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Discussion paper

# The unprecedented magnitude of the 2017 dengue outbreak in Sri Lanka provides lessons for future mosquito-borne infection control and prevention

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## KEYWORDS

Dengue;  
Dengue virus;  
Outbreak;  
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Control

**Abstract** *Background:* The outbreak of dengue during 2017 in Sri Lanka is the worst incidence of this mosquito-borne virus infection in the South Asian country since records began.

*Methods:* In this retrospective study, up to the end of December 2017 over 185,000 clinical cases were reported from all regions of the island nation.

*Results:* This crisis placed an overwhelming burden on Sri Lanka's public health system and also had a significant negative impact on its economy.

*Conclusions:* The unsurpassed level of morbidity and mortality has highlighted the pressing need for an effective operational plan to both manage the existing outbreak and to reduce the threat of a future episode of disease. This should involve an integrated nationwide program of vector surveillance and control, tertiary care of severely affected individuals and the implementation of measures to prevent future infections, including widespread vaccination.

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## Highlights

- Since the start of 2017 Sri Lanka has been confronted by a devastating dengue outbreak.
- The outbreak has broken national records for morbidity from dengue infection.

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- An environment conducive to mosquito population growth is escalating the crisis.
- Establishment of an effective control strategy is a major public health need.

## Introduction

Dengue is an arboviral infection of humans that often causes febrile illness and influenza-like symptoms as well as, in a minority of clinical cases, severe complications such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). In this century, dengue outbreaks have escalated enormously, posing serious hazards to public health and impacting significantly on the global economy. According to a recent estimate from the World Health Organization (WHO), over 70% of the world's dengue-vulnerable population lives in the Asia-Pacific region, thereby earmarking countries in this geographical location as the epicentre of dengue outbreaks [1].

The causative agent of dengue infection is Dengue virus (DENV), a member of the genus *Flavivirus* and family *Flaviviridae*. DENV has four authoritatively recognized antigenically distinct serotypes (DENV 1–4). The transmission of DENV is facilitated by vector mosquitoes of the day-biting *Aedes* genus. As the major invasive species that flourish in urban and peri-urban settings in tropical and subtropical climatic conditions *Aedes aegypti* and *Ae. albopictus* are the principal vectors of dengue transmission between humans [2].

## The 2017 dengue outbreak

The Indian subcontinent is one of the major regions confronted with DENV infection every year. Since the start of year 2017, Sri Lanka is facing a fresh outbreak of DENV that is spreading across the island nation of 21 million people [3]. According to data released by the country's Ministry of Health, over 185,688 clinical cases have been notified from the start of the year till the end of December 2017 (Fig. 1). The level of morbidity is extremely high compared to figures for recent previous years (Fig. 2) [4]. Data related to the age group of infected individuals show that many of the patients are young people (Fig. 3) [5]. According to a report released by the WHO, the present outbreak is thought to be responsible for at least 250 fatalities [6].

Although Sri Lanka is endemic for DENV, a possible reason for the escalated morbidity and mortality in the 2017 outbreak may be a change in the virus strain, i.e. dengue serotype, which is acting as the etiological agent of disease [7]. The preliminary findings of the present outbreak indicate DENV-2 as the causative serotype [6]. According to reports, DENV-2 is not common in Sri Lanka and hitherto had been detected only infrequently over the preceding decade [7]. Therefore, local inhabitants may well lack exposure to, and hence not show immunity to, this serotype; indeed, those who have a history of previous dengue infection (due to a different serotype) might be more vulnerable to dengue-associated complications due to antibody-dependent enhancement of infection [8]. This phenomenon occurs

when pre-existing antibodies present in a person's body from a primary DENV infection bind to an infecting DENV virion during a subsequent infection with a different dengue serotype. The antibodies from the primary infection cannot neutralize each virus particle. Instead, the antibody-virus complex attaches to Fc $\gamma$  receptors on circulating monocytes. By so doing the antibodies inadvertently help virions to infect monocytes more efficiently. The outcome is an increase in the overall replication of the virus, leading to a higher viremia and a greater risk of severe dengue.

The disastrous floods that affected most of the island during 2017 [9], combined with the heavy monsoon rains that left behind standing water, created ample opportunities for mosquitoes to breed and therefore for the *Aedes* vector population to flourish [9]. Moreover, municipal authorities in Sri Lanka failed to tackle the rain-soaked heaps of garbage that built up as a result of floods and rains in urban and suburban areas, which worsened the situation still further [10]. As a consequence of the unprecedentedly high incidence of dengue infection in 2017 the already overstretched healthcare system of the country faced an overwhelming burden of clinical cases. Hence, due to limited or absent appropriate medical resources, lack of adequate health infrastructure and delay in delivery of mandatory services, an unexpectedly high death toll has resulted [11]. The greatest number of dengue-related mortalities has been recorded in Western province (128), followed sequentially in descending order by Eastern province (24), Sabaragamuwa province (22), Southern province (17), North Western province (15), Central province (15), North Central province (8), Uva province (5) and Northern province (2). Being the most intense outbreak of dengue in the history of Sri Lanka (Fig. 2), incidence of infection was not confined to a specific area, rather it spread actively to all major cities throughout the country (Fig. 1).

## History of dengue in Sri Lanka

Dengue outbreaks in Sri Lanka date back to 1962, when DENV was identified for the first time [12]. It is evident from molecular genotyping of past outbreaks that all four serotypes of DENV have remained prevalent in the country to the present day (Table 1). Many outbreaks manifested as co-circulation of multiple serotypes. Record keeping reveals that DENV is highly endemic on the island. Among the various reasons that may facilitate the spread of infection, a combination of the island's conducive climatic conditions and the lack of an effective control strategy are notable.

## Climate-related reasons for increased dengue incidence

In recent decades there has been a global surge in the number and extent of dengue outbreaks. According to the

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