Factors influencing establishment of dengue fever vectors in urban areas

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Dengue fever is the most rapidly spreading mosquito-borne disease, with a 30-fold increase in global incidence over the past 50 years (*1*). It is caused by the dengue virus, which is transmitted to humans mainly through the bites of infected *Aedes aegypti* and *Aedes albopictus*. The risk of vector-borne disease spread is higher in the WHO Eastern Mediterranean Region (EMR) due to its geographical location, fragile health systems, complex humanitarian emergencies, and other socioeconomic factors. Dengue is one of the fastest emerging mosquito-borne viral diseases in the region and it is endemic in at least 8 of the 22 countries and territories. Large dengue outbreaks have been reported in Afghanistan, Egypt, Pakistan, Sudan, and Yemen (*2*). Understanding the factors influencing the establishment of dengue fever vectors is crucial for effective control and prevention and for implementing targeted interventions to reduce mosquito populations effectively (*3,4*).

Environmental factors

Temperature, rainfall and humidity directly impact vector breeding, survival, establishment, and spread (*2,5*). Higher temperatures accelerate mosquito development, reducing their incubation period and increasing their biting frequency; a warm and humid climate provides an ideal breeding ground for dengue virus vectors (*6*). Excessive rainfall creates stagnant water pools, which serve as breeding sites for *Aedes* mosquitoes. An increase in temperature was associated with an increase in dengue fever outbreak in 9 of 73 provinces in Thailand (*7*), and aggregate negative binomial regression model showed that precipitation, humidity and air pressure significantly influenced the spread of dengue fever in Sri Lanka (*5*).

Climate change influences the spread and establishment of dengue fever vectors; increasing temperatures and changing precipitation patterns can expand suitable habitats for the vectors (*1,8*). Climate change can alter the geographical distribution of Aedes mosquitoes, allowing them to thrive in regions previously unsuitable for their survival (*8*). For example, the heavy rainfall pattern, which caused widespread flooding, may have been the main reason for the establishment of invasive dengue vectors in Pakistan (*9*).

Human factors

Rapid urban growth often leads to inadequate housing, increased construction activities, improper waste management, and limited access to clean water (*10,11*), which in turn lead to the creation of artificial water containers that provide ideal breeding grounds for mosquitoes. Urban areas often have higher population densities and poor sanitation services, further exacerbating the risk of dengue transmission. Improper waste disposal and poor sanitation contribute to the proliferation of dengue fever vectors in urban areas (*12,13*). Deforestation disrupts natural ecosystems and forces mosquitoes to seek alternative hosts closer to human settlements (*6*).

The movement of people and goods contributes to the spread of dengue fever vectors in urban areas (*14*). Aircrafts and ships are believed to be directly responsible for rapid *Aedes aegypti* expansion (*15*). Dire Dawa in East Ethiopia reported 40 confirmed dengue fever cases at the end of 2013. Because Dire Dawa is an industrial and tourism centre, migration of infected populations may have been responsible for the increased transmission and the high number of cases (*16*). Efforts to mitigate the establishment of dengue fever vectors must consider the role of globalization in facilitating the spread of the vectors across borders (*17*).

There was a consistent association between urbanization and the distribution and density of *Aedes* mosquitoes in 14 of 29 studies, and a strong relationship between vector abundance and disease transmission in 18 studies (*14*). Urbanization substantially increased the density, larval development rate and adult survival time for *Aedes albopictus*, which in turn increased the vector capacity and, therefore, disease transmissibility (*18*).

Socioeconomic factors

Poor communities often lack basic sanitation and health care services, making them more vulnerable to dengue transmission (*6*). Limited access to health care facilities may delay diagnosis and treatment, allowing infected individuals to serve as reservoirs for further vector propagation.

Challenges in implementing dengue vector control programmes and how to address them

Many challenges can impact dengue vector control programmes. These include lack of interest in control efforts, local community dependency on the health sector, lack of enthusiasm among local organizations and community leaders, poor communication by health authorities, low awareness and preparedness at community level, lack of detailed control policy guidelines, low enforcement of related policies, and limited budget (*19*).

The EMR is characterised by extreme temperatures and precipitation fluctuations, and the scarcity of natural water and agricultural land (*20*). To mitigate the climate crisis, there is a need to build climate-resilient infrastructure, develop early warning systems, restore ecosystems, improve water supplies and security, and promote long-term planning (*21*). Delays in addressing the interlinkages between climate and health will undermine decades of progress in public health (*22*).

Efforts to control dengue fever vectors should focus on the reduction of mosquito breeding sites (19), including regular removal of stagnant water from artificial containers and promoting proper waste disposal practices. Public awareness campaigns can help educate individuals on the importance of maintaining clean and sanitized living environments that will minimize human-mosquito contact.

Collaboration with urban planning authorities is essential in designing and constructing mosquito-resistant infrastructure that can help control dengue fever vectors (*23*). This should include incorporating proper drainage systems and mosquito-proof water storage facilities into urban development projects. Creating environments unfavourable for *Aedes* breeding should be a priority (*24*). Community engagement and participation are crucial in sustaining long-term vector control efforts, because local residents can play a significant role in identifying and eliminating potential mosquito breeding sites in their neighbourhoods. Collaboration between countries and regions is also essential for effective cross-border surveillance and control measures.

There is a need for intersectoral collaborations to develop, implement and evaluate dengue control initiatives at various levels (*25*). Intersectoral collaboration can play an important role in reducing vector-borne diseases or vector densities. A study found that community participation increased collaboration considerably and increased acceptability of interventions from 66% to 78% (*26*). An intervention that adopted intersectoral planning for dengue prevention, focusing on source reduction, helped increase knowledge about breeding sites and disease symptoms significantly and increased the proportion of community members eliminating containers in and around their homes (*27*).

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