

Urban Health Planning Policies, Sanitation and Outbreaks: interfaces with Solid Waste Management

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ABSTRACT

Urban and territorial planning has a decisive impact on health. Waste management is an important planning and health action, ensuring quality of life and environmental quality. Urbanization and poor sanitation are associated with the *Ae. aegypti* mosquito's presence, which has caused outbreaks of dengue, yellow fever, zika, and chikungunya in Brazil. This study aimed at correlating the *Aedes aegypti* mosquito infestation (HI) with the information on Urban Solid Waste management (USWM) in all Brazilian territory. Through exploratory data analysis and an Ordinal Logistic Regression (OLR) model, we related HI classification of each municipality to its Municipal Human Development Index (MHDI), demographic density, and variables related to USWM. Results suggest that municipalities with higher MHDI have better infestation indicators. Various USWM indicators do not influence mosquito infestation, but financial and human resources have proved crucial to vector control. Finally, municipalities with SWM Plans and Municipal Sanitation Plans and Policies presented a higher probability of "satisfactory" HI classification. Sanitation and quality in USWM contribute to prevent the *Aedes aegypti* mosquito infestation and diseases outbreaks transmitted by it. Fragmentation among public health, sanitation, and regional planning cause diseases and social problems, bring them together can provide well-being to the population.

1. INTRODUCTION

The work of urban and territorial planning has a decisive impact on health (Koohsari et al. 2013, WHO, 2020). In developing countries, urban planning actions regarding sanitation do not take place in a systemic way (Nhamo et al. 2021). Waste management is an important planning and health action, ensuring quality of life and environmental quality to societies. However, in many places this action is neglected, which leads to many problems, especially in developing countries (Tukahirwa et al. 2013; Kaza et al., 2018; Batra et al., 2020). They are punctual in the territory, and do not appear as planning actions, but as corrections to installed problems and ongoing processes. In outbreak of the COVID-19 urban planning for public health gained importance (AbouKorin et al. 2021, Mouratidis 2021, Mouratidis & Yiannakou, 2021, Jasiński, 2022). But prior to COVID-19 outbreak developing countries were experiencing outbreaks of vector-borne diseases, so different outbreaks have happened together. Pan American Health Organization data – PAHO (2019), reported that dengue fever cases exceeded the American continental record in 2019. There were 2,070,170 cases notified in Brazil, the highest number of cases in the world (OPAS, 2019). Lack of adequate sanitation service infrastructure is related to disease and health inequalities in many cities (WHO, 2020). This is evidenced by Wilder-Smith et al. (2016), analyzing an unprecedented increase in dengue, yellow fever, zika, and chikungunya (Zaid et al. 2021) around the world. Moreover, inadequate infrastructure for integrated vector management strategies (Lizzi et al. 2014, Bertolino et al. 2021) unfold in increase in the *Ae. aegypti* mosquito population. This scenario is known to be strongly related to socioeconomic and environmental factors, especially in cities in low-income countries. Thus, correct urban solid waste management (USWM) becomes an important aspect in the fight against the mosquito's proliferation (Moura et al., 2020). Wilder-Smith et al. (2020) refer that *Aedes*-free cities will require reducing aquatic habitats of *Ae. aegypti* providing among others, solid waste management. So, enhancing solid waste management reduces habitats for *Ae. aegypti* larvae development (Lindsay et al., 2017). To assess solid waste management, you can use indicators in different places for different purposes (Cervantes et al., 2018).

The sanitation influence on public health is well known, but there is a lack of data in the literature relating USWM data to *Ae. aegypti* infestation measured by *Aedes* larval index (House Index HI). Therefore, this study aims to identify the relationship between the USWM indicators in Brazil and the HI.

2. METHODOLOGY

2.1 STUDY AREA

Located in South America, Brazil (Figure 1) has 207,660,929 inhabitants, 15,167.40 km² of urbanized areas with urban concentrations above 300,000 inhabitants, 207,660,929 inhabitants and, 24.38 inhabitants/km² and 5,572 municipalities, (IBGE, 2017). Country's HDI is 0.727 (PNUD, 2013). Database from USWM, and *Ae. aegypti* infestation considered is 2017 and were collected from the Brazilian Information System on Sanitation (SNIS) platform (<http://app4.mdr.gov.br/serieHistorica/>) and from the Brazilian Health Ministry through Brazilian Government Transparency Portal (www.portaltransparencia.gov.br) respectively. The tropical climate represents 81% of the Brazilian territory, 14% of the territory presents subtropical climate Southern and 5%, semi-arid climate, mainly in the Northeast Region, (Alvares *et al.*, 2013).

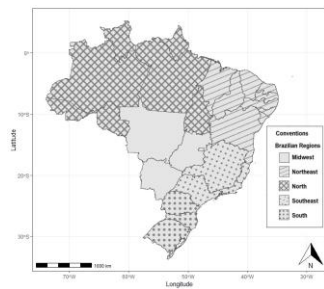


Figure 1. Brazilian regions

2.2 DATA COLLECTION

2.2.1 USWM Data

Data and indicators are from the SNIS regarding 2017. The SNIS data are grouped by theme into: general; financial; paid workers; household and public collection; selective collection and sorting; solid waste collection from health services; civil construction waste collection; sweeping services; weeding and mowing services; other services; waste pickers; processing units; and Municipal Sanitation Master Plans and Policies. The indicators are grouped by theme: expenses and workers; household and public collection; selective collection and sorting; health service waste collection; sweeping, weeding, and mowing services.

2.2.2 HI

In Brazil vector control activities are mainly based on *Aedes* larval index - House Index HI (MacCormack-Gelles *et al.* (2020)), it is indorsed by Pan-American Health Organization (WHO, 2014). HI uses a cluster sampling technique, which divides the municipality's urban area into strata with similar social, cultural, economic, and environmental characteristics, aiming to make the post-survey vector control actions easier. HI is calculated, Equation 1, where the term "positive properties" indicates properties with the presence of *Ae. aegypti* larvae (MS, 2013). Table 1 provide HI classification criteria.

$$HI = \frac{\text{positive properties}}{\text{surveyed properties}} \times 100 \quad (1)$$

Table 1 - HI classification criteria.

HI (%)	Classification
Less than 1	Satisfactory
Between 1 and 3.9	Alert
Greater than 3.9	Risk

2.3 DATA ANALYSIS

We analyzed the *HI* and USWM data in an integrated way. Municipalities that presented only one of the two data were discarded; 3,489 municipalities remained. A descriptive statistical analysis was performed,

and HI values were combined with MHD (PNUD, 2013) and Population density (IBGE 2017). After Ordinal Logistic Regression (OLR) was used to verify the relationship between HI and USWM. HI was considered as ordinal dependent variable grouped from a continuous variable, since HI values were used to classify the municipalities' HI as "satisfactory", "alert", and "risk". The USWM data were the explanatory variables, in continuous and categorical formats. A bivariate analysis was performed to investigate the association between each explanatory variable and a response, with the Proportional Chances Model (PCM). The assumption of proportional odds was tested for each explanatory variable by means of *deviance* and Pearson's test with a significance level of 5%.

3. Results

Initial results show that:

i- The variable *USWM expenses regarding urban population* also presented statistical significance (p-value < 0.001). This result is important, as it confirms that the more resources *per capita* are applied to USWM, the less HI. The variable *Does the municipality charge for the regular collection, transportation, and final disposal of USW services?* (p-value < 0.001) presented an interesting result. Municipalities that charge for USWM services were more likely to be classified as "satisfactory". High-quality USWM provides citizen commitment, approval, and trust, motivating them to pay for the services (Augusto *et al.* (2016), Kaza *et al.* (2015), Anshütz (1996)). Transferring the total or partial costs of USWM to the population, the latter starts demanding a counterpart, through an efficient urban cleaning service, which reduces favorable receptacles for the *Ae. aegypti* mosquito development. The OLR analysis of the HI with the variable *ratio of the number of workers regarding urban population* (p-value < 0.011) indicated that the higher the ratio of workers per capita, the higher the probability of a "satisfactory" HI.

ii- Weeders rate regarding urban population identified a result statistically associated with the outcome (p-value = 0.013), indicating that the higher the ratio, the greater the "satisfactory" chance for the HI. The variables result involving ratios of the number of employees may indicate that, when present, the service must be well sized, to avoid HI increasing.

iii- The variable *population rate served by direct selective collection (door-to-door) regarding municipality's urban population* presented a well-fitting model and its analysis indicated that the higher the ratio, the higher the probability of the HI's result "satisfactory" (p-value = 0.003). This result indicates that direct selective collection, besides being the best alternative for the effective recycling of materials, is equally important for reducing the HI. The variable quantity of material collected in selective collection by pickers associations or cooperatives is significant (p-value = 0.034).

iv- The variables *does the municipality have a Sanitation Policy according to Law 11,445/2007 (Brasil 2007)?* and *does the municipality have a Municipal Sanitation Master Plan, prepared according to the terms established by Law 11,445/2007?* presented statistical significance (p-value < 0.001) and indicated that municipalities whose answer was "yes" were more likely to be classified as "satisfactory" for HI (Table 5). Federal Law 11,445/2007 defines sanitation as: drinking water supply, sanitary sewage, urban cleaning, solid waste management, drainage, and rainwater management (Brazil, 2007). Thus, we can see that the *Ae. aegypti* population expansion is influenced by the lack of planning in sanitation, not limited to USWM. Relationship between lack of disease control and the expansion of large urban centers without quality sanitation are known (Wilder-Smith *et al.* 2016, Batra *et al.* 2022). Sanitation actions bring satisfaction, public health, and other positive effects to communities (Zeng *et al.* 2022). Municipalities that have sanitation master plans presented them in a more tactical and operational level (Oneda e Barros 2021), this means that no strategic point of view is observed. In a strategic level the fragmentation among public health, sanitation, and regional planning could be addressed. But in a municipal level this is very difficult because there is no support among different administrative levels (Federal, States and Municipalities) and cities do not go beyond what is strictly necessary, often due to lack of human and financial resources. So, important issues are treated in a very simple way. The master plan, as an element of public administration different dimensions could be incorporated as risk and vulnerability analyses, transforming it into a participative planning tool to avoid loss of lives and economics, as well as increase resilience.

v- *Does the municipality have a SWMP in accordance with Law No. 12,305/2010 (Brasil, 2010)?* clarified that municipalities equipped with SWMP had a higher probability (p-value < 0.001) of "satisfactory" HI.

SWMPs are not mandatory, but their existence is a condition for access to federal resources for undertakings and services related to urban cleaning and solid waste management. Therefore, the SWMPs have become economic instruments to stimulate compliance with legislation, which is not always sufficient for effective environmental protection. The plans bring gains mainly at the municipal level, through proposals for better waste management, expansion of recycling, and elimination of landfills (Teixeira, 2017). According to the results we obtained, we can see that SWMPs are instruments that induce public health.

vi- We also highlight the variable *is the municipality a member of any inter-municipal consortium regulated by Law 11,107/2005 that has among its attributions the provision of one or more urban cleaning and solid waste management services?*. This variable's analysis indicated that municipalities that are members (p-value < 0.001) were more likely to be classified as "satisfactory" than municipalities whose inter-municipal consortium is "in the drafting process". According to Lisbinski *et al.* (2020, p. 11), "inter-municipal consortia emerge as an instrument used to raise funds and solve problems common to the municipalities involved, as they provide greater efficiency in the application and distribution of public resources". The need for improvement of collective infrastructure, and the search for waste disposal in landfills are the main factors to make the inter-municipal consortium feasible, Ventura *et al.* (2020). Therefore, municipalities that have consortium structuring underway have not yet solved the problems regarding USW management, although they are on the way.

CONCLUSIONS

Relationship between sanitation and public health were evidenced in this work. USWM Problems in SNIS data were identified as sending of incomplete data by municipalities. Thus, besides the need to improve the SNIS, there is also an urgent need to make the municipalities aware of the importance and responsibility of filling out the information correctly. Sanitation actions have caused repercussions on public health. Instruments for measuring the sanitation management system performance are necessary for planning and managers' decision-making, to improve public health and quality of life of the population. *Ae. aegypti* uses wastes as habitat for larvae development, and in developing countries urban areas are sensitive because of inequalities. It is essential to relate the management system to the *Ae. aegypti* mosquito infestation data, as *Ae. aegypti*-borne diseases cause deaths, decreased productivity, and economic losses. The results obtained in this study are relevant for the sanitation and public health sectors in Brazil, because, besides identifying gaps left by the SNIS methodology, they proved the importance of sanitation and of quality USWM for the control of *HI*. It is urgent that public health, sanitation, and regional planning walk together, with no fragmentation, enabling joint actions to provide a better life quality to the population. Outbreaks prove this statement and decision makers must plan the future thinking in improving quality of live for the next generations.

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