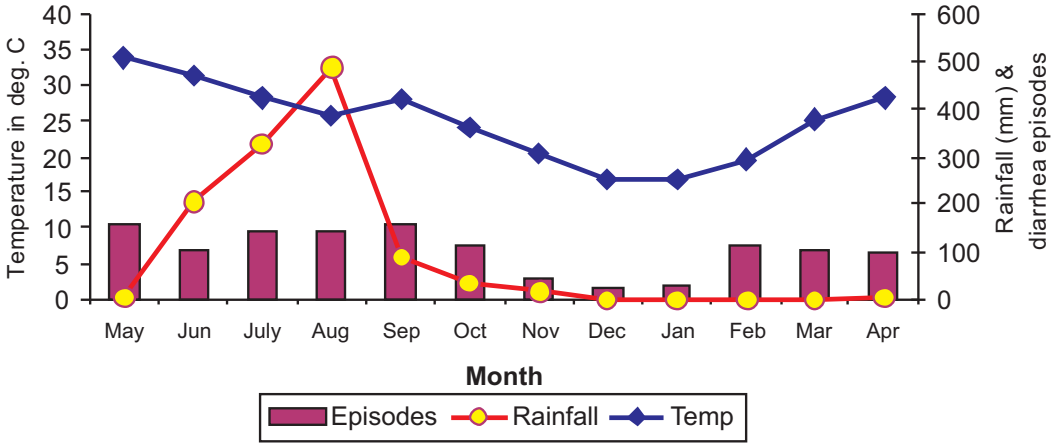
		EaggEC (n=64)	EPEC (n=27)	ETEC (n=10)	EHEC (n=2)
Age	6 Months–2 yrs.	45	16	7	2
	> 2 years	19	11	3	0
Sex	M	36	14	6	1
	F	28	13	4	1
Stool character	Watery	49	21	9	2
	Mucoid	12	6	1	0
	Bloody	3	0	0	0
Associated symptoms/signs	Fever (>38^{0}C)	11	0	1	1
	Vomiting	10	2	0	0
	Pain in abdomen	9	2	0	0
	Dehydration	17	3	1	1
Antibiotic susceptibility (%)	Nitrofurantoin	59.4	66.7	60	100
	Norfloxacin	43.8	63.0	70	100
	Furozolidone	50.0	66.7	70	100
	Ciprofloxacin	45.3	63.0	70	100
	Chloramphenicol	48.4	74.1	80	100
	Ampicillin	39.1	55.6	50	50
	Cotrimoxazole	28.1	40.7	30	100

Seasonal variation in the number of episodes of diarrhea was strongly correlated with the average temperature (r = 0.79, P = 0.01) (Fig.2). There is a

hypothesis that diarrhoeal episodes also increases with increase in rainfall, but the association was not statistically significant in this case.

The study shows that E.coli plays a significant role in the burden of diarrhoea in children and EAggEC is an important enteropathopgen.

Fig. 2: Monthwise episodes of diarrhea, average temperature and rainfall



Role of antimicrobial therapy and hand washing on Shigellosis 1990

Sheigellosis is an important public health problem and has caused serious epidemics all over. Shigella, like other diarrhea causing organisms are transmitted by faeco-oral route and this is facilitated by unhygienic conditions. The study was conducted to know the impact of combined intervention measures like hygienic disposal of excreta washing of hands with soaps and effective case management on the incidence of shigellosis. The study was conducted in Shahpura block of Mandla district, 5 experimental and 3 control villages were studied. A population of 3736 was surveyed and a total of 629 preschool children were registered for the study. Hand washing was introduced in the experimental villages. Faecal samples from children with diarrhea were collected. Hand

washings and nail clippings of mother and siblings were also collected. The samples were processed in the laboratory for isolation and identification of enteropathogens. Shigella isolates were further tested for their sensitivity to antibiotics.

All the villages had hand pumps as well as open well facilities for drinking water. Episode of 1.35 and 1.77 was noted in the experimental and control villages respectively. *Shigella spp*. was isolated from 19.8 % in experimental and 21.5 % in control villages ($p<0.1$). The major isolate was *Sh.dysentriae* type I. Most of the strains were sensitive to Furazolidone (97%) followed by Gentamycin and Kanamycin (94%) and to Chloramphenicol (60%) to some extent. They were resistant to commonly used antibiotics like Sulphadiazine, Ampicillin, Co.trimoxazole and Tetracycline. Shigella was isolated in 19 out of 220 specimens (8.6%) of hand washings and nail clippings collected randomly from mothers and siblings.

Thus, the present study concludes that an antimicrobial therapy if combined with hand washing could be highly effective method in controlling Shigellosis as well as other diarrhoeal diseases, which should be implemented therough various methods of health education.

Sexually Transmitted Diseases in Tribal Population 2004-05

Sexually Transmitted Diseases (STDs) continue to be major public health problem in the developing world, leading to considerable morbidity, mortality and stigma. The prevalence rates of STD are far higher in developing countries where STD treatment is less accessible. The situation may still be worse in tribal areas where there is little or no access to the health delivery system. There is dearth of information regarding the epidemiology of STDs in India for many reasons such as recent recognition of STDs as a major public health problem, stigma and discrimination associated with the STDs, lack

of interdepartmental coordination for studies, poor attendance of STD patients at the public clinics and academic institutions, availability of limited diagnostic facilities, etc. However, the prevalence and incidence of some STDs, which are curable, changes quickly, and can be used as a proxy marker for changes in sexual behaviour and ultimately, the HIV incidence. Keeping this in view the study was done to assess the situation of STD in tribal area.

This was a community-based cross sectional study carried out in seventeen tribal villages of Kundam block of Jabalpur district. Villages were selected using stratified random sampling. All married men and women in the age group of 15-49 years from selected villages were included in the study. The survey instruments included pre-coded and pre-tested questionnaires. Clinical examination was done to identify STD syndromes. A lady doctor examined female patients. Blood, urine, vaginal/urethral and endocervical swabs were taken for laboratory diagnosis of sexually transmitted infections (STI) from the subjects and were tested by standard methodology.

All the surveyed villages were predominantly inhabited (>85%) by Gond tribal population. Majority of the households were of nuclear type and the average size was 4.9. Most of them (>90%) were either cultivators and/or agricultural labourers. The educational background showed that 33% were illiterate, 42.5 % had primary education, 18.6 % had middle school education, 4.6% had high school education and only 1.3 % had higher education. More than half, 1327 (51.7%) individuals got married before the age of 18 years.

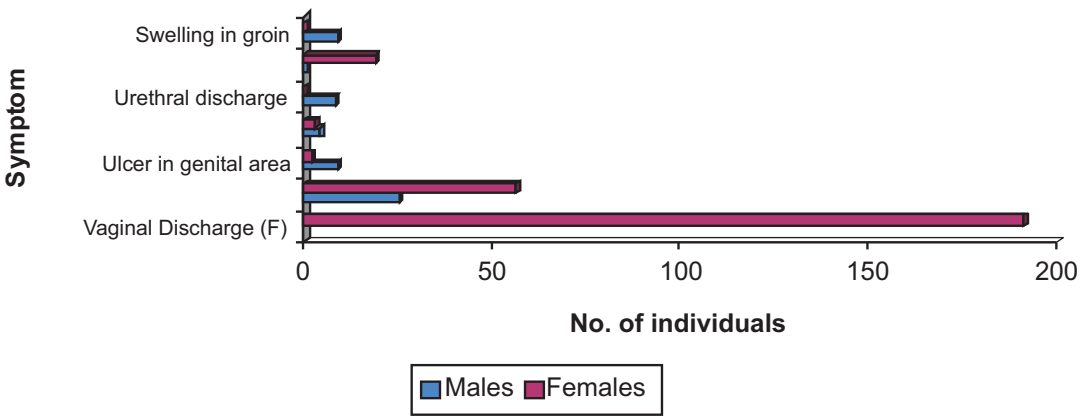
A total of seventeen villages were covered under the study. The eligible population of the study villages was 3387, of which 2568 (75.8%) individuals were interviewed. The study population comprised of 1372 males and 1196 females (M/F ratio: 1.15). It was found that 326 (12.7%) had at least one symptom suggesting the presence of STD. Of these, 268 individuals agreed for genital examination.

Reporting of STI was more than double in females (17.5%) as compared to males (8.5%). In males, the maximum number of individuals (46.2 %) was in the age

group 30-39 years followed by 25-29 years (14.5 %) and 40-44 years (14.5 %). In females, the maximum number of individuals (43.6 %) was in the age group 30-39 years followed by 40-44 years (17.7 %) and 25-29 years (13.9%).

In females, the commonest symptom was vaginal discharge followed by frequent painful urination and pain in lower abdomen. The commonest symptom in males was painful micturition, followed by genital ulcer swelling in groin and urethral discharge (Fig. 3).

Fig.3: Symptoms reported



The commonest STD found was gonorrhea (27 individuals, 26.7%), followed by syphilis, genital herpes and chlamydia. Of the 274 men tested randomly for HIV, HBV and HSV-2, eleven (4%) were positive for Hepatitis B and twenty (7.3%) for herpes simplex. No individual was found HIV positive. (Table 2) Of the 1196 women, 209 gave history suggestive of STD. One hundred and sixty seven women agreed for genital examination. The commonest STD found was bacterial vaginosis seen in 107 (64.1%) women. This was followed by trichomoniasis (43.1%) and candidiasis (27.5%). Gonorrhea was seen in 16 (9.6%) women. Of the 252 women tested randomly for HIV, HBV and HSV-2, 4 (2.9%) were positive for Hepatitis B and 45 (12.4%) for herpes simplex. None of them was positive for HIV. Multiple infections were seen in 47 individuals.

Table 2: Prevalence of different STIs in men and women

STI	Males (n= 101)	Females (n= 167)	Total (n=268*)
Syphilis	4 (4.0)	0 (0.0)	4 (1.5)
Gonorrhea	27 (26.7)	16 (9.6)	43 (16.0)
Chlamydia	2 (2.0)	6 (4.0)	8 (3.0)
Bact Vaginosis	----	107 (64.1)	107 (39.9)
Trichomoniasis	----	72 (43.1)	72 (26.9)
Genital herpes	3 (3.0)	0 (0.0)	3 (1.1)
Candidiasis	----	46 (27.5)	46 (17.2)
Hepatitis B**	11 (4.0)	4 (1.6)	15 (2.9)
H simplex**	20 (7.3)	45 (17.9)	65 (12.4)
HIV**	0 (0.0)	0 (0.0)	0 (0.0)

(Figures in parenthesis indicate percentage)
*No. of individuals agreeing for genital examination
**Tests were carried out on a random sample of 526 (274 men and 252 women i.e. about 20% of covered population)

Infertility Among Khairwar Tribe of Sidhi District, Madhya Pradesh 1996-97

Khairwar tribe, which is one of the sub tribe of Gond mostly confined to the north eastern part of Madhya Pradesh. Tribal Research Institute, Bhopal, had reported low fertility among the Khairwars living in the Kusmi Block of Sidhi district. To understand the underlying cause of the low fertility a health survey was undertaken among the Khairwars living in all the four blocks of Sidhi district in the year 1996-97.

In-depth investigations revealed a very high sexual promiscuity in the community. Twenty seven percent eligible females were suffering from primary sterility and 48 % from secondary sterility. Reactivity of VDRL was found in 61 % of the eligible females. Fifty seven percent males and 70 % females among the eligible couples studied were VDRL reactive (Table 3). Overall 35.4 % blood samples were positive for

VDRL test. All the VDRL positive samples were subjected to supplemental test TPHA, which confirmed positivity for syphilis.

Table 3: Percentage distribution of VDRL and TPHA positivity in Kusmi and other block

Name of Block	% VDRL positive (n)	% TPHA +ve (n)
Kusmi (n=41)	41 (25)	63.4 (26)
Other block (n=41)	9.8 (4)	17 (7)

VDRL and TPHA positivity of 64 % among the Khairwar tribe of Kusmi block indicated that the infertility/low fertility was probably due to underlying Syphilis. However, in depth study like semen analysis, Hysterosalpingography of the fallopian tubes etc. are required to pinpoint the problem. The findings along with the recommendations were communicated to the Govt. of Madhya Pradesh for appropriate intervention. Intervention measures carried out by state health authorities brought significant increase in the fertility of the tribe which was seen in subsequent demographic study carried out by the centre. (Annual Report RMRCT, 2002- 03). The details of study are given in section on socio-economic and behavioral studies on health.

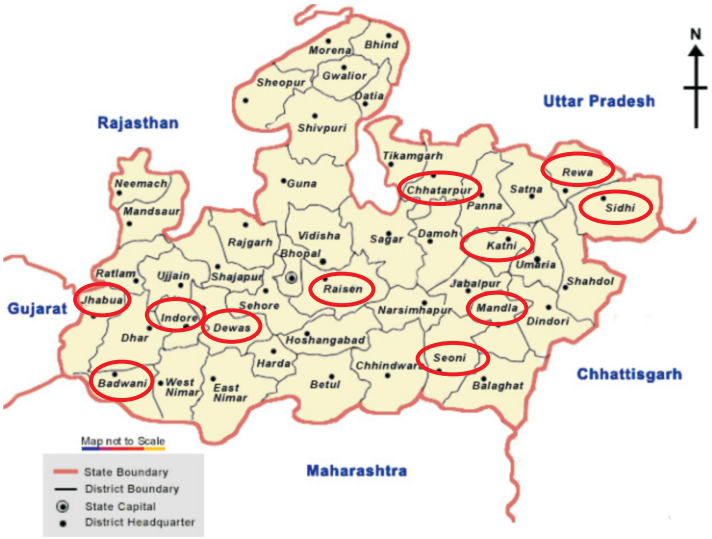
Tuberculosis Among Tribal Population 2006-08

Tuberculosis (TB) is a global public health problem. With 1.8 million new cases annually, India is the highest TB burden country in the world. It also accounts for one-fifth of world's new TB cases and two thirds of the cases in the South-East Asia region. Epidemiological information on tuberculosis is vital for planning the control strategies. This is particularly important in tribal areas. However, this information is lacking in tribal population except a few studies in various pockets. The National Sample Survey for Tuberculosis in 1955 - 1957 did not include tribal groups. The centre conducted studies on tuberculosis amongst the tribal population of the state to estimate the prevalence of tuberculosis infection and annual risk of tuberculosis infection (ARTI) and the

prevalence of pulmonary TB (PTB) disease. Prevalence of TB infection and the computed ARTI are indicators to assess the extent of transmission of infection with Mycobacterium tuberculosis in a community and trends over relatively longer period of time. The ARTI is defined as the probability of acquiring new tuberculous infection or reinfection over a period of one year. It expresses the overall impact of the prevalent infectious cases in the community and the efficiency of disease control measures. ARTI estimates also enable us to calculate the extent to which cases may emerge in the future. Prevalence of TB disease is an important epidemiological index to measure the burden of the disease in a community. Epidemiological information on TB is also vital for the planning of control strategies and service delivery systems.

Tuberculosis infection and ARTI: A community based cross sectional tuberculin survey was undertaken among children aged 1-9 years in the tribal population of Madhya Pradesh during 2006 - 07. This is the first tuberculin survey carried out on a large scale in tribal population in the country. A representative random sample of villages predominated by tribal population was selected from eleven districts in the state adopting multistage stratified cluster sampling. The children were subjected to tuberculin testing with 1TU of PPD RT 23 and the reaction sizes were read after 72 hours.

Map of M.P showing the study areas



Among the 4802 test read children, no BCG scar was found in 3062 (64%) children. The prevalence of infection among children without BCG scar was estimated as 6.8% (95% CI: 4.8 8.9%). The ARTI was computed as 1.3% (0.9-1.7%) (Table 4). The results indicate that the TB situation in terms of risk of infection in tribal population of Madhya Pradesh is not different from other areas of the country. These findings throw light on the current tuberculosis situation and will serve as baseline data for evaluating the impact of disease control measures and epidemiological trends in the coming years.

Table 4: Estimated prevalence of infection and ARTI among children

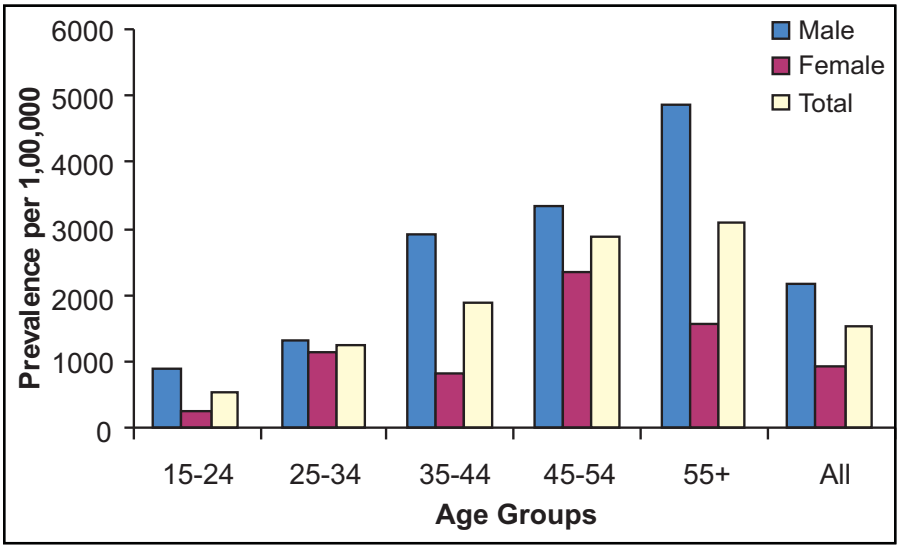
Classification	No. test/ read	No. infected			ARTI (%)	P value
		No	%	(95% CI)		
BCG Scar						
No	3062	209	6.8	(4.8 – 8.9)	1.3 (0.9-1.7)	NS
Yes	1550	118	7.6	(4.4 – 10.9)	1.4 (0.8-2.0)	
All*	4802	343	7.1	(5.5 -8.8)	1.3 (1.0-1.7)	
Sex						
Male	2359	158	6.7	(5.0 – 8.4)	1.3 (0.9-1.6)	NS
Female	2443	185	7.6	(5.6 – 9.6)	1.4 (1.0-1.8)	
Age (in yrs)						
1-4	2093	42	2.0	(1.3 – 2.8)	0.7 (0.4-0.9)	<0.001
5-9	2709	301	11.1	(8.6 – 13.6)	1.6 (1.2-1.9)	

* Children with doubtful scar and no information on scar included

Pulmonary TB (PTB) disease: This is the first TB prevalence study amongst the tribal population across the state of Madhya Pradesh. A community based cross-sectional survey was undertaken among tribal adults aged 15 years and above in randomly selected eleven districts of the state during 2007-08. The overall prevalence of PTB was found to be 390 per 100,000 population. The prevalence increased with age and was also found significantly higher among males (550/100,000) as compared to females (230/100,000) (Fig. 4). The study results provide vital information on the TB disease situation amongst the tribal population of the state and can serve as baseline data for future evaluation of the impact of disease control measures and epidemiological trends. The findings suggest that the TB situation amongst the tribal population is not that different from the situation among non-tribal population in the country. However, TB remains a major public health problem amongst the tribal population and there is a need

to maintain and further strengthen TB control measures.

Fig. 4: Age and Sex wise prevalence of tuberculosis among tribal population



Tuberculosis situation among primitive tribes of Madhya Pradesh: Among all the tribal groups, three tribal communities in the state have been identified as primitive tribes based on their primitive traits, low level of education, economic backwardness and stagnant or low level of population growth. These are:

- Saharias of Chambal Division
- Baigas of Baigachak
- Bharias of Patalkot

Map of M.P showing location of primitive tribes studied

Geographical isolation, unique cultural and social practices, lack of formal education & treatment seeking behavior, poverty, etc. make these populations vulnerable to several health problems. The centre conducted studies among these tribal groups to assess the tuberculosis situation among them.

Tuberculosis situation among Saharias over a period of fifteen years (1991-92 to 2007-08): The tuberculosis situation among Saharia was assessed by the centre during 1991-92 by conducting tuberculin as well as disease survey in Sheopur district (a part of earlier Morena district). The results showed a very high prevalence of TB infection (16.9%) and annual risk of TB infection (ARTI) (3.3 %) amongst children, with an overall adult TB disease prevalence of 1,270 per 100,000 population (Table 5). A well demarcated BCG scar was seen in 10.8% of the children (Fig. 5) (Chakma et.al, 1996).

Fig. 5: BCG Scar distribution among Saharia children (1991-92)

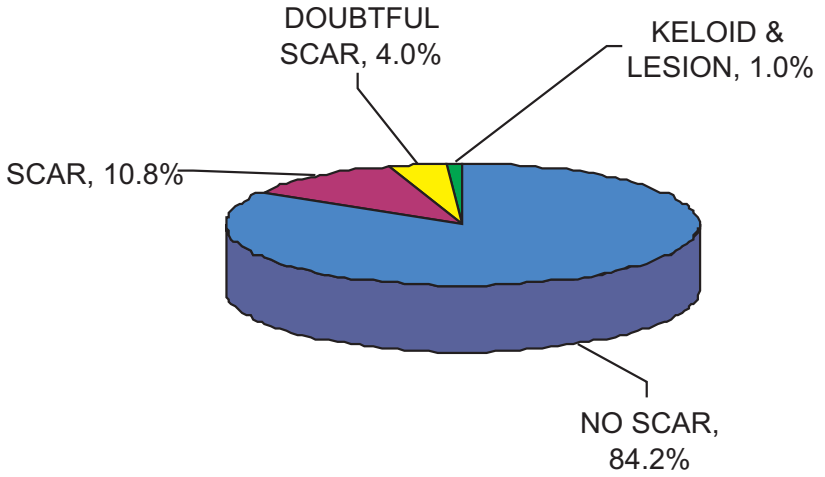


Table 5: Age-Sex wise prevalence of pulmonary tuberculosis (1991-92)

Age group (Years)	Prevalence of PTB (per 100,000 population)		
	Male	Female	Total
15-20	770	390	600
21-30	1120	510	113
31-40	2260	630	1450
41-50	3720	470	2040
51	4150	670	2370
Total	1990	530	1270

A re-survey was carried out after fifteen years (2006-07 and 2007-08) in this tribal community to estimate the prevalence of infection & ARTI and Pulmonary TB (PTB) disease. There was an improvement in the proportion of children with BCG scar from 10.8 % to 35 %. The prevalence of TB infection and ARTI among children without BCG scar was estimated as 21.1 % and 3.9 % respectively (Rao et.al, 2008) with the overall prevalence of pulmonary TB disease of 1,518 per 100,000 population (Table 6).

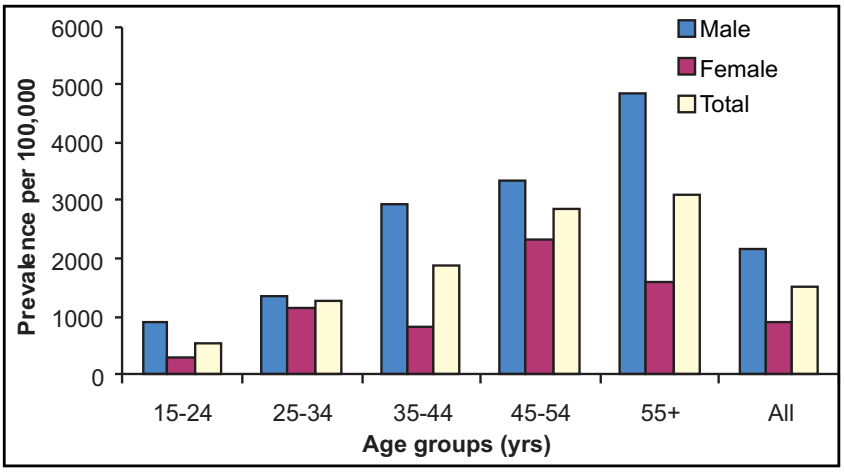
The prevalence of bacillary PTB was more than double (p<0.001) amongst males (2,156 /100,000) compared to females (933/100,000). The prevalence increased with age being 546 per 100,000 in 15-24 year age group to 3,086 in 55+ year age group (Fig. 6). The increase in trend with age was statistically significant (p<0.001).

The study findings indicate that there has been no real improvement in the TB situation amongst this primitive tribal group over the intervening 15 years. The findings suggest that TB remains a major public health problem amongst the Saharia "primitive" tribal community of Madhya Pradesh. There is an urgent need to further strengthen TB control measures in the area.

Table 6: Estimated prevalence of infection and ARTI among Saharia children (2006-07)

Classification	No. test/ read	No. infected			ARTI (%)	P value
		N	%	(95% CI)		
BCG Scar						
No	877	185	21.1	(18.3 –23.8)	3.9 (3.4-4.5)	NS
Yes	464	88	19.0	(15.4 –22.5)	4.0 (3.2-4.8)	
All	1341	273	20.4	(18.2 -22.5)	3.9 (3.5-4.3)	
Sex						
Male	660	108	16.4	(13.5 – 19.2	3.1 (2.6-3.7)	<0.001
Female	681	165	24.3	(21.0 –27.4)	4.7 (4.0-5.4)	
Age in yrs						
1-4	538	40	7.4	(5.2 – 9.7)	2.5 (1.8-3.3)	<0.001
5-9	803	233	29.0	(25.9-32.2)	4.5 (3.9-5.0)	

Fig. 6: Age and sex wise prevalence of tuberculosis among Saharia (2007- 08)



Tuberculosis situation among Baigas of Baigachak and Bharias of Patalkot: This is the first TB prevalence study amongst the Baigas of Baigachak in Dindori district (a part of earlier Mandla district) and Bharias of Patalkot in Chhindwara district. A community based cross-sectional survey was undertaken during 2007-08 among adults aged 15 years and above in randomly selected villages in Baigachak area. Total coverage was done among Bharias in Patalkot area. The overall prevalence of PTB was found to be 150 per 100,000 population among Baigas of Baigachak and 430 per 100,000 population among Bharias of Patalkot. The findings suggest that the TB situation amongst these tribal groups is not that different from the situation among non-tribal population in the country. The information on the TB disease situation amongst these tribal groups can serve as baseline data for future evaluation of the impact of disease control measures and epidemiological trends.

Drug susceptibility testing: Drug susceptibility testing was performed on the strains identified as *M. tuberculosis* for INH, rifampicin, streptomycin and ethambutol by using proportion method. Of the 79 isolates tested for drug susceptibility, thirty eight isolates were found sensitive to all the tested drugs. Two isolates were found to be MDR (multi drug resistant). Thirty four isolates were found resistant to single drug and five to two drugs.

Tuberculin testing in the field

Disease survey being conducted in the field

Studies on Hepatitis in Different Primitive Tribes 2004-08

Viral hepatitis is caused by different viruses that belong to different taxonomical families and genera. HAV and HEV are transmitted by fecal-oral route. Mostly, drinking water or consumption of food contaminated with sewage water results in local outbreaks and epidemics. HBV and HCV are blood-borne viruses and the transmission occurs

through contaminated blood, blood products and through improperly sterilized needles/syringes. HBV can also be transmitted through sexual routes. HDV is a defective virus needing active HBV replication for its multiplication. Thus, the spread of this virus is restricted to individuals with active HBV replication. The prevalence of these viruses in tribal areas of India mostly remains unknown. Hepatitis B is common in tropical areas. The national average for HBsAg positivity in the healthy donor population in India is around 4.7 % with a population base of 900 million the total HBV carrier pool in India is around 43 million.

Indian tribes are considered to represent the aboriginal population(s) of the country. The Bondo tribe, one of tribal groups from Orissa, India, is located in inaccessible, interior areas of Khairput block of Malkangiri district of Orissa. Total population of the tribe is around 5,129 (according to 1991 census), which is distributed in small groups; the population of each group ranging from 50 to 200. The Bondos, known as Remo (men) are a small tribe of the wild and mountainous region north-west of Machakunda river. Their contact with main stream population is very less. The inaccessibility of their abode separates them from other tribes of the district. They live on the mountains at the height of 3000 feet and practices Podu cultivation. Bondo ladies help men during cultivation.

PPS technique was adopted to draw the samples from these groups to attain a total sample of 1000. Demographic and socio-cultural information was collected from the sample households by using a predesigned interview schedule. Information about different risk factors for transfusion transmitted hepatitis viral infections like history of surgery, parenteral treatment, blood transfusion, ear piercing, tattooing and sexual promiscuity was collected. Informed consent was obtained from the study individuals.

The number of females participating in the study was higher than males. This is because males are usually out of their homes in search of livelyhood. All the blood samples were tested for hepatitis B surface (HBsAg) antigen, Anti HBs antibodies, Anti HCV and HIV. HBV genotyping was carried out at National Institute of Virology, Pune.

Twenty samples were found positive for hepatitis B (prevalence 4.4%). The prevalence was higher in males (5.3%) as compared to females (3.4%). The difference

was statistically insignificant (^{2}=0.97, p>0.05). The prevalence of hepatitis B increased as age increased (Table 7). All HBsAg negative samples (n=437) were tested for antiHBs antibodies. Sixty four samples (14.6%) were anti HBs positive. Anti HCV antibodies were present in 38 samples (Prevalence 8.3%). The prevalence in males was 6.7 % while that in females, 9.9 %. (Table 8).

Table 7: Age Sex distribution of HBsAg positivity in Bondo tribe

Age group	Males Positive/no. tested (%)	Females Positive/no. tested (%)	Total Positive/no. tested (%)
upto10	0/53 (0)	1/36 (2.8)	1/89 (1.1)
11-20	2/47 (4.3)	2/36 (5.6)	4/83 (4.8)
21-30	2/41 (4.9)	0/30 (0)	2/71 (2.8)
31-40	4/47 (8.5)	3/64 (4.7)	7/111 (6.3)
41-50	3/29 (10.3)	2/51 (3.9)	5/80 (6.3)
51 & above	1/8 (12.5)	0/15 (0)	1/23 (4.3)
Total	12/225 (5.3)	8/232 (3.4)	20/457 (4.4)

Of the nine representative samples processed for HBV genotyping, six were of genotype D while three belonged to genotype A. One sample was positive for HIV-1. There was a strong association between receiving injections and the prevalence of anti HBs. There was no history of drug abuse. There was no history of acupuncture therapy. Tattoos were observed in 82 individuals. No correlation was seen between tattooing and HBsAg positivity.

Table 8: Age Sex distribution of Anti HCV positivity in Bondo tribe

Age group (in years)	Males Positive/no. tested (%)	Females Positive/no. tested (%)	Total Positive/no. tested (%)
Up to10	0/53 (0)	0/36 (0)	0/89 (0)
11-20	4/47 (8.5)	2/36 (5.6)	6/83 (7.2)
21-30	3/41 (7.3)	2/30 (6.7)	5/71 (7)
31-40	3/47 (6.4)	12/64 (18.8)	15/111 (13.5)
41-50	4/29 (13.8)	7/51 (13.7)	11/80 (13.8)
51 & above	1/8 (12.5)	0/15 (0)	1/23 (4.3)
Total	15/225 (6.7)	23/232 (9.9)	38/457 (8.3)

The results of the study indicated that hepatitis B was present in this tribe. Overall prevalence of hepatitis B was 18 % with a carrier rate of 4.4 %. The prevalence of anti HCV was also high. The rates were similar to the rates seen in non tribal populations. But considering the fact that this is a primitive tribe living in geographic isolation, the rate seems to be higher. Presently the institute is conducting a study on prevalence of different hepatitis markers in the primitive tribes of M.P. and Chattisgarh. It is an ICMR task force study being undertaken among primitive tribal communities in different parts of the country. The primitive tribal communities in Madhya Pradesh and Chhattisgarh are being covered by the centre. These are Baigas, Bharias, Saharias in Madhya Pradesh and Abujhmarias, Hill Korwas, Kamars and Birhors in Chhattisgarh.

Abujhmaria: In the year 2006, 66 samples were collected from this tribe. Out of 66 samples 62 were found to be positive for anti HAV antibodies (93.93%). Ten samples were found positive for anti HCV antibodies (15.15%).

Kamar: Two hundred and fifty eight blood samples were collected from Kamar tribe. The prevalence of HAV antibodies was 94.2 % in this tribe. The prevalence of HBsAg and anti HBs was found to be 3.1 % and 4.7 % respectively. The prevalence of anti HCV was 12.0 %.

Baiga: The prevalence of HBsAg and anti HBs was found to be 5 % and 11 % respectively. The prevalence of anti HCV was 7 %. The Anti HAV positivity has been found to be 100 % Three HBsAg positive samples were studied by Real time PCR to determine HBV DNA and found HBV DNA in only one sample. The prevalence of anti-HEV was 59 %

Saharia: Of the 173 blood samples collected so far, the prevalence of HBsAg and anti HBs was found to be 5% and 33% respectively. The prevalence of anti HCV was 1%. Anti HAV antibodies were present in 165 samples (99%). The prevalence of anti HEV was found to be 40%. Four samples were positive by Real time PCR for HBV DNA.

Bharia: A total of 247 blood samples have been collected. Anti HAV antibodies were present in 223 samples (96%). Twelve samples were found positive for HBsAg (5%) and twenty for anti HBs (8%). Sixty five percent samples were found to be positive for

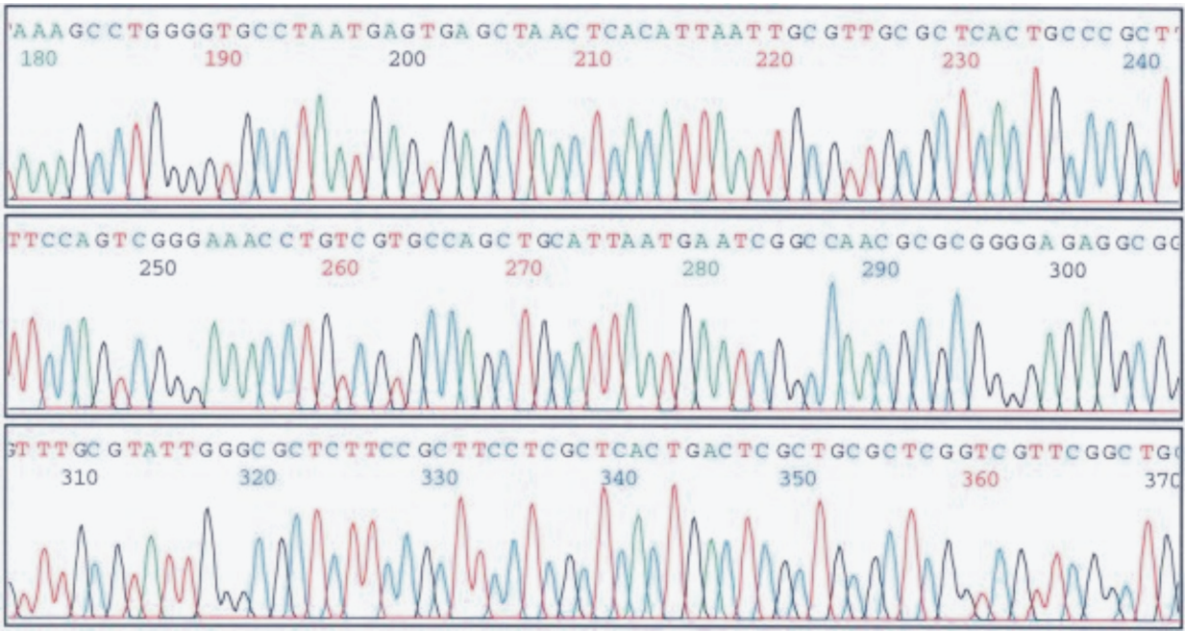
anti HEV. A total of 235 samples were tested for anti HCV out of which 35 samples were positive (15%). The HBV DNA was found in 10 samples.

Birhor: A total of 247 blood samples have been collected. Ninty five percent samples were found positive for Anti-HAV. While the prevalence of HBsAg and anti-HBs was found to be 5 % and 6 % respectively. The prevalence of anti-HCV was 6 %.

Hill-Korwa: A total of 158 blood samples have been collected. About 98 % of the samples were found positive for Anti-HAV. The prevalence of HBsAg and anti-HBs was found to be 15 % and 7 % respectively. Out of 117 anti HEV antibodies were present in 45 samples (38%). The prevalence of anti-HCV was 6 %.

Prevalence of anti HCV in Bharia and Kamar tribes is very high and needs attention. The prevalence of hepatitis B (7%) and C (8%) was higher in 20-50yrs age group. Twenty four serum samples were studied by PCR to determine viral genotypes. Determination of HBV genotypes showed that in our study population genotype D was the most prevalent genotype which is also prevalent in non tribal population in other parts of the country.

Electropherogram of sequencing of HBV DNA



Persistence of Yaws in Abujhmarh of Bastar 1987-2001

Yaws is a chronic relapsing non venereal contagious disease caused by *Teponema pertenue*. It was believed to have been eradicated in 1960. But in 1977, 21 cases were reported from 9 villages of Abujhmarh area of Bastar district of Chhatisgarh. Following this in 1981 NICD Delhi made a rapid survey which did not reveal any case. A health and nutrition survey of the Abujhmaria tribe of Bastar district was undertaken in the year 1987. The prevalence was 7 % in February 1988 and the same was notified to both state and central health authorities. In response Govt. of India with WHO organized a workshop in Bastar in June 1988. Subsequently in December 1988 Govt. of Madhya Pradesh launched Yaws eradication Programme. The prevalence of Yaws was reported to be 25.8/1000 in December 1988 which came down to 13.5/1000 population in May 1989 after first penicillin campaign. This was further brought down to 2.6/1000 population in December 1989. Then the second penicillin campaign was launched and yaws was brought down to 1.2/1000 population in May 1990.

There after another study was undertaken in 1996-97 to see the effect of earlier campaigns and find out the possible cause of persistence of Yaws in Abujhmarh. The study was carried out in 19 villages of the Abujhmarh. With the help of two interpreter house to house survey was carried out. Detail clinical examination was done by medical officer. All suspected cases i.e. any person having ulcer in the body, any eruptions with serious secretion or any healed ulcer were short listed. Smear was prepared from the serous secreting ulcer, air dried and brought to RMRCT main laboratory for demonstration of *Treponema* by Fontana stain. Skin and scab samples were collected for the old and healed scar and preserved in formaldehyde brought to RMRCT main laboratory from histopathological examination.

A total of 3500 individuals were covered of which 34 cases were clinically suspected. Maximum numbers of cases were between 11-20 years age group. In depth interview revealed that 73.5% suspected cases were living in over crowded environment and 70.5 % of suspected cases were using scanty clothing (Langothi).

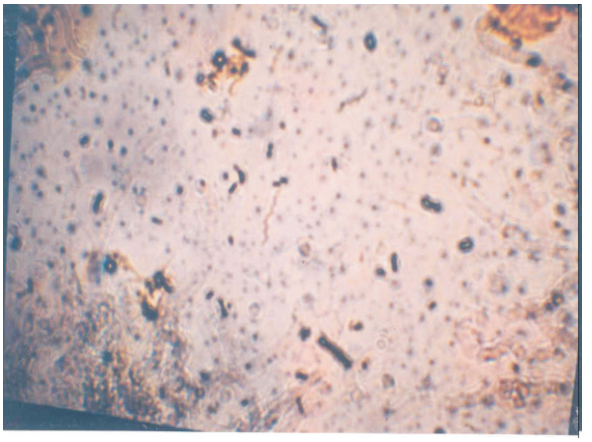
Presence of *Treponema* was demonstrated in 14.7 % of the smears made from exudates. VDRL test was reactive in 33.3 % males and 14.3 % females of the 34 clinically suspected cases. Histopathologically 23 % of the skin and scab samples showed specific changes like intra epidermal bullae and edema of intra epidermal zone.

No active case of yaws was found in the tribe after the year 2000. Last serosurvey was conducted in the year 2001 among 132 children of age group 2 5 years. All the samples were non reactive.

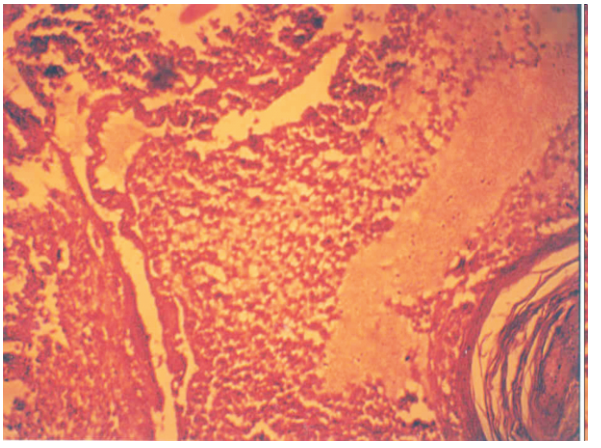
Lesions of yaws

A chronic case of Yaws in Bastar, showing deep ulcer in both buttocks.

Multiple spirochaetes seen in smears from the exudates by Fontana stain (10x100 magnification)



Histopathology of the skin showing Intraepidermal bullae (H & E Stain 10x25 magnification)



NUTRITIONAL DISORDERS

Endemic Genu valgum and Other Bone Deformities in Two Villages of Mandla District of Central India 1995

In April 1995, centre received a request from the collector and chief medical officer of Mandla district to investigate the cause of a mysterious disease characterized by pain and deformity (Genu valgum) in the lower limbs, mostly among children and adolescents below age 20 in two villages of the district. Thus this epidemiological investigation was undertaken with the objective to find the cause of the knock-knee deformity.

The investigation was carried out in two affected villages of Mandla district. The first village was Tilaipani, located about 12 km east of the district headquarter Mandla; the second village was Hirapur, which was about 50 km southwest of Mandla City. Tilaipani had a population of 542 in various age groups, and Hirapur had about 620. Evaluation of data comprised of obtaining and recording of medical histories, detailed clinical and radiological examinations, examination of biochemical parameters of blood, fluoride levels in urine and in all drinking water sources and dietary surveys. Biochemical investigations included serum alkaline phosphatase, inorganic phosphorus and serum calcium. Dietary surveys were conducted using the 24-hr recall method. Fluoride levels were estimated using a fluoride ion selective electrode.

Group of children with genuvalgum from village Tilaipani

Group of children with genuvalgum from village Hirapur

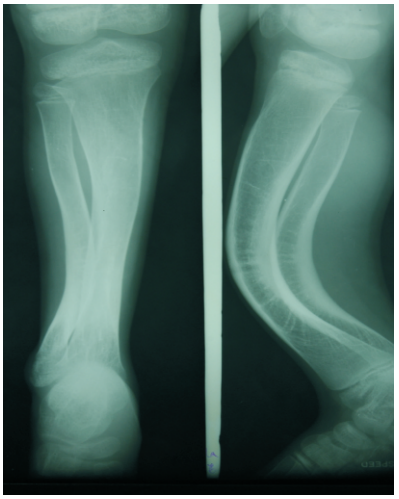
Clinical: The percent distributions of knock knee (Genu valgum) and dental mottling in Tilaipani and in Hirapur are given in Tables 1 and 2, respectively. In Tilaipani the overall prevalence of Genu valgum below 20 years of age was 51.2% with more prevalence among males than females (2:1). The children affected with Genu valgum are shown in photos above. The prevalence was significantly higher ($p<0.05$) in this age group than above age 20 ($Z = 4.99$). Dental mottling was seen in 74.4% of children below age 20 and was significantly higher ($p<0.05$) among persons age 20 years and above ($Z = 5.81$) (shown in photo below). In Hirapur, the incidence of dental mottling in individuals below age 20 years was 56.9%, and no case of dental mottling was seen above this age group. The prevalence of Genu valgum was only 6.25% among children below age 20 years. In Hirapur, however, this deformity was much more severe than in Tilaipani. Apart from Genu valgum, severe anterior bowing and flattening of tibia and fibula were also evident.

A boy with severe dental mottling seen in upper incisors

Radiological: Radiographs of upper extremities, lower extremities, spine and hip bones were taken of a few affected children. Osteosclerosis with a coarse trabecular pattern was seen in most of the cases. A few X-rays showed juxta articular bone resorption of metacarpals and phalanges. Periosteal reaction with thickening of cortex was seen in most of the lower limb X-rays. In few cases severe bowing of tibia and fibula as well as radius and ulna were seen. Multiple horizontal lines of trabeculae, which are

known as growth arrest lines suggesting repeated interruption of osteoblastic activities, were visible in long bones. Bony exostoses, which are considered to be a severe form of skeletal fluorosis, were seen in two cases. No spinal or forearm calcification was found.

X-ray showing bowing of tibia and fibula with thickening of cortex and multiple growth arrest



X-ray of a 8 year old girl with severe bowing of radius and ulna lines

Table 1: Age and sex distribution of knock knee (Genu valgum) and dental mottling in the village Tilaipani, Mandla district

Age	Sex	Number examined	Number with Genu valgum	% Prevalence	Distribution of Genuvalgum %	No. with Dental mottling	Prevalence %	Distribution of Dental mottling %
0-5	M	7	0	0	0	0	0	0
	F	7	2	28.6	10.5	3	42.9	9.1
	T	14	2	14.3	3.8	3	21.4	3.9
6-10	M	20	16	80.0	48.5	19	95.0	43.2
	F	13	7	53.8	36.8	11	84.6	33.3
	T	33	23	69.7	44.2	30	90.9	39.0
11-20	M	25	13	52.0	39.4	21	84.0	47.7
	F	14	6	42.8	31.6	10	71.4	30.3
	T	39	19	48.7	36.5	31	79.5	40.3
21 +	M	32	4	12.5	12.1	4	12.5	9.1
	F	34	4	11.7	21.1	9	26.5	27.3
	T	36	8	22.2	15.4	13	36.1	16.9
Total	M	84	33	39.3	100.0	44	52.4	100.0
	F	68	19	27.9	100.0	33	48.5	100.0
	T	152	52	34.2	99.9	77	50.7	100.0

Table 2: Age and sex distribution of knock knee (Genu valgum) and dental mottling in the village Hirapur, Mandla district

Age	Sex	Number examined	Number with Genu valgum	% Prevalence	Distribution of Genuvalgum %	No. with Dental mottling	Prevalence %	Distribution of Dental mottling %
0-5	M	15	0	0	0	2	13.3	3.4
	F	7	0	0	0	2	28.6	6.1
	T	22	0	0	0	4	18.2	4.4
6-10	M	60	6	10.0	85.7	49	81.7	84.5
	F	49	2	4.1	28.6	25	51.0	75.8
	T	109	8	7.3	57.1	74	67.9	81.3
11-20	M	13	0	0	0	7	53.8	12.1
	F	16	2	12.5	28.6	6	37.5	18.2
	T	29	2	6.9	14.3	13	44.8	14.3
21 +	M	17	1	5.9	14.3	0	0	0
	F	21	3	14.3	42.9	0	0	0
	T	38	4	10.5	28.6	0	0	0
Total	M	105	7	6.7	100.0	58	52.2	100.0
	F	93	7	7.5	100.0	33	35.5	100.0
	T	198	14	7.1	100.0	91	46.0	100.0

Biochemical: A total of 86 blood samples from Tilaipani and 84 from Hirapur were collected and subjected to biochemical analysis. The mean value for serum alkaline phosphatase was 16.6 ± 6.4 KA Units, 3.4 ± 0.9 mg% for serum inorganic phosphorus, and 9.5 ± 0.5 mg/100 ml for serum calcium.

Dietary surveys: Dietary surveys were conducted in 22 households in Tilaipani and in 26 in Hirapur. The average intake of calories, calcium and iron in both villages was significantly ($p<0.05$) less than the recommended dietary allowance (RDA). Protein consumption was higher than the RDA in Hirapur but significantly lower in Tilaipani. Vitamin C intake was also significantly lower in Tilaipani ($p<0.05$). The average consumption of cereals and pulses was higher than the RDA in both villages, whereas that of green leafy vegetables, sugar and jaggery, milk and milk products, and oil and

fats was significantly ($p<0.05$) below the RDA.

Fluoride content of water: Water samples from five different hand pumps in Tilaipani contained fluoride levels ranging from 9.22 ppm to 10.83 ppm. In Hirapur four hand pumps and three well water samples were analysed. The fluoride levels were below 1 ppm in all the sources except one hand pump where the fluoride content was 13.5 ppm.

Fluoride content of urine: To determine fluoride content, a total of 34 spot urine samples from Tilaipani and 10 from Hirapur were collected from individuals with skeletal deformity. The mean fluoride level was 4.42 ppm ± 2.87.

Thus it was concluded that fluorosis was the cause of the bone deformities aggravated by high fluoride in the drinking water. The following recommendations were made to the Govt. of Madhya Pradesh:

- Alternative water sources.
- Closure of all contaminated hand pumps
- Surgical shoe to be provided to the affected Children <10 Years old
- Therapeutic Supplementation of Calcium, Vitamin C, D_3, Iron for a period of 3 months
- Dietary counseling and health education on continuous basis to improve the intake of the above micronutrients
- Initiate ICDS activities

Epidemiological Survey of Endemic Fluorosis in District Mandla With Special Reference to Nutritional Aspects, Particularly Calcium and Vitamin C Intake and a Total Intake of Fluoride 1997-1999

Subsequent to the findings of the earlier study that fluorosis was the cause of bone deformities among the children of Mandla district, this study was planned to study the total fluoride burden i.e. through water, food and other habit forming substances among

the affected villages.

Five most affected villages were selected as study and two non affected were selected as control villages for this purpose. House to house health survey was carried out to see the prevalence of dental and skeletal fluorosis. Spot urine samples were collected from the affected individuals to estimate the urinary fluoride level. A detailed dietary survey was carried out in 10% households. All the available food samples consumed by the villagers were collected from these households for the estimation of trace elements, Cu^{++}, Mo^{++}, Zn^{++}, and Mg^{++} and fluoride. Habit forming substances like, tea, tobacco, beetle nut, snuff etc were collected from the local market for estimation of fluoride. Trace element estimation was done at National Institute of Nutrition, Hyderabad.

A total of 2263 individuals were examined from study villages and 852 from the control villages. Dental fluorosis was observed among 252 individuals (11.1%) from study villages and only three individuals from control villages (0.3%). Genu valgum was seen in 171 (7.5%) individuals from experimental villages and 5 individuals from control villages (0.5%). Skeletal fluorosis was observed among 303 individuals (13.3%) from experimental villages and none from control villages. Drinking water fluoride level ranged from 0.14 ppm to 10.6 ppm. Consumption of green leafy vegetables, milk and milk products were also much lower than the RDA (Fig. 1). Dietary calcium, Iron, vitamin C intake was much lower than the RDA (Fig. 2). Out of 66 water samples analysed for mineral contents, 16 samples showed Ca^{++} hardness more than recommended value (75 mg/lit.). In 18 samples Mg^{++} contents were also more than the recommended value (130 mg/lit.). Cu^{++} and Zn^{++} contents were below detectable limit in all the water samples. Indepth analysis of the 17 severely affected children showed very poor micronutrient intake (Fig.3). Tea leaves, Tobacco and Beetle nuts were found to contain high fluoride (list of food stuffs containing fluoride are shown below).

It is only the water fluoride which is causing fluorosis, along with multiple micronutrient deficiencies. The findings of the study were communicated to the Rajiv

Gandhi Drinking Water Mission, Govt. of India, Ministry of Rural Development and Govt of Madhya Pradesh for necessary intervention measures which were implemented by Govt. of Madhya Pradesh.

Fig. 1: Average consumption of foodstuffs gm/day in Mandla

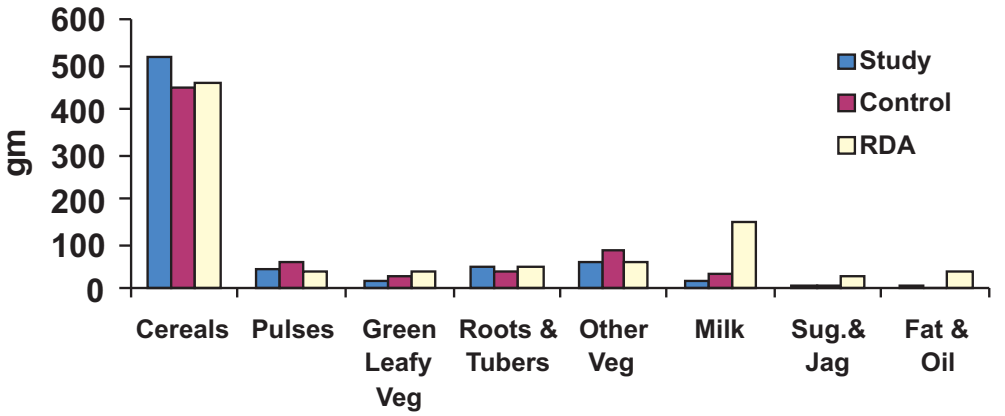


Fig. 2: Average nutrient intake per day in Mandla, (1998)

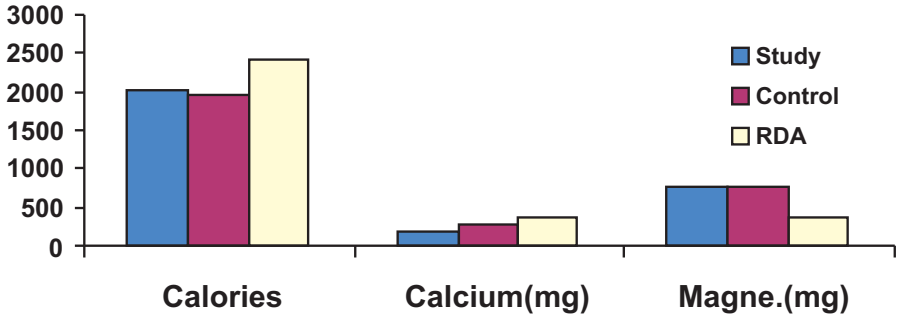
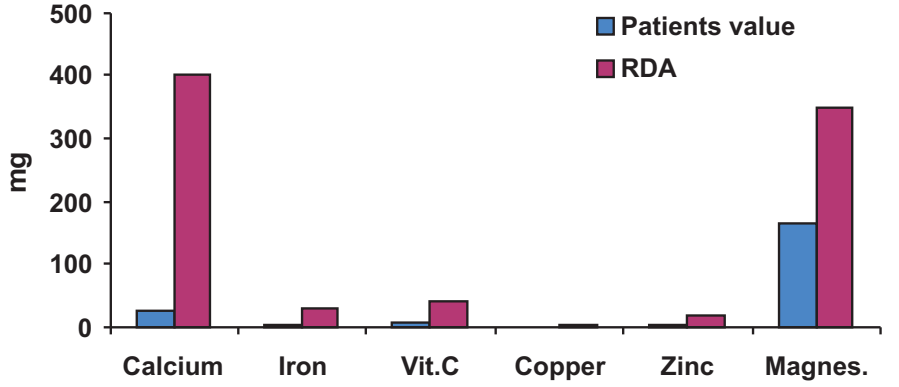


Fig.3: Mean micronutrient intake of severly Fluorosis affected children (n=17) of Mandla, 1998



List of food stuffs containing fluoride from Mandla district

CODE / SL.NO.	FOOD STUFF	NAME OF VILLAGE	ug/F-/g dry food
01	KUTKI	BARBASPUR	0.26
02	RICE HAND POND	BARBASPUR	0.20
03	KANKI RICE	BARBASPUR	0.26
04	KODO	BARBASPUR	0.26
05	CHECH LEAVES	BARBASPUR	0.59
06	PEAS DRY	BARBASPUR	0.28
07	CHECH LEAVES	GAJIPUR	0.51
08	MUSTERED LEAVES	BARBASPUR	0.00
09	KODO	BARBASPUR	0.19
10	LENTIL & PEAS DAL	GAJIPUR	0.42
11	DRY MANGO	BARBASPUR	0.76
12	CHAKODA LEAVES	BARBASPUR	0.46
13	CHAKODA LEAVES	KHAMARIA	0.87
14	MAIZE FLOURS	KHAMARIA	0.67
15	MAIZE & WHEAT	BARBASPUR	0.53
16	KODO	KHAMARIA	0.38
17	GREEN GRAM	BARBASPUR	0.32
18	RICE	KHAMARIA	0.54
19	MAIZE WHOLE	BARBASPUR	0.54
20	RICE ROW	GAJIPUR	0.22
21	LENTIL	GAJIPUR	0.30
22	BLACK GRAM DHAL	GAJIPUR	0.29
23	RICE GOVT.SUPL.	GAJIPUR	0.14
24	CHECH LEAVES	PATPARA	0.35
25	CHAKODA LEAVES	PATPARA	0.27
26	RICE HAND POND	PATPARA	0.10
27	KODO	PATPARA	0.15
28	BENGAL GRAM LEAF	PATPARA	0.26
29	MAIZE WHOLE	PATPARA	0.11
30	RICE HAND POND	PATPARA	0.11
31	WHEAT	PATPARA	0.23
32	LENTIL DHAL	PATPARA	0.22
33	CHECH&MUST.LEAV	SIMARIA	0.51
34	RICE HAND POND	SIMARIA	0.17
35	KODO	SIMARIA	0.16

36	KUTKI	SIMARIA	0.16
37	MANGO DRY	SIMARIA	0.24
38	PEAS DHAL	SIMARIA	0.18
39	CHECH LEAVES	SIMARIA	0.41
40	BENGAL GRAM LEA	SIMARIA	0.00
41	CHAKODA LEAVES	SIMARIA	0.00
42	CHAKODA LEAVES	TILAIPANI	0.35
43	MANGO DRY	TILAIPANI	0.28
44	CHECH LEAVES	TILAIPANI	0.27
45	MAIZE	TILAIPANI	0.16
46	RAJGIRA LEAVES	TILAIPANI	0.00
47	BLACK GRAM DHAL	TILAIPANI	0.17
48	PEAS	TILAIPANI	0.00
49	PEAS DHAL	TILAIPANI	0.18
50	RICE GOVT.SUPL.	TILAIPANI	0.16
51	RICE HAND POND	TILAIPANI	0.10
52	LENTIL DHAL	TILAIPANI	0.20
53	BENGAL GRAM WHO	TILAIPANI	0.16
54	BENGAL DHAL	TILAIPANI	0.17
55	BOTTLE GOURD	TILAIPANI	0.39
56	KODO	TILAIPANI	0.16
57	PEAS DRY	TILAIPANI	0.12
58	KUTKI	TILAIPANI	0.14
59	RICE HAND POUND	AMATOLA	0.13
60	KODO	AMATOLA	0.15
61	CHAKODA LEAVES	AMATOLA	0.36
62	CHECH LEAVES	AMATOLA	0.61
63	LENTIL WHOLE	AMATOLA	0.11
64	TALAB GUTKA	MARKET	2.44
65	SAHI GUTKA	MARKET	4.05
66	SUPARI	MARKET	0.53
67	TEA POWDER	MARKET	19.36
68	RED TOOTH POWDER	MARKET	0.87
69	SWAMI SNUFF	MARKET	1.60
70	TOBACCO	MARKET	1.32
71	GUDAKU	MARKET	2.30

Epidemiological Survey of Endemic Fluorosis in Mandla A Tribal District 1999 - 2000

In-depth study of the five fluoride affected villages, revealed that water fluoride is the main cause of fluorosis in Mandla district. Hence it was felt to map out the endemic area for fluorosis in order to provide safe drinking water and to study the ground water fluoride level in the entire area.

A total of 32 villages from all the 16 blocks of Mandla district were selected through PPS sampling method, covering 29000 populations. Out of these, about 40% i.e. 11,600 children were preschool and school going children. Efforts were made to cover 100% children from these villages. After a complete census of the villages, house to house survey was carried out for physical examination by the trained investigators for dental and skeletal fluorosis. About 25% of the cases seen by the investigators were cross checked by the medical officer for quality control. Water samples from all available drinking water sources were collected in a screw capped plastic bottle and transported to the RMRCT main laboratory for fluoride estimation. Spot urine samples were also collected from the children with clinical symptoms for fluoride estimation.

Map of Madhya Pradesh showing Study area, districts Mandla and Dindori

A total of 11791 individuals belonging to 16 blocks have been surveyed. Dental fluorosis was observed among 241 individuals (2.04%). Maximum numbers of dental fluorosis cases were below 20 years. There was no difference among male and female individuals.

Genuvalgum was observed in 2.94% individuals and skeletal changes were seen among 1.03% individuals. A total of 504 individuals (4.27%) were observed suffering from gastrointestinal disturbances and other related symptoms like chronic headache, increased frequency of micturition, and extensive weakness was seen in about 1.45% individuals.

A total of 266 drinking water sources were tested for fluoride out of which 19 (7.14%) drinking water samples showed high fluoride ($\geq$1.0 ppm). Urine sample of 204 individuals were collected from clinically symptomatic individuals, out of these 101 (49.5%) samples showed urinary fluoride more than 2 ppm. The average intake of calories, calcium, iron, vitamin C, carotene, riboflavin, fat and zinc intake was much lower than RDA. The difference was statistically significant at $p<0.05$ level. The consumption of roots & tubers, other vegetables, oil & fat, milk and milk product, sugar & jaggery were much lower than RDA. ($p<0.001$)

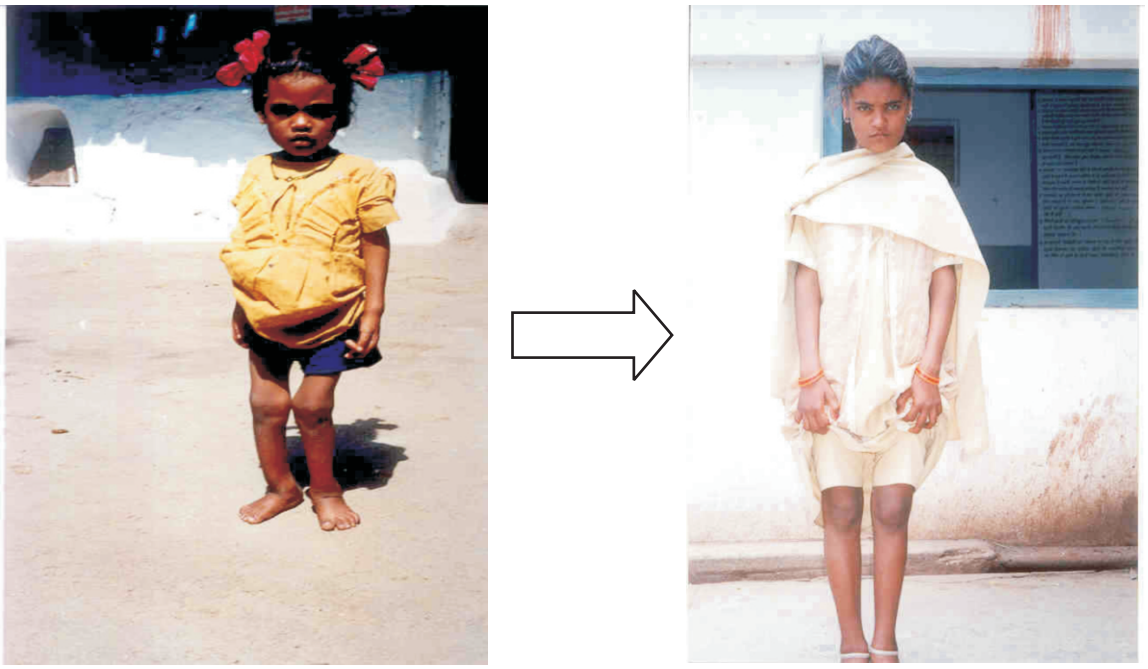
About 50% of the water samples of Mandla and Dindori district contained high fluoride which requires immediate attention. The findings of the study were communicated to the Govt. of Madhya Pradesh for necessary intervention measures which were implemented by Govt.

Evaluation of Effect of Intervention (Safe Drinking Water and Micronutrient Supplementation) on Endemic Fluorosis in District Mandla, Madhya Pradesh 2003 - 2004

The intervention measures suggested in fluorosis affected villages were in force since 1996-97. Effect of intervention was evaluated in two worst affected villages. Evaluation comprised of obtaining medical histories, doing clinical and radiological examination,

analysis of various biochemical parameters, conducting dietary survey and estimation of fluoride level in urine and drinking water sources. Fluorosis affected individuals (identified in 1996) were examined for signs and symptoms for fluorosis. Fluoride level was estimated using fluoride ion selective electrode.

Clinical: The overall prevalence of Genu valgum was 34.2% at baseline (1996), which came down to 1.2% after intervention (2003) in Tilaipani village. The prevalence of Dental mottling was 74.4% in 1996, which came down to 70% after intervention in the same village. The bowing of lower limbs, which were seen in 1996, disappeared in 2003. There was a complete reversal of bowing among mild cases and partial reversal in severe cases. Similar reduction was also observed in Hirapur village.

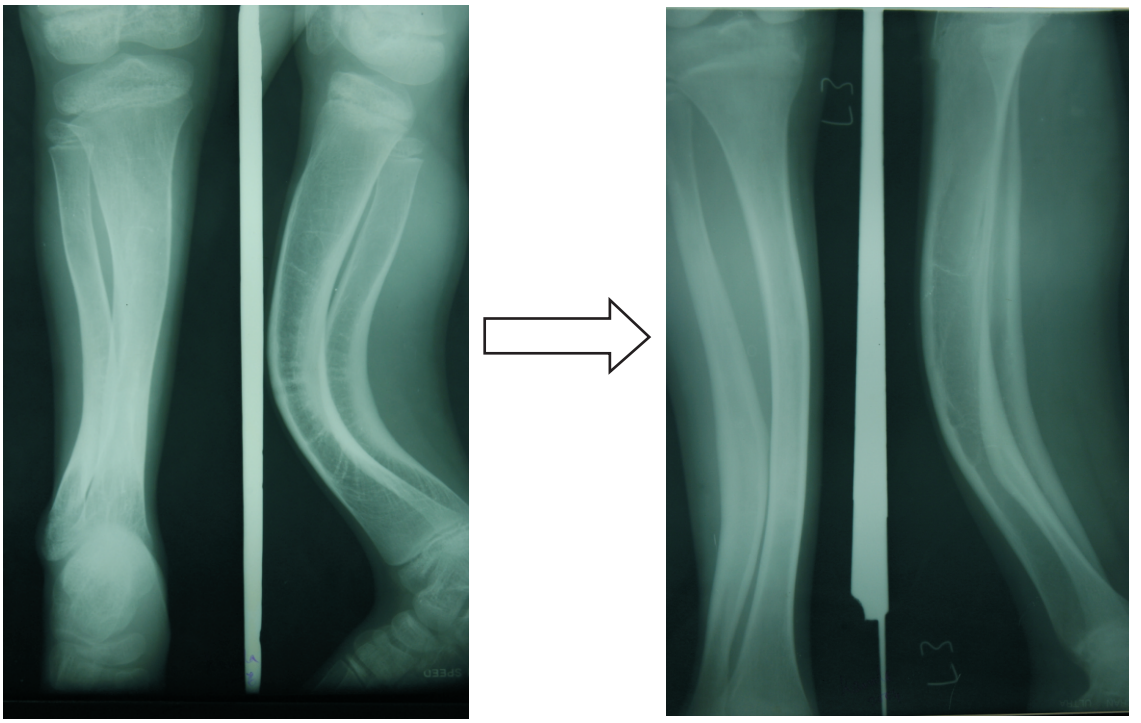


Before intervention 1995 After intervention 2004

Photograph of a girl before and after intervention showing reversal of genuvalgum

Radiological: Radiological features like coarse trabecular pattern. Multiple growth arrest lines, thinning of cortex which was present in most of the cases at base line were not seen in the present series of X-rays of the same children. Mild form of bowing of tibia & fibula, which were seen in many cases, were totally corrected after intervention. Even in severe cases of bending, there was a great radiological improvement. Bony

exostosis, which is considered to be one of the severe form of skeletal fluorosis, was seen in few cases at baseline. In the present series of X-rays of the same children, no bony exostosis was seen.



Before intervention 1995 After intervention 2004

X ray of a lower limb of a girl before and after intervention showing clear reduction in bowing

Biochemical: A total of 86 blood samples from Tilaipani village were collected before intervention and subjected to biochemical analysis. Mean value of serum alkaline phosphatase was 16.6.

Dietary surveys: Average dietary intake of protein, calories, calcium and iron was significantly ($p<0.05$) less than the recommended dietary allowances (RDA) (Fig. 4 & 4a). Vitamin C intake was also significantly lower. The average consumption of cereals and pulses were higher than RDA, whereas that of green leafy vegetables, sugar and jaggery, milk and milk products & oil and fats was significantly ($p<0.05$) below the RDA (Fig. 5) However the intake of micronutrients like iron, calcium, copper and zinc were increased after intervention. This is mainly due to increased intake of green leafy vegetables i.e. locally available green leaf called Chakoda or *Cassia tora*.

Fig. 4: Average nutrient intake of the population in the fluorosis affected villages

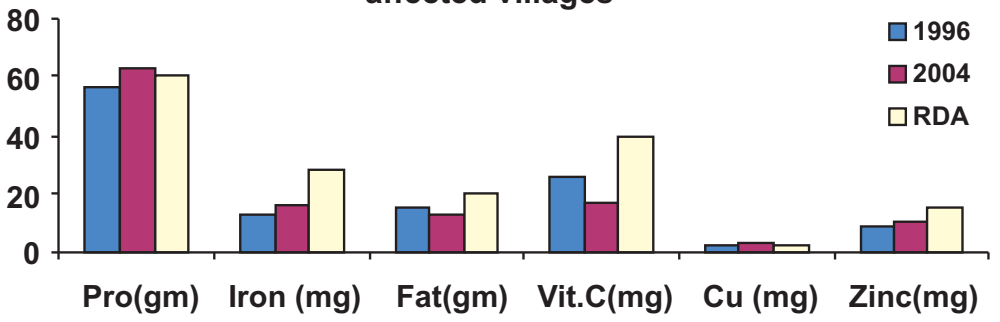


Fig. 4a: Average nutrient intake of the population in the fluorosis affected villages

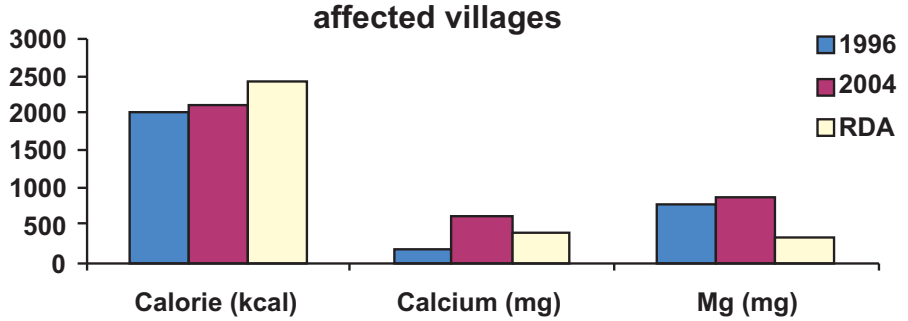
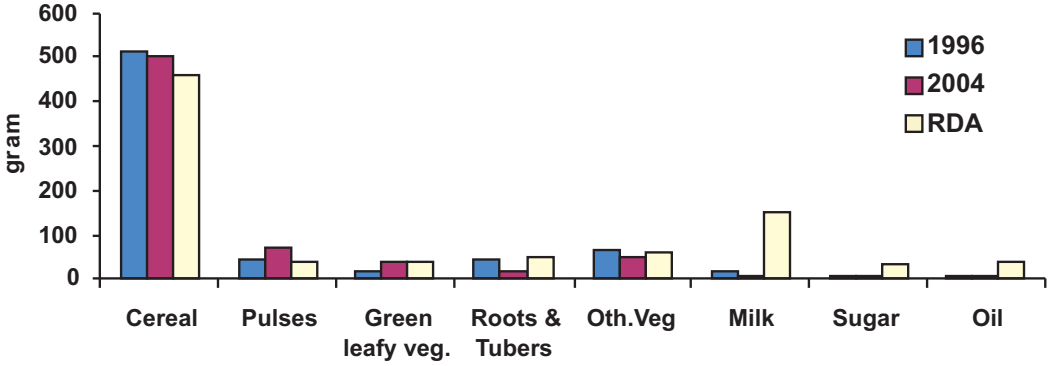


Fig. 5: Average consumption of food stuff



Fluoride content of urine Investigations: About 41% urine samples had acceptable (<2ppm) levels of fluoride in 1996. This proportion increased to 91% in 2004.

Table 3: Comparison of results of fluorosis affected village Tilaipani

Health complaints	1995-96	2004	- test; df,
Genu valgum (<20 Yrs)	51.2%	2.6%	6.96; 162
Dental Mottling (<20 Yrs)	74.4%	70%	
Water Fluoride (ppm)	9.2-10.8	<1	
Urine fluoride (>2ppm)	40.8%	9.8%	

Cassia tora Plant- A major source of Calcium, vitamin C and Iron in the affected villages

Intervention of safe drinking water (fluoride levels less than 1 ppm) combined with nutritional supplementation prevented occurrence of new cases and also cured the earlier cases. Thus there was complete reversal of mild skeletal deformities and partial reversal in severe deformities. There was slight reduction on the prevalence of dental mottling. The findings were disseminated in various National and International forum. Following this UNICEF evaluated the intervention model in Dhar and Jhabua district of Madhya Pradesh through NGO with technical guidance from RMRCT. Later the module was included in the "International Learning Exchange Programme" of UNICEF from Geneva office for two years in 2006 and 2007.

Growth Profile of Baiga Children of Baigachak Area 1987-1988

Indian population can be broadly grouped into three clusters namely, Urban, Rural and Tribal. People of these clusters are living under different environmental conditions, having different nutritional status and belonging to different ethnic groups, present interesting morphological differences and variations in body form and proportions. Such

differences begin to appear as soon as the conception takes place. The present study was carried out in Baiga community of Baigachak area. This community is one of the six primitive tribes of undivided Madhya Pradesh. It was delved with the objectives to observe growth pattern of Baiga children from age one to 18 years and to compare the growth pattern rate and bodily changes of Baigas with other communities.

In total 1094 (613 male and 481 female) subjects between the ages one year to eighteen years were studied from 25 villages of Baigachak area to understand growth pattern of children using cross sectional design. The level of nutritional status of preschool children was also adjudged employing Gomez and Waterlow classification. To achieve the proposed objectives, 14 body measurements (Weight, 4 body lengths, 4 breadths, 3 circumferences and 2 fat folds) were studied up to 18 years of age. Four indices (Sitting height/Leg length, Bicristal breadth/Biacromial breadth, Head circumference/Chest circumference & Cephalic index) were computed to understand the relative changes in body proportions. Statistical analysis using mean, measure of variability, student's t- test of significance and annual mean increments were carried out to interpret the data numerically. Velocity and distance curves were constructed to observe growth rate and pattern visually

Over 80% of pre-school children found to be suffering from mild to severe degree of nutritional deficiencies. 5-7% pre-school children observed to be affected with acute and chronic nutritional deficiencies. Boys and girls were equally susceptible to nutritional deficiencies. Incidence of poor nutrition was high between ages 2-5 years (Table 4 & 5).

Each body measurement except fat folds increased progressively from age 1-18 years. However, intermittently, high and low mean values obtained could be due to small sample size and hence a chance error. No consistent pattern for fat folds was obtained. Decrease in fat folds was almost observed up to 10-12 years of age in both sexes. There was no significant difference between boys and girls in either of the measurements in most of age groups below 18 years of age. Comparative account of

available studies indicated that Baiga children had better growth than the tribal children of other areas particularly below puberty but poor growth than the non-tribal. However, the physique of a Baiga children turned out to be of relatively small compared to tribal as well as non-tribal children.

Table 4: Percent distribution of Baiga pre-school children according to Gomez Classification

Age in Years	Normal >90		Mild (I) 75-90		Moderate (II) 60-75		Severe(III) <60	
	Male	Female	Male	Female	Male	Female	Male	Female
1-2	17.2	33.3	20.7	44.4	37.9	11.1	24.4	11.1
2-3	8.6	-	57.1	51.9	22.9	44.4	11.4	3.6
3-4	8.3	23.5	61.1	55.9	30.6	20.6	-	-
4-5	14.3	20.8	42.8	54.2	40.0	20.8	2.9	4.7
5+	19.4	17.4	41.7	43.5	33.3	30.4	5.6	8.7
Age & Sex Pooled	15.5		47.8		30.0		6.7	

Table 5: Percent distribution of Baiga pre-school children according to Waterlow Classification

Age in Years	Normal		Stunted		Wasted		Stunted/Wasted	
	Male	Female	Male	Female	Male	Female	Male	Female
1-2	27.6	44.4	55.2	50.0	10.3	5.6	6.9	-
2-3	48.6	40.6	34.3	37.0	2.9	18.6	14.2	3.7
3-4	44.4	40.0	47.2	40.0	5.6	8.6	2.8	11.4
4-5	54.3	45.8	40.0	45.8	5.7	8.4	-	-
5+	66.7	69.6	25.0	21.8	5.6	4.3	2.7	4.3
Age & Sex Pooled	48.3		39.3		7.4		5.0	

Impact of Sickle Cell on Physical Growth of Tribal Impact of Sickle Cell on Physical Growth of Tribal Children of Mandla district (Madhya Pradesh) India 1998 1989

Consanguineous marriages are very common among tribal being ethnically close knitted groups. Due to this, several genetic disorders and hemoglobinopathies exist influencing their health and disease pattern. Sickle cell hemoglobinopathy is commonly prevalent among tribals and the prevalence is as high as 40%. The present study was undertaken to understand the influence of sickle cell hemoglobinopathy on the physical growth in terms of growth pattern and velocities of tribal children and to observe the difference in growth pattern between various groups.

A total of 6987 children of both sexes from age 0-12 years were identified from 52 villages of Mandla district of Madhya Pradesh. Of these, 66.9 % were tribals and remaining 33.1% were non-tribals. Eleven body measurements (Weight, Height, Head, Chest and Arm Circumference; Arm & Leg Length; Biacromial & Bicristal Breadth and Biceps & Triceps Skin folds) were measured using standard technique. Presence of sickle cell among studied children was ascertained, using 2% metabisulphite slide test and electrophoresis was carried out using cellulose acetate membrane technique. Drabkin method was used to observe the Hb level among children in the field.

It was observed that 13.6 % children were sickled among the study group, of these 1.5% (53) were homozygous. Hb level of all the children were below normal, barring 3% (Table 6). The growth pattern was relatively less consistent in sickled children compared to normal children. More or less similar mean values for weight in both sexes were observed between sickled and non sickled children of tribal and non-tribals up to age 6-7 thereafter, sickled children had low values, such phenomenon was not observed in height of children of all age categories were close to each other (Fig. 6 & 7).

The circumferences of head, chest and arm were higher in sickled children followed by decline up to age 2, thereafter, intermittent catch up growth was found in

head and chest in sickled children, but mean arm circumference were lower in sickled children compared to non-sickled. The mean values of biacromial and bicristal breadths, were higher among non tribal children compared to sicklers, however, such difference was not found among tribal children. Steady decline in both skin folds was observed in both sickler and non-sickler children but decline in fat folds was slightly higher in sickled children.

Sickled children though followed the similar growth pattern but their growth pattern was less consistent showing catch up growth intermittent age groups to make up the growth, rate of growth found to relatively less compared to normal children beyond age 5-7 years in both sexes than their co-partners.

Fig.6: Weight of Males and Females

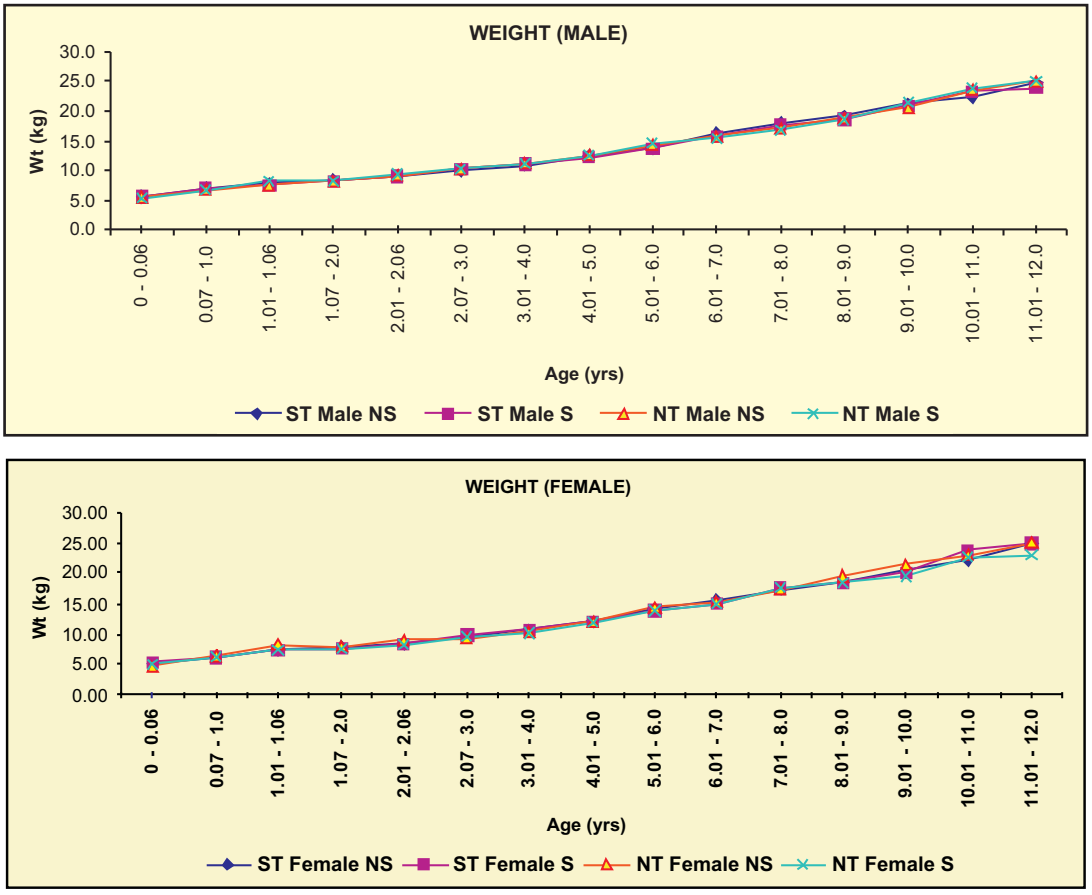
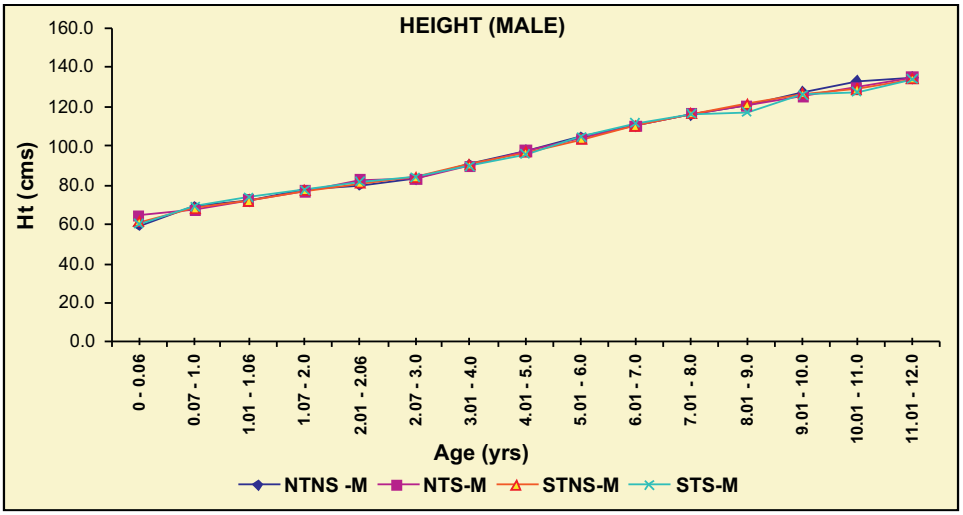
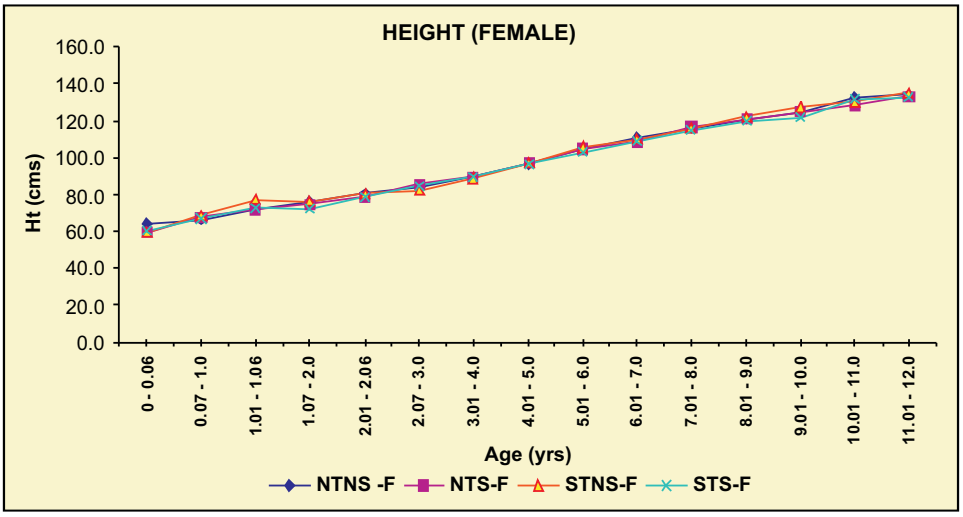


Table 6: Hemoglobin level of studied children

Hb Level		Male	Female	Total	Male	Female	Total
Normal	n	13	21	34	90	70	160
	(%)	(2.15)	(3.3)	(2.7)	(2.4)	(2.0)	(2.2)
Mild	n	268	239	507	1513	1418	2931
	(%)	(44.4)	(39.2)	(41.8)	(40.1)	(40.2)	(40.1)
Moderate	n	175	202	377	1141	1022	2163
	(%)	(29.0)	(31.8)	(30.4)	(30.2)	(29.0)	(29.6)
Severe	n	148	163	311	1033	1016	2049
	(%)	(24.5)	(25.7)	(25.1)	(27.3)	(28.8)	(28.0)

Fig.7: Height of Males and Females





Randomised Community Trial on Effect of Helminthic Infestation on Growth Patterns of Children and Adolescents among Gond Tribes of Madhya Pradesh 2000 - 2001

Helminthic infestations affect growth and development of children. Hence, stress needs to be laid on the role played by infestations in childhood especially in the presence of other contributory factors such as malnutrition, ARI and diarrhea. Periodic deworming - a short term measure, along with effective implementation of existing health programs may result in improvement in growth pattern of the children. Hence, this study was undertaken among the Gond tribals in Kundam Block of Jabalpur district to observe the pattern of growth in the age group between 2 to 6 years and adolescent (11 to 18 years.) boys and girls in relation to their helminthic infestation.

The study revealed severe degree (below -3SD) of underweight, stunting and wasting: 27.8%, 30.3%, and 6.5% in children, respectively. High prevalence of under-nutrition (below -2SD) in terms of underweight (61.6%), stunting (51.6%) and wasting (32.9%) was observed among pre-school (age 2-6 years) children. The prevalence of under-nutrition among adolescents was 61.7%, 51.7% and 32.8%, respectively. Prevalence of under-nutrition was found similar in both the sexes. High prevalence of intestinal parasitic infestation (53.3%) was observed among them. Adolescents had higher prevalence (59.9%) compared to the preschool children (48.3%). Intestinal parasitic infestation was found similar in boys as well as girls. *H.Nana*, Hookworm and *Ascaris lumbricoides* were principal invaders either alone or in both the sexes. Infestation ranged from 200 epg to 10,000 epg for various helminths. Very high prevalence of anemia was observed in preschool children as well as adolescents and the prevalence was found to be higher in adolescents (95.1%) as compared to preschool children (86.7%). Though only 7.3% preschool children and 3.6% adolescents had severe anemia, the prevalence of moderate to severe anemia was found to be very high at 71.1% in preschool children and 58.9% in adolescents.

Feasibility of iron-folic acid supplementation among tribal adolescent girls of Mandla district, Madhya Pradesh 2005

Globally, iron deficiency anemia (IDA) affects more than 2 billion people. In India and Madhya Pradesh IDA prevalence ranges between 38-72% and 72-75% respectively. Anemia prophylaxis programme for adolescent girls in Madhya Pradesh is not implemented. A community based study of adolescent girls of Bijadandi block was undertaken with the aims of determining prevalence of anemia and factors associated with anemia and to know the effect of 100 mg iron supplementation for 100 days.

A cross sectional study was undertaken in the Bijadandi Block of Mandla district of Madhya Pradesh (2005). A sample size of 274 adolescent girls was drawn from 12 villages (clusters) through PPS sampling of 100 villages. Anemia was assessed clinically and hemoglobin estimations were done using cyanmethemoglobin method. To identify factors associated with anemia adolescent girls were interviewed using a semi structured interview schedule. Tablets of 100mg of elemental iron were given once daily for 100 days to all the girls. Post supplementation, blood hemoglobin was measured. Pill counting and cards were used to assess compliance. Participants were interviewed using structured questionnaire to assess pre- and post-intervention physical and school performance. Adolescent girls with sickle cell disease and/or pregnancy during survey were excluded. A compliance rate of >50% was considered feasible.

The prevalence of anaemia was 94%; mild 48.9%, moderate 38.7% and severe 6.2%. Severe anemia was more in 16-17 years as compared to 12-13 years age group (95% CI 1.12 -201, p<0.01). Of the total; 45.3% had clinical pallor. Factors associated with anemia: fathers who were daily wage earners (95%CI=0.16-0.9); higher education (95%CI=1.32-3.90), scanty menstrual flow (95%CI=0.00-0.15). 233 girls were available for post intervention assessment. Anemia was reduced from 94% to 69% of the participants after intervention (Fig. 7 & 8). Compliance rate (>80 tablets) was 88%.

Improvements in self-reported performance include (i) school activities (p=<0.001), (ii) physical activities (p<0.001), (iii) ability to focus on studies (p<0.0001). Due to short study period school performance could not be verified with results, and seasonal diet survey could not be conducted.

Iron supplementation reduced anemia by 25%, improved physical and school performance. High compliance rate under programmed conditions suggests feasibility of iron supplementation on larger scale.

Recommendations: Iron supplementation for adolescent girls is recommended for special indigenous population.

Fig. 7: Distribution of Hemoglobin level before and after intervention

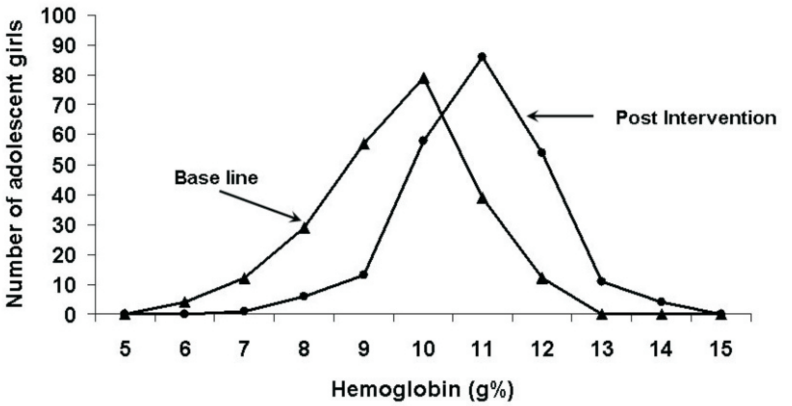
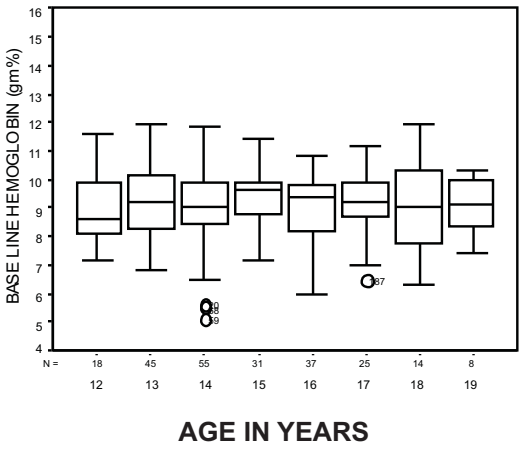
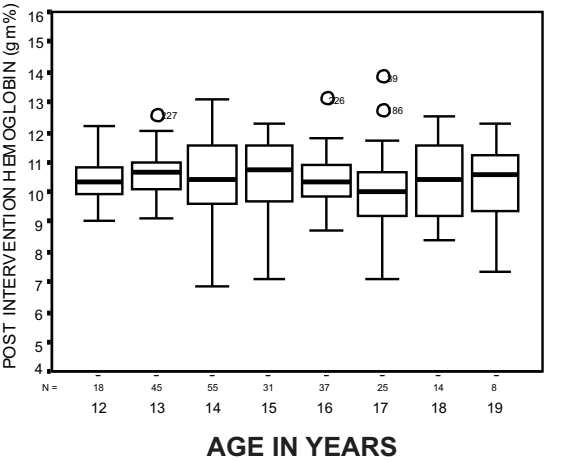


Fig.8: Distribution of change in hemoglobin level in each age group of adolescent girls in pre and post intervention period



AGE IN YEARS



AGE IN YEARS

Nutritional Status of Baigas A Primitive Tribe of Madhya Pradesh 2002

The Baiga's economy is still highly depended on agricultural pursuits and collection of minor forest produces. Assessment of nutritional status is considered as a measure of health and it is necessary for planners to understand the food and nutrition situation among tribal population for upliftment of these vulnerable groups. There is very little information available regarding the diet and nutritional status of Baigas. Hence to fill up some of this knowledge gap, the present study was carried out to assess the nutritional status of the Baiga Tribe.

The Baigachak area is spread out in 39 villages in three blocks. Total eight villages were selected for this study by adopting simple random sampling method. Trained investigators measured body weight and height. Diet survey was carried out in every fifth household using 24 hours dietary recall method. Blood samples were collected from all the willing individuals for the estimation of Haemoglobin by Cyanmethaemoglobin method.

The statistical analysis was carried out using of SPSS 11.5 and univariate analysis using t-test was applied to evaluate the statistical significance. Mean and Standard Deviation of the anthropometric data was calculated for each age group and compared with NCHS (National Center of Health Statistics) standards. The extent of different types of undernutrition was assessed in preschool children using standard deviation (SD) classification based on weight for age (under weight), height for age (stunting) and weight for height (wasting). The nutritional status of the adults was assessed based on Body Mass Index (BMI), which is ratio of weight in Kilograms and square of height in meters and grouped into different nutritional grades using James' classification. The nutrient intake was calculated using food tables for Indian foods and food intakes were compared with the balanced diets recommended for Indians. The intake of nutrients was compared with the Recommended Dietary Allowances (RDA) for Indians. The results were compared with the tribal data of National Nutrition Monitoring Bureau.

Anthropometry: A total of one thousand five hundred and forty five individuals' height and weight were recorded. Preschool and school age children were comparable with respect to height & weight of the both sexes. However adolescent girls were taller by about 2-3 cm and heavier by 1-2 Kg as compared to boys of the same age group (15+ years). In contrast boys of 16 years age were taller by about 6-10 cm and heavier by 3-5 Kg as compared to the girls of the same age. Same observation was made with respect to adults also. The tribal were shorter and lighter when compared with the NCHS standards (Fig 9&10). Nutritional deficit of pre-school children using standard deviation classification of under weight (weight for age), stunting (Height for Age) and wasting (Weight for Height) is shown in Table 7. The proportion of children with low body weight (<median -2sd) was 61.1%, while the severe grade (<-3sd) underweight was 24.3%. The overall stunting was 44.3% and wasting was 37.2% and severely stunting and wasting was 21.2% and 9% respectively. Prevalence of chronic energy deficiency (BMI<18.5) through body mass index was about 75 per cent among adult population (Table 8) and adults females were little better nourished (26.4%) as compared to males (1.4%).

Table 7: Percent prevalence of malnutrition according to SD classification in pre-school children

Indicators	< -3SD	- 3SD to –2SD	-2SD to –1SD	<1SD to Median	Median
	Severe	Moderate	Normal		
Weight for Age (**Underweight**)	24.3	36.7	29.2	8.4	1.3
Height for Age (**Stunting**)	21.2	23.1	23.7	17.9	14.1
Weight for Height (**Wasting**)	9.0	28.2	28.2	22.4	12.2

Table 8: Percent Distribution of Baiga adults according to body mass index

BMI Grades	Male	Female	Total
CED III (<=16.0)	39.7 (199)	35.3 (166)	37.6 (365)
CED II (16.0-17.0)	15.3 (77)	14.7 (69)	15.0 (146)
CED I (17.0-18.5)	23.1(116)	23.6 (111)	23.4 (227)
Low Weight Normal (18.5-20.0)	14.9 (75)	16.4 (77)	15.6 (153)
Normal (20.0-25.0)	6.5 (33)	9.6 (45)	8.0 (78)
Over Weight (>=25.0)	0.2 (1)	0.4 (2)	0.3 (3)

Fig. 9 Mean Height of Baigas compared with NCHS standards by Age and Sex

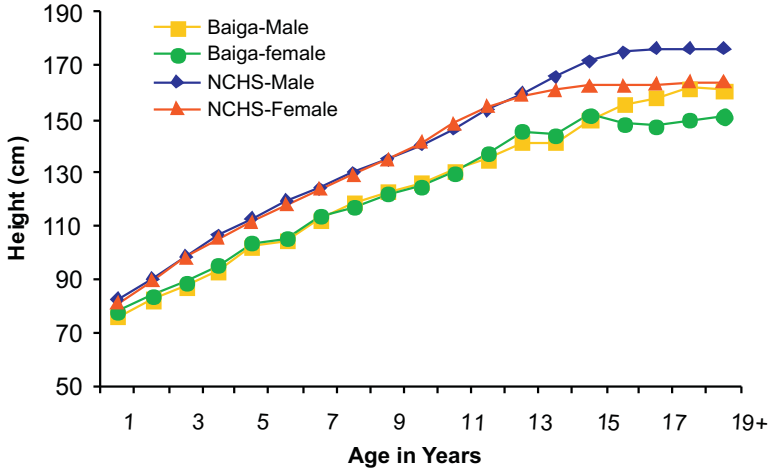
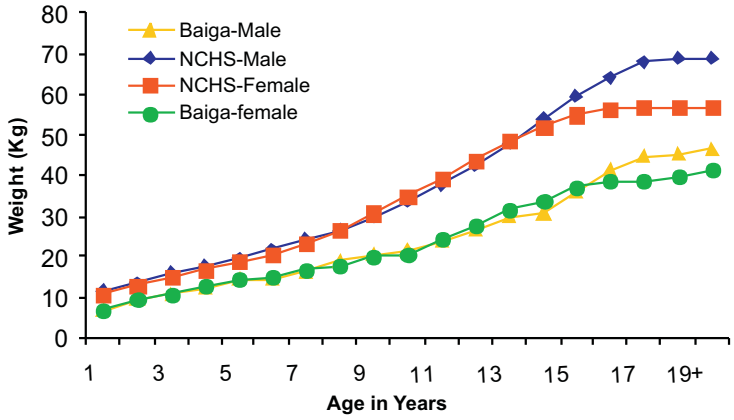


Fig.10: Mean weight of Baigas compared with NCHS standards by Age and Sex



Haemoglobin status: Classification of anaemia was done using WHO Guidelines. About 31.9% individuals were anaemic. Moderate and severe anaemia was more in females 39.7% than males 24% (Table 9).

Food and Nutrient Intake: Four hundred and seventy five individuals were assessed for Dietary intake information. Maize and rice formed the bulk of Baigas diet. The mean intake of cereals was higher than the recommended level. However the intake of foodstuffs, such as pulses, green leafy vegetables, root and tubers, oil & fat, sugar and jaggery was significantly lower than recommended level (Table 10). The milk intake was almost negligible in Baigas. The intake of all nutrients except calcium was significantly lower than recommended level (Table 11).

Table 9: Percent prevalence of anaemia in Baiga Population

Haemoglobin (gms/100ml)	Male (n=309)	Female (n=315)	Total (n=624)
<7	2.58	3.80	3.20
7-9	21.35*	35.87*	28.68
9-11	51.13	51.42	51.28
11>	24.91	8.88	16.82

Table 10: Average consumption of food stuffs in the Baigas (gm/cu/day)

	Cereals	Pulses	Green leafy Vegetables	Roots & Tubers	Other Vegetables	Flesh Food	Milk & Milk Products	Oil & Fats	Sugarcane Jaggery
Mean SD (n=475)	478.8* 197.9	29.9* 44.9	30.8* 43.8	14.3* 34.7	47.6* 85.5	1.8* 17.0	5.6* 30.3	2.1* 3.7	0.3* 4.1
RDA (ICMR1981)	460	40	40	50	60	40	150	40	30

* Significant at p<0.05

Table 11: Average Nutrient intake in the Baigas (cu/day)

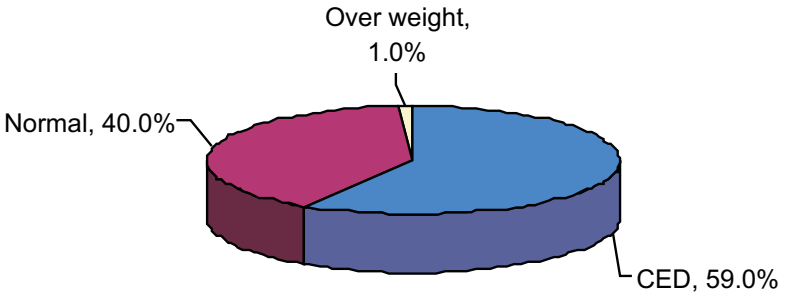
	Energy	Protein	Calcium	Iron	Vitamin C	Carotene	Thiamin	Riboflavin	Fat
Mean SD (n=475)	1818.6* 747.9	51.5* 22.2	447.5 582.3	16.7* 13.4	18.8* 35.8	379.2* 866.7	1.2* 0.6	0.5* 0.4	12.3* 7.5
RDA (ICMR 1990)	2425	60	400	28	40	2400	1.2	1.4	20

Baiga's diet is mainly a cereal based diet. Relatively high proportion of severely stunting and wasting was seen indicating chronic protein and energy deficiency. As compared to the earlier study of 1987, the grade III malnutrition (-3sd) has increased to 24.3% from 7.3% among preschool children which requires urgent attention. The findings were communicated to the Govt. of Madhya Pradesh.

Similar study was undertaken in Saharia tribe. Majority of the preschool children (85.3%) were found undernourished. Moderate to severe under-nutrition was seen in 53.2% children. Though only 11% adults had severe chronic energy deficiency, overall prevalence of CED in adults was found to be 58.7% (Fig.11). Very high prevalence of anemia (93%) was observed in the tribe. Consumption of pulses, green leafy vegetables, other vegetables and fats & oils was much below the recommended dietary allowances. Nutrient consumption pattern indicated that there was a gross deficiency in the intake of Iron, Vitamin A, and Vitamin C. Major morbidity observed was anemia,

respiratory tract infections, cervical lymphadenopathy, skin infections and Vitamin A deficiency.

Fig. 11: Nutritional status of Saharia
Nutrational Status Adults by BMI Grades



Endemic Goiter and Cretinism in Bharias of Patalkot Area of Chhindwara 1986-87

Goitre is hypertrophy of the thyroid gland due to iodine deficiency. In India about 60 million people are at risk of goiter. A health and nutritional survey carried out by RMRCT Jabalpur in 1986-87 in the Patalkot valley revealed 11.6% children below five years of age. About 50% individuals from 15- 44 years also exhibited Goitre. Subsequent to this Govt. of Madhya Pradesh was informed of the findings and was requested to ban the uniodised salt in this area.

All the available willing individuals were included in the study. Census was carried out by house to house survey. Clinical examination was done by a medical officer. Blood samples of all the willing individuals were collected for hormonal analysis. Spot urine samples were also collected for urinary Iodine and creatinine level. Iodine creatinine ratio was calculated to be considered as indicator of iodine deficiency. Locally available foodstuffs consumed by the Bharias were collected for estimation of goitrogenic substances like thiocyanate. Salt samples from the households as well as from the local market were collected for iodine estimation.

Clinical survey revealed the visible goiter rate was 2.3% to 16.7% in different age groups, however total goiter rate was 7.6% to 31.7%. About 43% individual's urinary

iodine excretion was 50ug and 21% individual's urinary iodine excretion was less than 25ug (Table 12). Salt samples from 29 house holds and from 4 different local shops showed iodine contents as KIO_3 is 3.26±31.1 and 13.3±6.6 ppm. Iodine content of the drinking water was <5ug/l in 54% samples (Table 13). T_3, T_4 and TSH estimation showed normal value for all the 200 samples. Two locally grown food stuffs 1) Vejra (Lycopersicon esculentum) and 2) Kachhariya (Botanical name not known) contains Thiocyanate in the tune of 0.037ug/100 gm and 0.02 ug/100 gm.

Though the market salt sample shows adequate iodine in the salt, house hold samples showed very low iodine. Most of the goiter cases appear to be euthyroid goiter as hormonal profile was with in normal range. Though locally grown two foodstuffs contain some thiocyanate its contribution will be insignificant. Ground water also lacks iodine.

Table 12: Age sex distribution of Goitre in Bharias of Patalkot valley in 1992

Age group in years	Sex	Number examined	Grades of Goitre				Total Goitre Rate	Visible Goitre Rate
			Ia	Ib	II	III		
0-5	M	11	0	0	0	0	0	0
	F	8	0	12.5	0	0	12.5	0
6-10	M	92	0	0	0	0	0	0
	F	44	0	6.8	2.3	0	9.1	2.3
11-15	M	5	0	0	0	0	0	0
	F	13	0	7.6	0	0	7.6	0
>15	M	67	0	7.4	7.4	0	14.9	7.4
	F	60	0	15.0	13.3	3.3	31.7	16.7
Total		300	0	6.3	4.7	0.67	11.7	5.3

Table 13: Distribution of Iodine contents of salt Samples from Patalkot valley in 1992

Source of Salt	Mean Iodine Content
Market sample (n=4)	13.3±6.6 Range- 6.5-22.2
Household Samples (n=29)	3.26±3.1 Range- 0-11.1

Assessment of Iodine Deficiency Disorder in Baiga Chak Area of District Dindori 1986-1987 & 2004-2005

Salt iodisation programme was carried in Baigas (where the prevalence was 45% in the year 1986-87. A resurvey was done in the year 2004-05

A total of 1012 school children of Baiga Chak area were clinically examined for prevalence of goiter. Urine samples were collected to see the iodine content among them following wet digestive method. Besides, these salt samples were collected from different households and from market places. For estimating iodine contents, the Kit method procured from National Institute of Nutrition, Hyderabad, was followed.

Clinically the prevalence of goiter was found to be 20%. Goiter which is palpable but not visible (G1) was18.3% while visible goiter (G2) identified to be 1.8%. More than 87% school children were found to have low urinary iodine in nutrition. Iodine nutrition was low in females (91.6%) as compared to males (83.5).

About 48% of salt samples collected and examined showed, <7PPM iodine content. The probable reason could be as KAP survey revealed, the villagers prefer to use crystal salt as it is cheaper compared to other varieties of edible salt available. Since these crystal salts are available in crude and unclean from, these are kept in open and washed with water before use and in this process the iodine content gets evaporated and washed away.

The study indicated that severity of iodine deficiency disorder has decreased when compared with the previous study of RMRCT (ICMR), Jabalpur in 1986-87. The urinary iodine concentration, which is the most reliable indicator of IDD, showed severe to moderate iodine deficiency in Baiga Chak area. These results indicate that though the prevalence of IDD has decreased but iodine deficiency is still a public health problem in study area.