GLOBAL THREAT OF VECTOR-BORNE DISEASES TRANSMISSION AND CO-INFECTION IN URBAN AREAS

AN EVIDENCE BRIEF FOR POLICY MAKERS AT INTERNATIONAL/NATIONAL LEVEL

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ABSTRACT

The spread of mosquito-transmitted diseases in urban areas poses a serious threat to populations, economies, and development worldwide. Malaria control has been difficult to sustain after reintroduction and increased transmission in urban and peri-urban settings. Dengue and other viruses are still expanding, triggered by climate change, global travel, and trade. We are presenting the results of a systematic literature review on transmission dynamics, including co-infection and mosquitoes' ability to transmit the infectious pathogens (vector capacity). This evidence brief shows that population immunity, human mobility, co-circulation of diverse pathogens, and climate and environmental factors influence transmission dynamics. Considering the variability of vector-borne disease transmission in urban and peri-urban scenarios, the recommendations promote a multisectoral public health approach that is aligned with country emergency preparedness and health security.

This review was conducted before the Zika microcephaly epidemic in the Americas (2015–2016) and therefore did not capture knowledge about mother-to-child Zika virus transmission.

HIGHLIGHTS

- → **To understand vector-borne disease transmission, the role of asymptomatic individuals; human mobility; co-infection; vector competence; and climate, environmental, and socioeconomic factors must be addressed.**
- → **There is a need to reinforce surveillance that encompasses common symptoms, before specific disease diagnosis (syndromic surveillance*) in addition to single-disease surveillance and vector surveillance. This approach allows a timely response to the introduction of new pathogens and early outbreak detection.**
- → **Clinical management, surveillance and control activities must be integrated in urban areas given that viruses such as dengue, Zika and chikungunya share the same vector (*Aedes aegypti*).**
- → **There is a need to develop agreed upon ready-to-use forecast models to predict arboviruses outbreaks using multiple surveillance and entomological and meteorological parameters to build-up integrative models for control activities.**

INTRODUCTION

There is growing evidence that expanding urban population, climate change, and increasing global travel allow the spread of both vectors and diseases to new geographic areas and expose more humans to vector-borne diseases. This review evaluated the current knowledge on transmission dynamics, vectorial capacity, and co-infection of vector-borne diseases in urban areas in the literature (2000–2016). We focus on two groups of mosquito-transmitted diseases: 1. arboviruses, such as dengue, yellow fever, chikungunya, Mayaro, Japanese encephalitis, and Nipah virus; and, 2. malaria.

APPROACH AND RESULTS

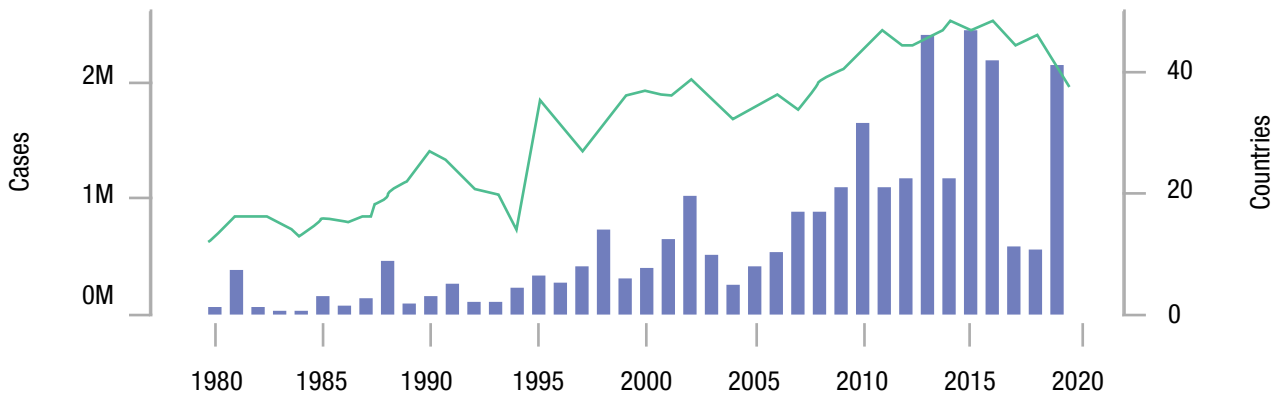
The review identified 50 articles related to transmission dynamics, vector capacity, and co-infection in urban areas, mainly from the Americas (23), Asia (15), and Africa (10). There were variations in study design and quality of the evidence, limiting comparability of the results. The funding sources were specified in two thirds of the studies.

For dengue, nearly all studies were from urban areas in the Americas and Asia. The findings showed significant variation of dengue incidence within cities and the importance of population immunity (susceptible, immune) for the transmission of infection. Infected individuals with no symptoms (asymptomatic) and increased human mobility contributed to viral infection spreading and persistence. Some studies found a positive correlation between climate factors (temperature and rainfall) and *Aedes aegypti* abundance, and dengue incidence, respectively. Other factors related to human behavior (water storage, waste, and sanitation) were associated with increasing mosquito breeding sites and dengue incidence.

Figure 1. The increase in dengue incidence in the American region (PAHO, 2018)

Dengue Cases 2019

Region	Total	Confirmed	Severe	Deaths
The Americas	2,144,325	860,413	16,667	800

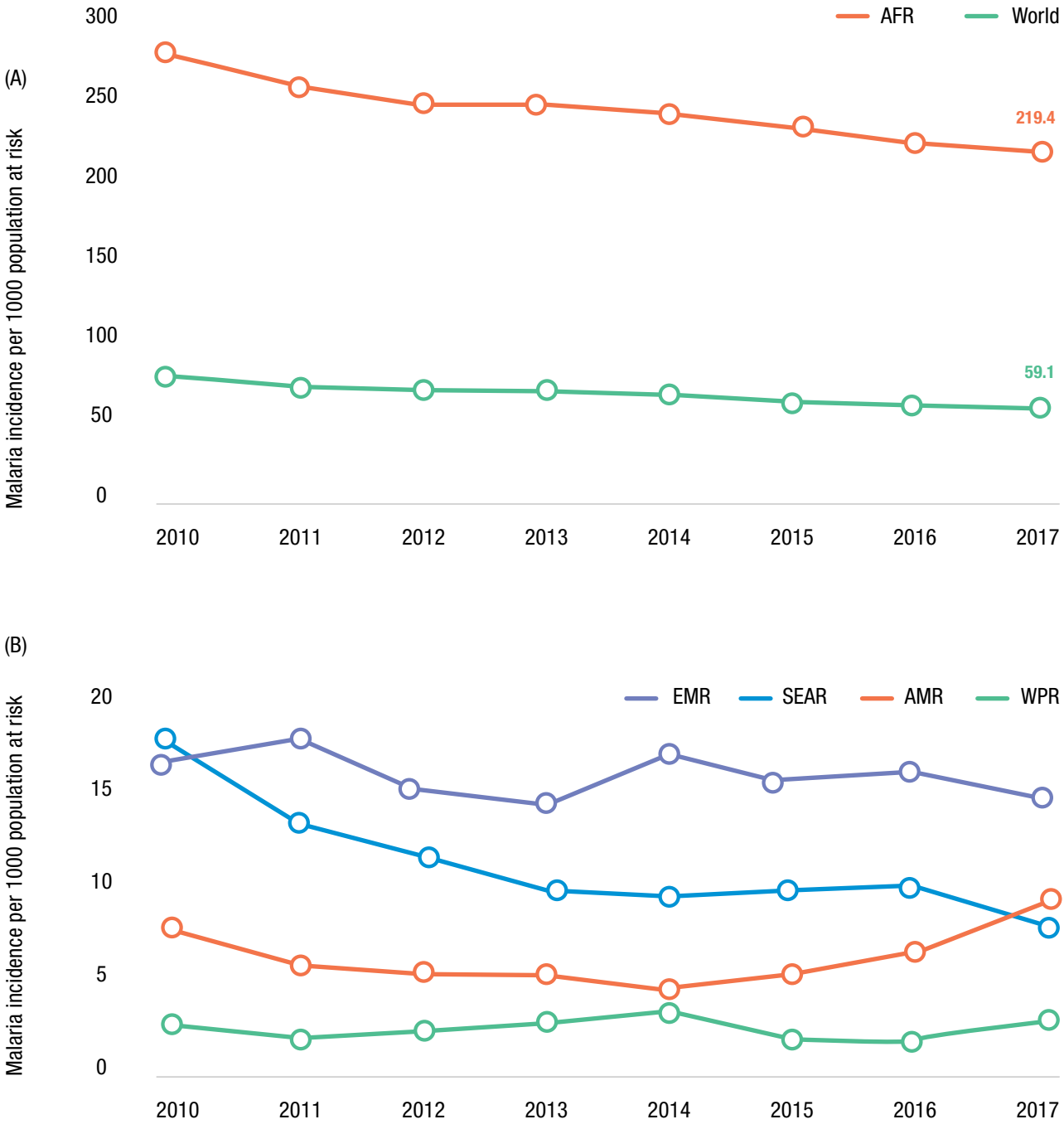


PLISA – Health Information Platform for the Americas:
Most Recent Reported Cases on Dengue

Dengue in the Americas. Increase in dengue incidence in the American region (PAHO, 2018).
https://www.paho.org/hq/index.php?option=com_topics&view=article&id=1&Itemid=40734&lang=en
http://www.paho.org/data/index.php/en/mnu-topics/indicadores-dengue-en/dengue-regional-en/315-reg-dengue-incidence-en.html?start=1

Most malaria studies were conducted in Africa and Asia, showing transmission in urban and peri-urban areas. Some studies highlighted the increase of malaria transmission as a result of urban expansion towards forested areas. Migration and travel were identified as important risk factors for malaria reintroduction in Singapore (2009). Malaria transmission increased during the rainy season and in warmer temperatures. Some studies suggested that climate change was affecting urban areas in the highlands of Ethiopia (2004) and India (2004), resulting in increased transmission.

Figure 2. The persistent malaria incidence worldwide (WHO, 2018)



AFR: WHO African Region; AMR: WHO Region of the Americas; EMR: WHO Eastern Meditarranean Region; SEAR: WHO South-East Asia Region; WHO: World Health Organization; WPR; WHO Werstern Pacific Region.

Trends in malaria incidence rate (cases per 1000 population at risk), globally and by WHO region, 2010–2017. The WHO European Region has reported zero indigenous cases since 2015. Source: WHO estimates. Data: Annex 3 - F. Population at risk and estimated malaria cases and deaths, 2010–2017.
World Malaria Report 2018. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.
https://www.who.int/malaria/publications/world-malaria-report-2018/en/

For both dengue and malaria, transmission risk was higher in low-income areas, compared to higher-income areas in the same region, even with similar vector distribution. Another area of common ground was the role of human mobility on transmission within and between cities and countries.

Only a few studies investigated the co-circulation of different pathogens at population level or coinfection at individual level.

CONCLUSION

There are still knowledge gaps around the key aspects of mosquito-transmitted diseases in urban areas regarding the affected individuals (host); mosquito distribution; and climate, environmental, and socio-economic factors. More studies on co-circulating pathogens transmitted by the same vector should improve surveillance and control of infections. Findings regarding vector-borne diseases transmission should be rapidly shared with policy makers, considering the ecological changes and the speed of human mobility and in urban and peri-urban settings. Closer collaboration between research, policy makers, and funding organizations would facilitate alignment of research calls and public health priorities to cope with new and old infectious disease threats.

RECOMMENDATIONS

1st **A syndromic surveillance approach covering mosquito transmitted viruses such as dengue, Zika, yellow fever, and chikungunya will improve the detection of old and new and co-circulating pathogens.**

2nd **Combine existing disease and vector surveillance and meteorological and environmental parameters to understand transmission variability and quickly detect changes in disease incidence and/or vector distribution over time, signaling the trend. Employing diverse data sources will allow early detection of transmission 'spikes' of mosquito-transmitted infection.**

3rd **Vector-borne disease interventions should integrate clinical management, surveillance, and vector control and follow a multisectoral public health approach, aligned with country emergency preparedness and health security.**

4th **Research calls on vector-transmitted disease should be prioritized according to public health needs, in coordinated initiatives. Due to the complexity of vector-borne disease transmission, translational research is recommended.**

*Syndromic surveillance refers to methods relying on detection of individual and population health indicators that are identifiable before diagnoses are confirmed.

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