Dengue is fast emerging as a significant public health challenge in all Member States of the WHO South-East Asia Region except the Democratic People's Republic of Korea. Epidemiological transition has been observed with loss of cyclical patterns and reduction in the gap between outbreak years. Prevention and control of arbovirus diseases has been challenging during the COVID-19 pandemic. The Region constituted a Regional Technical Advisory Group on dengue and other arboviruses to review the regional situation and advise WHO on case management.

The Group met virtually in October 2021 to review the emerging scenario of dengue in the Region and propose appropriate mechanisms for prevention and control. It recommended standardized training packages and the strengthening of entomological capacity for surveillance, prevention and clinical management of dengue and other arboviral diseases. This report highlights the meeting proceedings and recommendations.
Virtual Meeting of Regional Technical Advisory Group for dengue and other arbovirus diseases

New Delhi, India, 4–6 October 2021
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Acknowledgements

Dengue fever is emerging as a major public health challenge in the WHO South-East (SE) Asia Region. The COVID-19 pandemic has aggravated concerns over the effective adaptation of preventive and control measures supplemented with the management of coinfection of dengue and COVID-19.

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Organizers
RTAG-Dengue Meeting
Abbreviations and acronyms

AG  advisory group
CFR  case fatality rate
DENV  dengue virus
DF  dengue fever
DHF  dengue haemorrhagic fever
EOC  Emergency Operations Centre
GAI  Gravitrap Aegypti Index
GMM  genetically modified mosquito
GVCR  Global Vector Control Response
HCT  haematocrit
IHR  International Health Regulations
IRS  indoor residual spray
IVM  integrated vector management
LMWH  low molecular weight heparin
MODS  multi-organ dysfunction syndrome
NEA  National Environmental Agency
NTD  neglected tropical disease
PCV  packed cell volume
RDT  Rapid Diagnostic Test
RTAG  Regional Technical Advisory Group
SDG  Sustainable Development Goal
SE Asia  South-East Asia
SIT  sterile insect technique
TIRS  targeted indoor residual spray
ULV  ultra low volume
VBD  vector-borne disease
WHO  World Health Organization
WHO CC  WHO Collaborating Centre
WIN  Worldwide insecticide resistance Network
Executive summary

Dengue has emerged as a major public health challenge in the past few years in all Member States of the South-East (SE) Asia Region, except Democratic People’s Republic of Korea. Dengue is the most widespread and rapidly increasing vector-borne disease (VBD) in the world. The full global burden of dengue is still uncertain. Globally, 3.5 billion people are living in dengue-endemic countries and are at risk of contracting dengue fever. Of this, 1.3 billion live in dengue endemic areas in 10 countries of the SE Asia Region.

Five countries (India, Indonesia, Myanmar, Sri Lanka and Thailand) are among the 30 most highly endemic countries in the world. The factors responsible for expansion and distribution of the dengue mosquito vector and viruses in the SE Asia Region are: (i) high rates of population growth; (ii) inadequate water supply and poor storage practices; (iii) sewage and waste management systems; (iv) rise in global commerce and tourism; (v) global warming; (vi) changes in public health policy; (vii) development of hyper-endemicity in urban areas, etc.

Epidemiological transition has been observed in the transmission of disease in terms of the number of cases and extension to newer geographical areas with new boundaries. There is spread of disease from urban settings to the rural belt. Previously, outbreaks of dengue followed a cyclic pattern, but now there seems to be a loss of such cyclic pattern. The gap between two outbreak years is decreasing and frequency of outbreaks is increasing.

An effective dengue control programme requires a regional approach, collaboration among countries and sustained partnerships. The Asia–Pacific Dengue Strategic Plan (2008–2015) was developed to reverse the rising trend of dengue in the Member States of those regions. International Health Regulations (IHR) (2005) offers an opportunity to countries for dengue control by adopting surveillance practices and infrastructure developed during the COVID-19 pandemic and vice versa.

Dengue mortality can be reduced by: (i) implementing early case detection and appropriate management of severe cases; and (ii) training health personnel, along with appropriate referral systems, at the primary health-care level. Dengue case management needs to be strengthened at the primary level by enhancing the capacity of doctors and nurses to follow case management protocol to reduce the case fatality rate (CFR). This will avoid unnecessary burden on tertiary centres. Dengue morbidity can be reduced by implementing improved outbreak prediction and detection through coordinated epidemiological and entomological surveillance.

The World Health Organization (WHO) has developed a strategic approach to tackle VBDs under the concept of the Global Vector Control Response (GVCR) (2017–2030). Key priority actions under GVCR are to increase capacity, improve surveillance and better coordinate and integrate action across sectors and diseases. The four pillars recommended are: (i) strengthen intersectoral and intrasectoral action and collaboration; (ii) engage and mobilize communities; (iii) enhance vector surveillance and monitoring and evaluation of interventions; and (iv) scale-up and integrate tools and approaches. All Member States are advised to adopt GVCR principles based on the concept of effective locally adapted sustainable vector control. It has been observed that Aedes breeding sites have been
reported either in the residence/workplace of a positive case of dengue/chikungunya, or in the near vicinity. Success of the programme depends on advocacy and active mobilization of community members and the role of stakeholder partners. All communication should address the behavioural outcomes of community members. This will augment prevention programmes.

There is a need for integration of three surveillance systems, i.e. clinical surveillance, entomological surveillance and lab surveillance. Integrated dengue surveillance should collect, collate and analyse data from multiple sources. Stakeholders must work in a coordinated manner and should be made accountable to achieve sustained support. The capacity of public health staff must be enhanced on a regular basis and their skills upgraded. Entomological capacity and entomological surveillance should be strengthened, and the system must capture data on vector abundance/geographical distribution and take scientific decisions on vector control strategies. Insecticide resistance should be part of integrated vector management (IVM) strategies. Monitoring and evaluation of all activities should be an inbuilt mechanism.

Most space sprays (both aerial and ground) are relatively ineffective in controlling dengue, unless they are repeatedly delivered inside homes. Non-residual thermal fog or ultra low volume (ULV) spray outdoors generally misses indoor resting *Ae. aegypti* and kill for a short time. Targeted indoor residual spray (TIRS) shows promise of reducing dengue.

The current problem of coinfection of dengue and COVID-19 has raised concern globally. At the preliminary stage, it may be difficult to distinguish between these two diseases, as patients may present with the same signs and symptoms. Lab diagnosis may also pose challenges due to cross reactivity, as reported by many countries. There is a need to strengthen the capacity for proper diagnosis and case management. Vector control staff must be protected by using personal prophylactic equipment and staff should observe social distancing while undertaking vector control measures and conducting community-based measures. Care of high-risk groups, i.e. the elderly, pregnant women, infants and the sick must be given priority.

Newer tools for vector surveillance, i.e. ovitraps are good tools for vector surveillance. Wolbachia and other newer techniques may be adopted for replacement of the wild *Aedes* population. A United Dengue Campaign has been launched by National Environment Agency (NEA), Singapore with support from different countries. This campaign contributes to improving surveillance methods through the dengue surveillance networks in each country using standard protocol and provides various capacity-building programmes through various regional workshops.

A 3-day meeting of the Regional Technical Advisory Group (RTAG) on Dengue was held virtually from 5 to 7 October 2021 and coordinated by WHO Regional Office for SE Asia. The aim was to review the emerging scenario of dengue in the Region and propose appropriate mechanisms for effective prevention and control.
Recommendations

**Recommendations for WHO**

- Organize a review of the dengue situation in the SE Asian Region and progress made by Member States in control of dengue and other arboviral diseases in alternate years.

- Develop standardized training packages covering multiple aspects of health functionaries and skills relevant to prevention, control and clinical management of dengue and other arboviral diseases, including:
  - laboratory diagnosis and surveillance, clinical case management, prevention and control strategies;
  - IVM for prevention and control of dengue and other arboviral diseases including novel tools;
  - entomological surveillance and insecticide resistance management;
  - broad risk communication and community engagement (RCCE) on dengue;
  - Early Warning and Response System (EWARS) for dengue;
  - Use of WHO toolkit for burden estimation of dengue and other arboviral diseases.

- Provide technical inputs and support capacity-building in prevention, control and clinical management of dengue and other arboviral diseases for Member States in collaboration with selected research and academic institutions and WHO collaborating centres.

- Collaborate with selected tertiary centres or hospitals experienced in management of dengue patients in Member States for possible designation as WHO collaborating centres to support capacity-building in this aspect throughout the Region.

- Disseminate guidelines and standardized kits to Member States to monitor insecticide resistance in *Aedes* vectors.

- Organize cross-border meetings for dengue and other arboviral diseases at the Regional level at regular intervals to facilitate inter-country information sharing and collaboration.

- Provide training and technical support to Member States for implementation of Wolbachia and other novel interventions.

- Facilitate independent evaluation of dengue control programmes of Member States through the Joint Monitoring Mission by involving multidisciplinary experts across three levels of WHO.

- Facilitate external validation of rapid diagnostic kits with enhanced sensitivity and specificity with the support of WHO collaborating centres.
Recommendations for Member countries

Epidemiology and clinical case management

- Utilize information technology to capture real time data. States/provinces may be stratified based on morbidity and mortality data. Climatic data may also be incorporated in future for planning and implementation.

- Member States to update dengue clinical management guidelines periodically for uniformity in case management.

- Ensure adoption of uniform case definition of dengue, chikungunya and zika developed by WHO in all Member States.

- Establish sentinel sites (hospitals and labs) for laboratory diagnosis and management of dengue cases. These will function as a network for referral centres and should be quality assured by national authorities.

- Develop standard operating procedures (SOPs) on clinical case management and prevention of coinfection of dengue and COVID-19. These guidelines may be harmonized and provided by the Regional Office for SE Asia to Member countries.

- Enhance laboratory capacity of testing of VBD cases in the same way that capacity for COVID-19 test labs has been increased manifold in all Member States.

- Consider the objective of reducing CFR due to dengue below 0.1 by 2030, in line with the target of GVCR.

- Launch a zero-dengue death initiative in Member States by capacity-building, improving care facilities and tertiary referral centres.

- Enhance local capacity of hospitals based on WHO Guidelines for case management. Fluid and case management protocols to be developed by all Member States and displayed at emergency departments and dengue wards. Small pocket handbooks may be developed, printed and circulated for ready reference by doctors/nurses.

- Strengthen dengue case management at the primary health care level by enhancing the capacity of doctors and nurses to follow case management protocol to reduce CFR. This will avoid unnecessary burden on tertiary centres.

- Establish high dependency units in dengue wards for management of severe dengue/dengue haemorrhagic fever (DHF) cases depending on available resources and feasibility.

Vector surveillance

- Strengthen entomological capacity by filling up all vacant posts/engaging human resources and creating training opportunities. A career pathway for field staff should be established and implemented.

- Have an effective targeted approach for vector surveillance and control by identifying locally specific key high productive containers using standard
entomological indices. Utilize the data for raising community awareness and their sensitization. This data will support community and intersectoral actions.

- Use gravid traps/ovitraps as surveillance tools and to assess the impact of control measures.

**IVM**

- Strengthen entomological labs and facilities for viral detection. Mosquito pools may be added to help in forecasting.
- Strengthen and monitor IVM and all its components, with particular focus on source reduction and adult surveillance.
- Strengthen intersectoral coordination for effective prevention and control of dengue by involving non-health sectors, and eliciting political/administrative support by involving leaders/administrators from the central level (such as national task force) to the village level.
- Carry out targeted indoor residual spray in vulnerable localities and sites (schools, hostels, religious places, sites of tourist attraction, etc).

**Advocacy for behaviour change**

- Carry out impact assessment of all adopted advocacy strategies and promote the most effective strategies under advocacy. Behaviour change models should include provision of opportunities to communities through capacity-building, besides motivational exercises. This model must include highlighting area-specific breeding sites and addressing their control.
- Enhance capacity of health manpower to impart behaviour change communication.
- Develop a robust communication roll out plan to facilitate long-term behavioural change in target communities for sustainable dengue prevention and control.
- Sensitize and empower local resident welfare associations/local nongovernmental organizations (NGOs)/faith-based organisations with the responsibility to work in close coordination with the health sector from the planning to the implementation stage to ensure sustainability of the action plan. They can undertake their own innovative measures for source-reduction campaigns as one single key strategy for vector control.

**Others**

- Revive the public health engineering component with particular focus on design change and engineering methods for breeding control, i.e. design of overhead tanks, water storage containers, gutters, etc.
- Identify a second line of human resources from other non-health departments to provide training inputs. This human resource can be put in action in case of any future outbreak of communicable diseases or under situations of paucity of staff.
➢ Consider implementation of Wolbachia and other novel interventions as one of the tools for the future by engaging policy-makers and ensuring community sensitization and support. It may be initiated on a pilot project basis.

➢ Establish provisions for invoking public health by-laws with provisions for enforcement action. Such provisions may be included under the Penal Code of Member Nations.

➢ Make health impact assessment an integral component before any major construction project is initiated in urban and semi-urban areas.

➢ Sensitize urban local authorities on making provisions for civic amenities to all urban and peri-urban areas, as rapid urbanization and lack of civic amenities are major determinants for the spread of vector and virus leading to transmission of dengue.

**Specific recommendations for Member countries**

**Thailand, Sri Lanka and India**

Enhance local capacity for further reduction in CFR. Strengthen implementation of IVM.

**India**

Implement model building by-laws in all major urban local authorities.

**Indonesia**

Strengthen IVM, especially involving non-health sectors. Complete Wolbachia trials and support WHO to develop implementation guidelines for other Member countries. Develop protocols for community mobilization and risk communication for outbreaks.

**Nepal**

Strengthen intersectoral coordination at ministerial level, provinces level and down to village level. Public health by-laws to be developed with strong enforcement component. Strengthen implementation of IVM.

**Bangladesh**

Strengthen implementation of vector surveillance and IVM.

**Bhutan**

Identify high-risk and outbreak-prone areas. Strengthen implementation of IVM and community mobilization for source reduction. Develop public health by-laws for enforcement action.

**Timor-Leste**

Develop SOPs and guidelines on case management and IVM with support from WHO.
1. Introduction

Dengue has emerged as a major public health challenge among Member States of the World Health Organization (WHO) South-East (SE) Asia Region in the past few years. The Himalayan countries, which had never reported dengue, are also facing the challenges posed by this disease. Epidemiological transition has been observed in the transmission of the disease in terms of the number of cases and extension to newer geographical areas with new boundaries. There is spread of the disease from urban settings to the rural belt. So far, outbreaks of dengue followed a cyclic pattern, but now there is loss of cyclic pattern – the gap between two outbreak years is decreasing and frequency of outbreaks is increasing. Transition has also been observed in the age group of patients from the paediatric age group to the adult population involved in outdoor activities.

The factors responsible for frequent outbreaks and increased number of dengue cases can be attributed to rapid, unplanned and unregulated development, deficient water supply, improper solid waste management, water storage practices, excessive use of plastics and disposables, etc. These factors accentuate the problem during monsoons due to proliferation of multiple breeding sites of Aedes aegypti. Increased air travel and globalization have led to spread of the disease to different countries, states and provinces. A threat of trans-border spread has also been perceived, necessitating need for cross-border dialogues.

Globally, countries have been facing the challenge of prevention and control of vector-borne diseases (VBDs) during the COVID-19 global pandemic, especially arbovirus diseases. Currently available interventions need to be supplemented with newer tools for prevention and control of dengue. WHO SE Asia Region has constituted a Regional Technical Advisory Group (RTAG) on dengue and other arboviruses. This advisory group (AG) comprises of 17 members who are experts in clinical, programmatic and vector management of dengue and arbovirus diseases. This AG will review the regional dengue and arbovirus disease situation and advise WHO on its management. (List of members of the RTAG is attached at Annexure A).

Professor AP Dash, former Regional Adviser on vector-borne and neglected tropical disease in WHO SE Asia Region, Vice-chancellor Central University of Tamil Nadu at Thiruvanur, Tamil Nadu and presently Vice-chancellor of Asian Institute of Public Health University has been appointed as Chairman of RTAG-Dengue.

In its capacity as an advisory body to WHO, the advisory group shall have the following functions:

- To periodically review the dengue and other arbovirus disease situation and its epidemiology in the Region;
- To advise WHO on integrated vector management (IVM) approaches of prevention and control of the disease and minimize the public health impact in Member States;
- To review and advise WHO on the impact of new tools such as Wolbachia, traps, genetically modified mosquitoes, etc. for the control of dengue vectors in the Region;
To advise WHO on the best global practices of prevention and control of dengue and other arbovirus diseases under the umbrella of global vector control response (GVCR) for the SE Asia Region;

To identify gaps and challenges in surveillance and case management of dengue and other arbovirus diseases in Member States and recommend to WHO appropriate action to fill these gaps;

To identify cross-border collaboration in dengue and other arbovirus disease control.

2. Proceedings of the meeting

WHO Regional Office for SE Asia has taken the lead to organize this meeting with the objective of reviewing the dengue situation and providing technical guidelines for its Member States to combat the challenge of dengue to a level where it ceases to be a major public health challenge. In view of the COVID-19 pandemic and travel restrictions, a virtual meeting of RTAG-Dengue was organized from 4–6 October 2021. The meeting was coordinated and steered by the Office of the CDS, WHO Regional Office for SE Asia, New Delhi. The meeting was attended by the AG members, officers from Neglected Tropical Disease (NTD) Division, WHO headquarters, WHO country offices of Member States and programme managers from Member countries. (List of participants who attended the meeting is placed at Annexure B).

All programme managers of Member States were provided a template to facilitate them to make a presentation on their country scenario covering all aspects of epidemiology, case management, preventive measures, newer initiatives, challenges and support desired from WHO. (Copy of programme schedule is placed at Annexure C). The guidelines emerging out of the deliberations in the Meeting would provide the technical guidelines to Member States on prevention and control of dengue and how to mitigate the challenge of dengue and COVID-19 coinfection.

3. Objectives

To review the emerging scenario of dengue in the Region

To discuss the epidemiology and clinical cycle of dengue as well as propose appropriate mechanisms for effective prevention and control

To review and identify areas of research on dengue prevention and control, especially operational research, including innovations.

4. Opening session

The Meeting was launched with opening remarks by Dr Suman Rijal, Director, Department of Communicable Diseases, WHO Regional Office for SE Asia. Welcoming the members of RTAG and other participants from Member States, he informed that dengue fever is widespread in around 129 countries and a risk of infection to more than half of the world's population. The number of dengue cases reported to WHO has increased sevenfold in the
last two decades. He added that dengue fever is endemic in all countries of SE Asia Region except the Democratic People's Republic of Korea. All four serotypes are currently hyperendemic in these countries. The SE Asia Region accounts for more than half of the global dengue burden. Over the previous decade, the number of dengue cases in the Region has tripled from 0.20 million in 2011 to more than 0.45 million in 2015 and 0.68 million in 2019.

Aedes transmitted diseases arise virtually every year as a result of high rates of population growth, inadequate water supply and poor storage practices, sewage and waste management systems, rise in global commerce and tourism, global warming, changes in public health policy and the development of hyper-endemicity in urban areas. Zika virus has been reported from India (recent outbreak in Kerela), Indonesia, Thailand, and the Maldives.

He appraised that because of the threat of dengue and other emerging arbovirus diseases with epidemic potential, RTAG-Dengue and other arboviruses have been reactivated in 2021. The last meeting of RTAG was held in 2012 in Bali, Indonesia. RTAG will provide guidance on the best worldwide practices for preventing and controlling dengue and other arbovirus diseases under the framework of GVCR for the SE Asia Region, identify gaps and challenges in surveillance and case management of arbovirus diseases in Member States and recommend appropriate action to fill those gaps. The most essential function of RTAG will be to promote cross-border collaboration in the control of arbovirus diseases.

Chairman, RTAG asked Dr B N Nagpal, Technical Officer, WHO Regional Office for SE Asia to propose a name from among the members of RTAG for appointment as Rapporteur for the said Meeting. Dr Naveen Rai Tuli of South Delhi Municipal Corporation, New Delhi, India was appointed as Rapporteur. A subcommittee was constituted to prepare country-specific guidelines for Member countries. The three members selected to the subcommittee were Professor PS Indu, India, Dr Hasitha Tissera, Sri Lanka, and Dr Naveen Rai Tuli, India.

5. Technical review session: 4–6 October 2021

5.1 Neglected tropical disease (NTD) roadmap 2030 and cross-cutting pillars (including GVCR)

Dr Gautam Biswas, Unit Head, NTD/WHO headquarters presented an overview of the NTD Roadmap 2021–2030 and cross-cutting pillars (including GVCR). He gave the definitions of “control”, “elimination” and “eradication”. He said that elimination of a disease which is posing a public health challenge includes achievement of measurable targets set by WHO in relation to the specific disease. He also stressed the need for continued action to maintain the targets and/or advance interruption of transmission. He informed regarding three essential shifts in Sustainable Development Goals (SDGs): (i) measuring process will include shift from accountability of impact to measuring impact, (ii) shift from a limited programming approach to holistic cross-cutting approaches; and (iii) shift of programme ownership to country ownership and domestic financing by partner support and funding. He elaborated on the provision of effective diagnostics, a robust monitoring and evaluation system and advocacy and funding as common gaps across most diseases that need to be overcome to accelerate progress towards elimination.
He highlighted the roadmap framework by crosscutting approaches to implement interventions through: (i) the health system – including leadership and governance, access to essential medicines and supplies, financing, health management information system (HMIS), health manpower and service delivery; and (ii) non-health sectors – including education department, nutrition, water sanitation and hygiene and other relevant sectors. He informed that under the monitoring and evaluation framework, the key area is quantitative monitoring based on 36 core indicators and qualitative monitoring through disease-specific assessment and gap assessment tools.

5.2 Global situation on dengue and other arboviruses

Dr Raman Velayudhan, Head, Vector Control. Veterinary Public Health and Environment unit (VVE), Department of NTD, WHO headquarters deliberated on the global situation of dengue and other arboviruses. The year 2019 had reported more than 5 million dengue cases. In 2020, many countries reported a smaller number of dengue cases which can be attributed to poor surveillance due to COVID-19 Pandemic while many other countries reported a greater number of dengue cases as compared to previous years. Globally, 2 750 683 cases were reported, which was more than the dengue cases reported in 2017 and 2018. There has been a 600% increase in dengue cases from 1999 to 2019. While addressing the burden of Dengue he quoted that dengue is only communicable disease that has grown four-fold from 2000 to 2013 and six-fold from 1999 to 2019.

Dr Raman informed that a tool kit has been developed by WHO headquarters for burden estimation of dengue. Burden estimation will help WHO, programme managers and donor agencies to allocate resources, plan preventive and control measures and help in economic burden analysis. Active surveillance must be an integral part of burden estimation to identify self-managed dengue cases and sub-clinical cases to reduce the mortality due to dengue. He also gave an overview of chikungunya and Zika. Globally, 187 367 chikungunya cases have been reported. Of these, 92 718 (50%) are from Brazil, 20% from Chad, 17% from India and 6% from Thailand. Zika cases have been reported from South America and India. However, no microcephaly has been reported from India.

The current problem of coinfection of dengue and COVID-19 has raised concern globally. At the preliminary stage, it may be difficult to distinguish between these two diseases as patients may present with the same signs and symptoms. Lab diagnosis may also pose challenges due to cross-reactivity as reported by many countries. He raised the need to strengthen the capacity for proper diagnosis and case management, vector control staff to be protected by using use personal prophylactic equipment and staff to observe social distancing while undertaking tasks of vector control measures and conducting community-based measures. Care of high-risk groups, i.e. the elderly, pregnant women, infants and the sick must be given priority. He informed that a new guideline document “Global Strategy for Dengue Prevention and Control 2021–2030” is at the draft stage and will be released soon. He summed up with the need for an integrated arbovirus strategy by strengthening vector control and coalition with partners, prevention and preparation of pandemics and use of innovative tools.
5.3 Regional situation on dengue and other arboviruses

Dr B N Nagpal, Technical officer, WHO, Regional Office for SE Asia, presented the Regional situation on dengue and other arboviruses. He gave an overview of the burden of dengue and chikungunya cases in Member States and informed that both *Aedes aegypti* and *Aedes albopictus* are prevalent in all countries except in Bhutan, which has only *Aedes aegypti*. As many as 1.3 billion people live in dengue-endemic areas in 10 countries of the SE Asia Region, the exception being Democratic People’s Republic of Korea. In the SE Asia Region countries, the number of dengue cases has increased over threefold over the last decade, from 0.19 million cases in 2011 to over 0.45 million cases in 2015 and 0.68 million cases in 2019. Deaths have increased from 1050 in 2011 to 1684 in 2019. In 2020, the number of dengue cases and deaths in seven SE Asia Region Member States dropped to 0.26 million and 928, respectively. Five countries (India, Indonesia, Myanmar, Sri Lanka and Thailand) are among the 30 most highly endemic countries in the world. There has been a reduction in the case fatality rate (CFR) to below 0.5% due to better case management.

It was highlighted that chikungunya is endemic in all Member States except Timor-Leste.

Dr Nagpal highlighted the technical shortfalls that pose a challenge in dengue control to include poor entomological capacity, lack of coordination between health and non-health sectors and lack of a sustained vector control programme. Under research shortfall, he highlighted the vacant posts of entomologists.

There is need to mitigate the challenge of prevention and control of dengue during COVID-19. All Member States must strengthen mobilization of community support for joint prevention of COVID-19 and dengue, devoting special sessions to raise awareness of COVID-19 and dengue in schools and colleges that have resumed classes and continue to encourage households to eliminate mosquito breeding sources.

5.4 Gaps and challenges in dengue and other arboviruses – prevention and control

Dr Raman Velayudhan made a comprehensive presentation on gaps and challenges in prevention and control of dengue and other arboviruses. Technical elements that need to be strengthened are as below.

*Diagnosis and case management*

There is a need for support from research organizations for quality assurance of rapid diagnostic test (RDT) kits. All countries have escalated their facilities for RT-PCR testing for COVID-19. The same resources can be utilized for scaling up facilities for dengue diagnostics. Facilities at WHO collaborating centres can be utilised for capacity-building and providing technical support to Member States. Hospitals need to develop a triage system to identify the cases that need immediate life-saving treatment and those that need early treatment. A network of a proper referral system will help in decreasing CFR due to dengue.
Integrated surveillance and intervention preparedness

There is a need for integration of the three surveillance systems, i.e. clinical surveillance, entomological surveillance lab surveillance. This integrated dengue surveillance should collect, collate and analyse data from multiple sources. Indices used must be reliable and be able to make predictions. Stakeholders must work in a coordinated manner and should be made accountable to achieve sustained support. Capacity of public health staff must be enhanced on a regular basis and their skill must be upgraded. Entomological surveillance should be strengthened, and this system must capture data on vector abundance/ geographical distribution and take scientific decisions on vector control strategies. Insecticide resistance should be part of IVM strategies. Indices based on immature and adult densities should be measured for stratification of areas. Monitoring and evaluation of all activities should be an inbuilt mechanism.

Sustainable locally adapted vector control

Vector control measures need to be comprehensive and sustained. Dengue vector control strategies must be evaluated for reducing human infection and disease. Due to the paucity of reliable evidence, standardized high-quality studies on effectiveness should be a priority. New products for control of Aedes-borne disease are under review by Vector Control Advisory Group (VCAG). These include a variety of spatial repellents, vector traps for surveillance and control, sterile insect technique (SIT) combined with microbial infection (population suppression) and microbial control (Wolbachia) of human pathogens in adult vectors.

Most space sprays (both aerial and ground) are relatively ineffective in controlling dengue, unless they are repeatedly delivered inside homes. Non-residual thermal fog or ultra-low volume (ULV) spray outdoors is generally ineffective because it misses indoor resting *Ae. aegypti*. To be effective, repeated indoor applications are needed. Targeted indoor residual spray (TIRS) shows promise for reducing dengue. TIRS is labour intensive and intrusive. It can be ineffective if mosquitoes are resistant or if coverage is poor. Adulticiding should not be done in isolation. Adulticiding should be part of an IVM plan, in partnership with a larval control programme involving source reduction and/or larvicides.

Effective and affordable vaccine

Two vaccines are in the pipeline – Takeda vaccine, currently undergoing Phase 3 studies; and NIH vaccine, also currently in Phase 2/3. Dengvaxia has been registered in over 20 countries and WHO/Strategic Advisory Group of Experts on Immunization (SAGE) recommendations will be followed.

Dr Raman addressed the issue of role of urbanization in the spread of *Aedes* mosquitoes and the disease. It is reported that urbanization (defined by population density or by artificial geographical space) correlates with a significantly higher risk and abundance of *Aedes* mosquitoes through provision of favourable breeding sites, higher larval development rate and adult survival time. The degree of urbanization and population density is significantly associated with a consistent gradient in disease incidence. Rapid urbanization with large populations living in unplanned urban areas provides attractive conditions for the *Aedes* mosquito and promotes disease transmission. Socio ecological factors might either
separately or jointly influence the spatial distribution of *Aedes* mosquitoes and disease transmission. This dependence of transmission of VBD to urbanization can be reduced by robust integrated surveillance (cases, lab and entomological) with public–private partnerships and implementing multisectoral health care and health prevention. Effective coordination, leadership and financial support and shared resources (skilled workforce) need to be established to address complex challenges. Preventive services should be result based and sustained and integrated with national, regional and provincial resources. Community mobilization and media need to play an active role.

### 5.5 Recent advances in dengue and other arboviruses case management

Dr Lakkumar Fernando gave an overview of dengue case management and best practices adopted at the Centre for Clinical Management of Dengue and Dengue Haemorrhagic Fever (CCMDDHF), Negombo, Sri Lanka. He informed that CCMDDHF is the first dengue treatment facility that manages both children and adults (6-day-old neonate to 92-year-old grandmother) under one roof by a common team of physicians, paediatricians, medical and nursing staff using common management principles. CCMDDHF has managed 12,213 dengue patients since 2013 of whom 96% are serologically confirmed. Currently, five beds are reserved for dengue + COVID-19 patients.

CCMDDHF follows the classification (dengue classification since 1975) that dengue illness has two clinical entities – dengue fever (DF) and dengue haemorrhagic fever (DHF). The latter is the more severe form. He highlighted the three phases of the disease: (i) febrile phase – high fever for 2 to 7 days; (ii) critical phase – plasma leakage (lasts 24–48 h), usually on Day 5/Day 6, but earliest on Day 3; and (iii) convalescent phase: lasts for 2 to 5 days (longer in adults). There is transient plasma leakage through the capillary walls in the pleural and peritoneal cavities for a period of not more than 48 hours. The volume loss in the intravascular compartment can lead to shock and organ hypoperfusion. CFR in Sri Lanka is 0.11 and they aim to bring this down to 0.01%. It was reported that the best way to diagnose dengue is by doing the Rapid NS1Ag test early in the fever using a reliable test kit. A lesson has been learnt from COVID-19 that before leukopenia is reported, a positive tourniquet test had the best positive predictive value (PPV) for dengue in an endemic set up. The best time to do the NS1 Antigen (Ag) test is at the end of Day 01 (sensitivity D1 – 95%, D2 – 90%, D3 – 70%, D4 – 50% and beyond that < 50%). If dengue NS1 Ag is positive on Day 1, the best time to do a full blood count is on Day 1 itself and repeat it on Day 2 to see if there is any fall in the number of platelets, e.g. from 485,000 to 230,000/mm³.

Various factors are responsible for Sri Lanka’s dengue success story. (i) Improving on early differentiation of DF and DHF by estimating the packed cell volume (PCV). A microcentrifuge is used for bedside/point-of-care capillary haematocrit (PCV) to assess the degree of plasma leakage and decide on the appropriate fluid response. (ii) Improving on early differentiation of DF and DHF and managing DHF better using limited ultrasound scan (USS), as fluid leakage occurs selectively in the pleural and peritoneal cavities. Limited USS done serially in suspected cases is the most objective way to prove continued leakage. (iii) Monitoring for shock by monitoring key parameters in patients with DHF. USS is useful only to detect the onset of leakage and confirm whether it is progressing, but PCV (haematocrit [HCT]) is crucial for monitoring and deciding on fluid therapy along with other parameters such as BP and Pulse Pressure. Serial PCV estimations (ideally capillary PCV) are essential for perfect fluid therapy.
Causes for mortality remain “doctors” giving steroids and NSAIDS to control fever, comorbidities and not following of clinical management protocols. Platelet transfusions are not needed even if the counts are very low. They are needed only if there is massive bleeding along with other blood components, or prior to surgery.

5.6 Coinfection of COVID-19 and dengue, their management, control and prevention

The topic was covered jointly by Dr Naveen Rai Tuli and Professor Ashutosh Biswas. Dr Tuli gave an overview of the burden of dengue in Delhi and highlighted that there had been a loss of the cyclic pattern of dengue fever in Delhi. He informed that just as in many other Member countries, fewer dengue cases were reported in Delhi and overall in India in 2020. Various factors were identified for these decreased cases. Dengue was a forgotten disease during the COVID-19 pandemic as all fever cases were given a presumptive diagnosis of COVID-19. Surveillance had received a setback as febrile patients were reluctant to seek treatment at hospitals for fear of being diagnosed as COVID-19 cases and sent for isolation. There was complete lockdown and workplaces were closed, leading to restricted community movement. As people were staying indoors, they took care to eliminate most breeding sites by keeping their houses clean.

The impact of various challenges in dengue prevention was mitigated by taking special measures, e.g. additional manpower was diverted from non-health departments such as the Horticulture Department. Drivers were drawn from different departments to enhance staff movement. Motorized equipment to maintain social distancing were donated by Indraprastha Gas Limited as part of their corporate social responsibility. Social media was used to spread the messages on prevention and control of dengue and to carry out collaboration with resident welfare associations. Newer tools such as gravid sticky traps were used in high-risk areas for vector surveillance. Special attention was paid to neglected sites such as abandoned construction sites and school buildings.

Coinfection of dengue and COVID-19 has emerged as a public health challenge as these patients have overlapping signs and symptoms and overlapping lab findings, i.e. leukopenia and thrombocytopenia. Warning signs for severe dengue, i.e. pain abdomen and vomiting can also be seen in multisystem inflammatory syndrome. There is thus a need for a high index of suspicion to identify coinfections by monitoring inflammatory markers, HCT and serology. IV fluid therapy is challenging in coinfections as it may lead to fluid overload and compromise the functioning of the lungs. Treatment with low molecular weight heparin (LMWH) may enhance bleeding in cases of dengue. There is a need to develop SOPs for case management and prevention of coinfections. COVID labs may also be equipped for testing of dengue, Vector control measures must be allowed to be performed unrestrictedly even during lockdown. Community awareness messages should include bionomics and methods for prevention of both diseases. Personal prophylactic measures must be used while carrying out vector control measures. Indoor residual spray (IRS) should be used in high-risk and vulnerable areas. Newer surveillance tools such as gravid traps should be used.

Professor Ashutosh Bishwas informed the members that national guidelines for dengue case management during the COVID-19 pandemic have been developed by the Directorate of National Vector Borne Disease Control Programme, Government of India and is available
on their website. He gave the pathophysiology of both diseases. Vasculopathy is a key feature in dengue that leads to plasma leakage. Coagulopathy needs heparan sulphate whereas in COVID-19, thrombosis is the main pathogenetic feature. A cytokine storm in dengue leads to release of different chemokines and cytokines with systemic manifestation. A cytokine storm in COVID leads to local inflammation by secretion of pro-inflammatory cytokines and chemokines (IL-6). Systemic manifestation will lead to shock and multiorgan dysfunction syndrome (MODS). Cytopathy will lead to thrombocytopenia and leukopenia in dengue cases.

He also highlighted the therapeutic challenges in graded monitoring of fluid requirement. Fluid therapy depends on the hemodynamic status of the patient and the degree of severity. One may follow the fluid chart for coinfection cases. There is a need to be careful with aggressive fluid administration as it may lead to pulmonary oedema and worsening of oxygenation. Anticoagulant therapy with LMWH has been used in management of moderate-to-severe COVID-19 cases as the illness is associated with increased thrombosis. If the platelet count falls below 100,000/mm², it may be withheld based on the clinical condition. In any case of coinfection with active bleeding, LMWH needs to be discontinued immediately.

Dexamethasone has recently been shown to be effective in severe COVID-19 and has been recommended for use. Dexamethasone is also given after the viremic stage of dengue, i.e. after 5/6 days of dengue illness. Hence, the use of steroids can be continued as per COVID-19 management guidelines.

5.7 Wolbachia: its role in the control of dengue and other arboviruses

Professor Jambulingam informed that novel strategies manipulate mosquito biology to reduce vector population and limit their ability to transmit the viruses. The objectives are to suppress the population and reduce the ability of vector pathogens. Novel strategies (rear and release) involve mass rearing and release of modified mosquitoes that mate with wild populations to bring following changes i.e. induced sterility also called Sterile Insect technique (SIT), infecting with a microbe that sterilizes the female mosquito population and lead to sterility and reduced vector competence, (incompatible insect technique/trans infection) and introducing a specific genetic element leading to genetic change and genetically modified mosquitoes (GMM). He informed that Wolbachia pipiensis is a common maternally inherited intracellular type of bacteria that occurs naturally in 60% of insects but not in Aedes aegypti. It can influence mosquito reproductive biology to enhance its spread within populations (called cytoplasmic incompatibility).

This bacterium is unable to survive outside its host. It does not infect humans or other vertebrate hosts. It has been shown that Wolbachia-infected mosquitoes pose negligible risk for humans and the environment. Wolbachia in Ae. aegypti inhibits replication and transmission of dengue and other arboviruses. The release period extends from 11 to 27 weeks. Virus replication is inhibited by a set of factors, i.e. nutritional and modification of the host cell environment.

He also highlighted different trials undertaken in different countries. He quoted a cluster randomized trial of Wolbachia infected Aedes aegypti deployment in Indonesia. In the trial, 9–14 rounds of release were made and 77% reduction in dengue cases was
observed with 86% reduction in dengue hospitalization. Epidemiological modelling predicted that even 50% transmission reduction would reduce global dengue incidence by up to 90%. There has been no indigenous transmission in Australia for the past 5 years. Regarding the impact of heat in tropical climates, he informed that in 2018 there was a heat wave in Cairns when temperatures went up to 43°C. Wolbachia infection was reduced to 83%, but recovered to 100% in 4 months.

Challenges in trans infection can be met by release of high-quality Wolbachia mosquitoes to compete with the resident (wild) population. There has to be a system to monitor the stability of Wolbachia infection in space and time and the results need to be monitored quickly to have any potential breakthrough.

Trans infection of Wolbachia is considered to be more advanced than GMM. Monitoring should include evolutionary changes, human behavioural changes, long-term ecological impact and development and regulatory approval of new Wolbachia strains. Monitoring should consider managing either the Wolbachia infected population or the mosquito population that has been infected with Wolbachia.

### 5.8 Role and future of ovitraps in vector surveillance and control of arboviral diseases

Dr Indu PS related her research experience based on the Kerala model. In Kerala, dengue cases with serological evidence have been reported since 1979 and the first major outbreak was reported in 1997. The largest dengue outbreak affecting 21,993 persons was reported in 2017 and contributed to 10.6% of the total cases reported in India. All four dengue serotypes have been isolated from the vector mosquitoes and human sera in Kerala. Zika cases have also been reported in 2021. The dengue burden estimation of Kerala and field testing of vector traps was done in collaboration with WHO.

The gravitraps that were assembled was similar to the structural design of the Biogents Gravid Aedes Trap (BG-GAT), using locally manufactured components. Two hundred traps (both sticky and IRS coated) were used and placed in coastal areas, hospitals and designated areas. As many as 79% sticky traps were found to be positive in 3 days’ time and 75% IRS traps were positive in 2 days. *Culex quinquefasciatus* was found to be the most dominating species across all the sites.

The density of *Aedes aegypti* was very high in coastal areas with high indoor breeding. Dengue cases were reported in field areas where the gravitrap aegypti index (GAI) was >1. A significant correlation (correlation coefficient=0.65, p=0.001) was obtained between GAI and dengue cases reported in households during 2 weeks of installation. A significant decrease (p<0.001) in the mosquito menace was obtained in the before-to-after comparison on the installation of the gravitraps.

### 5.9 Impact of climate change on transmission and control of dengue and other arboviruses

Dr Meghnath Dhimal said that global warming is causing a public health emergency. There is no vaccine for climate change. The life cycle of *Aedes aegypti* is dependent on temperature
and humidity. Increase in temperature will lead to an increased risk of dengue due to the increased rate of mosquito development and decreased viral incubation time. Conversely, very high temperatures will also lead to increased mortality of mosquitoes, thereby decreasing the risk of dengue. Climatic conditions may affect the virus, the vector, and/or human behaviour, both directly and indirectly. Climate change will alter the geographical distribution of mosquito-borne diseases. The poor regions of the world will be the most vulnerable. The greatest effect of climate change on transmission of VBDs is likely to be observed in cooler areas where the lower temperatures are limiting disease transmission. The warming rate is higher as we get closer to the poles and in the highlands as compared to the tropics.

He informed that the minimum criteria for a causal relation between climate change and VBDs are – evidence of biological sensitivity to climate, meteorological evidence of climate change and epidemiological change in relation to climate change. Causal relation between climate change and VBDs can be evaluated using a key epidemiological metric known as the basic reproductive number \( (R_0) \).

Dr Dhimal highlighted that an increasing number of cases indicate that climate change can increase the altitudinal ceiling of vector distribution as well as length of the transmission season in the mountains. Entomological transect surveys along an altitudinal gradient provide direct evidence of the distributional shift of disease vectors in response to climate change.

Since we have to live with climate change, adoption measures can be provided to minimize its impact on VBDs, i.e. intensifying community awareness campaigns. These should be targeted towards behaviour change of community members. An early warning system needs to be adopted using climatic data and making forecasts. We need to strengthen the surveillance mechanism, vector control and health education to make the public health department more effective and efficient. Socioeconomic conditions and practices need to be addressed to move towards disease prevention.

5.10 Cross-border collaboration in dengue and other arbovirus diseases

Dr Lee-Ching NG highlighted various activities being performed by the National Environmental Agency (NEA), which is a WHO collaborating centre. Surveillance is a key area where different activities are being performed. A United Dengue campaign has been launched incorporating different countries. This campaign contributes to surveillance in countries of the Region. The United Dengue campaign has assisted in improving surveillance methods by promoting the establishment of dengue surveillance networks in each country using standard protocol for testing, serotyping and sequencing so that data can be compared.

This campaign also provides various capacity-building programmes through various Regional workshops. This unified protocol and sharing of data has enhanced the quality of data. Member countries are sharing their case and virology data digitally. She quoted a study wherein it was seen that though Singapore and Malaysia are neighbouring countries and have observed synchronized outbreaks, there is no virus sharing and both countries have different serotypes causing outbreaks. This they have attributed to environmental factors. They have observed shrinkage of diversity of virus due to lack of mobility as a result of restrictions imposed during the COVID-19 pandemic.
Singapore has developed a design of an adult trap for mosquito surveillance. The design has been put up on the website for use. Suggestions on design to improve efficacy are welcomed. More than 68,000 traps have been distributed across Singapore and areas have been stratified based on the findings. Notification of areas with high Aedes mosquito population are shared with the public and stakeholders on the NEA website.

Another collaboration NEA has with WHO is the worldwide insecticide resistance Network (WIN). This consists of 19 internationally recognized Institutions in vector research, providing a unique framework for tracking Insecticide resistance in mosquito vectors of arbovirus around the world. They have established inter-country surveillance of insecticide resistance in Aedes aegypti.

Singapore has been working on the Wolbachia Project since 2016. The GIA is getting lower and the project is getting extended to newer areas. There has been reduction in the Aedes mosquito population and dengue at release sites. A phased approach is being followed. With its experience on Wolbachia for five to six years, NEA has contributed to IAEA guidelines. This is also cross-border collaboration facilitated by WHO and IAEA. Malaysia is doing a replacement approach and Singapore is doing a special approach using the same Wolbachia mosquitoes.

NEA is also providing cross-border collaboration by organizing workshops and sharing knowledge. International workshops have been organized for different countries. These countries share their best practices with one another. In 2021, a regional online training of trainers was organized jointly by WHO (Regional Office for the Eastern Mediterranean and headquarters) and NEA. An online workshop on Wolbachia and SIT is proposed for next year.

6. **Country presentations**

6.1 **Thailand**

*Epidemiological situation*

Thailand presented 12 years’ data since 2009. Dengue outbreaks were reported in 2010, 2013, 2018 and 2019. The number of cases reported in 2013, 2015 and 2019 were 154,444, 144,952 and 131,157, respectively. Dengue cases were reported from all 77 provinces. The peak transmission season was reported in May–June in 2021. A high CFR was observed in the paediatric age group from 2012 to 2016 and in 2021. A high CFR was reported in the age group above 15 years from 2017 to 2020. All four serotypes have been reported in Thailand but DENV 1 has been the predominant serotype followed by DENV 2. Seventeen chikungunya cases were reported from seven provinces in 2016, whereas 10,986 cases were reported from 72 provinces in 2020. Zika cases numbering 1114 were reported from 43 provinces in 2016. In 2019, 190 Zika cases were reported from 37 provinces. An analysis of Zika data showed a declining trend since 2016 to the present date (1.66 per 100,000 population to 0.22 per 100,000 population till 2020.
**Preventive and control measures**

Priority areas for action include surveillance, i.e. eliminating mosquito larvae in all settings throughout the year, case investigation and disease control within 28 days and activation of an emergency operation centre (EOC) for outbreak control. Case management includes increasing capacity for diagnosis, strengthening the training courses for health-care providers and setting up dengue corners and dengue wards in hospitals and health facilities. The risk communication pillar includes awareness generation on prevention of mosquito bite, using non-steroidal anti-inflammatory drugs (NSAIDs) and knowledge of symptoms that need immediate medical attention. During COVID-19, dengue coinfection was prevented by distribution of mosquito repellent to field hospitals, ULV fogging and Bti spray to control *Aedes aegypti* before opening field hospitals and larval survey and elimination of mosquito breeding places.

**Innovations**

Thailand has adopted a novel concept of 3–3–1, i.e. report dengue cases within 3 hours, kill the infected mosquitoes in a patient’s house within 3 hours and spray insecticide in the patient’s house and 100 meters around it within 1 day. Other innovations include TanRabad, which is a software for dengue vector surveillance and dengue situation analysis; Aor Sor Mor Online, an online social networking platform for dengue vector surveillance for village health volunteers; and Rootan, which is an application for general public alert.

In certain areas, *Aedes aegypti* are resistant to pyrethroids including deltamethrin. The problem has been resolved by recommending to pesticide manufacturers to add piperonyl butoxide (PBO) to their pyrethroid products. Thailand is trying to use the Wolbachia technique for *Aedes aegypti* control by using it to sterilize the wild females of *Aedes aegypti*.

**Challenges**

Most of the challenges have been due to the COVID-19 pandemic. They are: (i) infected people are asymptomatic or have mild symptoms and late hospital admission or delayed treatment of dengue fever amid the COVID-19 situation; (ii) clinics or private hospitals do not report cases to the surveillance system; (iii) the dengue campaign and mosquito survey cannot be implemented due to social distancing measures to contain COVID-19; (iv) health officers have increased workload from COVID-19 detection and response, which leads to insufficient officers being available for dengue surveillance and control; (v) elimination of mosquito breeding places cannot be done in closed public places such as parks, schools, hotels, etc. Vector control is ineffective in urban areas due to limitations of community engagement.

**6.2 Nepal**

**Epidemiological situation**

The first dengue case in Nepal was reported from Chitwan in 2004 and the first dengue outbreak was reported from the same place in 2006. Several sporadic dengue cases and outbreaks have been reported since then, mainly in urban and semi-urban areas. All four serotypes have been reported. A major outbreak was reported in 2020 with 10,808 cases. A few cases of chikungunya have been reported since 2016. No Zika case has been reported till date.
**Preventive and control measures**

Vector control measures in terms of larval and adult control and personal protective measures are in place. Search and destroy activities are conducted for source reduction through community involvement in high-risk districts. Nepal revised its National Guidelines on Prevention, Management and Control of Dengue in 2019 and training programmes are being organized for doctors and other health-care staff.

The search and destroy activity for vector control is an innovation.

**Challenges**

The challenges are: (i) difficulty in implementation of IVM; (ii) lack of strong collaboration and support from different ministries to control breeding sites at various places such as offices, schools, hospitals, construction sites, recreational sites, etc. (iii) no proper legislation to control *Aedes* mosquito breeding sites, especially in urban areas; (iv) lack of adequate human resources for effective vector surveillance; (v) outbreak response capacity at each level needs to be strengthened; (vi) capacity strengthening is needed for vector surveillance and entomological capacities; (vii) diagnostic support for chikungunya detection and laboratory support for dengue serotyping need to be strengthened; (viii) difficulty in health workers'female community health volunteers' mobilization for effective vector control support activities; and (ix) difficulty in effective community engagement on search and destroy activity for vector control.

**Support from WHO**

Support from WHO is needed for (i) capacity strengthening for vector surveillance and entomological capacities; (ii) diagnostic support for chikungunya detection; and (iii) laboratory support for dengue serotyping.

### 6.3 Sri Lanka

**Epidemiological situation**

A major outbreak of dengue was reported in Sri Lanka in 2017 and again in 2019 when 186 101 and 105 049 cases were reported, respectively. CFR has shown a declining trend from 0.72 in 2010 to 0.12 in 2020. Transmission has been reported in the months of January–February and June–July. The primary vector of dengue transmission is *Aedes aegypti*. *Aedes albopictus* has been reported as a secondary vector. The reasons for outbreak have been classified under environment related and human related. Environment related factors include multiple indoor and outdoor breeding sites, unsanitary open garbage dumping, cryptic breeding places (tube wells, refrigerator trays, etc.) and rapid growth of building construction. Human related factors include non-consistency with adopting to healthy behaviour, exposure to multiple serotypes and population movements to high-risk areas. DENV 2 was the predominant serotype reported in 2021 followed by DENV 3 and DENV 4.
**Preventive and control measures**

Three types of vector surveillance have been adopted. Routine surveillance is conducted regularly in high dengue transmission/transmission risk areas, as it helps to guide dengue vector control activities and helps in epidemic prevention. Sentinel surveillance is carried out in 37 pre-decided sites. This helps to make trend observations on vector density, dynamics of vector breeding sites, changes in vector behaviour and monitoring vector susceptibility/resistance status to insecticides. Spot checks are made in special circumstances based on epidemiological and environmental information, e.g. outbreak situations/in contact places of reported dengue cases/in high-risk institutions, etc. Water storage articles and discarded items have been reported as common breeding habitats. Temephos 1% SG is used for larval control, while thermal fogging using Malathion, Gokilaht® and Pesguard® and cold fogging (ULV) (since 2020) using Gokilaht® and Pesguard® are used as anti-adult measures. Source reduction remains the strategy of choice.

**Innovations**

A Presidential task force was established in 2010 at the national level. Different committees have been constituted with different stakeholders from the provincial level to the village level. A national dengue control unit was established in 2005 and staff have been recruited with 50 dedicated utility vehicles along with 50 drivers. Environmental police have been deputed for checking on breeding sites. Budgetary provisions have been made for Vector control measures at construction sites in Bills of Quantities (BoQ). Sakya karya sahayakas (SKSs) (field mosquito control assistants) have been deployed to carry out premise inspection activities at least thrice a week.

Support for field activities is provided through the district secretariat and local government authorities for dengue prevention programmes. Messages have been disseminated that hospitals are safe to visit (safe hospital bubble concept). Awareness messages are disseminated through public–private partnerships to broadcast messages in major supermarket outlets across the country. High dependency units (HDUs) have been established in 121 hospitals island-wide. Maximum retail price for NS-I and FBC laboratory testing has been brought under the purview of the Consumer Affairs Authority Act No.09 of 2003.

A pilot project has been initiated in Colombo in 2020 for Wolbachia Implementation with long-term monitoring for five years, to start from December 2021.

**Challenges**

The challenges are: (i) frequent changes in viral serotypes leading to large outbreaks and limited capacity for serotyping in peripheries; (ii) vector adaptability, geographical expansion and distribution of the vector beyond the traditional hotspots and changing vector breeding sites; (iii) coinfection with COVID-19; (iv) difficulty in sustaining best practices of prevention; (v) climatic variability and lack of proper waste disposal mechanism; (vi) limited financial allocations and limited laboratory capacity; (vii) human and physical resource constraints; and (viii) lack of continuous support from stakeholders and proactive community engagement.
Support from WHO

The desired support from WHO includes: (i) training/capacity-building on clinical management, IVM, disease burden estimation, insecticide resistance monitoring, risk communication and operational research; (ii) physical infrastructure development – establishment of a molecular biology lab at National Dengue Control Unit (NDCU) and strengthening of high dependency units (HDUs) in major hospitals; (iii) development of centres of excellence (both central and provincial), i.e. central laboratory and clinical management centres in Western, Southern, Northern, Eastern, North-western, Sabaragamuwa and North-central provinces; (iv) support for operational research including “Release of Wolbachia-infected Aedes mosquitoes”.

6.4 Bhutan

Epidemiological situation

The first dengue case was reported in 2004 with a massive outbreak in the border town of Phuntsholing. Presently, sporadic cases have been reported from all bordering districts towns. The transmission period is from April till August. A major dengue outbreak was reported in 2019 when 18 out of 20 districts reported 5480 dengue cases and 6 deaths (CFR of 0.10%). The reasons for the outbreak were analysed as increasing trade and population movement, erratic water supply in outbreak areas leading to improper storage of water, poor community ownership and participation in Aedes control and prevalence of multiple serotypes and strains of dengue.

The first chikungunya case was reported in 2012 from Samtse. Chikungunya cases were mostly reported from three districts in the southern border and an outbreak was reported in 2019 with 18 cases. No case of Zika or yellow fever has been reported from Bhutan. The dengue situation following the 2019 outbreak was reviewed and it was observed that more than half of the doctors had no experience in dengue case management. Nurses played a minimal role in monitoring, recording and notifying doctors for early abnormal signs/symptoms of dengue patients. There was overdependence on RDT kits for diagnosis even during outbreaks and there was limited utility/availability of complete blood count (CBC)/HCT.

Preventive and control measures

Entomological surveillance is carried out as routine surveillance in five dengue sentinel sites and larval Indices are monitored. Spot surveys are carried out to determine presence of vectors and their degree of infestation. Search and destroy operations are recommended as sustainable control measures. The maximum breeding has been reported in water storage drums in indoor areas and in tyres in outdoor areas. Vector control measures are carried out by larviciding during routine surveillance by using Barcelo tabs, Pyreproxyfen granules and Sandabate. Thermal fogging using pyrethroids is used as adulticide. Besides vector control measures, household awareness on source reduction for dengue controlled is carried out.
**Innovations**

A dengue task force has been constituted at each municipality level and a workforce of volunteers is used for raising community awareness.

**Challenges**

Following challenges have been observed: (i) limited community ownership and participation in dengue prevention activities; (ii) HR and capacity issues in Aedes surveillance; (iii) challenges in Aedes surveillance and their usefulness; (iv) protocol for vector breeding-free environment for local task force/LGUs; and (v) there are no legal teeth for repeat offenders.

**Support from WHO**

Training of trainers (ToT) is required from reputed institutes in the Region for senior doctors for carrying out national ToT on clinical management of dengue, nursing management and monitoring of dengue cases and dengue surveillance, prevention and control for field and programme officials.

6.5 Indonesia

**Epidemiological situation**

Regular outbreaks of dengue have been reported in Indonesia since 1988. Other occurrences were in 1998, 2007, 2016 and 2019. The incidence rate has come down from 78.85 in 2016 to 39.92 in 2020. In 2021, incident rate has been reported as 12.56 and CFR as 0.92. Chikungunya outbreaks were reported in 2009 and 2010 when 83,756 and 55,183 cases were reported, respectively. Reasons for outbreaks have been reported as: (i) natural factors – global warming and climate change, prolonged rainy season and changes in dominant serotype of dengue virus; (ii) human factors – expansion of endemic areas due to environmental change and human manipulation such as urbanization, increase of population mobility, construction of new settlement areas and insecticide resistance issues.

**Preventive and control measures**

Dengue is transmitted by *Aedes aegypti* as the principal vector and *Aedes albopictus* as the secondary vector. *Aedes albopictus* has been reported as the primary vector for chikungunya. Vector surveillance is performed by health centres (*puskesmas*) each month and House Index is monitored. The system is integrated with all health centres, district health offices and provincial health offices under the Ministry of Health. The objective is to maintain a threshold value of HI < 5%. IVM is implemented by engaging the community, physical source reduction, using mosquito traps and biological methods, i.e. Bti. Natural predator and spatial repellant are used. Chemicals are used for larval control and adult control.

There is a proper referral mechanism for patient referral from district hospitals to the National Referral Hospital. Disease prevention and control (DPC) units undertake control measures and are called technical implementing units.
Innovations

A number of measures have been adopted to achieve the target of reducing dengue morbidity to <49 per 100,000 population in 90% of districts/cities by 2025 and to reduce dengue mortality to 0.5% by 2025.

Challenges

Following challenges are being faced in programme implementation: (i) lack of community participation in vector control activities, as the majority of community members prefer to use the fogging approach; (ii) to optimize early diagnosis efforts; (iii) to optimize cases and vector surveillance system; (iv) inadequate outbreak management system; (v) inadequate interministerial/agency coordination system that should be led by the National Task Force; (vi) lack of commitment from the local government at the province and district level in supporting vector control activities; (vii) inadequate financial resources at all government levels; (viii) climate change issues such as changes in the rainy season, air temperature and optimum humidity for vectors.

6.6 India

Epidemiological situation

The arboviral diseases prevalent in India and covered under the umbrella of the National Vector-borne Disease Control Programme are dengue, chikungunya, Japanese encephalitis and Zika (vector control part). Other arboviral diseases that have been reported in India are Kyasanur forest disease (KFD), Crimean-Congo haemorrhagic fever (CCHF), West Nile virus and Chandipura virus. Dengue has established endemicity in Indian states. Dengue outbreaks have been reported during 2016, 2017 and 2019 when 129,166 cases with 245 deaths, 188,401 cases with 325 deaths and 157,315 cases with 166 deaths were reported in respective years. Chikungunya outbreaks have been reported in India during 2016, 2017 and 2019. In 2017, India reported the first four cases of Zika virus infection. In 2018, 159 cases of Zika virus infection were reported from Rajasthan, 130 cases from Madhya Pradesh and one case from Gujarat. No case was reported in 2019–2020, while in 2021, 81 cases were reported from Kerala and one case from Maharashtra. The transmission season starts from July and lasts till November.

A total of 707 hospitals have been designated as sentinel surveillance hospitals. These institutions have labs equipped with facility of MAC-ELISA test and are providing free diagnosis and management of cases. These institutions are linked with 17 apex referral labs (ARLs) with advanced diagnostic facilities. ARLs carry out serotyping and all four DENV strains have been reported to be in circulation. Epidemiological stratification of Indian states has been done based on disease endemicity, transmission, outbreaks, areas/districts affected, deaths due to dengue and serotype. Dengue CFR has been sustained at <1.0% since 2008 and at 0.2% since the last 5 years.
Preventive and control measures

Seventy-two entomological zones were created in 1977, which have since been increased to 84. The Central Cross-Checking Organisation has been established at Directorate of National Vector Borne Disease Control Programme (NVBDCP) and has been entrusted with the responsibility of monitoring antilarval activities in Delhi and adjoining areas. There is a shortage of entomologists in most of the states except a few municipalities that have got entomologists posted.

Methods and tools used for prevention and control area are: (i) source reduction by detection and elimination of Aedes breeding containers; (ii) larviciding in positive containers by using Temephos 50% EC; (iii) Diflubenzuron 25% WP and Pyriproxyfen are used as Insect growth regulators; (iv) indoor space spray is carried out using Pyrethrum extract and Cyphenothrin 5% and outdoor fogging is done by using Technical Malathion and Cyphenothrin 5% EC; (v) Gambusia fish and Bti have been used as biological control methods for vector control; (vi) many states have implemented legislative methods by enacting bye-laws.

Innovations

Monitoring of vectors at points of entry (POEs) is done as per the provisions under the International Health Regulations (IHR) 2005, whereby all ports and land crossings are to be made Aedes free. India has 33 international airports and 11 seaports and as per IHR norms, Aedes survey in the international airport/port organizations is carried out to ensure zero Aedes aegypti index in and 400 meters around the installation. Survey reports are submitted to the IHR focal point.

National guidelines have been developed for clinical management of dengue including during the COVID-19 pandemic and clinical management of chikungunya. Guidelines on mosquito and other vector control response (MVCR) have been developed and vector control need assessment has been carried out in four states in 2020 with WHO support.

Challenges

Challenges have been experienced in implementation of the NVBDCP. These are: (i) non-availability of specific drugs and vaccines; (ii) vector control is the only option for Aedes-borne disease control; however, limited vector control tools are available for Aedes support; (iii) vacancies of entomologist positions from the zonal up to the national level; (iv) research required on impact of global climate change on Aedes-borne diseases for understanding the future need for programme strategies; (v) absence of high-level political commitment for dengue is a resource constraint and a threat for epidemic preparedness and response; and (vi) need for strong public health bye-laws and building bye-laws with provision for health impact assessment (HIA) in large scale construction sites with increasing urbanization.

Support from WHO

Technical support is needed from WHO for organizing training workshops on management of dengue cases in the light of COVID-19 up to the sub-national level. Other requirements are capacity-building of states on IVM, monitoring of insecticide resistance in Aedes vector and support for advocacy and community engagement through observance of “National Dengue Day” up to the sub-national level.
6.7 Maldives

**Epidemiological situation**

Maldives is an Island nation with 188 islands that are inhabited where case management facilities are available. This huge number of islands poses a challenge in coordination. Dengue is a major public health challenge and cases have been reported from all atolls. The highest number of 4987 cases with 2 deaths was reported in 2019. In 2020, cases came down due to restrictions of COVID-19. The season peaks with intermittent rainfall. A shift in the peak months of transmission has been observed – earlier the peak used to be in June–July which has now shifted to April–May. Increased cases are seen in the month of January. Chikungunya is also an endemic disease and the first case was reported in 2006. No chikungunya cases were reported from 2012 to 2018 but an outbreak was reported in 2019 and testing was done with Trioplex (RT-PCR). No Zika cases have been reported since 2020. No microcephaly has been reported among the positive cases. Test kits for chikungunya have been procured. For Zika surveillance, test kits are yet to be procured.

The reasons for outbreaks have been analysed as climate change, intermittent rains, increased urbanization, crowded living arrangements, increased developmental sites, increased population movement, i.e. local or migrant labourers, behavioural change and insecticide resistance. Insecticide resistance can emerge as a major challenge.

Disease surveillance data is transmitted to the central level at Male city by fax/email. SIDAS web-based system is used from atoll level to the central level. From the island level, surveillance data is communicated to the atoll level through phone conferences or fax.

**Preventive and control measures**

Breeding sites have been identified in collaboration with the Entomological Division of WHO Regional Office for SE Asia. The highest breeding has been reported in water storage containers and all common breeding sites are communicated to citizens through the local language. *Aedes albopictus* and *Aedes aegypti* have been identified as the vectors for transmission. Insecticide resistance was being checked during the malaria and lymphatic filaria programmes. However, currently this activity is not in place. Deltacide and Malathion have been in use since long. The same chemicals are being used for the past more than 30 yrs. One medical entomologist hired by one resort has been requested to support the national programme to monitor insecticide resistance using WHO approved kits. A mortality of 24% was observed with deltamethrin, which shows Insecticide resistance at the national level.

Vector control methods adopted in the Maldives include vector surveillance during home visits by community health workers (CHWs) or vector control teams. Breeding sites are treated by using chemical and biological larvicides. Community mobilization programmes are organized through the virtual and digital mode in accordance with the national dengue campaign launched by the Office of the President, called “Madhiri ho ho.” IVM mode is implemented by organizing capacity-building programmes and involving stakeholders. The community is involved, and their participation is through different community-based campaigns. Awareness programmes are organized through schools. Construction site supervisors are provided training on elimination of breeding sites and awareness programmes for migrant workers are organized through NGOs.
Private hospitals and clinics are also involved in surveillance. Regional hospitals are well equipped. Dengue clinical management checklists have been made available in all emergency rooms and dengue wards. The limitation has been shortage of trained manpower especially in public health entomology.

**Innovations**

The national dengue campaigns launched by President of Maldives exhibit political will.

**Challenges**

Technical capacity-building of staff at the island and atoll levels has not been done, especially in public health entomology. Epidemiological and entomological data is not collected regularly and there have been no studies for their correlation. There is a need for task forces or committees to collaborate with stakeholders and ministries/departments for prevention and control of mosquito breeding. There has been limited financial allocation for this programme at the national and sub-national levels. Insecticide resistance has been reported by one medical entomologist but needs regular monitoring. Community engagement and mobilization strategies are not designed as per social science research. The staff of public health was involved in COVID–19 prevention. Elimination of breeding sites was difficult due to COVID-19 restrictions and construction sites were neglected and were major breeding sites.

**Support from WHO**

The following support is needed: (i) capacity-building programmes on public health entomology for vector control may be organized for staff; (ii) a vector control plan may be reviewed and finalized, (iii) technical support is needed for use of new tools, i.e. Wolbachia project; (iv) technical and financial support is needed for establishing serological surveillance at the national level; (v) capacity-building programmes on clinical dengue case management may be organized for clinicians and paramedical staff; (vi) support in developing monitoring and evaluation of tools; and (vii) assistance is needed for procurement of essential resources including RDTs and other diagnostics.

### 6.8 Bangladesh

**Epidemiological situation**

In Bangladesh, the first epidemic of dengue was reported in 2000 with 5551 cases (62.4% DF and 37.6% DHF) and 93 reported deaths. *Aedes aegypti* was identified as the main vector. Since then, the epidemic has been reported in 2019 with 101,354 cases and 179 deaths (CFR 0.18). The prevalent serotypes of dengue virus are DENV 1, DENV 2, DENV 3 and DENV 4, of which DENV 3 is the predominant serotype. A chikungunya outbreak was reported in 2017. The transmission period is from July till September with decline in October. The reasons for the outbreak were identified as rapid urbanization, impact of climate change, excessive usage of non-biodegradable products (plastic materials), less community involvement in prevention activities and insecticidal resistance.
**Preventive and control measures**

The National Malaria Elimination (NME) and Aedes Transmitted Diseases (ATD) Control Programme (CP) conducts three Aedes mosquito surveys per year in Dhaka City during the pre-monsoon, monsoon and post-monsoon periods. The survey results are discussed and disseminated among stakeholders, viz. city corporations and municipalities. No insecticide resistance monitoring activity has been conducted by NME and ATD CP for Aedes species in the past 5 years. Vector control activities are done by city corporations and municipalities. IVM components need to be strengthened. Advocacy meetings with society members and community leaders, religious leaders (imams), house owners of Real Estate and Housing Association of Bangladesh (REHAB) and other societies are being carried out. There is also involvement of print and electronic media and school children.

To have effective case management, hospitals at the national and sub national levels upto the root level were provided sufficient quantity of dengue detection kits (NS1) for proper diagnosis (108 200 in 2020, 83 500 in 2021). Training on dengue management was provided to doctors working in both national and sub-national level hospitals.

**Innovations**

National Guidelines for Dengue Management and Dengue Management Fluid Chart have been printed as pocketbooks and provided to doctors nationwide for ready reference. A one-stop dengue corner has been opened in all hospitals.

**Challenges**

The authorities are finding the following challenges in effective programme implementation: (i) elimination of breeding sites and source reduction; (ii) rapid urbanization; (iii) community mobilization; (iv) excessive use of non-biodegradable products (plastic materials); (v) the health system is overburdened with the COVID-19 pandemic; (vi) coordination and collaboration among stakeholders needs improvement.

**Support from WHO**

The support needed from WHO is in the following areas: (i) capacity-building programme on entomological and disease surveillance; (ii) finalizing guidelines (dengue strategic plan, IVM operational manual, etc); (iii) support in raising community awareness and developing awareness materials in Bangla language; (iv). technical and financial support to establish an insect laboratory at the central level and operational research; (vi) technical and financial support for conducting a pilot study on prevention and control of dengue by reducing Aedes breeding sources in Dhaka North City Corporation and Dhaka South City Corporation areas.

### 6.9 Timor-Leste

**Epidemiological situation**

Timor-Leste has reported a rising trend of dengue cases with 251 dengue cases and 3 deaths reported in 2016, and 1450 dengue cases and 10 deaths in 2020. The transmission period for dengue is from February to May with a declining trend in June every year. The CFR has
decreased from 1.2 in 2016 to 0.7 in 2020. On analysis, the 2020 outbreak could be attributed to the following reasons: domestic water storage containers in indoor and outdoor settings, storages of tyres in companies and houses, lack of diagnosis tools (RDT and reagents) at health facilities, lack of capacity-building for health workers on diagnosis and clinical management and low priority and lack of funding support for implementation of dengue control.

Low footfall at the health facilities was observed during the COVID-19 pandemic due to fear and stigma. Health professionals were intimidated by the communities due to non-acceptance of COVID-19.

**Preventive and control measures**

Survey for *Anopheles* is carried out every two months (three sites for malaria) and for *Aedes*, survey is carried out where there is an outbreak of dengue, other than routine surveys. Environmental management by source reduction, biological control with application of abate granule and fogging are used as vector control measures. Monitoring is before the rainy season and when an outbreak occurs.

**Innovations**

A Friday cleaning-up day campaign is conducted every week, led by the Prime Minister with involvement of all public services officers of ministries and communities. A community award has been initiated for the best hamlet with the cleanest environment (free of rubbish). The Secretary of State for Environment has declared a “zero plastic” initiative in Timor-Leste in September 2018. Involvement of community volunteers for implementation of vector control activities (larviciding and fogging) and health education has been started.

**Challenges**

The country has observed a rising number of dengue cases since 2016. Challenges remain due to: (i) cross-border migration by Timorese and Indonesians across the uncontrolled land border every day; (ii) lack of human resources, tools for dengue diagnostics and implementation of the dengue programme at all levels; (iii) lack of funds; (iv) no routine implementation of entomology surveillance in the high-risk areas. Multiple agencies are involved, i.e. CDC department, surveillance unit and department of environmental health for vector control; (v) the strategic plan for dengue, which was developed in 2010, has not yet been finalized and implemented; (vi) lack of coordination and communication among various departments when a dengue outbreak occurs; (vii) national guidelines on clinical management for dengue have not been updated since 2010.

**Support from WHO**

Support needed from WHO is as follows: (i) revision of the national dengue clinical management guidelines; (ii) SOP for dengue diagnosis, (iii) finalization of the dengue strategic plan for 2021–2025; and (iv) assessment and development of policy and strategy plan for VBD Control including human resource plan (under GF funding for malaria).
Annex 1

Agenda

Opening Remarks: Dr Suman Rijal, Director, CDS, WHO SEARO

NTD Roadmap 2030 and cross-cutting pillars: Dr Mwele Malecela Director, NTD

Global situation on dengue and other arboviruses: Dr Velayudhan Raman, WHO HQ

Regional situation on dengue and other arboviruses: Dr B.N. Nagpal

Country presentations: Bangladesh, Bhutan, DPR Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste

Discussions led by the Chair

Gaps and challenges in the prevention and control of dengue and other arboviruses: Dr Velayudhan Raman, WHO HQ

Recent advancements in case management of dengue and other arboviruses: Dr K. Hasitha Arvinda

Discussions led by the Chair

Coinfection of COVID-19 and dengue, their management, control and prevention: Dr N.R. Tuli

Wolbachia: Its role in the control of dengue and other arboviruses: Dr Jambulingam

Role and future of ovitraps in arboviral disease vector surveillance and control: Professor P.S. Indu

Impact of climate change on transmission and control of dengue and other arboviruses: Dr Meghnath Dhimal

Cross-border collaboration on dengue and other arboviruses diseases: Dr Lee Ching

Discussions led by the Chair

Recommendations and closing
Annex 2

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Dengue is fast emerging as a significant public health challenge in all Member States of the WHO South-East Asia Region except the Democratic People's Republic of Korea. Epidemiological transition has been observed with loss of cyclical patterns and reduction in the gap between outbreak years. Prevention and control of arbovirus diseases has been challenging during the COVID-19 pandemic. The Region constituted a Regional Technical Advisory Group on dengue and other arboviruses to review the regional situation and advise WHO on case management.

The Group met virtually in October 2021 to review the emerging scenario of dengue in the Region and propose appropriate mechanisms for prevention and control. It recommended standardized training packages and the strengthening of entomological capacity for surveillance, prevention and clinical management of dengue and other arboviral diseases. This report highlights the meeting proceedings and recommendations.