CHAPTER V

ECOLOGY AND DISTRIBUTION OF DISEASES
The difficulty of defining the word 'disease' is implicit in its very structure: dis-ease. The disease may be defined as a condition in which body health is seriously attacked, deranged, impaired, a departure from a state of health and an alteration of human body interrupting the performance of vital functions. It is the symptom, not the cause of ill health. A disease, termed as pathological imbalances of man, is caused due to convergence of environmental stimuli intime and space. It is the alteration of living tissues which jeopardises survival in their environment and which results from an accidental collision between two or more forms of life [1] i.e. human beings and minute organisms like viruses. The organisms will succeed in jeopardising the health of a person only when both the external environment (geographical and socio-cultural) in which it originates and internal environment (the human body) in which it grows offer favourable conditions for multiplication [2]. Disease occurrence or non-occurrence are dependent upon a systematic integration of three factors: causative, preventive and curative [3]. Fig. 5.1A evinces the dynamic relation of these factors and their constituents.

Ecology of Disease

The word 'ecology' is etimiologically originated from the Greek word 'oikos' meaning thereby house or place to live and thus, the ecology may be referred to as the study of organisms
at home. Usually, it is defined as the study of relation of organisms or group of organisms to their environment or the science of inter-relations between living organisms and their environment.

With the ecological point of view, health is considered as state of dynamic equilibrium or adjustment between man and his environment. The state of imbalance between man and environment results in disease. Thus, the disease may be defined as maladjustment of human organism to the environment. The factors such as agent, host and environment are of the cardinal importance representing the basic concept of disease ecology (Fig. 5.1B). The disease agent is defined as a substance, living or non-living or a force tangible or non tangible, the excessive presence or relation lack of which is immediate cause of particular disease [4]. The disease agents may be grouped as biological, nutrient, chemical, physical and mechanical. Human host contributes to disease through his inherent characteristics such as age, sex, race, nutrition, occupation, immunity status, customs, habits and human behaviour. The integration of physical, biological and social circumstances affecting human well-being forms environment contributing to disease. Thus, disease ecology may be referred to as the matrix of various ecological factors grouped into natural environmental ecology, cultural environmental ecology and ecology of associative occurrence (Fig. 5.1C).
CLASSIFICATION OF DISEASES

Bundelkhand is the sufferer of number of diseases associated with the temperate climate and exceptionally those related with tropics (Appendix IV) but due to number of limitations, it is not possible to discuss all the prevailing diseases. Here, only most common diseases of geomedical importance have been considered in the view of ecological perspectives. The main diseases of the area may be classified as under -

(A) Deficiency Diseases
   (i) Avitaminosis A
   (ii) Anaemia
   (iii) Rickets and Osteomalacia
   (iv) Teeth and Gum diseases

(B) Arthropodal and Helminthic Diseases
   (i) Malaria
   (ii) Filariasis
   (iii) Helminthic diseases

(C) Communicable Diseases
   (i) Dysentery and Diarrhoea
   (ii) Gastroenteritis
   (iii) Enteric Fever
   (iv) Infectious Hepatitis
   (v) Whooping Cough
   (vi) Tuberculosis
   (vii) Measles
   (viii) Venereal Diseases
   (ix) Leprosy
(D) Non-Communicable Diseases

(i) Cancer

(ii) Cardiovascular Diseases

DEFICIENCY DISEASES

Though the deficiency of almost every nutrient produces some clinical manifestations in human beings, the term deficiency disease, as commonly used is restricted to only some of them. Partial or complex absence of one or more nutrients in the diet leads to nutritional deficiency diseases [5]. In absence of adequate supply of nutrients like proteins, minerals and vitamins, the whole metabolic process is disordered and resistance power of the body is reduced which creates the favourable environment for occurrence of various deficiency diseases resulting in poor health. The diets of poor caloric value and a poor nutritional quality cause a number of diseases specially among children and pregnant women. The foremost in all the diseases, though nonclinical in nature, caused by deficiency states is laziness and unwillingness to work. The deficiency diseases which are frequently reported in area, are discussed here.

Avitaminosis A

The effect of vitamin A deficiency is recognised as rough dry skin, poor sight, night-blindness, xerosis, xerophthalmia and other eye disorder. Vitamin A is termed as vitamin of prosperity
as it is available in costly food items. Most of the richest sources of vitamin A fall short of requirement in comparison to recommended allowance in Bundelkhand as well as the country as whole.

Table 5.1. Requirements and Availability of Vitamin A Enriched Food Articles in India.

<table>
<thead>
<tr>
<th>Article</th>
<th>Recommended Daily Allowance</th>
<th>Daily Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk and Milk product</td>
<td>180</td>
<td>125</td>
</tr>
<tr>
<td>Meat Fish and Egg</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>Vegetables</td>
<td>235</td>
<td>46</td>
</tr>
<tr>
<td>Fruits</td>
<td>37</td>
<td>46</td>
</tr>
</tbody>
</table>


The deficiency of vitamin A is arised due to low dietary availability or inability to utilise available amount. In case of protein caloric malnutrition, absorption of vitamin A and beta carotene is improved by inclusion of proteins in daily diet as the protein, calories and vitamin A deficiency seem to go hand in hand.

**Geoecology** - In the study area, the main sources of vitamin A are fruits and vegetables which contribute about 65-85% of dietary vitamins. The contribution of foods of animal origin is little. Due to poor economic condition and vegetarianism people
generally prefer cereal based diet which is suplimented by pulses, vegetables, fruits and animal foods in order. The considerable amount of vitamin A is lost due to faulty cooking practices which depends upon cooking period, temperature, presence of water and pH, as acidic medium is destructive to vitamin A. The absorption of vitamin A from intestine is lowered due to infestation by intestinal parasite and infection. In the children, belonging to lower socio-economic groups suffering from repeated respiratory and gastrointestinal infection, the level of vitamin A absorption is low. It is the major cause of serious complications of vitamin A deficiency like xerophthalmia and keratomalacia.

Poor nutritional status of the mothers is also one of the factors responsible for vitamin A deficiency right from birth. The infants of the region are entirely dependent on breast milk which is poor in vitamin A. The increasing income ultimately increases the intake of vitamin A. The areas of high agricultural productivity are, therefore, characterised with low incidence of avitaminosis.

Anaemia

Anaemia is a disorder of blood as a result of which the patient's tissues get less oxygen and thus the oxygen carrying capacity of the blood is reduced. Nutritional anaemia is defined as a condition in which haemoglobin content of the blood is
lowered than normal as a result of one or more essential
nutrients. It is the ultimate result of a severe nutrient
deficiency usually iron, less frequently folic acid and rarely
vitamin B\textsubscript{12}. From the public health and socio economic point of
view, anaemia secures special significance because it interferes
with the sense of individual well-being and reduces productivity
and working capacity. It contributes to over all morbidity
associated with malnutrition and in case of anaemia in pregnancy,
it proves a threat to life and maternal health at the time of
delivery resulting low birth weight and poor infant vitality. The
effect of anaemia on vulnerable group of the society can be
recognised as high maternal mortality, high premature death,
perinatal mortality, general ill-health and reduced working
capacity. Anaemia, if severe (haemoglobin in blood less than 5
grams per 100 ml) can produce symptoms and signs of heart
diseases. Generally, three types of nutritional anaemia i.e. iron
deficiency anaemia, nutritional megaloblastic anaemia and anaemia
of protein caloric malnutrition are common in the area under
study. Most common among all the nutritional anaemias is iron
deficiency affecting all ages and both sexes.

**Geoecology** - The factors causing iron deficiency in human body
are intestinal worm infection, malaria, chronic loss of blood due
to uterine bleeding, cancer cervix, peptic ulcers, dysentery and
diarrhoea, bleeding from gums, excessive sweating during summers,
pregnancy, lactation and professional blood donation. Among
pregnant women and vegetarian people, the deficiencies of both
B₁₂ vitamin and folic acid causing nutritional megaloblastic anaemia are frequently reported. The main source of B₁₂ for vegetarians is milk, the availability of which is meagre. The nutritional megaloblastic anaemia has the fair chances among infants and children due to increasing demand and presence of malabsorptive diseases specially among the poor section of the society. In the case of prolong protein caloric malnutrition, the anaemia results among infants and children having deficiency not only in proteins and calories but also in other nutrients such as folic acid, vitamin B₁₂ vitamin A and sometimes vitamin C.

The nutritional anaemia is not only the product of poverty but also the ignorance about the low cost nutritious foods and food habits. Thus, literacy plays a decisive role in prevalence of nutritional anaemia.

Rickets and Osteomalacia

Both the chronic conditions, due to hypovitaminosis D are associated with deficiency of calcium and phosphate. The principal function of vitamin D in the digestive metabolism in the human body is absorption of calcium from intestine. Protein enriched food helps in absorption of calcium in diet by formation of soluble calcium salt with aminoacids. Osteomalacia is a form of adult rickets and generally prevails among women who observe purdah and remain indoor specially during pregnancy. It is almost common in young mothers with the burden of repeated pregnancies
and lactations. Osteomalacia may cause anorexia, weight loss, bone pains, bony deformities, muscular weakness etc.

**Geocology** - Fundamentally, vitamin D deficiency results from inadequate exposure to ultraviolet rays. Human body has natural capacity to synthesise vitamin D directly from sunrays. It is paradox that mass of rural community which is exposed to sun rays is suffering from hypovitaminosis D. This is due to the fact that the dietary intake of vitamin D is too poor to fulfil the body requirement. Besides, the sun is too hot in the region during most of the year. It is, therefore, difficult to tolerate it for adequate duration to synthesise the required amount of vitamin D. Moreover, dark colour skin of major part of rural people has lower capacity to make vitamin D from sun rays.

The daily diet of rural mass consisting of cereals, pulses and vegetables are totally deprived of vitamin D. The human (as well cow's) milk has very poor content of vitamin D. The food items of animal origin such as egg, shark liver oil, butter and cheese are rich sources of vitamin D which are rarely available to the large part of regional population. In such circumstances, the sun rays exposure is the only source of vitamin D. In urban areas, due to high density of population and poor housing conditions the cases of hypovitaminosis D are frequently observed. It may be concluded that variety of ecological factors, such as low intake of vitamin D through diet and low formation by skin due to lack of exposure and dark colour skin, low dietary proteins.
and calcium, high phylates, oxalates and fibre content in diet and repeated loss through pregnancy and lactation are responsible for high incidence of hypovitaminosis D.

Teeth and Gum Diseases

These diseases include dental caries, bleeding and swelling of gums and contact pain in the inner part of the mouth. The diseases take place due to deficiency of multiple nutrients like calcium, vitamin A, ascorbic acid (vitamin C) and vitamin D. The deficiency of calcium and vitamin C played a more crucial role in the widespread teeth and gum diseases [6].

The average daily Indian's intake of vitamin C is only 4.4 mg as compared to recommended allowance of 30-50 mg [7]. Inspite of such a low intake, the people do not suffer serious malnutritional problems at large scale while even low deficiency of other nutrients such as vitamin A, iron, calories, have resulted serious nutritional disorder.

Geoecology - The man has natural capacity to synthesize ascorbic acid from D glucose. The fact which helps more in prevention of clinical manifestation of vitamin C deficiency is that the natural source of our body takes about 90 days to be depleted 90%. During such a long period our primarily vegetarian diet with the inclusion of some raw fruits might be helping in preventing complete depletion of reserves.
The factors contributing to the teeth and gum diseases are high urbanization, literacy, low intake of vitamins A, C and D, area under vegetables and fruits cultivation, percentage of irrigated areas, dietary pattern, food habits and personal hygiene.

ARTHROPODAL AND HELMINTHIC DISEASES

Arthropodal Diseases

The arthropoda phylum plays a very important role in human health. They act as carrier agents in transmission of various diseases. Malaria and filariasis are main diseases of the region transmitted by arthropods.

Malaria

The word malaria is derived from two words mal (bad) and aria (air). It was believed that the disease has a close relationship with bad air of marshy or wetland. The disease is caused by a protozoal parasite named Plasmodium of malaria which invades, multiplies in and destroys red blood cells in a cyclic rhythm varying from 48 to 72 hours. The incubation period varies from 12 days to months or even years. In malaria, fatality in untreated cases varies from 1-10% depending upon the character of the parasite and degree of the resistance of the host [8].

Geoecology - Malaria is a trifactor complex involving man as host, anopheles mosquitoes as vector and plasmodium as the
causative agent [9]. High rainfall provides more breeding and
living space for the vectors. Temperature determines the seasonal
periodicity and mechanism of the epidemics. Temperature between
22°C to 30°C is optimal for development of sexual cycle of
malaria parasite in mosquitoes. It is, therefore, rarely occurs
in epidemic form beyond 10°C isotherm. Besides, temperature plays
a decisive role in time required by mosquito to become infectious
after taking his blood meal. Drainage pattern decides the flood
affected and stagnant water areas. Soil porosity secures considere-
able importance as it shows association with water logging and
mosquito breeding. The chemical constituents of the soil and
vegetal cover influence the growth of vector population.

The man is considered as an important factor in transmission
of disease as malaria parasite can survive only in man. Human
activities such as construction of irrigation channels, agricul-
tural practices, land use, human settlements and house types
influence the disease pattern [10]. The construction of railways,
roads embankments, and houses promotes malaria as it provides
fresh breeding sites for mosquitoes by interfering natural
drainage system. The disease is more common in rural areas. In
villages, due to poor housing and insanitary environment, the
people and anopheles live in close proximity. Thus, the probabi-
ity of malaria incidence may be explained by equation - ut
Malaria incidence \((M) = f(x + y + z)\) e.m.i.
where \(x\), \(y\) and \(z\) stand for man, mosquito and plasmodium respectively and e,m and i mean environmental (both physical and cultural) conditions, medical facilities and disease immunity respectively.

Filariasis

Filariasis is a general term used for variety of diseases caused by growth of worm filariae in various tissues injected by arthropodal vectors. Filariasis persists as one of the most important of disabling entities causing much physical and psychological discomfort and considerable social stigma in its trail [12]. Filaria accounts for considerable handicap due to hydrocele and elephantiasis.

Epidemiologically, the filaria prevalent in India can be classified into two types i.e. bancroftian filariasis and malayan filariasis. It is transmitted by night biting vector mosquitoes of genera culex fatigans or Anopheles and day biting Aedes. The common breeding places for C. fatigans are domestic cesspools, drains, tanks and rivulets. The stagnant water with considerable amount of organic pollutants favours the higher infection of disease.

Geoecology - The inorganic factors responsible for incidence of malaria are equally responsible for filarial infection. Heavy
rainfall, stagnation of water due to ill drainage, high percentage of soil moisture are the ideal conditions for mosquitoes breeding. The peak infection months of filaria are March-April and October-November which are optimum seasons for mosquitoes breeding and disease transmission as the risk of contracting the infection depends upon the vector density. The limits of filaria occurrence are set by 80°F temperature and 60% humidity.

The cultural factors influencing the prevalence of the disease are the migration of infected hosts, congested and poor housing conditions specially in urban areas, types of clothings and occupational structure. Increased population density and movements of people to and from endemic areas contribute to easier transmission of filariasis in urban areas. Filaria incidence is generally higher in males than females as they have to work outside with less clothings and are more exposed to the attacks of the mosquitoes. Industrialization, urbanization and sleeping habits are important social factors associated with disease transmission. In urban areas, poor drainage for disposal of water, wastes and sewage have intensified the problem due to high culix breeding in the presence of organic pollutants. Besides, urban areas attract the symptomless micro-filarial carriers from filaria endemic areas in the want of employment. Unplanned and uncontrolled urbanization resulting in break down of sanitary services has led to increase prevalence of the disease. Improper methods of night-soil disposal, ecological changes brought out by dams and improper method of irrigation are
the factors of utmost significance as regard the incidence of the disease.

**Helminthic Diseases**

A variety of diseases, caused by endoparasite inhabiting the alimentary canal of human beings are called helminthic diseases. These diseases are seldom fatal but nevertheless, they sap the vitality of the affected persons and thus expose them to the danger of being attacked by various epidemic diseases [13]. Anaemia is the most important symptom of helminthic syndrome which results due to loss of blood by blood sucking activities of worms along with prevalence of malnutrition.

**Geoecology** - Widespread pollution of soil in the combination with health ignorance and prevalent customs and habits are mainly responsible for the endemicity of helminthic infestation. *Ascaris lumbricoides* (round worm) is the most important soil transmitted helminthic pathogen. Prevalence of ascariasis is directly related to local habits and method of disposal of faeces in the community and represents a direct index of the community's progress toward desired level of sanitation [14]. The worms inhabiting small intestine of man do not require secondary hosts to complete their life cycle and hence infection passes from man to man. Hot and humid areas receiving more than 100 cm rainfall are highly endemic. Sandy alluvial tract containing humus matter is found suitable for the growth of hookworm larvae. Human beings are the only host and sole reservoirs of hookworm infestation. The infec-
tion takes place generally through skin and rarely through drinking water taken from open sources. The eggs, fertilized in intestine, expelled out with faeces. Under the favourable conditions of moisture, oxygenation, temperature (25°C), shade and pH of the soil, a rhabditoid larva emerges which after few days with favourable circumstances results infilariform larvae which are infective to human host.

Schistosomiasis is mainly a rural occupation disease affecting people engaged in agriculture or fishing and children by the age of 14 years. The presence of snails as intermediate hosts and water reservoirs are essential for spread of the disease. Guinea-worm infection is another disease of helminthic group mainly found among agricultural labourers. The disease mainly occurs in rural areas where community depends on stagnant sources of water like ponds, tanks and step wells. Although prevalence varies directly with density of population within the endemic community, the disease seldom establishes outside the known endemic areas even if infected persons migrate to such disease free zones.

COMMUNICABLE DISEASES

The communicable disease is one in which causative agent may pass or be carried from an infected person through an intermediate host, insect, vector or some other injected agency of the environment. Thus, the communicable diseases include the contagious as well as infectious diseases like gastroenteritis, enteric fever, tuberculosis, leprosy, measles, whooping cough,
infectious hepatitis etc.

Gastroenteritis

Gastroenteritis is a waterborne communicable disease quite akin to cholera and often it is difficult to differentiate it without proper test. It is the disease of bacterial origin and transmitted through food and water borne infections. The history of the disease dates back to 1957, prior to which no statistical record of the disease incidence is available.

Geoeconomy - The geoeconomic factors responsible for cholera incidence may be considered as causative factors for gastroenteritis. In the upland part, rainfall flushes off sources of contamination and thus the incidence of the disease comes to an end but in plain and water logging areas, high incidence of the disease is observed. Gastroenteritis cases increase with the onset of summer specially in the rural areas suffering with the problems of water scarcity and poor environmental sanitation. During the month of April and May the newly harvested crops of coarse grained e.g. barley, gram, peas etc. often work as gastrointestinal irritation. Gastroenteritis cases, therefore, appear in March and April almost clock like precision. Besides, these months are the period of mass contact and general assembly of persons at marriage ceremonies and fairs and festivals. Various socio-cultural factors and food habits such as religious practice of bathing and drinking contaminated river water, taking cold food etc. provide an open front for gastroenteritis infection.
Dysentery and Diarrhoea

Dysentery and diarrhoea mean impairment of the functioning of intestine resulting loose motions and passing of blood and mucus in motions. It is fairly spread in our country and is second only to common cold and cough. One can get dysentery at any time in year but some type of diarrhoea like cholera and gastroenteritis occur only in form of epidemics.

Dysentery may be sub divided as bacillary dysentery caused by organisms like S. Shiga, S. Flexner etc. and amoebic dysentery due to attack of Endamoeba Histolytica on intestine. Indigestion, cancer of intestines, certain systematic diseases, fear, anxiety and sorrow can also lead to diarrhoea.

Geoecology - The incidence of diseases is closely related with hot season and poor environmental sanitation. The organisms causing dysentery are transmitted to man by flies. The conditions favourable for growth of flies' population may be considered ideal for incidence of bacillary dysentery. Breeding of flies are closely related to temperature. At 16°C, the average time required by house fly to develop from egg to adult stage is 44 days. The hatching time reduces to 16 days at 25°C and 10 days at 30°C. Amoebiasis is widely prevalent in the tropics where warm and humid climate, over crowding, unhygienic conditions of living, abundance of flies and cockroaches, unsatisfactory disposal of night-soil, contamination of drinking water, unsatisfactory method of food preservation all contribute to propagate
the infection [15]. The infection rate of the disease is high when adequate water is not available for personal hygiene. It is, therefore, termed as disease of unwashed hand.

**Enteric Fever**

It is classical example of water borne infection which is endemic only in communities with low standard of sanitation and personal hygiene. It combines typhoid and paratyphoid fevers and is caused by Bacillus typhosus and the latter by Bacillus paratyphoid A, B or C. These are acute infectious and highly communicable fevers of long duration found all over the world affecting middle age groups prevalent more in males than in females [16]. It is transmitted person to person by an unclean carrier or contact with an infectious case. The disease spreads through intake of contaminated food articles such as water, milk, solid foods and drinks and also through flies, fomits and dust.

**Geocology** - The disease prevails throughout the year with increasing intensity during rainy season. The incidence of disease increases in the young and adults and decreases with age. The lack of safe drinking water, improper method of night-soil disposal, low level of environmental sanitation and personal hygiene are the basic factors contributing to high incidence of the disease. Certain food habits and kitchen practices help in transmission of the disease. The flies are the main transmitting agent of typhoid germs, therefore, the factors suitable for
growth of flies may be considered favourable for incidence of enteric fever.

Infectious Hepatitis

Infectious hepatitis is a virus borne highly communicable disease caused by heat resistant gastrointestinal viruses which are transmitted by finger to mouth, person to person contact, food handler - contaminated food, and fecal or sewage - contaminated water. The virus of the disease can also be transmitted by injection and blood transfusion. The disease is often seen in epidemics. The incubation period is from 6 to 26 weeks. The carrier state may persist for several years [17].

Geoecology - Although natural factors such as rainfall contribute to the incidence pattern, the cultural and socio-economic environmental conditions appear to have an overwhelming on occurrence of the disease. The incidence of the disease among upper class is nearly absent while middle and lower income groups are worst hit by this disease. The poor people, living in congested and unhealthy surroundings, constitutes the group of the society more prone to infectious hepatitis partly due to their economic conditions and mainly due to unhealthy surroundings.

Whooping Cough

Whooping cough is an acute respiratory infection caused by
Bacillus pertussis or Hemophilus pertussis. The incubation period is often about 7 days and maximum limit is 21 days. The period of danger of the spread of the disease extends from 7 days after exposure to three weeks after onset of typical paroxysm [18]. It is basically young children disease but persons of all ages become prey to the disease.

Geoecology - The incidence of disease varies from season to season. The highest death rate is recorded during March and April. Female children are more prone to disease in comparison to males. High death rate is reported among females. Cultural phenomena such as density of population, literacy, sex ratio, housing conditions, availability of health care facilities etc. are the factors of utmost significance as regard the incidence and transmission of the disease.

Tuberculosis

Like most of the communicable diseases tuberculosis has a long historical background. The references of the disease are found in the Babylonian tablets and Egyptian mumies (2000 BC). Hippocrates (460-377 BC) and Aristotle (384-322 BC) named the disease as 'Pthysis'. In India, it is termed as 'Rajroga' being common among high class society and 'Kshaya roga' as the disease consumes body and its vitality gradually. Human beings as well as all warm blood animals seen to be susceptible to this disease. It is an acquired disease by ingestion and/or inhalation.
The disease is caused by tubercle bacillus belonging to genus Mycobacterium and is very high resistive micro-organism which can survive even in dry state for about six months. No age, sex or race secure immunization against disease but at the same time it is not hereditary acquired. The occurrence of disease at birth is, therefore, rare phenomena.

Geoecology - The ecology of tuberculosis reveals a magnitude of interaction of physical and cultural environment in relation to the infection, morbidity and mortality of tuberculosis infection. The disease is associated with number of organic as well as inorganic factors. Various climatic phenomena such as temperature, humidity, rainfall and sunshine and altitude partially contribute in occurrence of the disease. There is a positive correlation between tuberculosis and rainfall and negative with temperature variation.

Various cultural factors such as economic status, housing conditions, occupational structure, level of industrialization and environmental sanitation contribute significantly in occurrence and transmission of the disease. Poverty, low vitality, over crowding, faulty dietary pattern, social customs like purdah, repeated pregnancy, child marriage, lack of timely and adequate treatment facilities and poor sanitation are some of the causes responsible for tuberculosis morbidity. Tuberculosis is less common in females than in males above the age of 35 years. Its prevalence is higher in overcrowding slums where people lives
under insanitary conditions. Infection is favoured by malnutrition and protein deficiency which depress the antibody formation. It is proved that protein and vitamin D deficiency favoured the persons more susceptible to tuberculosis than others. The spirituous liquor and smoking are major causes of tuberculosis among persons of lower income group. Besides, due to lack of medical facilities, poor diet, low standard of living and chronic diseases most of the patients of chronic fever and diabetes mellitus get into the rid of tuberculosis.

Measles

Measles is universally prevalent, highly communicable and specific infectious disease mostly affecting children. The disease occurs in epidemic form and transmits from sick to healthy persons by means of direct contact through discharges from nose and mouth. The incubation period from exposure to initial period consists of 10 to 11 days. Children under 5 years of age become easy prey to disease. Adults are also susceptible to this disease. Probably 85-90% of the persons surviving up to age of 20 years have had measles at one or other stage of their lives [19].

Geoecology - The disease prevails mostly in the early spring season. The disease mortality is higher among the people living in overcrowding locality with poor sanitary conditions as the result of complications such as bronchitis, broncho-pneumonia,
diarrhoea, encephalitis etc. Low temperature helps in the incidence and transmission of the disease.

Venereal Diseases

The venereal diseases, transmitted sexually, include syphilis, gonorrhoea, chancre, granuloma inguinale and lymphogranuloma venereum. The micro-organisms acting as causative agents are spirochetes (syphilis), cocci (gonorrhoea), bacilli (chancre), viruses (lymphogranuloma venereum) and bacterium (granuloma inguinale). The diseases are responsible for 35% of insanity, 40% of mental defectives, 40-60% of blindness, 30% sterility, 30-43% abortions and miscarriages and high percentage of diseases of heart and blood vessels [20]. The significance of venereal diseases from public health point of view is that they are communicable, preventable and affect relatively large number of people. They may appear as epidemics and remain endemic in many population groups.

Geoeconomy - The middle and lower class is worst hit by this diseases. The congested living conditions may be major cause of disease occurrence. The diseases are common among large number of urban labourers and workers which are forced to remain separate from their families due to high cost of living and residential accommodation and to fulfil their sexual hunger in the brothels and prostitutes. Changes in sexual behaviour and attitudes in the form of greater sexual liberty or new sexual patterns, increased
access to modern birth control methods, and social changes as a consequence of urbanization, industrialization and ease of travel are all factors which have contributed to a significant increase in the number of new STD cases in the recent years [21].

Leprosy

Leprosy, one of the most baffling disease of the world, is caused by Mycobacterium leprae. The disease is characterised by a long incubation period and a chronic course with development of lesion in the skin, tissues, peripheral nerves and bones. It is a chronic infectious disease and spread mainly by close contact with infected persons. The disease is posing health as well as socio-economic problems to the human society.

Geoeconomy - The assessment of the causative factors for regional concentration of the disease requires correlative studies on geophysical and anthropogeographical factors related to the disease. More leprosy cases are recorded in the areas characterised by hot and humid climate. Leprosy is invariably associated with an association of defilement, uncleanness and social stigma.

The population movement for the economic purpose tends to carry disease from and to the economic focus. There is a tendency among leprosy patients to migrate towns and cities where they get better facilities of living as beggar or recipients of alms from
charitable bodies and thus create health hazards in towns and cities. The problem of leprosy is more severe in urban areas due to over crowding and immigration of population. The fact that males are more prone to disease is widely accepted. Though genetic factors have a profound effect in the spread of the disease, it is not pereditary acquired. Children are, however more liable to infection. Persons consuming unbalanced diet with low vitamin content are prone to leprosy attack. There is a close relationship between occurrence of leprosy and tuberculosis as the immunity to tuberculosis is likely to confer immunity to leprosy also.

NON-COMMUNICABLE DISEASES

With the development of preventive and curative health care facilities, rates of morbidity and mortality of communicable diseases have been reduced upto considerable extent. But due to increasing trend of urbanization and industrialization, non--communicable diseases, associated with modern condition of life, are emerging out of which cancer, cardiovascular and industrial diseases secure special significance.

Cancer

Cancer constitutes second leading cause of mortality in developing world. The term cancer or malignant neoplasms includes a group of diseases characterised by transmission of normal body cells into abnormally growing parasite cells [22]. On global level, all human population is susceptible to the disease but the
cancer of different sites are more common than in others.

**Geocology** - The real cause of human cancer is still unknown but recent researches have shown that the disease bears some association with physical and cultural factors of the environment [23]. Different social and biological factors are responsible for variety of cancers viz. (a) lung and stomach cancers are common in males and breast cancer in females, (b) smoking is strongly associated with lung cancer, (c) early marriage and low level of genital hygiene contribute the cancer of cervix, (d) circumcision and breast feeding are associated with low incidence of penile and breast cancer respectively, (e) occupational cancers like leukaemia in radiologist, urinary bladder cancer in dye workers and lung cancer in asbestos (f) dietary deficiency are primarily responsible for liver cancer. In India, most of the cancer cases are related to oral cavity on account of poor oral hygiene. The habit of smoking or chewing tobacco is most important single factor in the genesis of the oral and pharyngeal cancers [24]. Combination of smoking and chewing aggravated the risk of development of oral cancer. The highest percentage of cases are reported among persons belonging to low income group. The living habit of the people, poor socio-economic status, early marriage, repeated child birth, inadequate genital hygiene, poor post natal care and poor maternity services are related to the frequency of the cancer of cervix uteri which is next to oral cancer in hierarchic order.
The excessive use of nitrogen fertilizers trapped into nitrosamine through the action of sunshine may be responsible for the large number of cancer cases. Vegetarians are reportedly more prone to cancer than non-vegetarians [25]. Deficiencies of vitamin A [26] and vitamin B_1, B_2 and B_12 [27] are associated with oral cancer.

**Cardiovascular Diseases**

Cardiovascular diseases are the gift of modern civilization. The group of cardiovascular diseases includes (a) arteriosclerotic and degenerative heart diseases, (b) diseases of arteries, (c) hypertensive heart disease, (d) chronic rheumatic heart disease, (e) congenital anomalies of cardiovascular system, (f) diseases of veins, (g) cardiovascular syphilis, (h) rheumatic fever and (i) vascular lesions of central nervous system.

**Geoeconomy** - Different cultural phenomena such as environmental pollution, habitual traits related with socio-cultural environment, dietary pattern, stresses and strains may be considered as causative agents. The diseases are associated with different, chemical, neurological and bacterial disturbances as well as modern traits like alcoholism, smoking etc. Increasing environmental pollution and socio-economic tensions have resulted cases of hypertension and heart attacks.

Rheumatic heart disease is more common amongst the poor community in India. The poor socio-economic status and adverse
conditions of living lead to very high incidence of rheumatic heart diseases and account for 25-50% of all cardiac cases [28]. In the case of rheumatic fever, overcrowding and undernutrition, predisposing to streptococcal infectious, are more responsible than climatic and racial characteristics.

Distribution of Diseases

The relationship between ecological factors and distribution of diseases has been well recognised. The ecological factors which are favourable for the growth and transmission of an infective agent, often produce an areal distribution pattern. Some diseases impose greater morbidity in particular regions due to dominance of certain conditions that give rise to an intra-regional ecological synthesis which is most favourable breeding ground for a disease or diseases. Such a synthesis needs a specific combination of multiple conditions related to the cultural, economic and physical aspects of a region.

To present the regional association of diseases, the distribution of diseases has been analysed both spatially and temporally.

SPATIAL DISTRIBUTION OF DISEASES

For the spatial analysis of disease incidence, the data of reported cases for particular disease at tahsil level have been obtained. As the absolute number of reported cases in each tahsil
is not the true indicator of levels of disease incidence, disease intensity rate (number of reported cases/1000 persons) has, therefore, been calculated for each tahsil for all selected diseases (Table 5.2). As the diagnosis and treatment facilities for diseases like cancer and cardiovascular are not provided at tahsil level and the data are not properly maintained. Hence, for the spatial analysis of these diseases, the district level data have been taken into consideration.

The distribution of diseases, presented by disease intensity rate, does not show as how the intensity of particular disease in tahsil compares the intensity of disease at regional level. For the purpose, the morbidity index for each selected disease has been considered.

Morbidity Index

A morbidity may be defined as any departure subjective or objective from a state of well-being due to effect of a disease, an injury or an impairment. The morbidity index may be expressed as the ratio between number of cases reported in an area to the number of expected cases. The expected cases are assumed to be in proportion to the ratio between total reported cases of particular disease and population of the region. To present the intensity of diseases in regional context, the morbidity index has been calculated using the formula [29] ut infra -

\[
MI = \frac{OC}{EC} \times 100
\]
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<td>1</td>
<td>Bhilai</td>
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<td>2</td>
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<td>Chhattisgarh</td>
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<td>Durg</td>
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<td>8</td>
<td>Jhansi</td>
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<td>9</td>
<td>Talbehat</td>
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<tr>
<td>10</td>
<td>Lalitpur</td>
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<tr>
<td>11</td>
<td>Mahroni</td>
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<tr>
<td>12</td>
<td>Hamirpur</td>
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<tr>
<td>13</td>
<td>Rath</td>
</tr>
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<td>14</td>
<td>Kulpahar</td>
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<tr>
<td>15</td>
<td>Charkhari</td>
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<tr>
<td>16</td>
<td>Maudaha</td>
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<td>17</td>
<td>Mahoba</td>
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<td>18</td>
<td>Banda</td>
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<td>19</td>
<td>Seberu</td>
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<td>20</td>
<td>Naraini</td>
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<td>21</td>
<td>Karwi</td>
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<td>22</td>
<td>Mau</td>
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<td>23</td>
<td>Seoncha</td>
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<td>24</td>
<td>Datia</td>
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<td>25</td>
<td>Niwari</td>
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<td>26</td>
<td>Jatara</td>
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<td>27</td>
<td>Tikamgarh</td>
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<tr>
<td>28</td>
<td>Laundi</td>
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<tr>
<td>29</td>
<td>Chhatarpur</td>
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<tr>
<td>30</td>
<td>Bijawar</td>
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<tr>
<td>31</td>
<td>Ajaigarh</td>
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<tr>
<td>32</td>
<td>Panna</td>
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<tr>
<td>33</td>
<td>Pawai</td>
</tr>
</tbody>
</table>

Bundelkhand Region 4.4
where MI = Morbidity Index
OC = Observed cases
EC = Expected cases

Table 5.3 evinces the distribution of diseases by morbidity index at tahsil level. On the basis of mean ($\bar{x}$) and standard deviation ($\sigma$), four levels of disease morbidity have been decided using formula $\bar{x} \pm \sigma n$, i.e. high morbidity, moderately high morbidity, moderately low morbidity and low morbidity (Fig. 5.2). To decide the role of different geomedical variables on distribution pattern, multiple correlation and regression techniques have been followed. For selected diseases relationship between dependent and independent variable has observed and the results have been discussed in the support of distributional pattern.

**Avitaminosis A**

The patients of vitamin A deficiency often slip through the system of recognition, registration and delivery of health care. The disease intensity rate for Bundelkhand region is 4.42 cases/1000 persons.

The distribution of avitaminosis A shows close correspondence to the economic level of the people. The main sufferers of the disease is under privileged class. The areas of moderately high to high prevalence of avitaminosis (MI $>\bar{x}$) are Moth, Garautha, Mauranipur, Jhansi, Hamirpur, Kulpahar, Jatara, Laundi, Ajaigarh,
<p>| | | |</p>
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<tr>
<td>9</td>
<td>Talhat</td>
<td>69.71</td>
</tr>
<tr>
<td>10</td>
<td>Lalitpur</td>
<td>51.96</td>
</tr>
<tr>
<td>11</td>
<td>Nihonpur</td>
<td>168.90</td>
</tr>
<tr>
<td>12</td>
<td>Hamirpur</td>
<td>109.87</td>
</tr>
<tr>
<td>13</td>
<td>Rat</td>
<td>65.38</td>
</tr>
<tr>
<td>14</td>
<td>Kulpur</td>
<td>131.95</td>
</tr>
<tr>
<td>15</td>
<td>Charhar</td>
<td>95.15</td>
</tr>
<tr>
<td>16</td>
<td>Maudaha</td>
<td>100.35</td>
</tr>
<tr>
<td>17</td>
<td>Mahoba</td>
<td>91.26</td>
</tr>
<tr>
<td>18</td>
<td>Banda</td>
<td>95.75</td>
</tr>
<tr>
<td>19</td>
<td>Beberu</td>
<td>87.17</td>
</tr>
<tr>
<td>20</td>
<td>Naraini</td>
<td>94.11</td>
</tr>
<tr>
<td>21</td>
<td>Karwi</td>
<td>149.38</td>
</tr>
<tr>
<td>22</td>
<td>Mau</td>
<td>172.44</td>
</tr>
<tr>
<td>23</td>
<td>Seodna</td>
<td>68.03</td>
</tr>
<tr>
<td>24</td>
<td>Datta</td>
<td>37.06</td>
</tr>
<tr>
<td>25</td>
<td>Niar</td>
<td>87.40</td>
</tr>
<tr>
<td>26</td>
<td>Jatara</td>
<td>104.11</td>
</tr>
<tr>
<td>27</td>
<td>Tilamgarh</td>
<td>71.19</td>
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<tr>
<td>28</td>
<td>Laundi</td>
<td>119.09</td>
</tr>
<tr>
<td>29</td>
<td>Chhatarpur</td>
<td>74.69</td>
</tr>
<tr>
<td>30</td>
<td>Bijawar</td>
<td>97.81</td>
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<tr>
<td>31</td>
<td>Ajigarh</td>
<td>118.51</td>
</tr>
<tr>
<td>32</td>
<td>Panna</td>
<td>97.84</td>
</tr>
<tr>
<td>33</td>
<td>Pausi</td>
<td>132.90</td>
</tr>
</tbody>
</table>
Mahroni, Karwi, Mau and Pawai tahsils (Fig. 5.2A). The tahsils of Jalaun, Orai, Lalitpur, Datia and Seondha show low morbidity pattern. The distributional pattern is dominated by nutritional density \((X_1)\), literacy \((X_2)\), agricultural productivity \((X_3)\) and levels of urbanization \((X_4)\) represented by multiple correlation \((R_{Y1234} = +0.468)\). The regression equation for four selected variables is observed as:

\[
Y_{1234} = 4.06 + 0.01 X_1 + 0.01 X_2 - 0.02 X_3 - 0.04 X_4
\]

**Anaemia**

Among several deficiency diseases anaemia is important next only to growth retardation. It is a commonest complication of pregnancy and has become a problem of global importance now a days. Intensity rate of the disease in the region is 11.95 cases/1000 persons.

The tahsils of Kalpi, Moth, Mauranipur, Mau, Tikamgarh, Bijawar, Ajaigarh and Panna form the areas of moderately high incidence of anaemia whereas high prevalence of disease (MI 144.8\(\pm\)) is observed in Orai, Garautha, Jhansi, Seondha, Datia and Pawai tahsils (Fig. 5.2B). The areas of high morbidity are characterised by high sex ratio and low protein availability.

**Rickets and Osteomalacia**

Rickets and osteomalacia are fairly prevalent in varying density in the entire region. The region records disease intensity rate as 1.12 cases/1000 persons.
Fig. 5.2C shows that Orai, Datia, Bijawar, Ajaigarh and Pawai tahsil indicate the pattern of high morbidity (MI ≥ 166.36) while Talbehat, Baberu and Naraini tahsil record low morbidity (MI < 38.76). The factors responsible for high incidence of the disease are low content of lime and magnesia in Parwa and Kabar soils and high sex ratio. The upland part exhibits high morbidity pattern.

Teeth and Gum Diseases

Teeth and gum diseases are commonly reported in the area under study. The disease intensity for the region is 5.91 cases/1000 persons.

The areas of moderately high to high incidence (MI ≥ 106.05) of teeth and gum diseases consist of Orai, Kalpi, Jhansi, Hamirpur, Charkhari, Mahoba, Mau, Garautha, Mauranipur, Seondha and Datia tahsil. The south-western part consisting of Lalitpur, Talbehat and Mahroni tahsil witnesses the pattern of low morbidity (Fig. 5.2D). The factors responsible for the high incidence of diseases are deficiency of vitamin A, C and D, deficiency of calcium in soil and high urbanization.

Malaria

The malaria intensity rate of Bundelkhand region is 7.41 cases/1000 persons which is too high in comparison to corresponding figures of U.P. (1.36) and M.P. (3.39).
Fig. 5.2E displays that the concentration of malaria incidence is observed in Konch, Talbehat, Seondha, Niwari, Tikamgarh, Laundi, Chhatarpur and Pawai (moderately high MI between 102.63 and 165.96) and Kalpi, Moth, Garautha, Muraunipur, Bijawar, Panna and Ajaigarh (high MI 165.96→). Generally, southern and south-eastern parts depict high incidence of disease. The disease is more common in rural areas than urban counterpart. The regression analysis based on independent variables - altitude \( (X_1) \), rainfall \( (X_2) \), area under forest \( (X_3) \) and irrigated area \( (X_4) \) concludes that these factors are positively related with malaria morbidity represented by multiple correlation coefficient \( R_{y1234} = +0.449 \) and regression equation

\[
y_{X1234} = 6.33 + 0.01 X_1 - 0.05 X_2 + 0.21 X_3 + 0.10 X_4
\]

Filariasis

Filariasis is important communicable disease. Filaria intensity in the region is recorded as 0.82 cases/1000 persons.

Fig. 5.2F visualises that Hamirpur and Panna districts are areas of high filarial endemicity (MI 169.81→). The areas of low morbidity comprise Konch, Jalaun, Orai, Moth, Talbehat, Lalitpur, Mahroni, Banda, Baberu, Karwi, Mau, Niwari, Jatara and Tikamgarh tahsils with morbidity index below 51.9. The major portion of endemic area of Hamirpur district is flood affected. The high incidence of filariasis in Panna district is mainly due to high rainfall and high percentage of area under rice cultivation.
Helminthic Diseases

As helminthic diseases differ considerably in their causative agents, modes of infection and intermediate hosts, the geographical distribution and incidence of diseases is greatly influenced by their life cycles. The region, being located in helminthic endemicity zone (36°N and 30°S) and poor socio-economic conditions, shows high helminthic endemicity. The intensity of helminthic diseases in the region is recorded as 4.12 cases/1000 persons.

Fig. 5.2G shows that southern upland part indicates high morbidity of helminthic diseases. The tahsils of Mauranipur, Lalitpur, Charkhari, Maudaha, Mahoba, Laundi, Bijawar, Ajaigarh and Pawai constitute the areas of moderately high morbidity while areas of high morbidity consist of Garautha, Jhansi, Talbehat and Mahroni tahsils. A close relationship is marked between intensity of helminthic disorder and rural drinking water facility. Besides, the distribution of rainfall plays decisive role in disease intensity pattern.

Gastroenteritis

The regional average of disease intensity rate is 1.42 cases/1000 population. The gastroenteritis cases are frequently reported in rural areas.

Whole of the Jalaun district and Seondha tahsil of Datia district jointly form the areas of high disease incidence (MI 173.36→). The areas of low morbidity dominate the distributional
pattern (Fig. 5.2H). The drinking water facility may be considered as a determinant in the incidence and transmission of gastroenteritis. To find out the relationship between incidence of gastroenteritis and some selected independent variables i.e. rainfall \(X_1\), arithmetic density \(X_2\), literacy \(X_3\), level of urbanization \(X_4\) and villages with drinking water facilities \(X_5\), multiple correlation and regression analysis has been made. The analysis concludes that selected variables are positively correlated with incidence of disease \(R_{Y12345} = +0.689\). The result is supported by the regression equation—

\[
Y_{12345} = 5.02 - 0.06 X_1 - 0.01 X_2 + 0.14 X_3 - 0.03 X_4 - 0.01 X_5
\]

Dysentery and Diarrhoea

These are most common diseases and are frequently reported in both rural and urban areas specially during rainy season. The regional disease intensity rate is 25.38 cases/1000 persons.

The areas characterised with moderately high to high incidence of diseases consist of Jalaun, Konch, Orai, Kalpi, Garautha, M aurani pur, Mahroni, Hamirpur, Kulpahar, Mahoba, Niwari, Jatara and Tikamgarh tahsils (moderately high) and Moth, Jhansi, Talbehat and Bijawar tahsils (high) with morbidity index above 99.89 (Fig. 5.2I). All the tahsils of Banda district and Datia tahsil of Datia district present low incidence of disease (MT < 55.81). Insanitary conditions, low level personal hygiene and lack of safe drinking water are contributing factors for high morbidity of the disease.
Enteric Fever

The intensity rate of enteric fever in Bundelkhand is higher (2.67) in comparison to the states of U.P. (0.27), M.P. (1.98) and also India (0.46) as a whole.

Fig. 5.2J displays the distribution pattern of enteric fever at tahsil level. Moderately low morbidity dominates the distribution pattern commanding over 16 tahsils. The tahsils of Jalaun,- Orai, Seondha and Datia are characterised with high morbidity (MI 156.39->) while Moth, Mauranipur, Talbehat and Lalitpur exhibit the trend of low morbidity. The distribution of disease shows close correspondence with rainfall (r = -0.54) and incidence of gastroenteritis (r = +0.59).

Whooping Cough

The disease is widely recognised in the region. The rural population of the area is easy prey to the disease. The region secures higher disease intensity (1.29) in comparison to respective figures of U.P. (0.41), M.P. (1.05) and India (0.27).

Fig. 5.2K reveals that the intensity of the disease increases from north to south. Moderately low morbidity pattern predominates the distribution pattern covering 17 tahsils. Moth, Garautha, Jhansi, Niwari, Jatara, Tikamgarh and Pawai tahsils record high morbidity (MI 151.40->) while low morbidity (MI < 49.28) is observed in Rath, Mahoba, Banda and Karwi tahsils. In urban areas due to high population density and congested housing
BUNDELKHAND
SPATIAL PATTERN OF DISEASES
MORBIDITY INDEX
1981
TUBERCULOSIS
LEPROSY
CANCER
CARDIOVASCULAR
ENTERIC FEVER
WHOOPING COUGH
MEASLES
INFECTIONOUS HEPATITIS
VENERAL DISEASES
KILometres
0 10 20 30 40 50 60 70 80 90
FIG. 5.2 II
and in rural areas due to lack of health facilities and less consciousness about health care, high incidence of disease is reported.

**Infectious Hepatitis**

The disease intensity rate for Bundelkhand region has been calculated as 0.42 cases/1000 persons.

The areas of high morbidity (MI 129.88→) include Garautha, Jhansi, Lalitpur, Seondha and Tikamgarh tahsils whereas the tahsils of Jalaun, Kalpi, Kulpahar, Banda, Baberu, Naraini, Karwi, Mau, Datia, Niwari and Jatara exhibit the trend of low morbidity. Conclusively, it may be remarked that the incidence of the disease concentrates over south and south-western part (Fig. 5.2L). The distribution pattern shows close correspondence with availability of drinking water facility (cf. Table 4.11).

**Tuberculosis**

The prevalence of the disease is mostly uniform in rural and urban areas. The disease intensity rate is higher in the region (2.48 cases/1000 persons) than U.P. (0.29), M.P. (1.51) and India (0.89). Apart from morbidity data ut supra, about 55% population shows positive reaction to tuberculin testing [30].

The high prevalence of tuberculosis (MI 169.97→) is observed in Kalpi, Garautha and Jhansi tahsils while Jalaun, Talbehat, Baberu and Naraini tahsils record low incidence (MI <25.54). Fig.
5.2M indicates that moderately low morbidity dominates the
distribution pattern. The distribution of tuberculosis is positi-
vely related with intensity rate of venereal diseases \( r = +0.66 \), level of urbanization \( r = +0.54 \) and literacy \( r = +0.40 \).

**Measles**

The distribution of disease is universal. The disease inten-
sity rate for Bundelkhand region is recorded as 0.38 cases/1000
persons against respective figures of U.P. (0.05), M.P. (0.09)
and India (0.92).

The pattern of high mobility is observed in Konch, Moth,
Garautha, Muraipur, Jhansi, Talbehat, Lalitpur and Mahroni
tahsils securing morbidity index above 144.52. Fig. 5.2N denotes
that the areas of high morbidity form a belt extending from north
to south in western part of the region with increasing intensity
toward south. The pattern of low morbidity is witnessed in Banda,
Baberu, Naraini, Karwi, Mau, Datia, Tikamgarh, Panna and Pawai
tahsils securing MI below 61.62.

**Venereal Diseases**

The disease intensity rate is higher in Bundelkhand region
(0.45) than U.P. (0.04), M.P. (0.03) and India (0.27).

The areas of high morbidity of venereal diseases are extend-
ed over Jalaun, Orai, Kalpi, Moth, Garautha, Muraipur, Jhansi
and Datia with morbidity index above 159.77. The areas of low morbidity (MI < 39.79) dominate the distribution pattern (Fig. 5.2 O). The distribution of the disease is positively correlated with intensity of tuberculosis ($r = +0.66$), literacy ($r = +0.54$), level of urbanization ($r = +0.38$). Tribal population of Ajaigarh, Chhatarpur and Bijawar tahsils suffers with high incidence of the disease.

**Leprosy**

On global level, the distribution of leprosy is concentrated in a narrow belt along equator bounded by 13°N and S latitudes. The disease is fairly distributed in the country. The disease intensity rate is lower (0.67) than corresponding figures of U.P. (2.32), M.P. (1.28) and India (2.98).

High morbidity index (157.78->) is observed in Jalaun, Orai, Kalpi, Garautha, Mauanipur and Mahoba tahsils while moderately high morbidity is the characteristics of Konch, Jhansi, Hamirpur, Charkhari, Banda, Karwi, Datia and Panna tahsil (Fig. 5.2P). The level of urbanization is closely associated with the incidence of leprosy in the region.

**Cancer**

Bundelkhand region secures higher cancer morbidity (0.45) in comparison to U.P. (0.01), M.P. (0.04) and India (0.08) as a whole.

The areas of high morbidity of cancer consist of Datia and
Hamirpur districts (MI X→) while Jalaun, Jhansi, Banda, Tikamgarh, Chhatarpur, Panna and Lalitpur districts exhibit low morbidity pattern (Fig. 5.2Q). The principal cultural traits of chewing tobacco with betel nut, betel leaf and lime causes high incidence of oral cancer in the region. The betel nuts grown in the north-eastern part may absorb some carcinogenic agents from the oil bearing soils and thus become more irritant [31]. The incidence of disease is positively correlated with protein caloric availability.

Cardiovascular Diseases

The disease intensity rate of cardiovascular diseases is 1.42 cases/1000 persons in the Bundelkhand region. The district of high incidence of cardiovascular diseases are Banda, Datia, Jalaun and Jhansi (Fig. 5.2R). The distribution of cardiovascular diseases shows close correspondence with level of urbanization. Prevalence of smoking and alcoholism help in increasing the disease morbidity.

TEMPORAL DISTRIBUTION OF DISEASES

To analyse the distribution pattern of diseases temporally, the district level data for two point of time i.e. 1971 and 1981 have been taken into consideration. In Bundelkhand region, negative change is recorded for Avitaminosis (-0.22%), anaemia (-4.66%), malaria (-6.36%), filariasis (-0.29%), Helminthic diseases (-2.93%), infectious hepatitis (-0.01%), enteric fever
(-0.20%), tuberculosis (-0.31%), measles (-0.26%), leprosy (-0.45%), cancer (-0.40) and cardiovascular diseases (-0.27%). It indicates that inspite of various health and disease eradication programme, the incidence of different diseases has been increased. There is a positive change in the cases of Rickets and Osteomalacia (+0.63), teeth and gum diseases (+1.86), gastro-enteritis (+0.56), dysentery and diarrhoea (+1.81), whooping cough (+0.93) and venereal diseases (+0.09). The positive changes in the distribution shows that intensity of various diseases has been decreased during the said period due to improvement in living conditions, economic development and increasing percentage of literacy. Table 5.4 presents the changing pattern of different diseases at district level.

RANKING OF DISEASES

A study of disease ranking is very useful in understanding the distributional pattern of the diseases in an area because it emphasizes the relative dominance of different diseases in morbidity pattern of a region. For the determination of ranking of individual disease, percentage share of each disease in morbidity pattern has been considered and results have been depicted cartographically (Fig. 5.3).

Dysentery and diarrhoea ranks first in all the tahsils excluding Karwi, Mau, Seondha and Datia. First ranking disease is anaemia in Karwi, Mau and Datia and teeth and gum diseases in
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Tehsils</th>
<th>Avitaminosis A</th>
<th>Anaemia</th>
<th>Rickets &amp; Osteomalacia</th>
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<td>Jalaun</td>
<td>+3.45</td>
<td>-1.97</td>
<td>-0.73</td>
</tr>
<tr>
<td>2</td>
<td>Jhansi</td>
<td>+4.37</td>
<td>-4.13</td>
<td>-0.88</td>
</tr>
<tr>
<td></td>
<td>Including Lalitpur</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Hamirpur</td>
<td>-3.10</td>
<td>-7.34</td>
<td>-0.13</td>
</tr>
<tr>
<td>4</td>
<td>Banda</td>
<td>-4.98</td>
<td>-4.39</td>
<td>+3.14</td>
</tr>
<tr>
<td>5</td>
<td>Datia</td>
<td>-0.76</td>
<td>-1.96</td>
<td>+0.27</td>
</tr>
<tr>
<td>6</td>
<td>Tikamgarh</td>
<td>+2.16</td>
<td>-3.76</td>
<td>+1.52</td>
</tr>
<tr>
<td>7</td>
<td>Chhatarpur</td>
<td>+2.76</td>
<td>-2.60</td>
<td>+0.40</td>
</tr>
<tr>
<td>8</td>
<td>Panna</td>
<td>-0.19</td>
<td>-3.23</td>
<td>+1.40</td>
</tr>
<tr>
<td></td>
<td>Bundelkhand</td>
<td>-0.22</td>
<td>-4.66</td>
<td>+0.63</td>
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<tr>
<td></td>
<td>Region</td>
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</tbody>
</table>
Seondha. Second ranking diseases exhibit much diversified pattern. Enteric fever in Jalaun; malaria in Konch, Niwari, Chhatarpur, Bijawar, Ajaigarh and Panna; helminthic diseases in Talbehat and Mahroni; dysentery and diarrhoea in Karwi and Mau; teeth and gum diseases in Datia and Anaemia in all remaining tahsils hold second rank. Third ranking diseases include anaemia in Jalaun, Konch, Kalpi, Niwari, Chhatarpur, Bijawar, Ajaigarh and Panna, teeth and gum diseases in Orai, Muraunipur, Hamirpur, Rath, Charkhari, Maudaha, malaria in Moot, Garautha, Talbehat, Lalitpur, Baberu, Naraini, Jatara, Tikamgarh, Laundi and Pawai; helminthic diseases in Jhansi and Mahoba and avitaminosis A in Mahroni, Kulpahar, Banda, Karwi and Mau tahsils. Teeth and gum diseases comes first order of fourth ranking diseases. The distribution of diseases of V, VI, VII and VIII shows varied pattern. The rank wise distribution shows that none of the disease holds all 8 ranks (Table 5.5).

DISEASE COMBINATION

The importance of combinational analysis of various elements in geographical research is well recognised. Combinational studies minimise the chances of over simplified generalization. It is a statistical device for identifying the group of significant functions which represent the functional personality of an area. The study of disease combination constitute an important aspect of medical geography as it provides good basis for medical regionalization.
Table 5.5 : Ranking of Diseases

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Tahsil/Region</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
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<tbody>
<tr>
<td>1</td>
<td>Jalaun</td>
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<td>Ef</td>
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<td>Ge</td>
<td>Ma</td>
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<td>An</td>
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<td>An</td>
<td>Ge</td>
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<td>Tu</td>
<td>Av</td>
<td>Ef</td>
</tr>
<tr>
<td>5</td>
<td>Moth</td>
<td>Dd</td>
<td>An</td>
<td>Ma</td>
<td>Tg</td>
<td>Av</td>
<td>Tg</td>
<td>Tu</td>
<td>Av</td>
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<td>Garautha</td>
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<td>An</td>
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<td>Hd</td>
<td>Av</td>
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<td>Wc</td>
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<td>An</td>
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<td>Hd</td>
<td>Av</td>
<td>Wc</td>
<td>Ma</td>
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<tr>
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<td>Jhansi</td>
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<td>An</td>
<td>Hd</td>
<td>Tg</td>
<td>Tu</td>
<td>Ma</td>
<td>Av</td>
<td>Wc</td>
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<td>Talbehat</td>
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<td>Hd</td>
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<td>An</td>
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<td>Ef</td>
<td>Tg</td>
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<td>Ma</td>
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<td>Ht</td>
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<td>Ma</td>
<td>Ef</td>
<td>Tu</td>
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<td>26</td>
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<td>We</td>
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<td>Tu</td>
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<td>An</td>
<td>Ma</td>
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<td>Tg</td>
<td>Ro</td>
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<td>Tg</td>
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<td>An</td>
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<td>Tg</td>
<td>Av</td>
<td>Tu</td>
<td>Ro</td>
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<td>Ma</td>
<td>An</td>
<td>Ht</td>
<td>Tg</td>
<td>Av</td>
<td>Tu</td>
<td>Ro</td>
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<td>33</td>
<td>Pawai</td>
<td>Dd</td>
<td>An</td>
<td>Ma</td>
<td>Ht</td>
<td>Av</td>
<td>Tg</td>
<td>Ef</td>
<td>Tu</td>
</tr>
</tbody>
</table>
In delineation of disease combinations the methodological approaches developed for determination of crop combination have been reviewed. For the determination of crop combination, the most valuable statistical formula has been suggested by Weaver based on minimum deviation [32]. In order to remove the shortcomings of Weaver's method, Rafiullah [33] proposed another method based on maximum deviation using the formula ut infra.

\[ d = \sqrt{\frac{\sum D_p^2 - \sum D_n^2}{N^2}} \]  
\[ d^2 = \frac{\sum D_p^2 - \sum D_n^2}{N^2} \]

where \( d \) = deviation  
\( D_p^2 \) and \( D_n^2 \) = Sum of square of positive and negative deviations from middle of theoretical value.

\[ N = \text{Number of crops.} \]

Applying the above formula, disease combinations of Bundelkhand region have been decided (Table 5.6). The components of different disease combination have been depicted cartographically (Fig. 5.4A).

DISEASE ZONATION

The study of zonation of disease constitutes important aspect of medical geography as it provides foundation to disease regionalization. The zonation of disease has been attempted on the basis of disease ranking and disease intensity.
Table 5.6: Disease-combination.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Combinations</th>
<th>Name of Tahsils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mono Disease</td>
<td>Talbehat, Tikamgarh.</td>
</tr>
<tr>
<td>2.</td>
<td>Two Disease</td>
<td>Jalaun, Konch, Orai, Moth, Jhansi, Lalitpur, Mahroni, Hamirpur, Rath, Kulpahar, Charkhari, Maudaha, Mahoba, Niwari, Jatara, Chhatarpur, Bijawar.</td>
</tr>
<tr>
<td>4.</td>
<td>Four Disease</td>
<td>Seondha, Panna.</td>
</tr>
<tr>
<td>5.</td>
<td>Five Disease</td>
<td>Pawai</td>
</tr>
</tbody>
</table>

Disease zones

Considering the results of disease ranking the study area has been divided into 3 first order and 7 second order zones (Table 5.7) and presented cartographically (Fig. 5.4B).

Intensity zones

In order to demarcate disease intensity zones ranking method has been followed. Considering the lowest value of disease intensity rate as one, each tahsil has been ranked for each selected disease. Finally disease ranking coefficient for each tahsil has been obtained using the formula.

\[ R_j = \frac{\sum_{i=1}^{n} D_{ij}}{n} \]
where \( R_i = \) Ranking coefficient of \( i \)th area
\( D_{ij} = \) Rank of \( i \)th disease in \( i \)th area
\( n = \) Number of diseases.

The ranking coefficients of the disease thus obtained have been divided into four groups on the basis of quartiling (Fig. 5.4B).

Table 5.7. Disease Zones.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Zones</th>
<th>Name of Tahsil</th>
</tr>
</thead>
<tbody>
<tr>
<td>I order</td>
<td>II order</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Dd zone</td>
<td>(a) Dd-If zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Dd-Ma zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Dd-An zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Dd-Hd zone</td>
</tr>
<tr>
<td>2.</td>
<td>An zone</td>
<td>(a) An-Dd zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) An-Tg zone</td>
</tr>
<tr>
<td>3.</td>
<td>Tg zone</td>
<td>(a) Tg-An zone</td>
</tr>
</tbody>
</table>

Low intensity zone – The low intensity \((R < 4.58)\) of the diseases is observed in the whole of the Banda district and Jatara and
Niwari tahsils of Tikamgarh district. Dysentery and diarrhoea, anaemia and malaria are the principal diseases of the zone. The area coincides with Dd-Ma zone (Niwari), Dd-An zone (Banda, Baberu, Naraini) and An-Dd zone (Karwi and Mau). The factors responsible for low intensity are proper drainage, low urbanization, better accessibility, rural drinking water facilities and availability of health care facilities.

**Moderately low intensity zone** - The tahsils of Talbehat, Lalitpur, Rath, Maudaha, Tikamgarh, Chhatarpur, Laundi and Ajaigarh with ranking coefficient between 4.58 to 6.87, constitute moderately low intensity zone. The Dd-Ma zone (Chhatarpur, Ajaigarh), Dd-Hd zone (Talbehat) and Dd-An zone (Lalitpur, Rath, Maudaha, Tikamgarh and Laundi) are characterised by moderately low disease intensity. The basic factors contributing to moderately low intensity are moderate density of population and literacy and higher rainfall.

**Moderately high intensity zone** - Jalaun, Hamirpur, Kulpaher, Charkhari, Datia, Seondha, Bijawar, Panna and Pawai tahsils exhibit the pattern of moderately high intensity (R between 6.87 to 8.77). Dysentery and diarrhoea, enteric fever, malaria, anaemia and teeth and gum diseases are important diseases prevailing within the zone. Ill drainage, high rainfall, higher percentage of area under flood, concentration of tribal population, high percentage of area under forest and irrigated area are
some important factors resulting moderately high intensity.

**High intensity zone** - The zone of high disease intensity comprises Konch, Orai, Kalpi, Moth, Garautha, Mauanipur, Jhansi and Mahoba tahsils. The zone coincides with Dd-Ma and Dd-An zones and is characterised by high urbanization, high density of population, low protein caloric availability and lower agricultural productivity.

The foregoing analysis of ecology and distribution of diseases concludes that different ecological factors are closely associated with distributional pattern and ranking of diseases in the area under study. The factors such as terrain, climatic phenomena and nature of soil influence the incidence pattern of diseases like deficiency diseases, malaria, filaria etc. cultural factors like population density, age and sex structure, racial characteristics, occupational conditions, nutritional status, level of urbanization and economic conditions attain significance in deciding the morbidity pattern of the region. Besides, religious practices, social customs and beliefs, dietary pattern and food habits have determined the areal distribution and ranking of diseases. The dominating influence of loss of moral values may be seen in the distribution pattern of venereal diseases. The study area notices regional imbalances not only in the distribution and ranking but also in intensity of diseases.
REFERENCES


