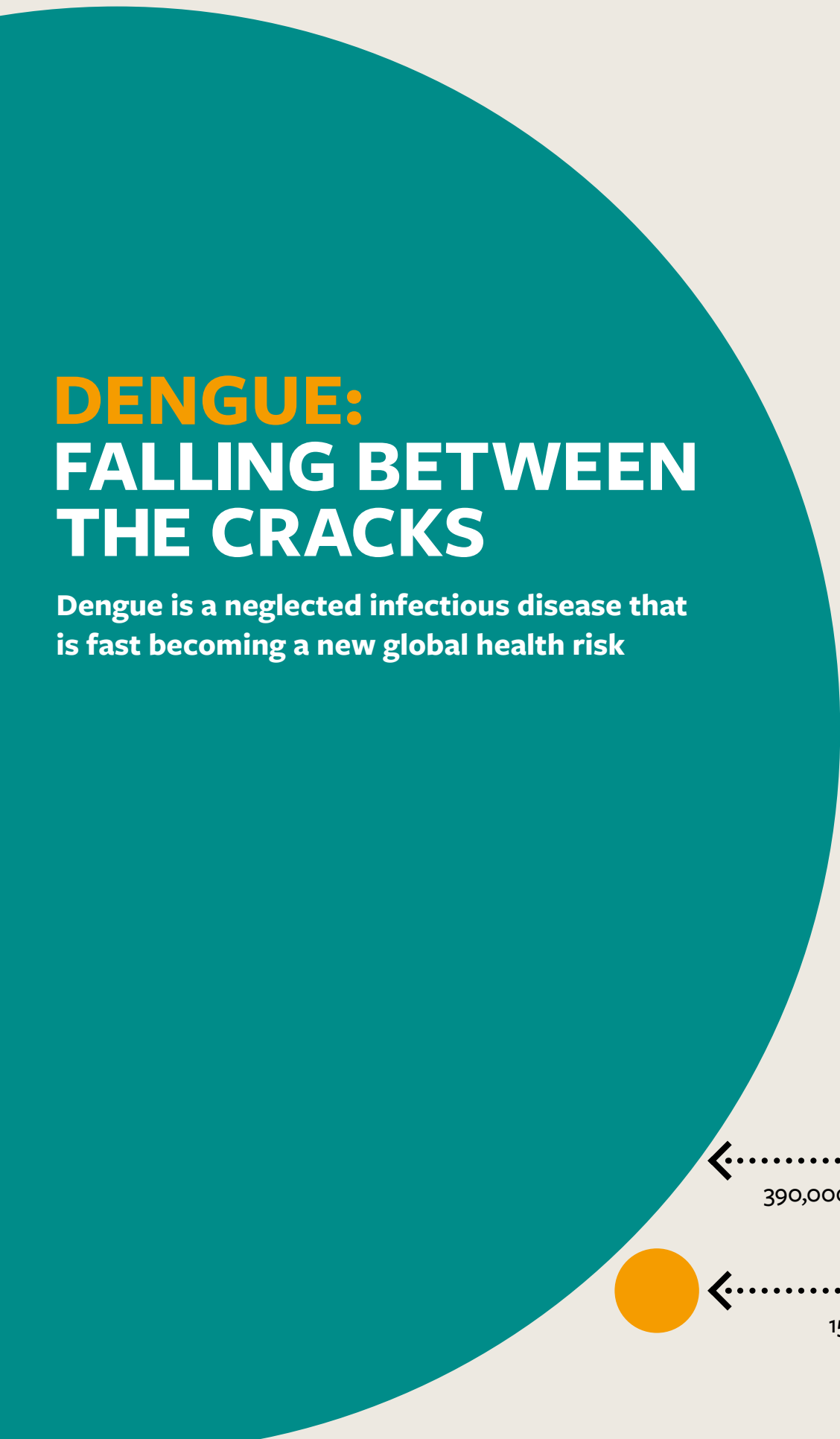


DENGUE: FALLING BETWEEN THE CRACKS

Dengue is a neglected infectious disease that is fast becoming a new global health risk



390,000,000 cases per year in 2012

15,000 cases per year in 1960

.....

“In just the past decade, the significance of dengue as a threat to health and a burden on health services and economies has increased substantially. Compared with the situation 50 years ago, the worldwide incidence of dengue has risen 30-fold. More countries are reporting their first outbreaks. More outbreaks are explosive in ways that severely disrupt societies and drain economies. Today, dengue ranks as the most important mosquito-borne viral disease in the world. Everywhere, the human and economic costs are staggering.”

Dr Margaret Chan, Director-General, World Health Organization¹

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Malaria Consortium wishes to thank all who contributed to this report.

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This material has been funded by UKaid from the UK government, however, the views expressed do not necessarily reflect the UK government's official policies.

Report design by Transmission. Infographics by nim design.

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¹. World Health Organization. Global strategy for dengue prevention and control 2012-2020. <http://apps.who.int/iris/handle/10665/75303>

INTRODUCTION

The World Health Organization (WHO) considers dengue to be the most important vector-borne viral disease in the world today. It is one of the fastest growing infectious diseases, spreading from nine to over 100 countries in the past 50 years. The disease burden has correspondingly risen from 15,000 recorded cases per year in the 1960s² to an estimated 390 million in 2012³.

Even though almost half of the world's population are at risk, global attention to this rapidly spreading disease has been minimal. Diseases such as malaria meanwhile, thanks to the Millennium Development Goals, have become high global health priorities and benefitted from dramatic increases in both focus and funding. The remarkable success that has been achieved in reducing the burden of malaria – averting more than 6.2 million deaths since 2001 – shows what concerted global action can achieve.

Dengue, meanwhile, continues to spread largely unchecked. The *Aedes* mosquito – which transmits dengue – has moved into new areas of Asia and into South and Central America, spreading a disease which is exerting a huge burden on populations, health systems and economies. In some endemic countries in Asia and Latin America, dengue is now the leading cause of serious illness and death among children.

Dengue is also expanding into Africa and the warmer regions of high-income countries such as Australia, Southern Europe and the United States. This is thought to be partly the result of human movement and increased urbanisation, as well as possibly climate change. In 2010-11 France and Croatia recorded the first indigenous outbreaks in Europe, and in 2015 all six WHO regions recorded cases of dengue fever. Yet early detection and experienced medical care can lower the death rate for those hospitalised with severe dengue from around 20 percent to well below one percent⁴.

Dengue is one of the 17 recognised neglected tropical diseases (NTDs), but even within NTD circles it has been one of the least prominent. It was not selected as one of the 10 target diseases to be controlled or eliminated by the end of the decade at the 2012 London Declaration on NTDs. This lack of attention has been mirrored by a lack of policy dialogue within the international community and among governments.

Later in 2012, WHO took the important step of publishing its Global Strategy for Dengue Prevention and Control 2012-2020⁵. Since then, what investment there has been in dengue has mostly supported vaccine development, however, funding for prevention and control at country and community level needs to be far greater if we are to slow and reverse this dramatic growth. As the world begins to focus on achieving the new Global Development Goals by 2030, and given the explicit commitment of these goals to *leave no one behind*, now is the time to raise the profile of this disease and mobilise to defeat it.

2. Anders KL and Hay S. 2012. 'Lessons from control to help meet the rising challenge of dengue'. *Lancet Infectious Disease*, 12(12): 977-984. [www.thelancet.com/journals/lancet/article/PIIS1473-3099\(12\)70246-3/](http://www.thelancet.com/journals/lancet/article/PIIS1473-3099(12)70246-3/)

3. Brady OJ, Gething PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG et al. 2012. 'Refining the global spatial limits of dengue virus transmission by evidence-based consensus'. *PLoS Neglected Tropical Diseases*, 6(8):e1760. <http://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0001760>

4. World Health Organization. Dengue fact sheet. www.who.int/mediacentre/factsheets/fs117/en

5. World Health Organization. Global strategy for dengue prevention and control 2012-2020. <http://apps.who.int/iris/handle/10665/75303>

CALL TO ACTION

If the spread of dengue is to be halted, there needs to be a shift from *ad hoc* responses to isolated outbreaks towards long-term, integrated programming.

This would require an increase in funding for a combination of dengue programmes that include prevention, management and treatment, and effective surveillance. Together these offer the way forward for controlling and then reversing the spread of dengue.

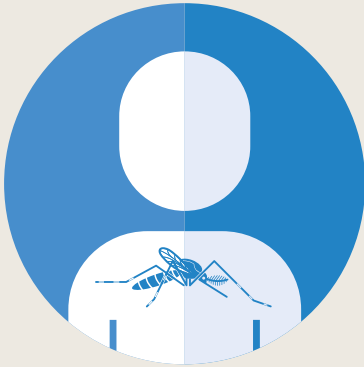
When such programming also includes community-level initiatives, it can lead to sustainable behaviour change that results in real and positive impact on health outcomes. Elements of the integrated community-based approach to preventing dengue include addressing environment cleanliness and vector control.

When communities are armed with the essential knowledge and skills concerning preventive behaviours and environmental sanitation, they can minimise their own vulnerability to dengue. Engaging and training community health volunteers to identify and refer suspected dengue cases, and improving community-based disease surveillance, is also crucial.

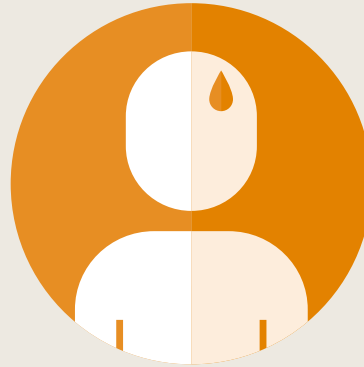
Dengue must be moved up the global health agenda before it becomes an even greater threat than it already is.

UNDERSTANDING DENGUE

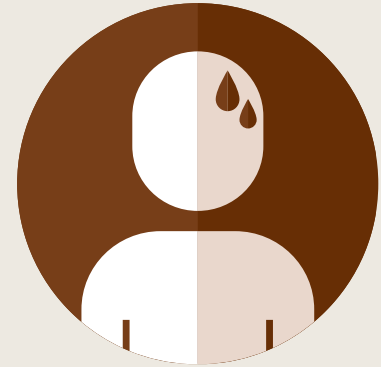
WHAT IS DENGUE?



Dengue is a mosquito-borne **VIRAL** infection

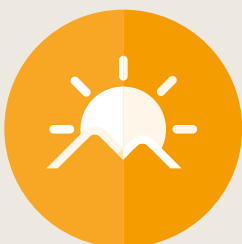


The infection causes **FLU-LIKE ILLNESS**, and occasionally develops into a **POTENTIALLY LETHAL** complication called severe dengue



The **SECOND TIME** you get dengue, the symptoms can be **MORE SEVERE**

HOW DOES IT SPREAD?



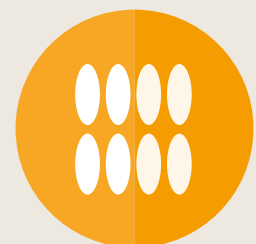
The mosquito typically bites during the daytime



Via the bite of an infective female mosquito, principally *Aedes aegypti*



The mosquito breeds mostly in water containers



Aedes eggs can withstand very dry conditions and are easily transported via international trade

* Sources: WHO; Shepard D et al

UNDERSTANDING DENGUE

Dengue is a viral infection that is transmitted by the bite of an infective female mosquito, principally *Aedes aegypti*, which predominately breeds in water containers that are discarded or left outside, such as water collection tanks, rubbish cans, tyres and other items that hold rain water.

The vast majority of cases of dengue are found in the Asia Pacific and Latin American regions but *Aedes aegypti* and *Aedes albopictus*, which are found in the tropics and subtropics, have expanded to new areas including Australia, the United States, southern Europe and Africa. The same vector also carries other arboviral diseases, including Zika, yellow fever and chikungunya.

Dengue illness typically starts from four to seven days after a person is bitten by an infected mosquito, but it can range from 3-14 days. The infection starts with a sudden onset of fever (up to 40°C) that lasts for about seven days, and is accompanied by headache and muscle pain in the back and limbs. Symptoms of moderate dengue include nausea, vomiting, pain in the eyes and rashes on the upper and lower limbs. Children are particularly susceptible to the disease and many who are infected for the first time experience asymptomatic infection or mild, undifferentiated febrile illness.

There is no specific treatment available, so timely interventions are crucial for saving lives. Severe dengue is characterised by severe plasma leakage leading to dengue shock syndrome and fluid accumulation causing respiratory distress, severe bleeding and multi organ failure⁶. For these cases, hospitalisation is required depending on signs of severity such as dehydration, bleeding or co-morbidities. Effective case management requires intravenous fluids, blood transfusions and intensive nursing care. With quick and effective treatment, fatality rates are below one percent of cases. However, the risk of contracting severe dengue can increase with further infections, particularly with a different serotype of the virus⁷.

Due to similarities in symptoms between dengue, malaria and other vector borne diseases such as chikungunya and Zika, there is often confusion when diagnosing and effectively treating dengue. In countries where malaria and dengue are prevalent, WHO guidelines stipulate that health staff should regularly screen malaria-negative fever patients for dengue. Blood should be sent to laboratories for testing to determine the serotypes (there are four dengue serotypes) circulating during an outbreak, as this can sometimes predict the severity of the disease outbreak and prepare the country's hospitals to deal with an increased numbers of patients.

6. World Health Organization. Dengue guidelines for diagnosis, treatment, prevention and control 2009. www.who.int/tdr/publications/documents/dengue-diagnosis.pdf?ua=1

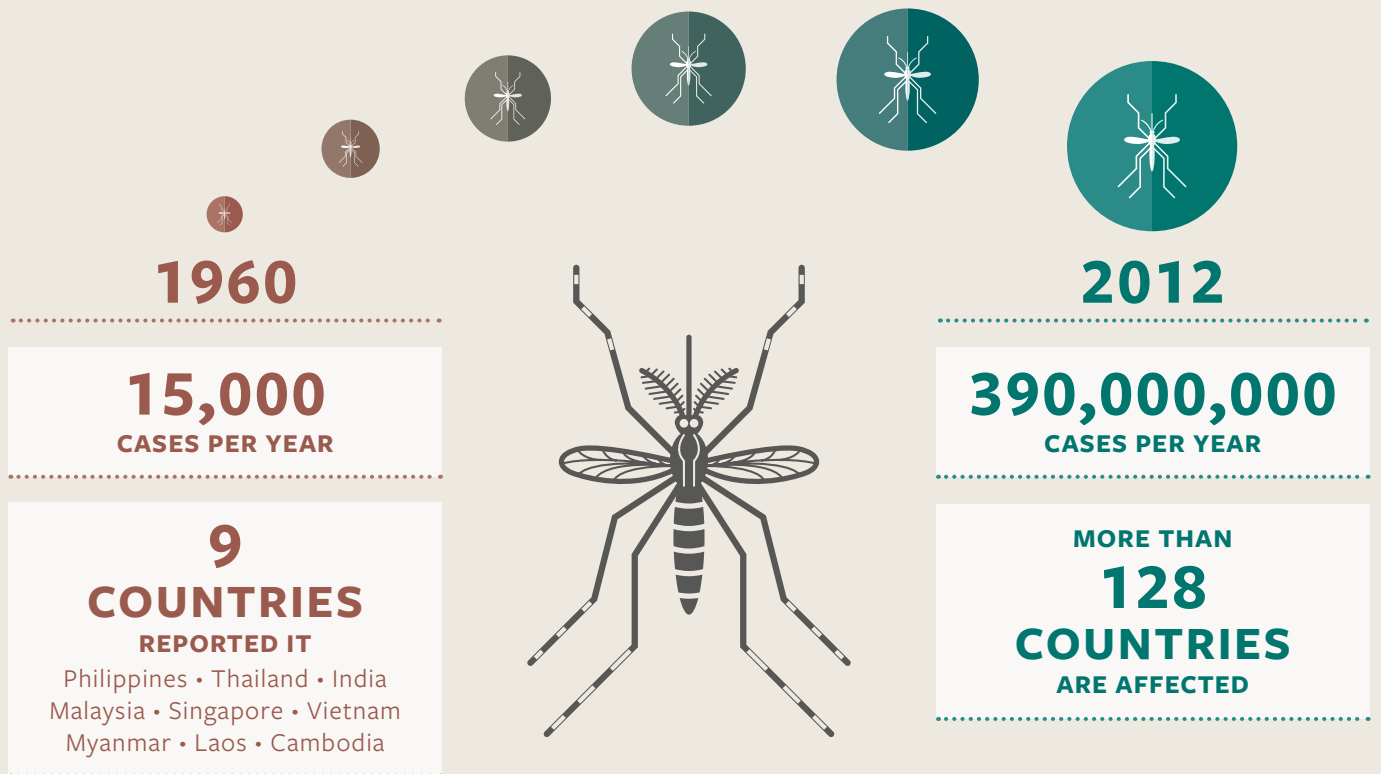
7. Vaughn DW et al. Dengue Viremia Titer, 2000. 'Antibody response pattern, and virus serotype correlate with disease severity'. *Journal of Infectious Disease*. 181 (1): 2-9. <http://jid.oxfordjournals.org/content/181/1/2.short>

CLIMATE CHANGE

It is predicted that climate change will have an effect on a wide range of health risks. To date, there has been insufficient research, and therefore there is a lack of evidence to establish the impact climate change will have on dengue transmission. However, since dengue is linked to climate and the movement of people – in higher temperatures the vector and virus replicates faster, and the vector bites more frequently and survives longer – it is highly probable that it will continue to extend to new geographical areas.

Although the disease has a seasonal peak, dengue can occur any time of the year. A better understanding of the relationship between climate change and dengue is needed, in order to inform dengue awareness campaigns, disease surveillance and the development of effective prevention and outbreak control strategies. In addition, more support should be given to countries to study climate data, including the El Nino effect, and to promote collaboration with respective agencies to support early warning systems.

THE RISE OF DENGUE



30 MOST ENDEMIC COUNTRIES

CARIBBEAN

Dominican Republic • Guadeloupe
Martinique • Puerto Rico

CENTRAL AMERICA

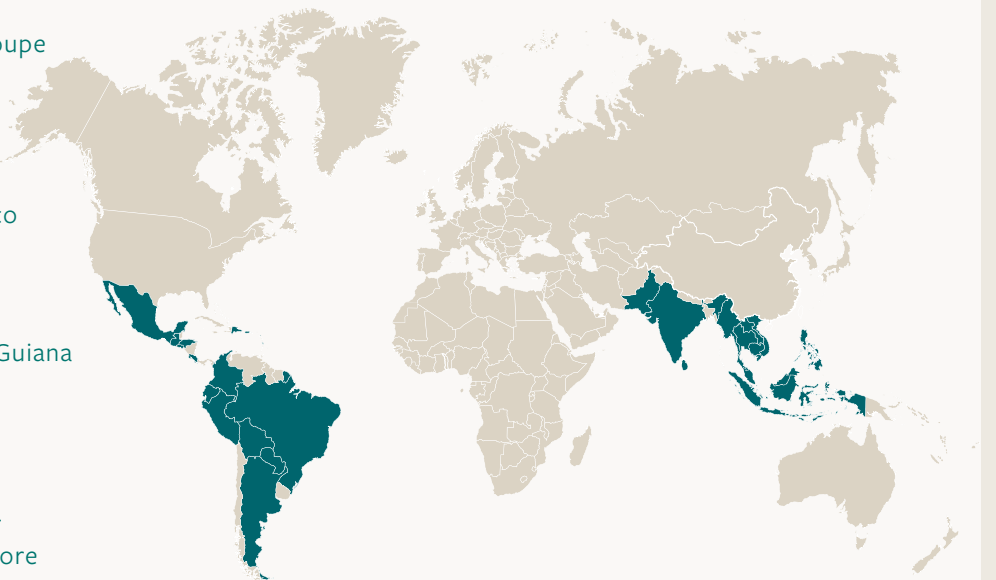
Costa Rica • El Salvador
Guatemala • Honduras • Mexico

SOUTH AMERICA

Argentina • Bolivia • Brazil
Colombia • Ecuador • French Guiana
Paraguay • Peru • Venezuela

ASIA

Cambodia • India • Indonesia
Lao PDR • Malaysia • Myanmar
Pakistan • Philippines • Singapore
Sri Lanka • Thailand • Vietnam



The global incidence of dengue has grown dramatically in recent decades
About 50% of the world's population is now at risk

Sources: WHO, 'Global Strategy for dengue prevention and control 2012–2020'
Brady et al., 'Refining the global spatial limits of dengue virus transmission by evidence-based consensus'
Anders and Hay, 'Lessons from control to help meet the rising challenge of dengue'

Dengue incidence is growing fast, increasing six-fold between 1990 and 2013 alone. However, estimating the true burden of dengue is extremely difficult. This is due to poor disease surveillance, low levels of reporting, a lack of affordable rapid diagnostic tests, and inconsistent comparative analyses. Therefore, estimates tend to vary; from 390m cases in 2012, to just 58.4m cases in 2013. Dengue can be severe enough to require the hospitalisation of roughly 500,000 people each year⁸. A large proportion of these are children and an estimated 2.5 percent (12,500) die⁹.

As well as an increasing overall number of dengue cases, explosive outbreaks of the disease are also becoming more common; 2015 saw more outbreaks than previous years, with notable examples in The Philippines, Malaysia, Brazil, India, Hawaii, Fiji, Tonga and Polynesia. The chance of an outbreak of dengue fever in Europe is now a distinct possibility, since local transmission was reported in France and Croatia for the first time in 2010. In 2012, an outbreak of dengue on the Madeira Islands of Portugal resulted in over 2,000 cases¹⁰.

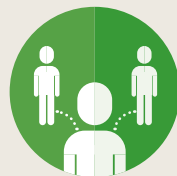
WHY IS DENGUE SPREADING?



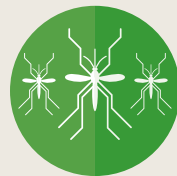
Population growth



Poor sanitation



Changing virus transmission dynamics



Large mosquito populations



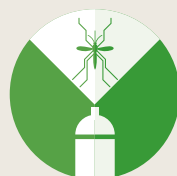
Lack of political attention and resources



Inappropriate spraying of insecticides



Changing lifestyles



Insecticide resistance



Population mobility



Increased urbanisation

8. Bhatt S, et al. 2013. 'The global distribution and burden of dengue' Nature. 496:504-507. www.nature.com/nature/journal/v496/n7446/full/nature12060.html;
 Wilder-Smith A, Byass P. 2016. 'The elusive burden of dengue'. Lancet Infectious Disease. 16(6):629-31. [www.thelancet.com/journals/laninf/article/PIIS1473-3099\(16\)00076-1/](http://www.thelancet.com/journals/laninf/article/PIIS1473-3099(16)00076-1/)
 9. World Health Organization. Dengue fact sheet. www.who.int/mediacentre/factsheets/fs117/en
 10. World Health Organization. Dengue fact sheet. www.who.int/mediacentre/factsheets/fs117/en

ECONOMIC IMPACT OF DENGUE



IT IS ESTIMATED THAT EVERY YEAR DENGUE COSTS THE AMERICAS

US\$ 2.1 BILLION



AND IN SOUTHEAST ASIA ECONOMIES COULD LOSE

US\$ 2.36 BILLION

DUE TO THE DISEASE*



STUDIES CARRIED OUT IN 8 COUNTRIES SUGGEST THAT THE OVERALL COSTS OF A NON-FATAL AMBULATORY CASE AVERAGED

US\$ 514**

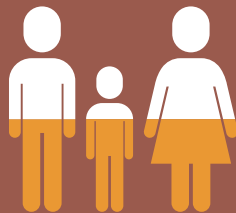


AND NON-FATAL HOSPITALISED CASE AVERAGED

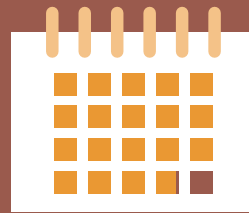
US\$ 1,394***



Hospitalised cases cost **3** times of what an ambulatory case costs



On average **45%** of health costs are borne by the patient or the family†



Between **14.8** and **18.9** days are lost in productivity for patients and families††



The costs of dengue can be **2** times, or even **3** times, the average monthly income of a family†††

* Disease Control Priorities Project. Tropical Diseases Lacking Adequate Control Measures: Dengue, Leishmaniasis, and African Trypanosomiasis. Available at: www.dcp2.org/pubs/DCP/23/Section/3154

** The eight countries where the study was carried out between 2005 and 2006 are: Brazil, El Salvador, Guatemala, Panama, Venezuela, Cambodia, Malaysia and Thailand; WHO and the Special Programme for Research and Training in Tropical Diseases. Dengue: Guidelines for diagnosis, treatment, prevention and control. Geneva, 2009. Available at: whqlibdoc.who.int/publications/2009/9789241547871_eng.pdf?ua=1

*** WHO, 'Global Strategy for dengue prevention and control 2012–2020', p.1

† www.oxitec.com/health/dengue-informationcentre/the-economic-burden/

†† WHO, 'Global Strategy for dengue prevention and control 2012–2020', p.12

††† Denguematters. Issue 1 – The human costs of dengue. www.denguematters.info/content/issue-1-human-costs-dengue

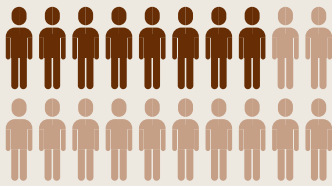
Although dengue has a relatively low mortality rate, due to the large number of cases and wide geographic coverage, it has a sizable economic impact upon countries that are affected.

However, studies on the cost-effectiveness of dengue interventions are few, with conflicting results that do not support an evidence-based approach to mobilising resources for dengue control. The benefits are often narrowly defined, focusing on healthcare costs, care-related increases in productivity, and reductions of morbidity and mortality rates.

A broader analysis is needed, that also takes into consideration outbreak control spending, the effect on income from tourism and other industries, community economic costs and long-term economic productivity, so that research accurately represents the full cost of the dengue burden.¹¹

11. Horstick O, Tozan Y, Wilder-Smith A. 2015 'Reviewing dengue: Still a neglected tropical disease?' PLoS Negl Trop Dis 9(4): e0003632. www.ncbi.nlm.nih.gov/pmc/articles/PMC4415787

WHAT IS THE HUMAN IMPACT?



Today **over 50%** of the world's population is at risk from dengue and severe dengue



Every **minute** someone is admitted to hospital because of dengue



Without experienced medical care the death rate from severe dengue can be as high as **20%**



Around **500,000** people, mostly children, are hospitalised with severe dengue each year



Every **20 minutes** a life is lost to dengue



Early diagnosis and appropriate quality care can bring down the mortality rate to below **1%**

* Source: WHO, www.who.int/mediacentre/factsheets/fs117/en

FINANCING THE FIGHT AGAINST DENGUE

In 2013 in London, the World Health Assembly passed a resolution on NTDs, calling on endemic countries to take ownership of national NTD programmes, and for international partners to provide sufficient and predictable funding for implementation, research and the development of new tools. However, because dengue is not one of the 10 NTDs prioritised under the 2012 London Declaration, it has not been prioritised by international donors.

Financial investments have been largely limited to vaccine development and emergency funding for outbreak response, leaving endemic countries to rely on their

own resources, if available, for dengue control and surveillance activities¹². This reactive approach to funding dengue prevention and control is unsustainable if we are to make real inroads in bringing down the number of dengue cases. As outlined in the WHO Global Strategy for Dengue Prevention and Control 2012-2020, investment in dengue preparedness and response, as well as a clearer understanding of the true burden of the disease, must be addressed as priorities. International donors should increase their funding of dengue prevention, control and surveillance, and use their resources to support endemic countries to engage in more routine and sustainable approaches to combating the disease.

12. Horstick O et al. 2015 'Reviewing dengue: Still a neglected tropical disease?' PLoS Neglected Tropical Diseases 9(4): e0003632. www.ncbi.nlm.nih.gov/pmc/articles/PMC4415787

HOW TO REDUCE THE DENGUE BURDEN



Preventing mosquitoes from accessing egg-laying habitats by environmental management and modification



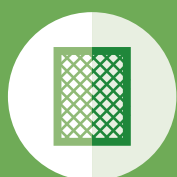
Disposing of solid waste properly and removing artificial man-made habitats



Covering, emptying and cleaning of domestic water storage containers on a weekly basis



Applying appropriate insecticides to water storage outdoor containers



Using personal and household protection such as window screens, long-sleeved clothes, insecticide treated materials, coils and vaporisers



Improving community participation and mobilisation for sustained vector control



Indoor and peri-domestic space spraying during outbreaks as one of the emergency vector-control measures



Carrying out monitoring and surveillance of vectors to determine effectiveness of control interventions

DENGUE VACCINE

Despite more than 70 years of effort, a dengue vaccine with high efficacy remains elusive. The current pipeline of vaccine candidates, however, is extensive with several vaccines at different stages of development. CYD-TDV, or Dengvaxia[®], developed by Sanofi Pasteur, is furthest along in development and is now registered for use in 9-45 year olds living in several endemic countries with pooled efficacy rates up to 65.6 percent for those aged nine and over involved in the Phase 3 trials¹³.

WHO's position is that the Dengvaxia[®] vaccine should only be considered for introduction in geographical settings with a high burden of the disease (70 percent or greater in the targeted age group), in order to maximise its cost effectiveness and public health impact. As well as Dengvaxia[®], two other vaccines are also currently being evaluated¹⁴.

Vaccines should be used as part of a comprehensive dengue control strategy that includes vector control so that the two strategies can complement and enhance one another. Predictive modeling and results from the fight against other vector-borne diseases support this hypothesis – the global malaria burden was reduced using anti-malarial drugs in conjunction with insecticides for vector control, and lymphatic filariasis is more rapidly and efficiently managed when mass drug administration is combined with vector control¹⁵.

13. Hadinegoro SR et al. 2015. 'Efficacy and long-term safety of a dengue vaccine in regions of endemic disease' New England Journal of Medicine, 373:1195-206. www.nejm.org/doi/pdf/10.1056/NEJMoa1506223

14. World Health Organization. Dengue vaccine: WHO position paper July 2016 www.who.int/wer/2016/wer9130.pdf?ua=1

15. Achee NL et al. 2015. 'A critical assessment of vector control for dengue prevention'. PLoS Neglected Tropical Disease 9(5): e0003655. www.ncbi.nlm.nih.gov/pmc/articles/PMC4423954

OUR APPROACH

Malaria Consortium specialises in designing and delivering innovative vector control programmes and pioneering data collection and surveillance interventions that strengthen both community and national-level capacity. We are currently engaged in context-specific programmes that support national efforts to tackle dengue in Cambodia and Myanmar. Below we outline Malaria Consortium’s approach to controlling and reducing the impact of the disease.

VECTOR CONTROL

Malaria Consortium believes that vector control is one of most important and effective interventions for reducing the burden of dengue. By reducing the size of the vector population, there is the potential of reducing disease transmission and therefore the number of cases.

Vector control, however, is complicated by the behaviour of the mosquitoes that carry the dengue virus, as they bite mainly during the day. This means that the standard approach to mosquito bite protection – using an insecticide treated mosquito net at night – is inadequate. Therefore killing the mosquito, controlling larvae or reducing mosquito breeding places through source reduction are among the most effective approaches to vector control.

Integrated vector control interventions for dengue are gaining support, but there is currently no consensus on which vector control approach is likely to have the greatest impact upon dengue transmission rates¹⁶. Although most community-based control strategies are simple and cost-effective to implement, it is important to ensure that planning and coordination is effective, that tools are integrated, targeting of immature and adult stages of the vector are improved, and monitoring and evaluation systems are in place. Efforts to reduce breeding sites are potentially effective against vectors breeding mainly in water containers around human dwellings, such as *Aedes aegypti*. By tackling both adult and larval stages, not only is the risk of dengue reduced but also that of Zika, chikungunya and yellow fever.

¹⁶. Horstick O et al. 2015. ‘Reviewing dengue: Still a neglected tropical disease?’ PLoS Neglected Tropical Disease, 9(4): e0003632. www.ncbi.nlm.nih.gov/pmc/articles/PMC4415787

Dengue vector control programmes are sustained mainly by community-based initiatives which are supported technically and routinely by ministries of health. Source reduction, which requires the removal of containers, may be logistically demanding but it is an essential outbreak response activity by the community. Its success depends on how informed and engaged the community is and how well they understand the importance of environmental sanitation. This approach emphasises the importance of behavioural change communication.

The roles and involvement of different stakeholders is sometimes ignored in outbreak response plans, causing problems in coordinating the various sectors and social groups involved in implementing source reduction. Better planning is needed that considers the importance of communication, recognises local capacity limitations and delegates authority responsibly¹⁷.

Implementation of vector control interventions remains challenging, and because routine vector control is difficult, most countries rely upon emergency vector control in response to outbreaks. However, novel strategies are on the horizon, such as the use of *Wolbachia*-infected mosquitoes or genetically engineered mosquitoes. Evidence of their effectiveness is limited, and therefore it may be many years until national programmes can make use of them¹⁸.

Malaria Consortium has looked to fill a gap in malaria prevention by investigating the potential of insecticide treated clothing. This method involves the application of insecticides and repellents on locally-made clothing for protection against mosquito bites. However, the insecticide – typically *permethrin* – is not as effective against *Aedes aegypti*¹⁹.

The WHO Pesticide Evaluation Scheme (WHOPES) has established the Global Collaboration for Development of Pesticides for Public Health to facilitate the search for and sale of more cost-effective pesticides and application methodologies. Malaria Consortium emphasises the need for funding for operational research, in order to evaluate the efficacy of new tools, as well as insecticide resistance monitoring, to inform expanded studies and management of resistance.

We also recommend a broader, more integrated strategy of vector control that targets more than one vector, as well as the use of different approaches and tools against mosquitoes transmitting diseases of public health importance.

17. Harrington J et al. 2013. 'Detecting and responding to a dengue outbreak: Evaluation of existing strategies in country outbreak response planning'. Journal of Tropical Medicine, Article ID 756832 <http://dx.doi.org/10.1155/2013/756832>

18. Achee NL et al. 2015. 'A critical assessment of vector control for dengue prevention'. PLoS Neglected Tropical Diseases, 9(5): e0003655. www.ncbi.nlm.nih.gov/pmc/articles/PMC4423954

19. Malaria Consortium. 2016 (unpublished). Technical report on the susceptibility study of *Aedes aegypti* to three insecticides: Temephos, Deltamethrin, Permethrin.

SURVEILLANCE

One of the challenges facing dengue control is that the true disease burden is not known. There is an absence of a harmonised case definition for reporting dengue cases – as a result, a large number of cases remain unreported or unconfirmed, or in some instances cases may be over-reported²⁰. Inadequate diagnostic tests for dengue detection, especially for secondary dengue, contribute to the challenges health structures are facing in confirming dengue cases. Furthermore, there is no agreement on what constitutes a dengue outbreak or when a response is necessary.

Detecting dengue cases early and responding before an outbreak becomes severe is highly important in dengue management. An integrated surveillance system, accompanied by clear clinical and operational definitions that can be used at the primary healthcare level, will help to address this, making outbreak response more effective.

In order to tackle the growing disease burden of dengue, surveillance needs to underpin planning, implementation and outbreak response. It should be integrated into all levels of the health system and included in every dengue intervention in all countries where the disease is endemic. There is a need for improved data collection systems at the local level, which can be achieved by training primary health workers to facilitate this process. Innovative and practical approaches to surveillance should be piloted, making use of community mechanisms for early detection of outbreaks²¹.

An effective surveillance system will contribute to building the evidence around dengue, which is currently lacking but essential to designing and targeting better interventions. Active disease surveillance can establish a baseline of the dengue burden including what affects the spread of dengue, the frequency of outbreaks, the impact of climate change, and the spread of insecticide resistance, to determine which interventions work best.

In order to strengthen disease surveillance systems there is an urgent need to:

- Develop new sensitive and specific rapid diagnostic tests for primary, and especially secondary, dengue case detection and confirmation in primary healthcare facilities
- Understand whether reported dengue outbreaks are real or are a reflection of a better reporting system and/or unusual seasonal variations. This involves formative research on historical epidemiological trends as well as information about case reporting processes and environmental data
- Assess the current capacity, knowledge and operating procedures in dengue surveillance and emergency response in areas where emergencies have been declared
- Investigate whether the most up-to-date dengue international guidelines are in use and assess potential obstacles to appropriate implementation.

20. Badurdeen et al. 2013. 'Sharing experiences: towards an evidence based model of dengue surveillance and outbreak response in Latin America and Asia' BMC Public Health, 13:607. www.biomedcentral.com/1471-2458/13/607

21. Special Programme for Research and Training in Tropical Diseases. Headway on dengue surveillance and outbreak response. www.who.int/tdr/news/2015/headway-dengue-surveill-outbreak-resp/en

Many endemic countries do not have the financial resources, technical expertise or capacity to establish a functioning surveillance system and will, therefore, require support from donors and development partners.

Detailed guidance on dengue prevention and control has been made available by WHO, and Malaria Consortium fully supports the WHO surveillance strategy²². Intense and detailed work must be carried out in order to understand the current situation in each context where ‘outbreaks’ have been declared before any surveillance work plan is implemented. Once this preliminary work is completed, Malaria Consortium fully endorses the harmonisation of country processes with the current surveillance guidelines, namely:

- Implementation of epidemiological surveillance via passive, active and event-based surveillance procedures
- Implementation of entomological surveillance via larval surveys, pupal demographic surveys, adult vector surveys and use of ovitraps. Insecticide resistance monitoring is also strongly recommended.

The next step would be to investigate specific practices that, within the framework of international guidelines, can be shaped and be successful in each specific context, making the best use of available resources. The community’s full engagement in the early detection of suspected cases and in vector control is highly recommended to ensure sustainability of the selected strategies. Policymakers and agencies working on dengue will consequently be able to estimate the real impact of the disease, define the gaps and shortcomings in each specific context and endorse current international guidelines as proposed by WHO. This process would provide a clear understanding of the global situation of the disease and its trends, allow for the harmonisation of procedures and provide a common denominator in the dialogue about the dengue burden worldwide.

22. World Health Organization. 2011. Comprehensive guidelines for prevention and control of dengue and dengue haemorrhagic fever, SEARO Technical Publication Series No. 60. New Delhi, WHO Regional Office for South East Asia. http://apps.searo.who.int/pds_docs/B4751.pdf?ua=1

STRENGTHENING CAPACITY: WORKING WITH COMMUNITIES AND THE HEALTH SYSTEM

Malaria Consortium takes a community-based approach to vector control activities. Through existing programmes, volunteers and communities should be provided with the relevant knowledge and skills to reduce health risks – including dengue. It is imperative that volunteers are recognised as a part of the community health work force and are trained in the basics of identifying different vector-borne diseases, and symptoms of dengue, mode of transmission and vector control options, so that they are able to communicate this knowledge effectively to their communities.

For outbreak detection and patient management, Malaria Consortium considers reinforcing outbreak response planning at the healthcare level as an important component of building capacity. Important elements of this planning are stock management, training staff in triaging procedures, and preparing staff on how to provide adequate medical treatment in emergencies and when resources are low. For management of a sudden rise in the number of patients, dengue emergency rooms and increased bed capacity should be planned, and strategies put in place to relieve the strain on hospital services. Adequate dengue case management in an outbreak has been crucial in reducing dengue case fatality to less than one percent²³ in some countries over the past two decades, and therefore increasing the capacity of staff to carry out effective patient management is a key element of tackling the burden of dengue.

23. World Health Organization. Dengue fact sheet. www.who.int/mediacentre/factsheets/fs117/en

CASE STUDY

Integrated vector management for dengue control in Cambodia: Community perceptions and policy development

Dengue is an endemic disease in Cambodia, with almost 200,000 cases being reported between 1980 and 2008, a figure which is continuing to rise.

This increase is reinforced through observations on the ground by the Provincial Health District Dengue Supervisor in Kampong Cham Province, Dr Hy Ra. “Dengue is an epidemic disease. In Kampong Cham province the number of dengue cases per year have generally been increasing. Each year many children have this disease; there is a big burden on our hospitals. It especially affects families’ living standards too.”

Currently, the National Dengue Control Programme (NDCP) in Cambodia focuses on two main interventions for vector control. One of these involves the use of temephos, which is a larvicide. However, while previously effective, temephos has now reported resistance. Malaria Consortium therefore identified an urgent need to find an alternative, low-cost solution for controlling the *Aedes* vector which is effective and feasible for routine use by the NDCP.

Several possible alternatives have emerged. For large water storage containers, the use of guppy fish (*Poecilia reticulata*) to reduce dengue vector populations has shown promise. In Cambodia and Laos, it has been demonstrated that the use of guppy fish is a low-cost, sustainable and effective approach to reduce dengue vector populations. However, for smaller containers (less than 50 litres) where guppy fish cannot effectively live and breed, Malaria Consortium is also trialling a long lasting slow release larvicide based on the insect growth regulator pyriproxyfen. This product is provided by Sumitomo Chemical Company and is known as SumiLarv® 2MR, containing 2% pyriproxyfen, which has an approximate life of six months.

Malaria Consortium has been using both of these vector control methods in Kampong Cham province, together with behaviour change methods among populations who are most at risk of contracting dengue. This strategy is called Communication for Behaviour Impact (COMBI), which

connects knowledge and behaviour, addresses the value of engaging in healthy behaviours, and recognises the gradual stages of behaviour change.

Sen Sokky, a community health volunteer from Chor Chork, explained her role in the project. “I received my training from dengue prevention experts, who gave me leaflets to distribute. Now I go to each house in my village twice a month to provide basic information on dengue and how to prevent it and to check the guppy fish in water containers. If the guppy fish were are present, I provide new ones.”

By pursuing behaviour change initiatives, Malaria Consortium has tried to ensure that preventive measures are accepted and practiced by the local communities.

“We want to know more about the mosquito that transmits dengue and whether it is increasing or decreasing,” said Dr Sam Bunleng, an entomologist from the NDCP. “When you put the guppy fish or biological agent [in the water containers] it is important to understand how effective they are in controlling the mosquito.”

The evidence produced from this project of what works and what is the most effective method of controlling the vectors and changing behaviours will drive the policies of the NDCP moving forward.

“If we can show these interventions work, then we can use these results as a proof of concept that they do reduce number of mosquitoes,” Malaria Consortium’s project lead, John Hustedt, explained. “This will allow us to expand the project to a larger area and look not just at entomology but disease surveillance. This can help us determine the effect of the number of mosquitoes on dengue cases and will provide a compelling case to use a community-based intervention that is sustainable.”

Malaria Consortium’s project on implementing integrated vector management for dengue control in Cambodia is funded by the UK Department for International Development and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

RECOMMENDATIONS

Reversing the upward trend of dengue globally requires action from both governments of endemic countries and international organisations, as well as leadership from WHO and increased funding from donors.

WHO and other international health organisations should ensure that WHO dengue treatment guidelines are used and adequately implemented and provide technical support for dengue prevention control and surveillance for national governments. They should ensure that each health facility implements the guidelines or at least that there is a harmonisation of reporting processes based on the available resources.

National governments should, through national policies, encourage basic preventive measures against the mosquito that transmits dengue. At a more strategic level, they should ensure coordination of dengue control activities, support effective surveillance efforts, and health emergency responses across the country, and provide leadership on matters of public health.

Districts and provinces should develop, strengthen and maintain the health sector's capacity to detect, report and respond to dengue outbreaks, and work with civil society to ensure an effective response to public health concerns. They should also help support community-based health workers to provide basic preventive services.

The international development community should work with governments and community-based organisations to help mobilise communities to manage their environments to reduce mosquito breeding. They also have a role in helping to sustain community level support for dengue vector management and promote good health behaviour.

The private sector should continue research and development of new treatments for dengue, including a vaccine, as well as developing creative and appropriate solutions for helping to reduce mosquito breeding at the community level. This may include simple covered water containers or safe, slow release larvicides.

Donors should support community behavioural change initiatives and integrated community health services, including staff training and patient case management. In addition, they should also support integrated vector control management and surveillance as part of NTD elimination efforts.

Research into the economic cost of the dengue burden should take into consideration the broader range of costs associated with the disease, such as outbreak control spending, the effect on income from tourism and other industries, community economic costs and long-term economic productivity.

CONCLUSION

If the spread of dengue is to be halted and the burden of disease, which falls heaviest on the poorest and most vulnerable across the world, is to be reduced, more needs to be done at a global, national and community level.

We have seen what can be achieved when a disease receives focused efforts and funding – malaria deaths have fallen by 60 percent since 2000, and progress is being made against a number of target NTDs²⁴. Given its growing impact, it is time that dengue becomes an increased global priority.

Central to reducing dengue transmission is moving away from simply responding to outbreaks when they happen, towards a more comprehensive approach to monitoring, detecting and treating dengue, with integrated programming which combines prevention, management and treatment, as well as effective surveillance.

The community *must* be involved in dengue prevention and control strategies, as the activities needed to tackle dengue – such as source reduction, environmental management and vector control – need to be carried out by communities themselves if they are to be sustainable and effective.

More research is needed – into the impact of climate change on dengue transmission, the true economic costs of the disease burden and the relative effectiveness of interventions – in order to provide the evidence base for planning, implementation and advocacy.

Finally, new tools are required, such as effective vaccines, new treatments and innovative preventive measures.

With a determined approach as outlined in this report, we can begin to turn the tide on the spread of this disease, and ensure that as progress continues to be made towards achieving the Global Development Goals, dengue no longer falls between the cracks of global health.

24. World Health Organization. 2015. World Malaria Report 2015. Geneva, WHO.

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