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STRATEGIES FOR CONTROLING INSECTS THAT TRANSMIT DISEASES: A BRIEF BIBLIOGRAPHICAL REVIEW

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Abstract: This manuscript is a brief literature review focused on the control of insect vectors of diseases. It is the result of a broad discussion encouraged in the classroom, during the Medical Entomology course offered to the Biomedicine course. The text presents prophylaxis and control strategies, from conventional to more elaborate, such as applying chemical insecticides at home; and innovative approaches, such as genetic vector control. It is suggested, however, that there be the integration of control techniques and methods for greater effectiveness at the public health level for disease prevention.
Keywords: Insect vectors. Control strategies. Insecticides

INTRODUCTION

Dengue, Zika, Chikungunya, Malaria, Yellow Fever, among other diseases, have similarities in terms of transmission. They rely on the participation of insects, known as vectors, which are capable of transmitting these and other infectious diseases between humans, or between animals and humans (BLUT, 2005).

The ability to cause diseases is related to eating habits, as hematophagy is the main form of propagation used (FIOCRUZ, 2022). However, the participation of mechanical vectors also greatly contributes to the spread of diseases (MARCONDES, 2011).

The transmission of diseases by insects is a recurring problem in society, affecting thousands of individuals each year. Mosquitoes, flies, ticks and other arthropods play an important role in the spread of a variety of pathogens, especially viruses, bacteria and parasites (NÚNCIO and ALVES, 2014). Knowing the insects that pose a risk to humans is extremely important for planning actions and control strategies that are efficient, sustainable and adaptable to different environmental and epidemiological conditions (FARIA et al, 2022).

There are different methods for controlling insects, the execution of which follows conventional principles, from the use of insecticides, to innovative approaches, such as genetic manipulation of vectors (OLIVEIRA et al., 2011). Still in this scenario, it is considered essential, to reduce the incidence of diseases and protect communities, that this control is carried out in such a way that the advantages and limitations of each strategy are understood (LEITE, 2018). From this expanded analysis, it is possible to develop more comprehensive and integrated approaches to protect individuals against the threats posed by this group of animals (SANTOS, 2018).

In this context, this manuscript aimed to bring understanding about control measures and the need to reduce insect populations involved in disease transmission, in addition to discussing strategies to combat them, through a brief literature review.

REVIEW OF LITERATURE

In recent years, it has been observed that the density of some groups of medically important insects and the number of disease cases have increased significantly. In 2023, the United States Center for Disease Control and Prevention (CDC) diagnosed the first cases of malaria in the country in 20 years (CNN Brazil, 2023).

It is known that deforestation, agricultural practices, urbanization and other human actions cause changes in the environment capable of causing climate change that leads to an increase in global temperature and, consequently, the concentrations of CO2 and ultraviolet radiation in the atmosphere are altered, which causes changes in the life cycles, nutrition and distribution of these insects. This way, the increase in the density of disease vectors has become increasingly common and tends to increase even further, posing a risk to the health of populations (VILA-VERDE et al, 2021).

In this regard, arboviruses, especially those transmitted by the Aedes aegypti mosquito, represent a concern for Public Health, presenting a significant number of human cases. Therefore, controlling this vector is of fundamental importance, as it is the main transmitter of the dengue, Zika and Chikungunya viruses (FARIA et al, 2022). On the other hand, other insects that do not pose a threat to human life, such as butterflies and bees, have declining populations and may disappear, mainly due to the intense use of fertilizers and pesticides (BBC News Brazil, 2019). Therefore, monitoring is a useful tool for early identification of changes in different groups of insects. Its application in monitoring the increase in reproduction rates of insects, pests or disease vectors stands out, since control measures can be taken in the initial phases of increasing population density, or even prevent their proliferation (MARCONDES, 2011).

Among the diseases transmitted by vectors, dengue is highlighted on the Brazilian national scene. Its ease of transmission is linked to the tropical climate, characterized by high levels of rainfall, as well as the disorderly growth of urban areas (MENDONÇA et al, 2009). It is a viral disease that has four serotypes and has persisted over the years, requiring special attention. This infection is associated with symptoms ranging from fever and malaise to more severe complications, such as severe bleeding. Its occurrence and prevalence have worried health authorities (BRAZIL, 2024). CNN Brazil presented relevant data on dengue cases in the country, which revealed alarming numbers in the first two months of 2024, represented in the graphs and table below:

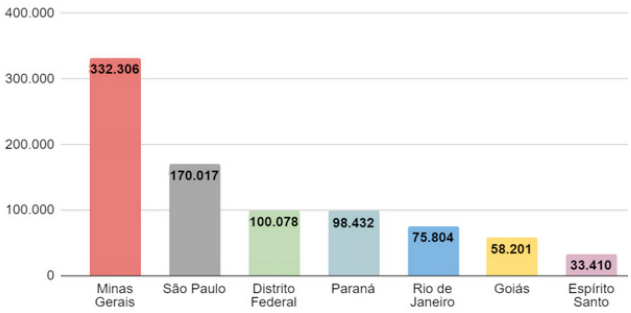
Dengue in Brazil in 2024

Situation	Records
Deaths	195
Probable cases	973.347
Deaths under investigation	672
Incidence coefficient	479,3

Table 1. Record of suspected dengue cases between January and February of the year 2024.

Source: CNN Brazil

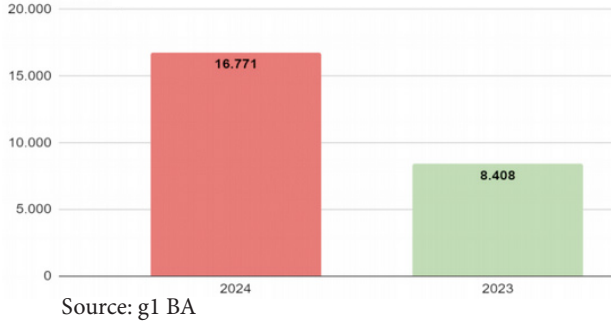
Dengue cases by state in 2024



Source: CNN Brazil

Graph 1. Record of the seven states most affected by dengue between the months of January and February of the year 2024.

Dengue cases in Bahia in 2024



Source: g1 BA

Graph 2. Comparison of dengue cases in Bahia between 2023 and the first two months of 2024.

In analyzing table 1 and graph 1, it is possible to notice the alarming data even in the first two months of the year 2024. When analyzing the state of Bahia, separately (graph 2), it is surprising that according to the records of the last day of the month From February/2024 the cases exceeded, and more than doubled, when compared to the entire

year of 2023. In fact, this situation alone is a cause for great concern and demonstrates the expansive power of dengue in the country and human exposure to the risk of contamination by this arbovirus.

PROPHYLACTIC AND CONTROL MEASURES

With regard to vectorial capacity, preventive actions must be concentrated on the insect, as it is a weak point in the transmission chain (TAUIL, 2002). This logic also serves to control parasitic insects. There are different prophylactic methods used in an attempt to reduce the proliferation of these arthropods. This is extremely important, considering that such a population increase is often directly related to the increase in the number of cases of diseases transmitted by them – hence the importance of paying attention to individual and collective risk. In this sense, endemic agents play an essential role in monitoring potential insect breeding sites within domestic environments. This task faces challenges, as it requires community collaboration, and also the encouragement of public policies that aim to reuse and reduce urban solid waste, including encouraging recycling (JESUS, 2020).

Individual measures are important to deal with this scenario. Therefore, health education is the main tool to enable the population to carry out prophylactic measures (DA SILVA et al, 2015). According to the Ministry of Health, among the measures recommended to control potential breeding sites, the following can be highlighted: not accumulating tires, bottles and containers with water; cover tanks and water reservoirs for consumption; and carry out regular hygiene in reservoirs (BRAZIL, 2024).

In addition to the basic measures to prevent insect breeding sites, other practices can be adopted. Many insects carry out oviposition in a humid and warm environment; and some, in an aquatic environment. Considering this reality, attention must also be payed to abandoned places, especially where there are swimming pools, aquariums and accumulation of rubbish. Another important prophylactic measure is vaccination, which is capable of conferring immunity to different pathogens (SANTOS et al., 2008). The start of vaccination against dengue in the country stands out, which is the result of many years of research and financial investments. According to CNN Brazil, the first batch, containing 712 thousand doses of the vaccine, was made available on February 8, 2024, by the Ministry of Health, for the Federal District and nine other states. The vaccination campaign has been aimed at individuals aged 4 to 60 years, and immunization is carried out in two doses, 3 months apart (BERGAMASCO, 2024).

Regarding control, the use of insecticides appears to be an important and efficient measure. However, its adoption can negatively impact human health. Neurotoxic insecticides have the ability to develop mental pathologies, such as depression. Pesticides are responsible for occupational poisoning and cases of cancer, in addition to contamination in foods of plant and animal origin - which creates food insecurity (OLIVEIRA, 2019).

The use of insecticides is widely used in Public Health as a measure to reduce the vector population. This control method affects insects, depending on the chemical composition of the insecticide, exerting toxic effects on the nervous system (MOREIRA et al., 2012). The choice is based on its high efficiency against a wide variety of these animals, in addition to presenting rapid effective power (MARCONDES, 2011).

The application of synthetic insecticides against Aedes aegypti is a model of practice that has been established globally for a long time and continues today, albeit with some

adaptations. These insecticides belong to four main categories: organochlorines (OC), organophosphates (OP), carbamates (CA) and pyrethroids (PY), all of which act directly on the Central Nervous System of insects. In Brazil, it is common to use the insecticide nebulization technique in external areas, such as traffic routes and around the home, using the Ultra-Low Volume (UBV) method, through nebulizers attached to vehicles, popularly known as ``*Fumacê*``, whose purpose is eliminating only the adult forms of A. aegypti (ZARA et al, 2016). Additionally, the application of chemical insecticides such as topical repellents is useful for humans, especially during daytime outdoor activities when there is greater interaction with insects. Considering that vectors use smell to locate hosts, repellents act by binding to odor and taste receptors to repel them (KWON et al, 2010). As an alternative to control, it is viable to develop effective homemade repellents, such as citronella, used to combat Aedes aegypti (MELLO et al, 2019).

In different regions of the planet, including Brazil, insects have shown resistance to insecticides. This resistance has been widely observed among dipterans subjected to the action of conventional insecticides. As a result, the National Dengue Control Plan (PNCD) has been guiding its replacement. This resistance may occur due to different factors such as genetic, biochemical, operational, biological and ecological (MARCONDES, 2011). Faced with this difficulty, some measures have been adopted, such as the use of biological control, for example, which consists of choosing natural enemies or substances produced by them, to control insects of health importance; and several organisms can act as controlling agents, such as viruses, bacteria, fungi, protozoa and nematodes (BRAZIL, Fundação Nacional de Saúde, 2004). In addition to these approaches, it is worth using biological control strategies that include the use of natural predators for Aedes aegypti larvae and adults. Some organisms, such as fish that feed on larvae, can contribute to this control. One example is Gambusia affinis, native to Central America and used in the United States since 1905 to control mosquito larvae. These fish have a high capacity for survival in different environments and climatic conditions (ANDRADE and SANTOS, 2004).

As for mechanical control, the use of clothing and mosquito nets impregnated with insecticides is a simple measure to avoid contact with the vector, suitable for people who spend the day outside the home, travelers, soldiers and/or inhabitants of endemic areas for transmitted diseases by mosquitoes (PENNETIER et al.). In genetic control, the use of genetically modified mosquitoes stands out, sterilizing male insects through the Sterile Insect Technique (SIT), exposing them to radiation. When released into the environment, these males' mate with wild females, resulting in eggs that do not hatch, reducing the reproductive capacity of the mosquito population. However, a challenge with this method is the competition of these sterilized mosquitoes with wild ones for mating (ATKINSON et al, 2007).

Considering the ease of obtaining, the use of domestic insecticides (homemade pesticides) is a reality and is part of the population's daily life, especially considering their practicality and efficiency. The term "homemade pesticides" encompasses items used to combat unwanted organisms or organisms that are harmful to human health, found inside the home. Although the term "defensive" is broad and may suggest different interpretations, other expressions such as "pesticides" or "pesticides", as well as "domestic insecticides and rodenticides", are not entirely accurate (SCHVARTSMAN, 1983).

The use of plants as a control strategy is also worth highlighting – they are natural sources of insecticidal and antimicrobial substances. Natural insecticides, such as powders, botanical extracts and essential oils of plant origin, can be used both in integrated pest management in commercial crops and in organic farming. These insecticides constitute an easily available resource due to their natural occurrence, however they can be depleted if they are not constantly replenished (MARANGONI, 2012). The implementation of phytochemical agents obtained from plants with insecticidal action can act in the control and elimination of larvae and adult insects (MACIEL, 2010). Formulations can also act in personal protection, through artisanal productions with repellent action on insects (ICMR Bulletin, 2003; BROUSSALIS et al, 1999).

In an attempt to reduce pest and vector populations, alternative insecticides can be used, whose forms of action are combined between chemical and biological methods (BARBOSA, 2006).

Pesticides of natural origin have many advantages, as they are biodegradable compounds and, therefore, have a low environmental impact, as well as greater food safety, reducing health risks for workers and end consumers. They represent a reduction in production costs compared to synthetic pesticides and demonstrate a low risk of promoting resistance or tolerance in pests or pathogens, as they are made up of more than one active ingredient that act in different ways. Its preparation can be carried out from crop remains or vegetables with proven effects, and can be produced on an artisanal, semi-industrial or industrial scale (BARBOSA 2006; PAVELA, 2016; SILVÉRIO, 2022).

Regarding the use of fertilizers, it is important to highlight that it can cause harm to the environment through its impact on water, soil, air and animal health, when used indiscriminately. As a consequence, there is contamination by heavy metals, soil acidification, water pollution and the consequent development of diseases in the population (SILVA et al, 2021).

The use of fertilizer products, as previously explained, may end up being harmful to the environment, resulting in problems that may be irreversible.

As seen, different alternative control methods are currently used and studied. But it is reasonable to assume that integrated vector control (CIV) is an excellent option, as its purpose is the rational and integrated use of different techniques (DIAS et al, 2017).

CONCLUSIONS

It is therefore inferred that the most effective and sustainable approach to face this global Public Health challenge is the integration of diverse techniques and control methods - from conventional methods, such as the use of chemical insecticides, to innovative approaches, such as control vector genetics; and preventive measures, such as environmental management and biological control. All play an important role in reducing the incidence of insect-borne diseases.

It is essential to understand the advantages and limitations of each strategy, as well as consider the environmental and health impacts associated with the use of chemicals such as synthetic fertilizers and insecticides. Furthermore, the promotion of preventive practices, such as the elimination of mosquito breeding sites and the use of repellents, is essential to reduce the proliferation of disease-transmitting insects. Community involvement through health education in an eco-bio-social approach as well as public awareness also play a crucial role in the success of control strategies.

Therefore, to effectively face the challenge represented by disease-transmitting insects, it is necessary to adopt an integrated and multidisciplinary approach, which takes into consideration, not only biological and epidemiological aspects, but also the social, environmental and economic impacts of different control measures.

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