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THE ECOLOGY OF TUBERCULOSIS DISEASE A STUDY IN MEDICAL GEOGRAPHY

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ABSTRACT :

The ecology of tuberculosis disease consists of a complex phenomena. This reveals a multitude of interaction of physical and cultural environment in relation to the infection, morbidity and mortality of tuberculosis disease. Thus in this paper, emphasis is given to outline some of the ecological factors and to demonstrate the ways in which such ecological factors as - terrain, tubercle bacillus, factors affecting host-resistance, over-crowded dwellings, social factors, space, ventilation, spirituous liquor etc. are intimately linked with the disease. The spatial organization of these ecological factors in the world is more heterogeneous in character. Each of these factors is linked with one another in complex relationship. In short, the paper concentrates on three major techniques, of describing and measuring the causes of prevalence of infection, morbidity and mortality of tuberculosis disease in different parts of the world, which are given as under:

I. To examine the linkages between the ecological factors and the spread of tuberculosis.

II. To highlight the ecological variations and associated concentrations of infection, morbidity, and mortality of tuberculosis disease.

III. To examine if man can check or alter the spread of tuberculosis.

Tuberculosis is a chronic, bacterial disease, the geography of tuberculosis adds strength to the locational aspects of all kinds of ecological factors, particularly in relation to location of natural and cultural environmental conditions. It gives a description of the assemblage of known problems of infection, morbidity and mortality in an area, as related to the physical, biological and cultural spheres of the environment. This helps to identify those medical and ecological factors which are area wide, those which are centered in any area or segments of the community. In other words, the areal differentiation of ecological elements and distribution of tuberculosis is discussed in a micro study of the Lower Chambal Basin (Central India) as well as at macro-scale or country-wide study.

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The Monsoon countries of Asia, the South-Western Asian countries, Mexico, Chile and Southern-most countries of Africa are revealing the highest range of infection, morbidity and mortality, while the Western advanced countries, Soviet Russia and Australia, revealed the lowest range of these probkems. But else where in the world, normally the infection, morbidity and mortality are of medium grades. Thus tuberculosis is a global disease.

Success in solving and" problems will not be achieved until the ecological conditions are more fully studied and until inter-disciplinary co-operation is established to analyse and understand them more fully than had been the case in the past. The geographers may contribute significantly to this work, for the majority of the factors involved, have spatial distributional conditions. The macro-scale approach, which is presented in this study, and the wide ranging over all view is maintained. But in terms of planning for action it needs to be linked with investigations a more detailed micro-scale.

Introductory

Tuberculosis is a chronic bacterial disease. It is caused by tubercle bacillus. Before the name tuberculosis came into common use, the disease was known as consumption disease. The ecology of tuberculosis consists of many geographical and ecological factors, among which there is always some interplay or some inter connection . Since there is a great deal of interrelationship between geographical conditions and infection or morbidity or mortality of tuberculosis, it is very difficult for the geographer to achieve more knowledge of influences of factors which may be or which definitely are not related to tuberculosis in a given range of geographical environment.

It is known that the 'Human' and 'bovine' types of infection are responsible for the spread of My co-tuberculosis disease. The infecting organism, first recognised by Robert Koch, in 1882, is a small rod-shaped bacillus. Infection in man from human tubercle bacilli is mainly by the sputum and inhalation of bacilli coughed up by patients specially of pulmonary tuberculosis disease. It affects particularly the lungs of the person. Thus pulmonary tuberculosis a major form of the disease. The of tubercle bacilli is found in raw milk of cow, the ingestion which tends to affects specially the intestines, bones and lymph nodes. It is not necessary that non-pulmonary tuberculosis is exclusively bovine and pulmonary tuberculosis is exclusively human in Origin. Generally, bovine type of tubercle bacilli infection particularly causes non-pulmonary and human type of bacilli infection causes pulmonary diseases.

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The Tubercle bacillus breaks through the tissues, and if the defence against infection in the human body is adequate, it is defected. The natural defence of human body helps the tissue to develop a scar which seals off the germs of infection temporarily or for the whole of life. On the other hand, if the defence is inadequate, the tissue loses its battle, the germs multiply inside the tissues, new foci are developed in the lungs or in the intestines and eventually the patient dies. Tuberculosis can attack other parts of the body as the bacilli always pass into general circulation causing abortive foci in many other parts of the human body. The following are the main symptoms. Any patient who has a cough for more than three weeks, who seems to recover rather slowly from an attack of 'influenza' or upper respiratory tract infection, who coughs up blood, who looses weight, who has dyspepsia, or bovine type who seems vaguely unwell.....in digestion may be a first symptom of tuberculosis' The other sumptoms are excessive fatigue, failure of appetite, rise of temperature in the evening, night sweating, husky cough and chest pain.

Ecology of infection, morbidity and mortality of tuberculosis.

The ecological interpretation offers the greatest promise in defining the causes and prevalence of tuberculosis. The intensity in the prevalence of infection and disease varies from region to region, unfavourable adaptation of man to his environment (i.e. environment of Tubercle bacilli, overcrowding of persons in a house or in a office etc.) results in infection and tuberculosis disease. In short, the paper concentrates on three major .techniques, of describing and measuring the causes of prevalence of infection, morbidity and mortality of tuberculosis disease in different parts of the world, which are given as under:

I. To examine the linkage between the Ecological factors and the spread of tuberculosis.

II. To highlight the Ecological variations and associated concentrations of infection, morbidity

and mortality of tuberculosis disease.

III. To examine if man can check or alter the spread of tuberculosis disease. The major ecological factors which affect infection and tuberculosis disease are as under:

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A. Natural Environmental Ecology

I. Terrain - Altitude and the nature of terrain generally affect the infection and tuberculosis disease; as an eminent British Geographer says, 'When the patient is in poor health or of poor physique however, the tissue loses its battle, infection spreads and eventually the patient dies. The lungs are helped in their battle by an abundance of fresh, specially mountain air, hence the building of vast sanatoria often in lonely mountain areas, where patient sleep whenever possible out in the open air'. Thus the areas of incidence of infection and mortality seemed to reary widely in their physical geographical character, specially the altitude and terrain. For example, normally the morbidity of respiratory and pulmonary tuberculosis is prevailing in every part of India, but the mountainous regions of the North revealed the lowest incidence of both the kinds of tuberculosis. The same results were obtained in the micro region of the lower Chambal Barin (Central India) where the high-risk areas from the view point of infection and tuberculosis mortality, are located in the low land area of Morena plain (10/1000 cases of mortality) than the upland areas of Sheopur (2/1000 cases of mortality).

II. Climate - The variation of temperature and moisture conditions are mainly responsible for the area! differentiation of the intensity of infection and the disease. For example the cold climate, with a mean annual temperature of 38 F. or lower, severe winter with heavy snow fall and short summer is disadvantageous for lungs. Even in Britain, the cold weather wind chill is disadvantageous for skin and lungs. Hence chill of cold air had been partly responsible for the growth of infection and tuberculosis disease in Britain. On the other hand, the temperate dry and sunny climates like prairies of North America are advantageous for lungs, human resistant and health. In the same way the hot and damp climate of Kerala (India) is disadvantageous for lungs and human health in comparison to the North-West-dry parts of India. Hence the rates of infection and tuberculosis diseases had been always higher (2.7 persons for thousand suffered from T.B. in 1961), than the rates of dry and sunny parts of North-West India (in Punjab 0.9/ 1000 persons suffered from T.B. in 1961).

The micro study of the Lower Chambal Basin (Central India) reveals that the sandy and dry soils of Morena and Dholpur plains are suitable for human health.....on the other hand the clayey moist alluvial soils around the tank areas of Sheo-pur plain are not suitable for health. In the clayey damp soil zone of high water table of Sheopur plain, the tuberculosis and rheumatism are the diseases where they have their strong grip (about 5 cases of morbidity per 1000 persons).

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III) Organism - (a) Bovine type of tubercle bacillus - The tubercle bacilli conveyed by raw milk are of course, of the bovine type. These are of similar virulence to human strains. Children are normally most likely to be infected. With an elementary mode of infection the primary lesion is likely to be in the intestinal tract, giving rise to tuberculous cervical adenitic. Netherlands, Britain, and in particular Scotland, formerly had an unenviable reputation for bovine tuberculosis.

From 1933 to 38, in Urban and Rural areas of Netherlands, when bovine tuberculosis was common in cattle, about 44% of non-pulmonary and 10% of pulmonary disease in children under 15 years of age, was of bovine origin. In the same way, in 1900, when bovine tuberculosis was common in cattle, about 10.4% persons of the total population in United Kingdom died of tuberculosis. On the other hand, in 1961 when dairy cattle were being freed from Tuberculosis, the farmers were helped to produce 'Tuberculin-Tested (T.T.) milk, the numbers of tuberculin-positive cows were decreased and the supply of pasteurised milk was steadily increased,. Then, only 0.62% persons out of the total population died of tuberculosis in United Kingdom. But these facilities are not available in most of the countries in the world. Therefore, higher intensity of infection and disease in comparison to U.K., is noted in most of the countries of the world. In developing countries like India, although the cows and buffaloes do not suffer from tuberculosis to the same extent as in Scotland as they live in open air and sunshine during most part of the year, yet due to the absence of supply of pasteurized milk and other facilities, the rates of respiratory cases per 1000 of population ranged from 2 to 7 in 1961. It reveals that the supply of pasteurized milk also plays an important role in determining the infection, morbidity and mortality of tuberculosis disease, as it is indicated here in the table below, (b) Human type of the tuberculosis bacillus. The infection in man from human tubercle bacilli is much more complex. The tuberculous infection can theoretically be acquired from patients who are discharging sinuses etc., but these sources are of minor importance. The persons who are coughing up infections sputum are worldwide and more numerous specially in South-East and South-West Asiatic countries. They are moving around in the community and worst of all, many do not know that they have tuberculosis, in halation is the commonest mod of entry of infection of tuberculosis disease. The bacilli are inhaled through 'drop-lets' ejected during coughing or through 'dust' contaminated by dried sputum. As a result, due to infection pulmonary tuberculosis is the commonest form of the disease in the world.

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THE EFFECT OF SUPPLY OF PASTEURIZED MILK (1970)
(Tuberculosis mortality rates per 100000 persons)

Countries consuming mainly pasteurized milk	Mortality rates	Countries consuming mainly non-pasteurized milk	Mortality rates
Australia	Under 0.31	Turkey	Under 2.2
U.S.A.	0.31	Mexico	2.2
Canada	0.32	Chile	2.3
New Zealand	0.33	Burma	*2.4*
Finland	0.3^	Phi1ippines	2.5
Norway	0.35		About
	About	INDIA	2.5
Sweden	0.35		

(Based on W.H.O. data)

With the increased facilities, now available in Great Britain, U.S.A., Canada, Norway and in certain parts of Australia, it is possible to isolate all diagnosed cases of infectious tuberculosis and to make almost all of them non-infectious. Thus these facilities are mainly responsible to get rid of most of pulmonary tuberculosis in these countries. It made a dramatic fall in infection, morbidity and mortality rates of tuberculosis disease specially in the Western European and North American Countries, as it is indicated below in the table.

B. Cultural Environmental Ecology

a) Host-Resistance

The factors affecting host-resistance are numerous. Although all of them are important and linked with the resistance and infection, yet they cannot be discussed in detail. A few important factors have however been individually dealt with hereunder.

I. Racial Characteristics - Resistance to infection and tuberculosis, in human beings differs from race to race and region to region. For example the Urban Englishman is less susceptible (Morbidity cases 0.5 per 1000 persons) than the Highlander or the rural Irishman (morbidity cases 1.2 per 1000 persons). In the same way Jews have the largest and the most extensive exposure to tuberculosis. In them the rates of morbidity and mortality are the lowest (1.5 morbidity and 0.1 mortality per 1000 persons). In India, the Punjabi have the most extensive exposure to the disease, hence revealed the lowest cases of respiratory tuberculosis (below 2 morbidity cases per 1000 persons) in India. Thus the racial variations are partly responsible for the areal differentiations in the rates of infection, morbidity and mortality of disease.

NEWLY REPORTED TUBERCULOSIS INCIDENCE CASES RATES PER 10000 (in 1969-70)

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The countries having facilities of isolation of infected cases		The countries having no isolation of infected cases	
U.S.A.	Under 2.00	Turkey	Under 17
Norway	2.00	Japan	17
Australia	3.00	Burma	18
Britain	4.00	Ceylon	19
Canada	5.00	India	20
Sweden	6.00	Malaya	Above 20
Netherlands	Above 6.00		

(Based on W.H.O. data)

II. Age Structure - Age structure is one of the important factors from the view point of variations in resistance. Children from the ages of five to twelve are much less susceptible, but during puberty, adolescence and young adult life, the registance is again lowered, progressive pulmonary tuberculosis is the main danger at these ages. Sex in relation to age, plays a great role also. Resistance in woman is lowest in young adult life and rises sharply after the age of forty, but male susceptibility remains much the same throughout life, and at the present time the majority of male mortality are in old men.

III. Nutritional Level - Resistance is lowered by starvation or under nutrition. There is some evidence that fats and proteins are important in protection. Meat, fish, eggs, milk, butter and cheese are generally accepted as protective foods. It is also proved that protein and vitamin D deficiency favoured the persons more susceptible to tuberculosis than others. Thus differences in the nutritional level of population, living in different regions of the world,, are responsible for the geographical variations in tuberculosis intensity. For example, the nutritional level in Asiatic tropical countries is" much lower than the North American countries. Thus it is one of the factors which caused higher rates of infection, morbidity and mortality in the Asiatic tropical countries than the North American countries (Table 1).

IV. B.C.G. Vaccination- B.C.G. (Bacilli Calmette-Guerin) Vaccine has derived its name from its discoverers Drs. Calmette and Guerin, the two French Scientists. The aim of Vaccination is to increase the patient's resistance by an artificial primary tuberculosis infection manner. The number and percentage of vaccinated cases differs from country to country which is partly responsible for the variations of infection, morbidity and mortality in different countries of the world. The vaccination is recommended to be used for gaining immunity against tuberculosis.

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V. Occupational Conditions - Occupations involving exposure to Silica (SiO_2) lower the resistance to tuberculosis. Working conditions in mica mining, Gold mining, Coal mining and stone quarrying lower the resistance of persons and are deeply linked with tuberculosis. Chronic alcoholism has the same effect, and barman have a high incidence of tuberculosis. In other occupations (specially in tropical S.E. Asia) such as printing, shoe making and repairing, tailoring, raw cotton works etc., lower the resistance. Being relatively sedentary they attract, infection in poor health, and because infectious patients are liable to remain longer at these works, the incidences of tuberculosis are very common.

C. Ecology of Associative Occurrence.

I. Disease - Some of the chronic diseases favour the growth of tuberculosis. The most important of these are chronic fever and diabetes mellitus. Besides, the significance of physical and mental strain is not less. It is noted that many patients seem to develop tuberculosis after a period of mental strain and worry. In India, due to the lack of medical facilities, poor diet and low standard of living, most of the patients of chronic fever and diabetes mellitus, due to the inadequate treatment and old chronic disease turn into the patient of tuberculosis.

II. Overcrowded Dwelling - The size of the infecting dose is likely to be much greater if an individual is living in an overcrowded dwelling in close contact with a patient who is coughing up large numbers of tubercle bacilli, especially if that patient does not know he has the disease and is taking no precautions against infecting others. Due to the over population, overcrowded dwelling and illiteracy, the size of the infecting dose in most of the countries in monsoon Asia (specially India) is much greater than those of Western European countries and U.S.A. At present, in Britain or in U.S.A. most people are infected at some time in their lives, but of those who do become infected only a relatively small proportion develops clinical disease. While in various developing countries of Monsoon Asia, where dense population and inadequately constructed housing is a common phenomena, a larger proportion of infected persons develop clinical tuberculosis.

III. As a Social Disease - An unknown infectious case may do most damage by infecting others. The unknown infectious cases in the course of their work can come into contact with a large number of people in the day and infect them. For example the hotel food servers, bus conductors, shopkeepers, hair dressers, barman, cinema attendants, school teachers, ticket collectors, dentists, doctors and all hospital employees can socially be infected.

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Little has been done in this direction even in the developed countries like Britain, Soviet Russia, U.S.A., Canada and Australia. This is one of the most important tasks that lie before the preventive and social medicines.

Because this is the main source of infection in most of the countries of the world; specially in the countries of South-Asia.

IV. Space and Ventilation - It is observed that in the cold countries in winter no one in going to endure draughty ventilation without adequate heating. Thus in the cold countries, (like Scotland, Sweden, Norway etc.) in the absence of adequate warmth and ventilation, the houses, places of work, cinemas, theatres and other places of entertainment are also the sources of infection. On the other hand, in the tropical countries like India, Ceylon, Burma etc., there is a problem of infection and disease due to heat, inadequate space and ventilation. Micro study shows that in the tropical areas the ventilation in houses is a must, because there is an association between the ill-ventilation and lung diseases. For example, in the Lower Chambal Basin (Central India), the cases of tuberculosis and rickets are partly due to ill-ventilation, dark and compact houses, and multi-purpose use of the houses.

Spread of infection is less likely if a factory population is working in a large numbers of small rooms than if every one works in a single large hall. An unknown case will come into contact with many more of his fellow-workers if they all work together in a large hall.

V. Spirituous Liquor and Smoking - Use of spirituous liquor and tobacco is disadvantageous for human health. There are many countries in the world, where local alcoholic spirit taking is common specially in lower income groups. It is very harmful for the lungs. It also encourages coughing and infection. In the same way smoking is also not good for 'health. It is very disadvantageous for lungs. In spite of harmful results, the usage of spirituous liquor and smoking is still prevailing in the world and caused the spread of tuberculosis. In India, the spirituous liquor and smoking are The major causes of spread of tuberculosis in the persons of lower income groups (i.e. in the Rickshaw drivers, Hair dressers mansons, Shoe makers etc.). The spirituous liquor and smoking are also one of the factors of tuberculosis spread almost in all countries of the world.

VI. Treatment Chemotherapy - Of all the ecological factors, treatment plays the greatest role in determining the morbidity and mortality rates in the world. But the efficiency of treat-ment differs from country to country which is responsible for the variation in the rates of morbidity and mortality in different countries of the world. At present it is found out that, by

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using proper combinations of two or more drugs, drug resistance can be avoided in almost all cases. Now a days there are three standard drugs whose efficacy is generally accepted. These are streptomycine Iscniaid or isonicotinic acid hydrazide (some times known as INAH or INH), and para-amino salicyclic (PAS). Other drugs are used only when the previous Chemotherapy is unsatisfactory or the primary infection is with a resistant organism.

Before 1940, when Chemotherapy was not available, even in the technically advanced countries like Britain and U.S.A. about 50% of all cases of tuberculosis died of the disease; which is reduced to 1% in 1961. This fall in mortality rates was due to the introduction of effective use of Chemotherapy. On the other hand, due to the lack of effective use of Chemotherapy, Chile, India, Pakistan, Thailand and Burma revealed 40% mortality out of the total cases of tuberculosis disease in 1961.

CONCLUSION

Thus the geography of tuberculosis gives a description of the assemblage of known problems of infection, morbidity and mortality in an area, as related to the physical, biological and cultural spheres of the environment. This helps to identify those medical and ecological factors which are area wide, those which are centred in any area or segments of the country.

Success in solving the problems will not be achieved until interdisciplinary co-operation is established to analyse and understand them more fully than had been the case in the past. The geographers may contribute significantly to this work, for the majority of the factors involved, have spatial distributional conditions. The macro-scale approach, which is presented in this study and the wide-ranging over all view is maintained. But in terms of planning for action it needs to be linked with investigations-at a more detailed micro-scale.

The prevalence of tuberculosis is markedly higher in the lower income groups of the world. It would appear that the diseases is largely the result, excluding the effects of nutrition, of infection from the unknown cases of tuberculosis disease. Raw milk consumption also appear to have played a similar role. We must hope that pasteurization of milk, rising living and housing standard, health education, rising nutritional level, environmental sanitation, extension of B.C.G. vaccination and medical facilities will certainly check up the infection, morbidity and mortality of tuberculosis, with all these remedies the disease will still remain a problem however, until the discovery of unknown cases of tuberculosis comes to be a popular habit in a community.

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We can very easily kill our children or mother unless we understand the dangers of over-crowded dwellings or usage of spirituous liquor, and unknown patients of tuberculosis in the society and bovine bacillus. Therefore the most important task we can do at present is to look at some of these intricate geographical relationship and problems, the solutions of which will reduce, the infection, morbidity and mortality of tuberculosis in the world. Further, we sincerely hope that a close co-operation and mutual assistance specially among physicians and geographers will contribute to the eradication of tuberculosis to a greater extent.

Study of the ecological associations, thus reveals alternative points of intervention for handling known tuberculosis problems and indicates where future problems might emerge. In view of paucity and quality of data and Short span of time the study is exploratory and tentative in its findings and conclusion. However, within possible limit of reliability it clearly indicates and highlights the regions or countries which call for greater and immediate attention in any future programme of health planning in the world. In short, the ecology of tuberculosis provides one of the essentials needed for planning a description of what places are like in terms useful to health planning.

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