MEDICAL GEOGRAPHY : ITS ROLE IN DISEASE CONTROL AND HEALrn DEVELOPMENT IN AFRICA WITH PARTICULAR REFERENCE TO ETHIOPIA

H. Kloos*

ABSTRACT

This paper attempts to review selected medical geographical studies with objective of providing an overview of the sub field to geography and suggesting possible areas of collaboration with epidemiologists and public health officials in disease control programmes in Africa, particularly Ethiopia. A combination of: (1) complimentarity between medical geography and epidemiology; (2) the appropriateness of geography in analysing man-environment interactions; (3) the broad range of topics in disease ecology and health care delivery and utilization covered by medical geographers; (4) the need to evaluate aspects of the physical and socioeconomic environment in socialist Ethiopia for planning purposes and; (5) existence of viable programmes in medical geography in other African countries warrant consideration of this applied discipline in collaborative and interdisciplinary disease control programmes in Ethiopia.

INTRODUCTION

Medical geography clearly overlaps with and supplements epidemiology .Whereas epidemiology is concerned primarily with the distribution of disease and physiological conditions in populations and the underlying factors of such distributions, geography is the study of spatial patterns & processes & the identification & explanation of links between humans and the environment. As a sub field of geography, medical geography focuses on the spatial distribution of disease and health care, with associative analyses of environmental (physical, biotic, social and cultural) influences. Although geographic variation is one well recognized factor in epidemiology , few epidemiologists are educated sufficiently in the areas of climate, vegetation, soils, land use, population distribution, culture, social organisation and statistical and methodological techniques that geographers commonly use in spatial analysis. Most medical geographers, on the other hand, know little about disease processes and pathogenesis. The dialogue between researchers in these two disciplines has been relatively weak in the past in spite of "the complimentarity between epidemiology and geography" and "the potential intellectual and social benefits of interdisciplinary collaboration have not been realized" (1). Recent approaches in health care and disease control world-wIde, particularly Primary Health Care, and the persistence of drought and other environmental problems in many African countries can provide the rationale and the necessary opportunities for increased interdisciplinary research and training not only involving epidemiologists and medical geographers but also medical sociologists, medical anthropologists and medical economists. The World Health Organization, recognising the need for interdisciplinary collaboration between the biomedical and social sciences, has established a socioeconomic section as part of the Special Programme for Research and Training in Tropical Diseases (2).

*Department of Geography, College of Social Sciences, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia.

The objectives of this paper are to:

(1) give a brief historical account of the development of medical geography;
(2) discuss the conceptual basis of medical geography in order to answer the question "Why can medical geography contribute to disease control and health development?";
(3) review selected medical geographical studies, mostly by geographers, in Africa and at the same time discuss some methodologies and techniques commonly used by medical geographers to answer the question "Where and how can medical geography contribute to disease control and health development?"; and,
(4) suggest some areas for further research.

HISTORICAL DEVELOPMENT AND PRESENT STATUS OF MEDICAL GEOGRAPHY

In a review of the development and present status of medical geography, Pyle (3) noted that although interest in the study of the geographic distribution of disease dates back, at least, to the Greek Physician Hippocrates (5th century B.C.), the term medical geography did not come into use before the 18th century . In the mid19th century, after Pasteur's discovery of disease causing organisms as the basic cause of infectious disease, the dominance of the germ theory of disease causation focused great attention on disease agents and resulted in the neglect of man in the totality of his environment. The development of highly successful pesticides and pharmaceutical drugs also delayed the adoption of a broader approach to health analysis based on man environment interaction. Since the 1950's, adoption of a broader approach to health analysis has benefited medical geography. Thus a combination of:

(1) environmental systems analysis of health problems;
(2) the appearance of drug-resistance in pathogens and insecticide resistance in mosquitoes and other vectors;
(3) sharp increases in disease associated with industrialization and urbanization, such as cancer and cardiovascular diseases; and,
(4) difficulties in meeting health care and nutrition needs in developing countries have resulted in a shift of emphasis toward holistic medicine.

As a result, both the social and physical environment, as well as human behaviour, nutrition, immunity and health care were finally recognized as interacting factors in health and disease (4).

Although differences in the scope of medical geography and techniques used in different countries do not permit a single definition of this discipline, the one offered by Hunter (4), as "the application of geographical concepts and techniques to health-related problems" is in agreement with most work by medical geographers. Since its development as a distinct discipline in Europe, the U.S.S.R., the United States and J apan during the 1930's, medical geography has been added to the curricula of geography departments in most industrialised countries. More recently programmes in medical geography have been developed in African and other countries, including Mexico, India, Kenya, Zambia, Nigeria and now in Ethiopia, and geographers are increasingly becoming involved in health-related research in developing countries (5). A recent bibliography lists more than 1,800 references of medical geographical works world-wide (6).

In Ethiopia, the monograph by Schaller and Kuls (7) and papers by Kloos (8-10), Roundy (11-13) and Yelizarov (14) are recent contributions to medical geography but medical geographical writings in this country can be traced further back in time. In the 19th century several physicians attempted to analyse the geographic distribution of infectious diseases in different parts of Ethiopia (15) and knowledge of the altitudinal distribution of malaria, typhus and acute upper respiratory infections is reflected in the treatises of debteras (16). Although these and other studies, mostly by physician/epidemiologists, revealed marked spatial variation in disease occurrence and transmission, few of them revaluated new opportunities and problems in disease

control and health development resulting from the Ethiopian Revolution. "For example" changes in health infrasturcture and priorities in socialist Ethiopia, with an emphasis on disease transmission and provision of and access to health care (17). Recurrent droughts and famines since the early 1970's add yet another dimension to the present health and disease situation in Ethiopia.

CONCEPTUAL BASIS

Essential to an understanding of the conceptual basis of medical geography is the realization that geography is an i interdisciplinary and synthesising discipline. Moreover, it is generally accepted that the environment and disease as well as health-seeking behaviour and health care delivery are interacting systems. Because geography is strongly synthesising and eclectic, it is committed to interdisciplinary cooperation with other social and environmental sciences as well as the biomedical sciences. As a discipline that bridges the social and environmental sciences, geography derives its integration and coherence from systerns-related analysis of man-environment interaction in space and time. Disease may be defined as an interaction of disease causing agent, host and environment (physical, biotic, social and cultural) (18). Disease control measures ideally focus on breaking the weakest link in the transmission cycle or causal chain but this is only possible when all relevant geographic, economic, sociocultural, logistic and administrative factors in a given area are studied comprehensively. The reviews by Knight (19), Mead (20), Howe (21) and Learmonth (22) of medical geographical studies wit4 a disease ecology perspective examine basic conceptual and methodological issues in infectious and non-infectious disease ecology and distribution.

In addition to disease ecology , health care planning, delivery and utilization have received much attention by medical geographers in recent years. Central place theory and related concepts. of locational analysis that allow for consideration of such factors as travel distance, duration and cost of travel to health facilities, their size and cost of treatment are all commonly evaluated in the development of location/allocation models (3). Unfortunately, nearly all existing models were developed in countries depending primarily on modem medical systems and few geographers have attempted to study health care in Africa, where the majority of the population in most areas continues to use primarily traditional medicine. Good (23), noting that traditional medical systems have been neglected by geographers, outlined areas of research that need attention.

REVEIW OF STUDIES AND METHODOLOGICAL CONSIDERATIONS

An increasing number of sub field specializations in medical geography have been recognised. Only some of the subfields are treated here. They were selected on the basis of some of the most pressing public health needs in Africa, particularly Ethiopia. Other sub fields are biometeorology, mental health and environmental pollution. It is well accepted, however, that the complexity of most health problems and the difficulties usually encountered in their solution defy simple classification and the categories identified here should be viewed as preliminary .

1. Historical: Historical studies of the occurrence and diffusion of disease in developing countries, long neglected due to scarcity of published information, are increasingly being pursued by geographers and other social scientists. The broad surveys by McNeill (24), Ackerknecht (25) and Henschen (26) of the history of disease distribution world-wide Patterson's (27) Health in Colonial Ghana: Disease. Medicine and Socio-Economic Change. 1900-1955 and Hartwick and Patterson's (28) Disease in African History: An Introductory Survey and Case Studies represent major contributions to our knowledge of health development in Africa. Papers by Hunter (29), Kwofie (30), Good (31) and the monographs by McKelvey (32) and Stock (33) also provide much needed information on the changing geography of diseases in Africa and develop useful methodologies. In Ethiopia, Pankhurst's (34-36) reviews of travel accounts and chronicles and Schaller and Kuls' (7) disease atlas indicate the impact and persistence of major diseases in this country.

2. Infectious Diseases: Several infectious diseases, including trypanosomiasis, measles, tuberculosis and leprosy, although reduced in prevalence in many areas, still constitute a major drain on human and economic resources. Schistosomiasis, malaria and some forms of fllariasis are increasing in many endemic areas. Ecological upsets related to water resources development, population movements, development of drug resistance in Plasomodium spp., insecticide resistance in Anopheles and the adaptation of fllariasis-transmitting mosquitoes to sewage and latrines in cities and other man-made habitats are major factors in this alarming situation (37-41).

In non-vectored infectious diseases, medical geographical studies typically focus on population movements and density indices for analytical purposes due to the person-to-person mode of transmission. Ferguson and Leeuneburg (42), in one of the first studies of the dynamics of non-vectored diseases in Africa, are working toward a simulation model of measles in a rural area of Kenya. In vectored diseases, the need to understand the requirements of appropriate vectors and intermediate, reservoir and definitive hosts in the disease transmission cycle necessitates the use of broader systems analysis. In schistosomiasis, for example, it is imperative, for control purposes, that the life cycle and ecology of both the parasite and the snail intermediate host, demographic, socioeconomic and behavioural aspects of the human host as well as the interactions of all three subsystems in space and time be determined (38). In Ethiopia, water temperatures in areas above 2,000 metres are generally too low for the survival of Schistosoma mansoni cercariae and too high for the survival of the Biomphalaria pfeifferi snail host below about 800 metres, where the more tropical snail Bulinus abyssincicus trans mits S, haematobium in swamps rather than streams and canal systems (9, 43). In our study of schistosomiasis in the Awash Valley between 1973 and 1976, we were able to predict the geographic distribution of both types of schistosomiasis, based on climatic and agriculturaldevelopment parameters and population movements (8), as confirmed by recent epidemiological studies (44). Studies of the flight pattern of Simulium sp. in relation to onchocerciasis prevalence (45, 46) and of the spatial correlation between cracking black soils, habitat preference of the sand fly vector and leishmaniasis prevalence in southwest Ethiopia (47) also illustrate the predictive value of medical geographical research. The geographic distribution of leishmaniasis in Ethiopia is probably less understood than that of any other vectored disease (48).

The appearance and spread of drug resistant malaria in East Africa and pesticide-resistant vectors of malaria, onchocerciasis and trypanosomiasis in various parts of the tropics (49-51) is another problem in need of medical geographical research. Beales (37) recommended mapping of the changing geographical distribution of drug-resistant malaria as a means of monitoring its diffusion and as an aid in the development of appropriate control measures. International, regional and local population movements (5, 12, 52, 53) all may result in the introduction of resistant parasites into Ethiopia, where the few studies to date have failed to detect chloroquine resistance (54). Conceptual and methodological issues in the study of population movements in relation to disease transmission and control were discussed by Kloos (55), Mayer (56), Meade (57) and Prothero (58). An equally relevant area of man-made disease is the spread of schistosomiasis and malaria in economic development projects The creation of large reservoirs and canal systems and congregation of large human populations with their attendant housing and sanitation problems pose major challenges to planners and health officials (10, 59-61). Plans call for irrigation development in all major river basins in Ethiopia (62), in most of which malaria and schistosomiasis are already endemic.This requires that well designed epidemiological and medical geographical studies be undertaken during the planning stage of agricultural and hydroelectric projects if these and other water borne diseases are to be controlled (2, 63).

3. Chronic, Non-infectious Diseases: Disease associated with aging, industrialization, urbanization and related stress and pollution, sedentarization, dietary changes and modem life styles in general, including cancer, heart disease, bronchitis and diabetes, are most prevalent in industrialized countries. They have received relatively little attention by medical geographers in the developing world, although urban populations are increasingly affected. Analysis of extensive hosptial data shows that African urban populations have significantly higher morbidity and mortality from cancer of the colon, hypertension, diabetes and heart disease than their kinsmen in rural areas who adhere to a traditional subsistence way of life (64). Several other non-infectious disease, however, including liver cancer, tend to be more prevalent in rural populations consuming moldy foods (aflatoxins) and certain traditional herbal medicines (65, 66).

Naturally occurring geochemical consistuents of soils and water are increasingly associated with chronic diseases (67). In Ethiopia's Rift Valley use of deep well water containing high concentrations of fluoride has resulted in severe forms of fluorosis (5, 43). In the highlands of Ethiopia, Kenya, Uganda and Cameroon, where red latosol soils of basaltic origin prevail, swollen feet and lower legs of barefooted rural people have been associated with absorption, through the skin, of iron oxide, alumina and silica, which are thought to produce a toxic reaction in the lymphatic system (68, 69). If this hypothesis can be proven to be correct, then simply the wearing of shoes could prevent this type of elephantiasis. Cancer, cardiovascular and many other chronic non-infectious diseases are mainly caused by a combination of environmental factors, many of which remain to be identified. Statistical analysis or spatially patterned disease occurrence and environmental factors may reveal causal relationships (70).

4. Nutrition: Although the nutritional state of an individual or a population has a significant impact on physical and mental development, well being and resistance to infection (71), medical geographers have paid relatively little attention to the geography of malnutrition and dietary patterns (72). May's (73-77) extensive work on the regionalization of dietary and nutritional patterns in Africa, Newman's (72) re;view on protein/calorie malnutrition in Sub Saharan Africa and Annegers' (78) work in West Africa provide a conceptual basis for medical geographical studies of diet and nutrition at the regional level. A valuable bibliography of cross-cultural dietary patterns comes from Freedaman (79). Grivetti (80) indentified several themes that need further attention by geographers, including religious food taboos and the relative roles of culture and the physical environment in famines. In-depth studies of the food ecology of individual ethnic groups can provide culture-specific information on food needs and nutritional levels in different areas and communities (81, 82). The seminal work by Simoons (83,84) on the geography of specific meat, fish and milk avoidances in different parts of Africa has many nutritional implications and should be useful to development planners and relief organizations providing food aid to .disaster areas. The avoidance of fish and fish products by many pastoralists in Africa, including the Afar, Somali and some Oromo groups (83, 85) and the preference for teff and ensete in different parts of the highlands are more obvious examples from Ethiopia. The importance of food habits research is indicated by the recent delay of food aid by voluntary organizations to the drought stricken areas in Wolayta Awraja, partly due to lack of information on food preferences of the local population (86). Moreover, diets normally change slowly and the use of new, unaccustomed foods has been associated with various health effects (85, 86).

Seasonality of food shortages, malnutrition, infection and mortaiity is increasingly considered as an important aspect of rural poverty (88, 89). The effects of more persistent drought conditions also require that medical geographical research findings be applied to solving pressing health problems (85, 90, 91). Measuring food intake(92) and nutritional level in populations (93) continue to be controversial issues in empirical studies. In spite of these methodological problems, medical geographers increasingly use anthropometric and other measurements of nutritional level (94-91).

Numerous factors affecting the avai1ability and consumption of foods and nutrition in Ethiopia remain to be studied in depth. They include economic policy (98), transportation systems and other distribution factors, such as domestic and foreign trade and markets, pricing structures and the development of production systems along socialist lines. Recurrent drought and famine in several regions (99, 100) constitute a serious health problem to the solution of which applied climatologists, agricultural geographers, regional planners and others can make contributions. For example, through collaborative studies with the Relief and Rehabilitation Commission (RRC), which Janitors food supply in drought prone areas, geographers may help to delineate food deficit areas. A similar approach was successfully used in Nigeria (101).

5. Health Care Delivery: The spatiality of health care se1Vices in regard to planning, delivery and utilization, has become one of the major sub fields of medical geography (3, 102, 103). Primary objectives of studies in these areas are:

(1) optimum location of all kinds of health care facilities, ranging from rural health centers, clinics and drug shops to large national teaching hospitals, in order to minimise patients' travel time and cost; and

(2) optimal allocation of new or added hospital beds and medical services for local, regional and national facilities. Planners of health care facilities must consider: (i) the range of services to be provided; (ii) the size of the catchment area of any given medical facility; (iii) the size and distribution of the potential patient population (usually dermed as the 'population at risk') as determined from their demographic structure and the prevalence and incidence of specific diseases; and (iv) anticipated population changes due to natural increase or decrease and migration.

The location of health practitioners, whether physicians, dentists, midwives, village health workers or traditional healers should be known, since this is an important factor in the efficiency of health care delivery Equitable distribution of medical services has not been achieved in any country but discrepancies between population distribution and accessibility to medical care are particularly pronounced in Africa (3, 5, 104).

Most studies of health care services utilization have considered distance, time and cost of patients' travel, type of facility as well as cultural and organiztional factors. It is increasingly recognized that broader conceptualization of health-seeking behaviour that takes into account the various steps of the illness behaviour process is needed. This consists of:

(1) perception of the severity of illness,
(2) determination of available treatment action sets,
(3) assessment of treatment plans and benefits,
(4) analysis of treatment costs and net benefits, and
(5) selection of a treatment plan (105,106).

The presence of two basic medical systems in Africa, the traditional and modern or consmopolitan types and marked variation in the geographic distribution of diseases in individual countries. require the development of more holistic and culture-specific systems of health services in agreement with the Primary Health Care approach (107-111). Although the modern system is generally most developed in urban areas and the traditional system continues to meet the health needs of the mcliority of rural people. traditional medicine is still widely used in large African cities. including Nairobi and Addis Ababa (112. 113).

Major geographical problems faced by health planners include proper evaluation of the distance factor in the utilization of health care. high population mobility and low density in areas of pastoral nomadism and migrant labour (114-119) and absence of national census data in several countries. Geographers. in collaborative studies. may make important contributions to the study of distance and population parametres.

A third system of health care in Africa usually described as the transitional system. has received little attention by social and medical scientists. illegal drug peddlers. injectionists and women carrying out abortions are some of the practices constituting and apparently widespread although unofficial system (120-122).

Traditional Ethiopian medicine (113,123-128) and the modern system (129-132) largely maintained their polarized po.sition in the past with few attempts at integration. The new 10-year Plan of the Ministry of Health emphasises primary health care and provides for the inclusion of certain aspects of traditional medicine in health care delivery .A revised health policy along with infrasturcture now in place in rural areas, particularly in farmers', women's and urban dwellers' associations, may form the basis of a spatially more efficient national health care system. As part of this ambitious programme of health stations and health centres is to be increased between two and three fold. Moreover, one community health agent and one traditional birth attendant are to be trained for each of the approximately 35,000 peasant associations by 1990, with community participation as an important ingredient (133). Location and staffmg of the new facilities will have to be based on the usual location/allocation parameters discussed above.

6. Data Measurement and Presentation: Mapping of diseases, their vectors, hosts and environmental paramtters is generally considered the first step in analysing medical geographical data. All mapping techniques commonly used in geographical research, including dot, chloropleth, isopleth, trend surface, interactance and computer maps, cartograms, diagrams and graphs, have been used (3, 134-136). McGlashan outlined some of the difficulties facing medical geographers analysing disease distribution data in Africa, particularly lack of adequate and reliable information. Stimson (137) urged geographers to pay greater attention to data reliability , particularly of statistically aggregated data. Commonly used methods of mathematical scaling, essential for quantifying and comparing health within and among populations, and derived from epidemiology , were reviewed by pyle (3). Computer graphics can greatly increase speed and accuracy of statistical mapping. Particularly geographical associations between health related and environmental variables and service are studies incorporating information on patient origin and time/distance of travel are effectively carried out with computer assistance. Spatial correlation of relevant environmental and disease variables may assist in elucidating new 'causal relationships in cancer and other non-infectious diseases. Data can be stored and continuously updated and edited for recall to produce maps showing changing disease situations. Lack of adequate and comparable data, as well as their high cost, however, have limited the application of computer graphics largely to extensive or continuous mapping operations in a few countries (3, 138, 139).

Remote sensing is a potentially useful technique in medical geographical research. Both geographers and epidemiologists have used it to predict vector occurrence and disease transmission. Cline (140) attempted to predict risk of hookworm transmission in Central American communities based on soil type, degree of shade cover, type of agricultural activities, altitude and slope as interpreted from aerial photographs. Recently, Chiness geographers associated changes in water regime and beach development in lakes with the distribution of Onchomelania snails, transmitters of Schistosoma japonicum in East Asia (141). Imagery available in Ethiopia could be used to define vegetation zones, geological structure, drought conditions and wetlands such as swamps and land use/settlement patterns conducive to vector breeding and thus disease transmission.

Modeling can play an important role in predicting the spread of diseases and evaluating the impact of individual control measures and their cost effectiveness. The transmission and diffusion of infectious and non-infectious disease and the incidence of malnutrition are the result of complex interactiot:ls in the physical, biotic and human environments as discussed above. The parameters selected for study will vary with each disease, from area to area, season to season, by disease prevalence and intensity, transmission characteristics, the stage of control campaigns and availability of resources. With changing situations, interventions will also have to change. Models can monitor inputs and outputs in this dynamic context, clarify decision making and thus assist in evaluating the effectiveness of disease control programmes. However, before computer utilization in disease modeling and rigorous quantification can become
useful it is necessary to develop reliable qualitative models (22, 142).

CONCLUSION

This review indicates the potential contribution of medical geography to the conttol of tropical diseases and the development of health in Ethiopia and other African countries. Ethiopia, due to its highly varied physical/biotic and human environment, the restructuring of its health care system and far-reaching socio-economic changes in the last ten years, offers particularly many opportunities to motivated scholars. What seems to be more urgently needed now is:

(1) increased awareness among geographers and other social scientists so that they can effectively contribute to national health development;
(2) the development of relevant courses in the respective curricula and
(3)greater interactions between social and biomedical scientists.

The need for social science input is increasingly recognised by public health officials (143). However, for social scientists to be most effective, it will be necessary that traditional attitudes that have resisted the multidisciplinary , collaborative approach worldwi de for many years be discarded by both social and biomedical scientists.

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