Intra-urbandiferentials in dengue distribution, Cuiabá, 2007-2008

Diferenciais intraurbanos na distribuição de dengue em Cuiabá, 2007 e 2008

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Abstract

Introduction: Cuiaba presents a huge number of cases of dengue in the endemic periods as well as in the cyclical epidemics. The aim of the study was to analyze the intra-urban differentials of the incidence in 2007 and 2008 relating them with socio--economical and environmental life conditions. **Method:** study of ecological approach using secondary data. The characterization of the life conditions was gotten from the Demographic Census (IBGE, 2000) and the epidemiologic data from the Surveillance National System (SINAN). The socio-economical index was based on school level and income of the head of family and overcrowding; the socioambiental index used information about sanitation and proportion of precarious domiciles. The variables were classified in quintis and points were attributed for each one. The score for neighborhood was resultant of the addition of the points for each variable. The neighborhoods had been classified in stratus of risk from the combination of results of the two indexes. **Results:** The incidence was lesser in stratus of average and low risk and very high in the stratum of the highest risk but was bigger then expected in the stratum classified at minimum risk indicating dissociation between life conditions and occurrence of the illness. **Conclusion**: Higher incidences of the dengue fever in Cuiaba in 2007 and 2008 have been observed in places with precarious conditions of sanitation and inhabited by populations with lesser level of income and education level but there is no linear correlation between life conditions and incidence.

Keywords: Dengue spatial distribution. Intra-urban differentials. Life conditions and health. Health-illness process. Ecological studies.

Resumo

Introdução: Cuiabá apresenta inúmeros casos de dengue tanto nos períodos endêmicos quanto nas epidemias cíclicas. O objetivo do estudo foi analisar os diferenciais intra-urbanos da incidência em 2007 e 2008 relacionando-os com as condições socioeconômicas e socioambientais. **Método:** estudo de abordagem ecológica usando dados secundários. A caracterização das condições de vida foi feita com dados do Censo Demográfico (IBGE, 2000) e os dados epidemiológicos foram obtidos no Sistema Nacional de Agravos de Notificação (SINAN). O índice socioeconômico mediu escolaridade, renda dos responsáveis pelos domicílios permanentes e aglomeração domiciliar; o índice socioambiental usou informações relativas ao saneamento básico e à proporção de domicílios precários. Os índices foram elaborados a partir da classificação das variáveis em quintis e atribuição de pontos para cada quintil. A pontuação por bairro foi resultante da soma dos pontos para cada variável. Os bairros foram classificados em estratos de risco a partir da combinação de resultados dos dois índices. **Resultados:** A incidência foi menor nos estratos de risco médio e baixo, e alta no estrato de risco muito alto; entretanto, foi maior do que a esperada no estrato de risco mínimo, indicando dissociação entre condições de vida e ocorrência da doença. **Conclusão:** Maiores incidências da dengue em Cuiabá nos anos de 2007 e 2008 foram observadas em locais com precárias condições de saneamento ambiental e habitados por populações com menor nível de renda e escolaridade, embora não exista correlação linear entre condições de vida e incidência.

Palavras-chave: Distribuição espacial de dengue. Diferenciais intra-urbanos**.** Condições de vida e saúde. Processo saúde-doença. Estudos ecológicos.

Introduction

Globalization and climate changes have interfered in the health-disease process favoring the growth of morbidity and mortality of transmissible diseases, among which dengue fever[1]. The World Health Organization estimates that 3 billion individuals worldwide are in risk areas for dengue. Tropical and subtropical countries, where the temperature and humidity favor the proliferation of the vector, tend to be endemic with cyclic epidemics[2]. The emergence of new agents of the disease results from social and environmental changes through human history, making pathogens capable of having access to new host populations[3].

Some infectious diseases have been reintroduced in Brazil as of the 1980s, among which dengue fever, whose epidemic spreads worldwide affecting dozens of millions of individuals. Despite efforts toward its elimination, dengue is considered an emerging disease in tropical and subtropical countries, including Brazil[4]. In Brazil, there are currently four virus types in circulation[5]. The simultaneous circulation of more than one serotype may have led to the increase in the incidence of severe forms with growth in fatality and mortality due to the disease[6].

The demographic changes that occurred in underdeveloped countries in the 1960s resulted in "swelling" of cities that were not capable of responding to the demands of the population, including housing and basic sanitation, that have been inadequate or inappropriate[7]. The intensification of the economic and demographic occupation process in the state of Mato Grosso has been causing an environmental impact and major transformations with serious consequences, and epidemics of dengue have been occurring in cycles since 1995[8].

In Cuiabá, as in other localities in Brazil, the incidence of dengue is related to favorable environmental factors, to the accelerated and disordered growth of neighborhoods and to poor basic sanitation that has been enabling the vector to remain and make its control difficult[9]. The way of life of populations enables, especially in the household setting, conditions for the proliferation of the *Aedes aegypti* and may influence the incidence of the disease[10]. Few studies discuss the social context as a complex unit where sociocultural and structural urban factors, together, generate a unique reality at each site, frequently favoring or hindering the dissemination of dengue[11].

The present study aimed to analyze the spatial distribution of the incidence of dengue according to living condition strata in the city of Cuiabá, in 2007 and 2008, and hopes to contribute to the rational planning of environmental intervention measures, and provide guidance on the definition of priorities in the formulation and execution of public policies, to improve quality in the urban environment.

Methods

The authors developed an analytical study design, with an ecological approach, using secondary data. The analysis period chosen were the years 2007 and 2008 that had available data on the municipal Disease Reporting Information System database (SINAN Net), version 14.0, of the city of Cuiabá at the time the study was performed.

Transmission risk strata

The analysis units adopted were the official neighborhoods defined by the IBGE for the demographic censuses in Cuiabá. To characterize the socioeconomic status of each neighborhood the following variables were selected: mean nominal monthly income of heads of permanent households; % of heads per permanent households with less than 4 years of schooling; % of heads of permanent households with nominal monthly income below 2 minimum wages; % of heads of permanent households with income above 20 minimum wages; and mean number of dwellers per permanent household.

The following variables were selected in order to characterize the socio-environmental status of neighborhoods: % of precarious households (*favelas*); % of households without piped water supply inside household; % of households without acceptable solutions (septic tank or sewage network) for sewage drainage; and % of households without regular garbage collecting by municipal services.

In order to classify neighborhoods in socioeconomic and socio-environmental neighborhoods, variables were classified in quintiles; a score from 1 to 5 was attributed to quintiles and the corresponding points to the set of variables of each neighborhood originated two indexes: socioeconomic (ISE) and socio-environmental (ISA). The classification resulting from the combination of both indexes led to the establishment of five risk strata for dengue transmission: minimum risk, low risk, medium risk, high risk and very high risk.

The procedure adopted was chosen to allow all stages to be performed using *Excel* spreadsheets, without depending on statistical programs that frequently are not available at health services.

New neighborhoods that emerged after the year 2000 Census could not be used in the present study as there was no corresponding information for them.

The objective was to build strata with different transmission risks established a priori, based on socio-economic and socio-environmental status, aimed at establishing possible criteria to guide the action of the control program. The subjacent assumption was the relationship between conditions favorable to the proliferation of vectors and to vector-host contact, and incidence rate of dengue. Thus, risk transmission strata were considered as exposure variables and the incidence rate as the outcome variable.

Cases of dengue

Data related to dengue cases were obtained from SINAN NET and were grouped according to the neighborhoods of the capital; the population per neighborhood was given by IBGE for 2007 and by the Town Hall Planning Department for 2008. Of the

984 cases reported in 2007 and the 960 cases reported in 2008 of Cuiabá residents, 59% and 76% respectively were classified in official neighborhoods. The remainder was located in new neighborhoods for which the lack of population data prevented analysis.

The incidence among strata was compared by calculating the relative risk using the incidence observed in the stratum considered as minimum risk for transmission of dengue as the reference value.

Incidence was classified as null in neighborhoods without any cases in 2007 and 2008; low (up to 100 cases per 100,000 inhabitants); average (101 to 299 cases per 100,000 inhabitants); high (300 to 999 cases per 100,000 inhabitants) and very high (over 1,000 cases per 100,000 inhabitants).

Vector density

Although vector density is quite relevant information on the production of the disease we could not use the information available due to the complete lack of standardization in the collection and recording of data from the field activities of the agent teams for endemic diseases. The city does not use SISFAD, the official data registration system and does not have any other official electronic system.

Ethical aspects

The Project was submitted to and approved by the Ethics in Research Committee of Santa Casa de São Paulo. The study used secondary data of unlimited and public access, and did not identify or cause uneasiness to groups of populations and/or individuals. As it is an operational study whose main objective was to provide information to the Cuiabá control program, results may have a positive impact on the epidemiological profile of the population.

Results

Of the 1,944 cases reported and analyzed in the study, 51% were females. The incidence was higher in 5 to 14 year-old children and in 15 to 19 year-old youth (data not presented).

Table 1 presents the socio-economic and socio-environmental characteristics of transmission risk, and the number of neighborhoods classified in each one of them. From the socio-economic perspective, minimum and low risk strata grouped the neighborhoods with better status; medium risk stratum covered those with an intermediate status; and high and very high risk strata, those with the worst status. From the socio-environmental perspective, the minimum risk stratum stands out from the remainder, with the lowest ratios of precarious households, without water piping or sewage and without garbage collecting. The variable that stands out the most in the strata is the proportion of households without regular garbage collecting (data not presented).

Table 2 shows incidence rates of dengue and does not show a correlation between the risk strata built from socio-economic and socio-environmental features and the incidence (non- significant Spearman correlation coefficient). The incidence was relatively similar in all strata, except for very high risk, in which the incidence was in fact very high. In the remainder, the incidence was of average intensity and, for the medium risk stratum, the incidence observed was the lowest in the two years studied. Relative risks or ratio of incidence rates were shown to be 3.63 times higher for the very high transmission risk. For the remainder strata, relative risks were not statistically significant.

In 2007 and 2008 there were 14 severe cases of dengue, 11 of which classified as dengue cases with complication (DCC), two with dengue shock syndrome (SCD) both developing to death, and one case of hemorrhagic dengue fever (FHD). Cases were not concentrated in one particular neighborhood (Table 3). Regarding risk strata built from living condition status, neighborhoods were classified in minimum, low, medium or high risk strata. In

Table 1 - Neighborhoods distribution and risk strata socioeconomic and socio environmental characteristics, Cuiabá, 2000.
Tabela 1 *- Características socioeconômicas e socioambientais dos estratos de risco de transmissão e distribuição dos bairros por estrato, Cuiabá, 2000.*

Variables	Minimum risk	Low risk	Medium risk	High risk	Very high risk
Number of neighborhoods	8	41	33	35	1
Nominal mean monthly income of heads of household (R$)	1889.22	1742.17	845.22	465.24	364.36
Dwellers per household	3.35	3.59	3.90	3.92	3.70
% of precarious households (shanty houses)	0.02	0.35	0.38	0.61	0.47
% households without piped water	4.10	6.71	10.55	46.04	65.08
% households without sewage network	0.09	0.33	0.65	4.52	7.11
% households without regular garbage collecting	2.89	13.13	9.18	16.77	27.49
% heads of household with less than 4 years schooling	6.75	9.33	18.55	32.61	35.07
% heads of household with income below 2 minimum wages	8.90	13.25	20.52	32.38	0.85
% heads of household with income above 20 minimum wages	17.54	13.30	2.82	0.85	0.00

Fonte/*Source*: IBGE Censo demográfico. 2000.

Table 2 – Dengue incidence rate (100.000 inhabitants) and rate ratio by risk strata, Cuiabá, 2007-2008.
Tabela 2 *- Taxas de incidência de dengue (100.000 hab.) e risco relativo por estratos de risco de transmissão, Cuiabá, 2007-2008.*

Risk stratum	Incidence rate (100,000 inhab.)	RR
Minimum	156.96	1.00
Low	121.48	0.77
Medium	93.21	0.59
High	178.95	1.14
Very high	570.03	3.63

Correlação de Sperman: ρ = 0,6; p > 0,10 / *Sperman Correlation:* ρ = *0.06; p > 0.10.*

the neighborhoods where severe cases were registered there is a correspondence between incidence and proportion of severe cases and risk strata, except for UFMT and Cidade Alta.

Discussion

The main objective of the present study was to check if neighborhood stratification of the city according to living condition indicators (socio-economic and environmental sanitation conditions) could guide the control work for the endemic disease, by identifying a priori areas of higher risk for the occurrence of cases of dengue.

Neighborhood stratification based on variables selected and indexes built showed a great diversity in living conditions in the city, leading to believe that such heterogeneity would also be reflected in the distribution of symptomatic cases of the disease.

However, the mean incidence rates for 2007 and 2008 showed little correspondence to living conditions. These findings should be interpreted with care, given the limitations of the study, the history of endemic

Table 3 - Severe cases distribution by neighborhoods, Cuiabá, 2007-2008.
Tabela 3 *- Distribuição dos casos graves de dengue por bairro de residência, 2007 e 2008, Cuiabá.*

Neighborhood	Risk stratum	Incidence rate of severe cases (100,000 inhab.)	% of severe cases	Clinical Forms		
					Hemorrhagic dengue Fever	Dengue Shock Syndrome
Alvorada	Low	7.1	4.5	1	-	-
Carumbé	Medium	35.7	9.1	1	-	-
Cidade Alta	Low	21.1	18.2	1	-	1
Jardim Passaredo	High	37.1	14.3	1	-	-
Osmar Cabral	High	24.8	14.3	1	-	-
Parque Cuiabá	Low	11.1	5.0	1	-	-
Três Barras	High	20.0	33.3	1	-	1
UFMT	Minimum	2272.7	20.0	1	-	-
unknown	...	...	...	3	1	-
Total*		26.9	15.7	11	1	2

*considerando apenas os bairros afetados / **considering affected neighborhoods only*.
Fonte/*Source*: SINAN/COVIDAE

status of the disease in the city, and the capability of the variables selected to translate relevant aspects to the production of the disease.

Among the main limitations, the impossibility to analyze the status of new neighborhoods developed after the year 2000, in which certain socio-environmental conditions probably favor infestation and the occurrence of the disease, stands out. The growth of the population observed in the city, in the past decade, mainly at the expense of an internal migration process, has been expressive, generating the occupation of new areas that could not be considered in our study. In 2007 and 2008 alone, there was a 3% growth in the population of Cuiabá. An important part of the cases was not classified in the neighborhoods existing in 2000, suggesting that these cases are concentrated exactly in the areas of more recent occupation and worse urban infra-structure. The inclusion of these cases would probably increase the incidence in the high risk and very high risk strata.

Another point to be taken into account is the time between the information on socio-environmental and socio-economic status and collection of incidence data. In these almost ten years, the neighborhood structure may have changed, which would result in a non-correspondence between rates calculated and the incidence observed. The fact that the city control program does not use the information system proposed by the Ministry of Health to register field activities or even does not have any other locally standardized system made it difficult to use this information to characterize infestation throughout the period of analysis.

Some studies have shown that when transmission of dengue begins to occur in a certain urban space, there is a directly proportional association between the levels of infestation and incidence with the living conditions observed in different neighborhoods or homogeneous areas[12-15]. With the progression of the endemic setting and the repetition of epidemic cycles this initial pattern tends to change and ceases to show association. However, even in these circumstances, very high incidences are observed in those locations in which socio-environmental conditions are favorable to the proliferation of the vector[15].

In Cuiabá, as already mentioned, transmission began in 1992 and, therefore, currently the disease is in place in this urban space, with several epidemic waves happening during this period. Thus, the situation observed in 2007 and 2008 is supposed to no longer reflect the directly proportional relationship between living conditions and incidence.

As there are breeding pools practically in all neighborhoods of the city, as highlighted by the building infestation rates and presence of positive pools throughout the year, transmission will be conditioned mainly by density and circulation of sources of infection. Given the great population mobility inside the urban space, the non-correspondence between local living conditions and the occurrence of cases no longer presents itself as a contradictory fact. People who live in areas with null or low infestation may possibly have been infected in other environments. Likewise, areas with major infestation, but a small concentration of sources of infection, may produce relatively few cases.

Another point to be considered in the analysis of this relationship is the appropriateness of the variables selected to explain the occurrence of the disease. Although in theory the areas with worse water supply, without sewage, with irregular garbage collecting and higher concentration of precarious households should have the highest infestation rates and, therefore, the highest incidence, several studies have shown that the epidemiology of dengue is more complex. So, the environment variables used in the analysis may not translate this complexity. In this way, given that vector control depends essentially on the level of involvement of the population in daily actions to eliminate breeding pools, populations with a better level of schooling and income would be expected to live in neighborhoods with lower or null building infestation rates. However, other factors may change this expectation, as, for example, a higher number of containers with breeding potential, such as not regularly treated swimming pools, large badly sealed water reservoirs, vases, types of plants used in gardening and ornaments, fountains, and others[15-17].

Like other studies on intra-urban differentials for dengue, although a linear relationship between living conditions and incidence was not observed, it was very high in the neighborhood classified as very high risk. Seroprevalence surveys performed in the city of Goiânia showed an inverse association between prevalence of the infection and level of schooling[15,18].

In theory, a higher incidence than expected in the minimum and low risk strata, comprised of neighborhoods with the best socio-economic and socio-environmental status, can be explained by the presence of a higher number of containers favorable to vector breeding in households of higher income families, as already pointed out in other studies. Results similar to ours were found in the cities of Nova Iguaçu in the Baixada Fluminense, and in São José do Rio Preto, interior of São Paulo, where the highest incidence was observed in high or medium to high living status neighborhoods, contiguous to bad living status neighborhoods[19,20].

Another explanation for the results found is the possibility of transmission of the disease in other environments other than the household itself. In the interior of a city with the same urban features of Cuiabá, population commuting for daily activities is frequent, favoring transmission in environments, other than the household environment [21,22].

Grouping neighborhoods in only five strata may also have been a factor responsible for the results found. Even though these neighborhoods are similar on average, internal diversity within each stratum may not be appropriately reflected by data. Some studies that have used census sectors as environmental analysis units found a direct relationship between environment conditions and incidence, suggesting that more homogeneous units could be more appropriate to the study of inequality and dengue[12,13].

Studies in the city of São José do Rio Preto, in São Paulo, showed total independence between infestation assessed through the Bretau index, building index and container index, and socio-economic conditions in the four city districts[17]. However, the levels of infestation in the city were higher in areas with a lower socio-economic level and deficient sanitary infra-structure. A molecular study on the dissemination of cases during the epidemic registered in 2006 in the same municipality allowed identifying the beginning of the transmission of DEN-3 in a peripheral neighborhood of recent occupation, from there disseminating to the rest of the urban area[23].

The spread of the dengue epidemic in 1995 in the city of Salvador, Bahia, had a similar pattern, with the epicenter in a region of the city comprised of 13 districts with a population with a low socio-economic level and precarious sanitary conditions[14].

The number of severe cases registered in 2007 and 2008 was relatively small, not allowing for the identification of a space distribution pattern, given the random occurrence in space. Some authors have pointed out the lower incidence of severe cases in countries in the Americas in comparison to the rates observed in the Asian Southwest[24]. In Cuiabá, the incidence and the proportion of severe cases per neighborhood showed a certain correspondence with risk strata in those neighborhoods where severe cases were registered. Data obtained for UFMT were distorted due to only 44 people living in the neighborhood comprised by University and where there were only 5 cases, one of which with complications. The Cidade Alta neighborhood, classified as low risk due to the excellent socio-economic conditions, had, however, precarious sanitation conditions in terms of piped water and regular garbage collecting, which would favor the higher incidence observed.

It is likely that the results that have been observed in different studies in Brazilian cities and that show this dissociation between living conditions, infestation rates and incidence, can be explained in the disease production process itself, for which the household microenvironment conditions may be more relevant than the context of the macro social environment[25]. Analyses based on ample and heterogeneous spaces, such as neighborhoods, may not allow relations between this micro social level and incidence to appear[26]. Studies based on more homogeneous areas, like census sectors, could possibly capture these differences more accurately, but in the case of Cuiabá there would not be corresponding entomological data for these areas.

Regarding case severity, individual vulnerability features are also probably important in the production of outcomes, along with existing conditions in health services and in the social conditions of the population itself that may change access and opportunity to seek theses services.

The complexity of the epidemiological characteristics of this endemic condition shows the need to develop other studies, with different levels of approach to social structure, in order to increase the knowledge on the possible mechanisms for distributing and producing cases[27].

Conclusions and recommendations

Regarding the general objective of the study a great heterogeneity in the distribution of dengue in the intra-urban space of Cuiabá was observed, although this spatial distribution could not be associated with living conditions of each city neighborhood. The incidence in the different neighborhoods was shown to be independent from the socio-economic and socio-environmental conditions in effect.

The complexity of the processes that produce cases and the determinants involved in the proliferation and maintenance of vectors is a challenge to epidemiological research that intends to identify the mechanisms of social determination of this endemic condition.

The aim to identify areas with different levels of risk for producing the disease, in order to stratify and assign priority to areas for vector control work could not be carried out with the information available. Probably, other approaches that favor microenvironment factors in more homogeneous areas of the city could be useful to give control teams more appropriate means.

In order to increase the efficiency of control actions in Cuiabá it would be important to better acknowledge the different conditions favoring vector proliferation and the circulation of infection sources in the different urban spaces.

The adoption of other measurements of infestation, such as the Bretau index, the positive container index, the mean number of existing and positive containers per household surveyed could provide a more correct idea of vector density in each activity neighborhood or zone of the control program. Standard electronic records of data collected in vector control activities would also represent a valuable tool for planning and monitoring activities.

The data analyzed in our study suggests that the problem has acquired, in Cuiabá, a universal dimension, that is, the spread of cases has practically reached the entire urban area, demanding greater effort in the synchronizing actions in the several areas so as to cause impact on vector density and, maybe on incidence. The control work during inter-epidemic periods and in periods of lower vector density is greatly important in this sense.

Despite the universal characteristic of the problem, the knowledge in greater detail of the conditions existing in each neighborhood may be a key element to greater efficiency in dengue control. As shown by data presented, neighborhoods with different socio-economic and socio--environmental status can have distinct mechanisms favoring infestation and that, therefore, should be considered in planning control actions.

Mobilization and awareness of the population is the essential element for the control of this endemic disease. Given the socioeconomic diversity of the population and the differences in level of schooling, this awareness work requires messages directed specifically to each type of audience, in addition to encouragements to keep up interest and commitment to fighting the disease.

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