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EPIDEMIOLOGICAL RISK STRATIFICATION OF MALARIA IN THE AMERICAS

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During the last years, malaria had a significant increase in Latin America, emerging again as one critical health problem in the Region of the Americas. More than 1.04 million new cases were reported in 1990. This resurgence of malaria needed a comprehensive strategy for its prevention and control. National malaria control programs recognized the epidemological stratification of malaria as a valuable method to assist them in the recognition of local variations and factors that specifically contribute to the level and intensity of transmission in critical malarious areas. Also it serves as a useful instrument for the selection of needed malaria prevention and control activities. The principal feature of this approach is to provide a dynamic and ongoing process for assessing the epidemiological importance of different risk factors (socio-economic, ecological, organization of health services) in malaria transmission. Health interventions are based on this assesment and are aimed directly at the reduction or elimination of the identified risk factors operating at the local level. Intersectorial co-participation and the integration of malaria programs in local health services are also important aspects of this public health approach.

Key word: malaria – epidemiologic methods – risk factors – local health services

Beginning in 1987, over a million new cases of malaria were reported each year in the Region of the Americas, with the figures reaching 1.1 million in 1989 and 1.04 million in 1990. These numbers reflect the intensification of malaria transmission that took place during this period.

This resurgence and aggravation of malaria during a time of socio-economic crisis has made it necessary to review and adjust the strategies aimed at malaria prevention and control. The purpose of this article is to briefly introduce some of the most important components of the epidemiological methodology that have been incorporated into the strategy of epidemiological stratification for malaria.

MALARIA SITUATION IN THE AMERICAS

During the last years, malaria became again one of the most important vector borne disease in the Region of the Americas. In 1991, the Region had 21 countries reporting the presence of malarious areas and malaria transmission. According to the malaria control programs reports approximately 278 million people are living in their malarious risk areas. As showed in Table, since 1987 more than a million cases of malaria have been reported every year in the Americas. In 1990, 1.04 million new cases of malaria were reported, reflecting the critical status of malaria transmission (PAHO-WHO 1990, 1991).

Examining the malaria situation in the Americas, the data on Table shows that malaria prevalence remained practically stationary during the 1970s. However, during the eighties this situation had important drawbacks. In the presence of intense and rapid socioeconomic deterioration of large portions of the population, the remaining small active malariogenic areas of the Region had a domino effect in the dissemination of malaria.

Directed to the search of better ways to address this situation, countries have shown increased attention to the epidemiology of malaria and its relation and utilization to improve control programs. This interest has been stimulated by the critical need for a flexible and more reliable approach to be implemented for malaria control and prevention programs.

In many endemic areas, current strategies rely mainly on repetitive chemical control, which resulted in limited results. In conse-

TABLE

Malariometric rates of 21 countries of the Americas with active malaria programs

Year	Population[a]	Positive number BSE	API
1960	187,910	79,048	0.42
1965	216,852	243,259	1.12
1970	250,421	339,825	1.36
1975	286,403	356,196	1.24
1980	328,805	599,959	1.82
1985	369,556	909,162	2.47
1986	378,861	948,906	2.50
1987	386,252	1'016,327	2.63
1988	394,720	1'118,132	2.83
1989	403,267	1'111,732	2.76
1990	411,811	1'042,817	2.53

a: thousands; API; annual parasite incidence (per 1,000 pop.); BSE: blood smear examinations.

quence, health planners required a better understanding of the different major risk factors that determine the epidemiological heterogeneity of malaria distribution. This heterogeneity requires a more integrated approach that unite different interventions in the programs of control of malaria.

An example of an integrated strategy of the prevention and control of malaria is provided by the *epidemiological stratification approach.* This innovative methodology is an attempt to sustain population-based programs with flexible tools to target the control interventions. This approach arose from the realization that local assessment of risk factors involved in the process of transmission is an essential component for all effective programs. Also, it was discerned that in countries where malaria is a public health problem, there are insufficient financial and manpower resources to eliminate transmission by an indiscriminated single intervention method.

The principal premises of this approach relate to the understanding of the basic forces underlying the process of malaria distribution. It is claimed by several policy makers that rapid impoverishment of population, detrimental ecological changes and inadequate health services are the three major pivots of the malaria revival in the Region.

IMPOVERISHMENT OF POPULATION AND DETRIMENTAL ECOLOGICAL CHANGES

Stricken by drastic impoverishment and incentivated by migration policies that proved to be inadequate, large number of population movements occurred in the 1980's across the countries of the Region. Rapid growth of vulnerable populations settled in unbalanced areas resulted in resurgence of transmission of malaria and other communicable diseases. Search for job opportunities in the mining and agricultural sectors is associated with this internal migration related to malaria revival. Public policies to address this phenomena were poorly contemplated. Public authorities did not feel obliged to provide basic services such as adequate housing, piped water supply, sanitation or waste disposal facilities in the new settlements. In such settlements occur more than 60% of malaria incidence of the Region.

Since health hazards, such as the transmission of malaria are not randomly distributed among the population. Individuals belonging to low socioeconomic class and the vulnerable migrant groups have more probability to develop malaria than groups belonging in middle and upper socioeconomic status. For instance, in the migrant groups, lack of housing and adequate services gave rise to inadequate settlements prone to the dissemination of communicable diseases. Social parameters need to be used in the formulation of malaria control strategies. Same interventions may have different impact depending of the socioeconomic characteristics of the affected populations.

Many health policy makers have stated that in malaria programs, one single intervention may not be appropriate for the permanent control of malaria. Chemical malaria control is known to be short-lived and needs repeated applications, which is costly and troublesome.

Also, it caused in several areas the development of multiple insecticide resistance in the vector, thus leading to the use of newer and more expensive insecticides. For other professionals, there is a need for incorporating more environmental management measures which are safer to society and the environment, and may contribute directly to improved land and water management.

In summary, rapid growth of vulnerable populations settled in unbalanced areas resulted in great pressure and strain placed into ecosystem, social structure, and sanitation and health services. The concept and principle of social epidemiology should be thoroughly understood by health programs as an essential part of the strategy of malaria prevention control.

THE PROVISION OF HEALTH CARE IN THESE AREAS HAS BEEN DEFICIENT

The enormous burden that malaria had imposed on the malarious countries of the Americas has been translated in high demand for health care and the enormous cost in delivering control interventions.

In addition to structural socioeconomic disarray of the population, and the negative transformation of the ecology, health services have played an important role in the widespread of malaria in the Americas.

In general, health services have not succeeded in providing a rapid and effective response to the rampant activation of malaria. Health services in poorer areas systematically have a small expenditure ratio per capita and they neglect the provision of preventive interventions.

Health services are an important facet of the welfare of the population. The last years have witnessed in the Region a limited expansion of the services in the areas with highest health care need. Health service coverage for malaria high risk populations is far from been completed. However, one of the most important weakness of health care institutions is its limited resolutive capacity for addressing complex processes such as emergent malaria transmission . In spite of data problems, it is recognized that adequate diagnosis and timely treatment are still goals to be achieved by general health care systems.

It has been acknowledged that primary health care and community participation should be essential part of all health programs. In most countries, community participation is not an integral part of control programs. Also, administrative centralization still is hindering the process of providing better interventions and adequate health services. Undoubtedly, all factors mentioned above are important risk factors of malaria growth in the Region.

The knowledge of the epidemiological role of health care factors as determinants of malaria risk should be incorporated in the framework of malaria risk epidemiology.

EPIDEMOLOGICAL RISK APPROACH AND THE MALARIA STRATIFICATION PROCESS IN THE REGION OF THE AMERICAS

In Latin America, malaria stratification emerged as a strategic approach beginning in 1979 (OPS-OMS, 1981). In 1985, it was recognized as a strategy for making objective epidemiological diagnoses on which to base the planning of action for malaria prevention and control.

In the early stage, the regional control programs recognized stratification as a valuable instrument to be used in the planning of control activities. As a result, the control programs have made better use of available information, stressing the importance both of different malariometric indicators and of their relationship to various geographical and ecological characteristics.

Recently the epidemiological risk approach has been incorporated into the stratification scheme, serving as a basis both for the situational diagnosis and for decisions on intervention strategies. Some of the most important concepts of this approach are detailed below.

BASIC CONCEPTS OF EPIDEMIOLOGICAL STRATIFICATION

Definition of stratification – In the Region of the Americas, epidemiological stratification in malaria control programs has been defined as a dynamic and ongoing process involving research, diagnosis, analysis, and the interpretation of information which serves as a basis for the comprehensive and methodological classification of geo-ecological areas and population groups according to *malaria risk factors*.

A *risk stratum* is an aggregate of individuals and social groups located in well-defined geographical areas that share a similar hierarchy of principal risk factors. Consequently, the measures or interventions undertaken to modify them are similar within each stratum.

The main feature of this new strategy is an epidemiological study conducted on specific individuals and social groups of the *risk factors* that are responsible for the incidence of malaria at the local level. An understanding of the profile of risk factors at the local level assists in the selection of prevention and control measures.

In summary, the purpose of this approach is to establish an epidemiological hierarchy of possible specific measures or interventions that may be used to reduce malaria transmission by *eliminating or reducing the underlying risk factors.*

Accordingly, on the basis of the local epidemiological situation and its risk factors, an attempt is made to recognize the fundamental characteristics of the malaria problem, based on which specific interventions can then be developed, rather than general control measures.

THEORETICAL BASES FOR THE EPIDEMOLOGICAL STRATIFICATION OF MALARIA

(A) The main assumption on which the epidemiological approach of malaria stratification is based is the need to recognize the great social inequities that exist in the distribution of the risk of contracting and dying from malaria. The involvement of social factors in the resurgence of malaria transmission in the Region of the Americas has been clear and decisive. Several sections of this document refer to the various components relating to the social determinants of malaria. (B) Malaria transmission is a focalized process that is both complex and dynamic. The frequency and distribution of malaria depends on a combination of several *risk factors*, which, at the local level, contribute to the specific configuration of malaria morbidity and mortality and its corresponding risk profile. Failure to take into account the local epidemiological situation and the social and biological forces involved in transmission has prevented traditional control measures from having the expected and programmed impact in several countries of the Region. (C) Epidemiological methodology is flexible, which makes it possible to adjust it to the different socio-epidemiological situations and specific eco-geographies of the countries in the Region. (D) Characterization of the risk factors for the stratification of malaria necessarily involves both the socioeconomic and ecological dimension, as well as the organizational aspects of the health services.

The epidemiological methodology has important advantages in malaria stratification for several reasons, the most important one being that at each risk stratum it addresses the specificity of the transmission process and the risk factors that contribute to it.

This methodology provides basic information for the selection of control strategies that can be integrated into health programs-strategies whose fundamental purpose is not only to reduce the incidence of malaria but to *eliminate the specific risk factors for malaria* in the areas of concern.

METHODS FOR EPIDEMIOLOGICAL RISK STRATIFICATION

Stratification is an integrated diagnosis-intervention-evaluation process that optimizes the decision-making process. It can be summarized in the following steps: (A) Study of annual parasite incidence (API) and its secular trends in recent years, in order to identify priority areas. (B) Identification and measurement of malaria risk factors in priority areas or localities using the epidemiological risk research methodology. (C) Determination of malaria epidemiological risk strata according to a ranking of the most importance risk factors. (D) Selection of interventions aimed at reducing or eliminating the most important risk factors at each stratum. (E) Adaptation of the health services for the implementation of actions based on epidemiological risk stratification. (F) Identification of structure, process, and impact indicators, so as to evaluate the effect of each intervention. (G) Execution of specific interventions aimed at reducing or eliminating each risk factor. (H) (a) *Measurement of:* reduction in the risk of contracting or dying from malaria. The indicators are the specific rates of incidence and mortality; changes in the risk factors, measured on the basis of relative risk and percentage of attributable population risk. (b) Evaluation of each intervention according to the indicators of structure, process, and im-

pact. (c) Monitoring and adjustment of the process at all stages.

IDENTIFICATION OF PRIORITY AREAS

By studying the annual parasite incidence (API) and its secular trends in recent years, it has been possible to identify those areas in which antimalaria interventions have not been successful.

Based on study of the API and its secular trends, priority areas are defined as those in which an increase is observed in the incidence and/or in which this incidence is of considerable magnitude. Most countries of the Region with active malaria transmission maintain an API register and have identified areas at risk on the basis of this indicator.

STUDY OF RISK FACTORS

Within this approach, and in the context of malaria, a RISK FACTOR is defined as any variable or set of variables that bear direct relation to the incidence of malaria. More broadly, it may be defined as any characteristic, attribute, condition, or circumstance that increases the probability of appearance of, or mortality from, malaria at any given moment.

The risk of becoming infected of sick of malaria implies an increase in the probability of becoming infected or sick as a result of the presence of one or more risk factors.

The risk factors for malaria may be classified in different ways. However, any classification should include ecological, geographical, entomological, social, economic, and demographic factors as well as aspects relating to organization of the health services.

As it has already been pointed out, the epidemilogical classification of risk factors has as its objective the identification of those risk factors, from among the probable risk factors, that account for the increase and magnitude of malaria incidence observed in priority areas.

Any classification of risk factors should be based on the recognition of particular determinants that exist within: (a) priority geo-ecological areas, (b) exposed human groups and their living conditions, and (c) the structure and organization of the health services. These considerations are of great importance given that malaria is a local problem, and its characteristics and dimensions may differ from one place to another.

EPIDEMIOLOGICAL MEASUREMENTS OF RISK FACTORS

Stratification makes use of the three basic epidemiological measurements of risk: absolute risk or incidence, relative risk (RR), and attributable risk (AR).

The API (annual parasite incidence) is used as a proxy indicator of absolute risk. The denominator of this rate refers only to the exposed population in malarious areas. Its objective is to provide information regarding the intensity and extent of malaria in the human groups studied.

Relative risk (RR) estimates the strength of the association between the exposure to each risk factor analyzed and the disease itself. It indicates the risk of developing malaria in the group exposed to the factor under study in relation to the risk found in the group not exposed to that same factor. For malaria, the RR is defined as the ratio of annual parasite incidence (specific API) in the exposed group divided by the API in the group not exposed to the risk factor.

Through calculation of the RR it is possible to select those risk factors which occur most frequently in the transmission of malaria in a given locality or social group. This measurement makes it possible to determine, in the groups studied, the most important risk factors which by being eliminated will reduce the incidence of malaria.

Within this approach, it is of the utmost importance to be able to estimate the percentage of risk of the population's contracting malaria that can be attributed to exposure to a specific risk factor. For malaria, this indicator of risk, called percentage of population attributable risk (%PAR), expresses the proportion of disease in the population under study that is attributable to the factor in question, so that this proportion of malaria risk can be eliminated if this factor is eliminated or controlled.

DEVELOPMENT OF MALARIA RISK STRATA

The RR and %PAR are the indicators of malaria risk that this approach uses to assess

the importance of each risk factors. These indicators make it possible to set up the risk strata and to combine communities and social groups within the strata. These measurements provide the information necessary for ranking the risk factors according to their importance. In this way control programs can target their resources and interventions on the factors that are most prevalent and most strongly associated with the incidence of malaria in the population, so that control measures will have greater impact.

The %PAR indicates the percentage of risk that is due to each factor studied in the population. By extension, it also tells us the impact that the elimination or control of a given factor is expected to have on the incidence of malaria.

In conclusion, within this approach, prevention and control measures are selected on the basis of the hierarchy of risk factors found, according to the magnitude of their %PAR. One of the basic features of this approach is that interventions are aimed directly at the reduction or elimination of risk factors. It is hoped that, by eliminating the specific determinants of malaria, it will be possible to have a direct and lasting impact on the reduction of malaria incidence, which is the ultimate objective of the prevention and control efforts.

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