Science in One Health 3 (2024) 100087

Contents lists available at ScienceDirect

Science in One Health

journal homepage: www.journals.elsevier.com/science-in-one-health

Review

Advancing knowledge of One Health in China: lessons for One Health from China's dengue control and prevention programs

Xinyu Feng [a,b], Na Jiang [c], Jinxin Zheng [a,b], Zelin Zhu [d,e,f,g], Junhu Chen [d,e,f,g], Lei Duan [d,e,f,g,h], Peng Song [d,e,f,g], Jiahui Sun [d,e,f,g], Xiaoxi Zhang [a,b], Lefei Hang [a,b], Yang Liu [i], Renli Zhang [j], Tiejian Feng [j], Binbin Xie [k], Xiaonen Wu [k], Zhiying Hou [k], Muxin Chen [d,e,f,g,***], Jinyong Jiang [l,**], Shizhu Li [d,e,f,g,*]

[a] School of Global Health, Chinese Center for Tropical Diseases Research, Shanghai Jiao Tong University School of Medicine, Shanghai 20025, China
[b] One Health Center, Shanghai Jiao Tong University-The University of Edinburgh, Shanghai 20025, China
[c] College of Life Sciences, Inner Mongolia University, Hohhot Inner Mongolia 010021, China
[d] National Key Laboratory of Intelligent Tracking and Forecasting for Infectious Diseases, National Institute of Parasitic Diseases at Chinese Center for Disease Control and Prevention, Chinese Center for Tropical Diseases Research, Shanghai 200025, China
[e] NHC Key Laboratory for Parasitology and Vector Biology, Shanghai 200025, China
[f] WHO Collaborating Center for Tropical Diseases, Shanghai 200025, China
[g] National Center for International Research on Tropical Diseases, Shanghai 200025, China
[h] School of Life Science, Fudan University, Shanghai 200438, China
[i] Sichuan Center for Disease Control and Prevention, Chengdu 610041, Sichuan, China
[j] Shenzhen Center for Disease Control and Prevention, Shenzhen 518073, Guangdong, China
[k] Hainan Tropical Disease Research Center, Haikou 570100, Hainan, China
[l] Yunnan International Joint Laboratory of Tropical Infectious Diseases, Yunnan Provincial Key Laboratory of Vector-Borne Diseases Control and Research, Yunnan Key Technology Innovation Team for Insect Borne Infectious Disease Prevention and Control, Yunnan Institute of Parasitic Diseases, Pu'er 665000, Yunan, China

ARTICLE INFO

Keywords:
Dengue
Control and prevention
Vector control
Community involvement
One Health

ABSTRACT

Background: The emergence of dengue fever has prompted significant public health responses, highlighting the need for a comprehensive understanding of One Health in addressing vector-borne diseases. China's experience in dengue control and prevention programs offers valuable insights into the successful integration of multidisciplinary strategies.

Aims: The review aims to: (1) systematically analyze lessons from China's dengue control and prevention programs, focusing on the integration of these efforts with the One Health approach; (2) underscore the reasons of optimizing the dengue control and prevention program; (3) highlight the alignment of China's dengue control strategies with the One Health framework; (4) contribute to global efforts in combating dengue, providing scientific evidence and strategic recommendations for other regions facing similar challenges.

Results: Through a comprehensive literature review and expert interviews, this study found China's approach to dengue control and prevention implemented through a hierarchical system led by the government, with collaborative efforts across multiple departments. This multi-sectoral collaboration mechanism enables the technical interventions well executed by health and disease control institutions, optimizing the integration of multiple cost-effeteness approaches, such as case management, early detection and outbreak response, reducing local transmission, and minimizing severe cases and fatalities. It was found that community participation and public health

* Corresponding author. National Key Laboratory of Intelligent Tracking and Forecasting for Infectious Diseases, National Institute of Parasitic Diseases at Chinese Center for Disease Control and Prevention, Chinese Center for Tropical Diseases Research; NHC Key Laboratory for Parasitology and Vector Biology; WHO Collaborating Center for Tropical Diseases; National Center for International Research on Tropical Diseases, Shanghai, 200025, China.

** Corresponding author.

*** Corresponding author. National Key Laboratory of Intelligent Tracking and Forecasting for Infectious Diseases, National Institute of Parasitic Diseases at Chinese Center for Disease Control and Prevention, Chinese Center for Tropical Diseases Research, Shanghai 200025, China.

E-mail addresses: fengxy@shsmu.edu.cn (X. Feng), jiangna200001@163.com (N. Jiang), jamesjin63@163.com (J. Zheng), zhuzl@nipd.chinacdc.cn (Z. Zhu), chenjh@nipd.chinacdc.cn (J. Chen), duanlei@nipd.chinacdc.cn (L. Duan), songpeng@nipd.chinacdc.cn (P. Song), sunjh@nipd.chinacdc.cn (J. Sun), zhangxiaoxi@sjtu.edu.cn (X. Zhang), lfhan@sjtu.edu.cn (L. Hang), renlizhangszcdc@aliyun.com (R. Zhang), fengtiej@126.com (T. Feng), xiebbhn@163.com (B. Xie), wuxn6@mail3.sysu.edu.cn (X. Wu), houzy_1122@163.com (Z. Hou), chenmx@nipd.chinacdc.cn (M. Chen), jiangjinyong@yipd.org (J. Jiang), lisz@chinacdc.cn (S. Li).

https://doi.org/10.1016/j.soh.2024.100087
Received 29 October 2024; Accepted 4 November 2024

education have played a vital role in raising awareness, promoting personal protective measures, and enhancing the overall effectiveness of control efforts. The implementation of these integrated interventions has resulted in reduced dengue cases and improved capacity of outbreak response. China's dengue control strategies under the One Health framework, with focus on interdisciplinary collaboration, incorporated environmental and ecological interventions, which reduced mosquito breeding sites and improved sanitation. The findings of the review underscore the need for continuous improvement in early warning systems, scientific research, and the adoption of the One Health approach to address emerging challenges posed by climate change and the cross-border spread of infectious diseases.

Conclusion: China's dengue control and prevention programs provide a compelling case study for the effective application of the One Health approach. By systematically analyzing the integration of multidisciplinary strategies, this review reveals valuable lessons on optimizing public health responses to vector-borne diseases. The alignment of these strategies with One Health principles not only enhances the effectiveness of dengue control efforts in China but also offers a framework that can be adapted by other regions facing similar challenges. Ultimately, the insights gained from this analysis contribute to the global fight against dengue, emphasizing the need for collaborative and holistic approaches in public health initiatives.

1. Background

The increasing interconnectedness between humans, animals, and the environment, driven by globalization and ecological changes, has heightened the risk of emerging and re-emerging infectious diseases [1,2]. To address these global challenges, the concept of "One Health" has emerged. One Health is a systemic health approach that emphasizes the synergistic relationship between human health, animal health, and ecosystem health. Its core principles include interdisciplinary collaboration, coordinated management, and comprehensive protection of humans, animals, and the environment [1,3,4]. Over the past decades, global attention to cross-species transmission of infectious diseases has increased, leading to the widespread recognition and adoption of the One Health. As global health crises continue to escalate, One Health has become a critical strategy for countries to address infectious diseases [5].

The One Health approach is particularly crucial in controlling infectious diseases including dengue fever, as the transmission process of dengue involves multiple biological interfaces [6,7]. The dengue virus circulates between humans and mosquitoes, with its transmission influenced by climate, environment, mosquito population dynamics, and human activities [8]. The multidisciplinary collaboration inherent in the One Health approach helps integrate these complex factors by combining strategies from human medicine, animal and plant health, and ecological management to effectively reduce the risk of dengue transmission. For instance, improving environmental sanitation and reducing mosquito breeding sites, along with coordinated efforts to control mosquito populations, can reduce dengue transmission at its source [9,10]. Furthermore, increasing public awareness about dengue can lead to timely adoption of personal protective measures, thereby reducing the risk of human infections [11]. Thus, One Health provides a systematic, comprehensive, and sustainable approach to dengue prevention and control.

As the most populous developing country, China has diverse climatic conditions and abundant flora and fauna, providing a conducive environment for the dengue virus and its vector, *Aedes* mosquitoes. In recent years, with global warming, accelerated urbanization, and increased human mobility, the incidence of dengue in China has shown a fluctuating trend, posing significant challenges to epidemic control [12]. The government of China has prioritized dengue prevention and control, implementing a series of integrated measures, such as case management, environmental management, vector control, disease surveillance, and health education, to reduce the risk of dengue transmission [13,14]. These measures largely align with the principles of the One Health approach, involving multi-sectoral collaboration and interdisciplinary efforts to optimize the overall health of humans, animals, and the environment. The integration of China's dengue control experience with the One Health concept not only contributes to reducing domestic dengue cases but also provides a reference model for other regions facing mosquito-borne diseases. China's success in multidisciplinary collaboration and interdepartmental coordination demonstrates that One Health is an effective strategy for dengue control, especially when addressing complex and dynamic ecological and epidemiological challenges [15].

This systematic review aims to summarize and analyze China's experiences in dengue control, exploring the connections between these experiences and the One Health concept, and deriving strategies that could be applied in other countries and regions. Against the backdrop of the global spread of dengue, studying China's control strategies can offer valuable insights for other nations, particularly regarding multi-sectoral collaboration, environmental management, and vector control. Specifically, this study will systematically review China's key measures in dengue control, assess their effectiveness and limitations, and examine their alignment with the principles of One Health. The analysis of China's dengue control experience will further promote the application and dissemination of the One Health approach globally.

2. Methods

The literature search covered relevant studies published between 2020 and 2024, drawing from both domestic and international research (Supplementary file 1). Chinese databases such as CNKI and Wanfang were utilized alongside English databases including PubMed and Web of Science. Supplemental data sources included academic search platforms like Google Scholar and ResearchGate. The search employed keywords such as "Dengue Fever," "China," "Prevention and Control," and "Epidemiology." This systematic review focuses on recent key research findings and practical case studies in dengue prevention and control in China, encompassing areas such as case management, vector control, disease surveillance, environmental management, and public health education.

In addition to the literature review, we conducted interviews with experts from various sectors, including public health, agriculture, veterinary medicine, and customs, as well as academic scholars. These interviews provided valuable insights from professionals directly involved in dengue control efforts. The study included representative publications selected from international and authoritative domestic journals, government reports, and expert research in related fields. We analyzed the strengths and challenges of China's dengue control measures and, with reference to the One Health approach, proposed recommendations for improvement. By systematically summarizing China's experience in dengue prevention and control, this review aims to provide scientific evidence and strategic references for dengue control efforts in other regions globally.

3. Results

Based on the search results from the four Chinese and English databases, a total of 1907 documents were retrieved. After excluding duplicates, abstracts, and irrelevant content, a total of 1063 documents were systematically analyzed in this study (Supplementary file 1, Fig. 1).

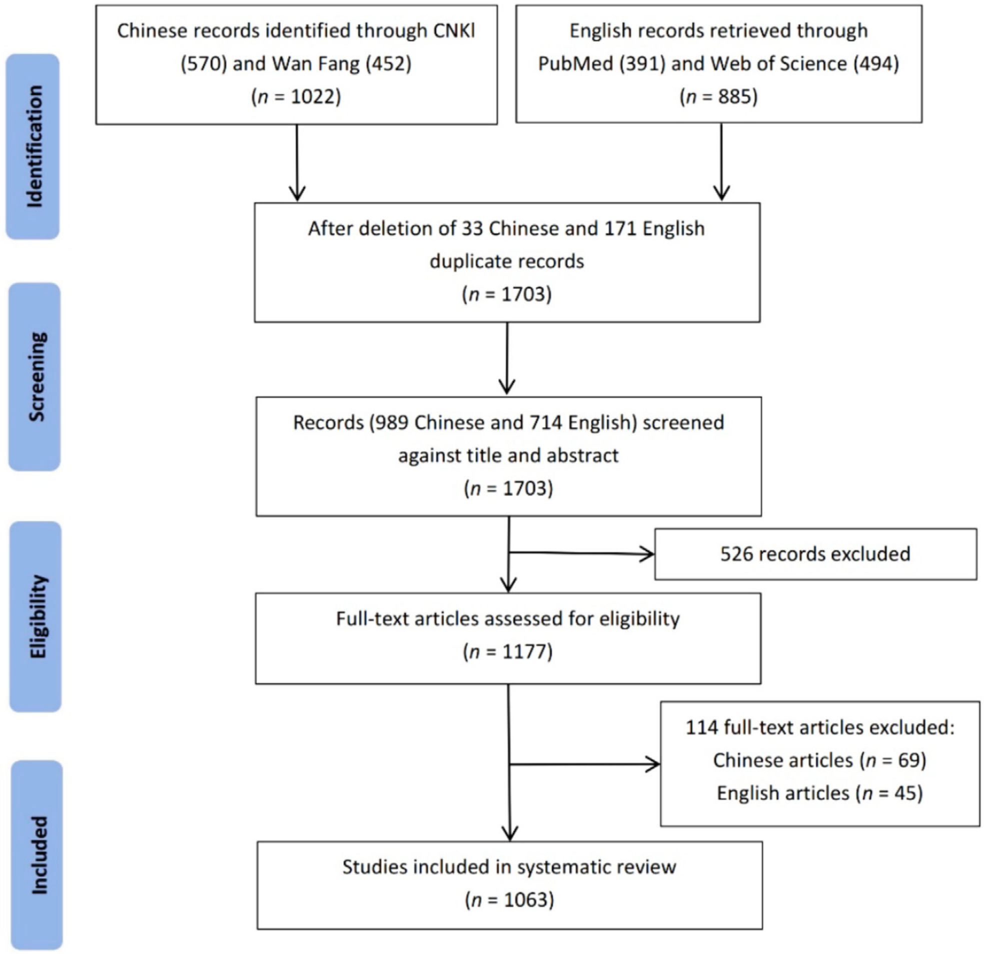

Fig. 1. Flow diagram of the literature retrieval strategy for dengue fever in China.

3.1. Epidemiology of dengue in China

Dengue fever in China is classified as an imported vector-borne disease, primarily affecting regions south of the Yangtze River. Between 2004 and 2023, China reported a cumulative total of 114,853 cases (excluding asymptomatic infections). During this period, several provinces and regions, including Yunnan, Guangdong, Guangxi Zhuang Autonomous Region, Fujian, Zhejiang, Hainan, Chongqing, Jiangxi, Hunan, Sichuan, Henan, Jiangsu, Hubei, Shanghai, and Shandong, experienced local outbreaks [16,17]. The Pearl River Delta in Guangdong and the border regions of Jinghong and Ruili in Yunnan are key epidemic hotspots [16,18,19]. Moreover, the epidemic has shown signs of spreading towards temperate regions, as exemplified by the 2019 outbreak in Puyang, Henan (35°78′N) and, marking the northernmost transmission of dengue fever in China [20].

In recent years, dengue fever in China has displayed marked regional variation, with significant fluctuations in case numbers and geographic distribution [16,21]. The primary epidemic regions are concentrated in the tropical and subtropical southern provinces, particularly coastal and border areas such as Guangdong, Guangxi Zhuang Autonomous Region, Yunnan, and Fujian, where climatic conditions favor mosquito vector proliferation and transmission [22–25]. In 2014, Guangdong Province experienced a significant outbreak, with over 45,000 reported cases—more than 95 % of the national total. Despite subsequent prevention and control measures, localized outbreaks continue to occur. In 2019, 15, 376 locally transmitted cases and 5813 imported cases were reported nationwide, mostly in Guangdong and Yunnan. In 2020, thanks to effective control measures, cases dropped to 616 locally transmitted and 158 imported cases. However, by 2023, China experienced another large-scale outbreak, with 19,538 cases, primarily in Yunnan and Guangdong. Climate change and increased international travel have contributed to a rise in cross-border imported cases, particularly in Yunnan, exacerbating the challenges of disease prevention and control [16,21,26].

Dengue fever in China exhibits distinct seasonality, with cases peaking during the hot and rainy months of summer and autumn, typically between June and November [27]. During this period, higher temperatures and increased rainfall create ideal conditions for mosquito reproduction, leading to a rise in the population density of *Aedes aegypti* and *Aedes albopictus*, which in turn heightens the risk of transmission. Research indicates that a 1 °C increase in temperature significantly enhances mosquito reproduction rates and viral transmission efficiency, accounting for the higher incidence of dengue in southern China during summer [28,29].

The prevalent dengue virus serotypes in China include DENV-1, DENV-2, DENV-3, and DENV-4. DENV-1 and DENV-2 are the most common, with DENV-1 frequently dominating outbreaks in Guangdong. In recent years, however, DENV-3 and DENV-4 have also been detected, particularly in border provinces with high levels of international travel and trade, suggesting an increasing diversity of circulating dengue virus strains. This growing diversity presents new challenges for prevention, control, and vaccine development efforts [30–32].

Dengue fever in China predominantly affects adults, with the highest incidence among males aged 25 to 44. Occupations with the greatest number of cases include students, service workers, laborers, farmers, retirees, homemakers, and the unemployed, while children are relatively less affected. The male-to-female ratio is similar, though severe cases are more common among the elderly [16,21,33].

3.2. Dengue control and prevention strategies in China

The primary goals of dengue control and prevention program in China are to swiftly detect and manage outbreaks, mitigate the risk of local transmission, confine the spread of epidemics, and minimize severe cases and fatalities. To achieve these goals, a multi-strategy of dengue control and prevention has been effectively implemented by a tiered framework of prevention and response. This system, led by governmental oversight, is supported by technical expertise from health and disease control institutions, and facilitated by multi-sectoral joint efforts and interventions.

3.2.1. Government policies and measures

The Chinese government has demonstrated robust leadership in dengue prevention and control, particularly in policy formulation, resource allocation, and multi-sectoral collaboration (Fig. 2). Central and local governments have jointly developed a policy framework for dengue control, such as the *National Dengue Fever Prevention and Control Guidelines*, to guide public health institutions at all levels. During periods of high dengue incidence, emergency response mechanisms are frequently activated to enhance epidemic monitoring and assessment, allowing for the timely adjustment of prevention strategies [27,34,35].

In terms of resource allocation, the government provides significant financial and human resources during outbreaks to support centers for disease control and prevention (CDCs) in monitoring mosquito density and conducting environmental clean-up campaigns. For example, during the large-scale dengue outbreak in Guangdong Province in 2014, the government rapidly mobilized medical personnel and epidemic prevention resources, coordinating efforts across sectors such as environmental health, transportation, and community organizations to implement control measures [36]. This model of multi-sectoral collaboration has significantly strengthened the overall capacity for epidemic control and enhanced policy implementation.

3.2.2. Monitoring and early warning systems

A comprehensive monitoring and early warning system is a cornerstone of dengue prevention in China. Since 1989, dengue has been classified as a category B notifiable infectious disease. The Ministry of Health and the China CDC have issued several documents, including the *Dengue Fever Surveillance Program* (*Trial*) and the *Technical Guidelines for Dengue Prevention*, which outline the content and scope of surveillance [13].

The monitoring system consists of case surveillance, outbreak surveillance, routine vector surveillance, emergency vector surveillance, and sentinel site surveillance [37] (Fig. 2). Case and outbreak monitoring are conducted nationwide, with responsibilities assigned to medical, disease control, and quarantine institutions at various levels. Confirmed cases must be reported online through the statutory infectious disease management system within 24 h, while outbreaks must be reported by local CDCs to health administrative departments and higher-level CDCs within 2 h. China has implemented a comprehensive approach to dengue case detection and management. When a dengue case is identified, a thorough investigation is conducted to identify potential sources of infection and contacts who may have been exposed. This information is used to implement targeted control measures and prevent further transmission.

China has established a multi-level disease surveillance network at national and local levels, allowing for real-time collection and analysis of dengue case data, enabling a swift response at the early stages of outbreaks. The system relies on the data platform of the China CDC, which updates case numbers, mosquito density, and meteorological data in real time, providing a scientific basis for government decision-making. In addition, an early warning mechanism, based on a comprehensive analysis of meteorological data, vector surveillance, and historical epidemic patterns, has been developed to forecast outbreaks. For example, Guangdong Province successfully predicted and controlled a potential dengue outbreak using this monitoring system in 2018 [38].

Vector surveillance, which includes monitoring adult and larval mosquito density, is an integral part of the monitoring and early warning system and is conducted by disease control institutions at various levels [39]. Routine surveillance is conducted in 23 provinces where the *Aedes* mosquito vector has been identified, with different levels of monitoring based on previous epidemic severity and vector distribution. Following case reports, local CDCs conduct epidemiological investigations and delineate core, warning, and surveillance areas for emergency vector monitoring. Sentinel site surveillance, conducted in 16 districts or counties across Guangdong, Fujian, Yunnan, Guangxi Zhuang Autonomous Region, and Hainan, focuses on epidemiological investigations, serological monitoring, and population antibody level surveys.

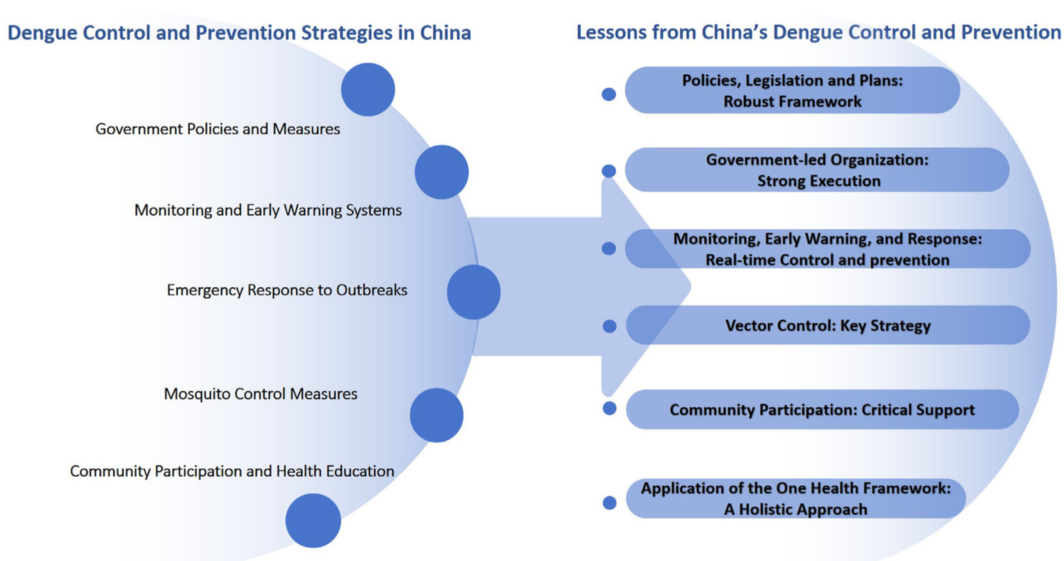

Fig. 2. Dengue control and prevention strategies in China and lessons may be learned.

3.2.3. Emergency response to outbreaks

China follows the “four earlys” principle—early detection, early assessment, early warning, and early action—for dengue outbreaks. According to the *Technical Guidelines for Dengue Prevention*, outbreaks are classified into six levels, with a graded response system. Levels 4–6 are managed by county governments, Level 3 by municipal governments, Level 2 by provincial governments, and Level 1 by national health administrative agencies [40,41]. The government is the primary entity responsible for prevention and control, ensuring institutional, material, and personnel support, and driving the implementation of measures. Disease control institutions provide technical support, conducting risk assessments, outbreak evaluations, and vector surveillance. Medical institutions are responsible for case diagnosis, reporting, and hospital infection control. Public health campaigns and local authorities mobilize community participation in mosquito control efforts, while publicity departments handle education and public opinion management. The ports and tourism departments work to reduce the risk of cross-border transmission, and the public security and finance departments provide legal and financial support. Other sectors, such as education, housing, and urban management, contribute to prevention efforts, including epidemic control in schools, environmental sanitation, and mosquito control [39].

This emergency response mechanism emphasizes government leadership, cross-departmental cooperation, and public participation. Through accurate classification, rapid response, and comprehensive measures, the system effectively controls dengue outbreaks and protects public health.

Additionally, China prioritizes data sharing and international cooperation in border regions for dengue prevention and control. For example, Yunnan Province collaborates with neighboring Southeast Asian countries through data-sharing platforms to address cross-border dengue cases in a timely manner. This cross-border cooperation enhances regional prevention capabilities and reduces the risk of dengue transmission across borders [42].

3.2.4. Mosquito control measures

Mosquito control is a core strategy for dengue prevention in China, involving environmental management, chemical insecticides, and biological control. Environmental management focuses on eliminating mosquito breeding sites by organizing community clean-up efforts, such as removing stagnant water and discarding containers [10,43]. In key areas such as Guangdong and Yunnan, local governments regularly conduct large-scale environmental sanitation campaigns, which have proven effective in reducing the likelihood of dengue outbreaks.

The use of chemical insecticides is a direct method of reducing mosquito density. During high-risk periods, disease control departments deploy chemical spraying techniques in public areas and residential neighborhoods to kill mosquitoes. Studies have shown that chemical insecticides can significantly lower mosquito densities in a short period, helping to quickly curb the spread of the disease. However, the long-term use of insecticides has led to increased mosquito resistance, prompting the gradual introduction of biological control methods [44–46].

Biological control includes using natural predators to reduce mosquito larvae, such as introducing mosquito fish into water bodies, and using bacteria like *Wolbachia* to infect mosquitoes, preventing virus transmission [47–49]. Research from Guangdong Province indicates that combining biological control methods with environmental management can significantly lower mosquito density during dengue outbreak seasons and reduce the risk of disease transmission [47,50]. This integrated approach is viewed as a promising direction for future dengue prevention efforts.

3.2.5. Community participation and health education

Community participation and health education play essential roles in dengue prevention and control in China [22,51,52]. Government and public health departments actively promote mosquito prevention awareness and self-protection behaviors through various community outreach efforts. Research has shown that community mobilization not only increases public acceptance of control measures but also encourages active participation in environmental clean-up and mosquito surveillance (Fig. 2).

Local governments and CDCs disseminate dengue prevention information through printed materials, health seminars, and social media platforms. For instance, in Shenzhen, the local CDC pushes mosquito prevention tips and disease information to residents via the WeChat platform, raising public awareness and encouraging proactive behavior [53]. These efforts significantly improve public knowledge of mosquito control and self-protection, fostering a favorable environment for dengue prevention.

In summary, China has adopted a multi-tiered and comprehensive approach to dengue prevention, encompassing strong government policy support, an advanced monitoring and early warning system, an effective emergency response mechanism, robust mosquito control measures, and active community participation. The implementation of these strategies has significantly reduced the risk of dengue epidemics and offers valuable insights for other high-risk regions worldwide.

3.3. Lessons from China's dengue control and prevention program

From 2019 to 2023, China reported a total of 43,095 dengue fever cases, with an average incidence rate of 0.61/100,000. Although annual incidence rates fluctuated significantly, they overall exhibited a decreasing trend (AAPC [average annual percent change] = −3.16 %). In 2023, China reported 19,541 cases and an incidence rate of 1.39/100,000, with Yunnan and Guangdong provinces reporting incidence rates of 28.74/100,000 and 3.54/100,000 respectively, significantly lower than those in neighboring countries such as Laos (402.34/100,000), Malaysia (314.17/100,000), and Sri Lanka (304.53/100,000) [33,54].

When compared with historical data, China's achievements in dengue fever control are even more prominent. China's first significant outbreak of dengue fever was recorded on Hainan Island in 1985–1986, with an incidence rate of 1913 cases per 100,000 inhabitants and a mortality rate of 0.25 % [55]. However, through effective monitoring, diagnosis, and treatment, China has successfully reduced the mortality rate of dengue fever. From 2005 to 2023, only 15 deaths from dengue fever were reported in China, with a mortality rate of less than 0.01/100,000 [56,57]. This represents a significant achievement in dengue fever control, as the mortality rate has been effectively controlled and both severe case and mortality rates remain low. The decrease in incidence rates and mortality rates demonstrates China's commitment and effectiveness in addressing this public health challenge.

3.3.1. Policies, legislation and plans: robust framework

China has implemented a comprehensive framework of policies, legislation, and plans to address dengue transmission. Based on the *Law on the Prevention and Control of Infectious Diseases of the People's Republic of China*, the country has established legal provisions that cover early detection to post-epidemic management, ensuring public health security (Fig. 2). The *National Emergency Response Plan for Public Health Emergencies* enhances the ability to swiftly respond to outbreaks through cross-sectoral coordination and resource allocation, effectively controlling transmission at the early stages [58–60].

Operationally, the *National Dengue Prevention and Control Plan* and *National Disease Prevention and Control Work Plan*, issued by the National Health Commission, outlines the long-term goals and phased tasks for dengue control, emphasizing vector control, scientific research, international cooperation, and vaccine development. The former Ministry of Health's *Dengue Prevention and Control Standards* established standardized procedures for case diagnosis, reporting, isolation, and epidemic control, enhancing the healthcare system's response efficiency and minimizing administrative errors. The *Infectious Disease Information Reporting and Management Measures* ensures transparency and accuracy of epidemic data, providing a sound basis for decision-making while raising public awareness of epidemic prevention [61].

3.3.2. Government-led organization: strong execution

China's organizational structure for dengue prevention is government-led and emphasizes cross-departmental collaboration to ensure the effective implementation of control measures (Fig. 2). Key departments include the health administrative authorities, which lead and coordinate medical, disease control, health education, health inspection, and health promotion institutions, providing technical support, expert coordination, and strategic guidance. Disease control institutions are responsible for epidemic monitoring, risk assessment, and proposing control measures [62,63].

The Patriotic Health Campaign Committee organizes public health campaigns, coordinating mosquito control activities and promoting environmental hygiene [64,65]. Medical institutions are tasked with diagnosing cases, isolating and treating patients, conducting laboratory tests, reporting outbreaks, and assisting with case investigations and epidemic analysis. Health supervision authorities oversee the implementation of dengue control measures according to relevant regulations. Publicity departments manage public education, media monitoring, and communication, reporting the epidemic status, conducting risk communication, and mobilizing the public to participate in prevention efforts, thereby enhancing public awareness and preparedness [65].

Other sectors also play critical roles. The education department ensures mosquito control and staff education in schools and kindergartens. Urban management departments oversee sanitation in construction sites and assist with environmental management to control mosquito breeding. Tourism departments provide dengue control information to tourism workers and travelers, coordinating with other departments to address suspected cases. The public security departments support the smooth implementation of control measures, while the finance department ensures sufficient funding for prevention efforts. Quarantine departments monitor and screen inbound and outbound travelers for infectious diseases, coordinating with health authorities to manage suspected cases and close contacts at border ports [66]. Additionally, subdistrict offices or township governments implement dengue prevention within their jurisdictions, including outbreak reporting, vector control, health education, and epidemic surveillance. Other departments may also be incorporated into the collaborative mechanism depending on local conditions and preventive needs, ensuring comprehensive control efforts.

3.3.3. Monitoring, early warning, and response: real-time control and prevention

Under government leadership and cross-departmental cooperation, China has effectively managed dengue epidemics by strengthening monitoring, refining emergency response mechanisms, implementing stringent control measures, and conducting risk communication and health education (Fig. 2). Monitoring and early warning are top priorities. China has reinforced its national disease surveillance system to ensure early detection and real-time reporting of dengue cases. Medical institutions and CDCs have established efficient information-sharing mechanisms to enable rapid responses and case confirmation. Routine surveys are conducted to monitor mosquito population density and distribution, track insecticide resistance, and evaluate the effectiveness of control measures, ensuring timely adjustments to intervention strategies [67,68].

Emergency response is a key component of the control system. China has developed detailed emergency plans, triggering rapid responses when an outbreak is detected [24]. Professional teams are dispatched to isolate cases, disinfect epidemic zones, and clean the environment, effectively curbing the spread of the disease. Cross-departmental collaboration platforms clarify the roles of participating entities, fostering a joint prevention and control working model. Regular emergency drills are conducted to enhance the response and coordination capacity of all departments.

Vector control and environmental management are central strategies for epidemic control. China employs an integrated approach using chemical, biological, and environmental measures to reduce mosquito density, eliminate breeding sites, and interrupt virus transmission. Legislation and regulations enforce sanitation standards at both community and household levels, ensuring the long-term efficacy of environmental management [69].

Case management follows strict isolation and treatment protocols. Confirmed cases are isolated and treated, while close contacts are subjected to medical observation and health monitoring to prevent community transmission. Dedicated isolation wards are established to ensure timely and effective patient care. Epidemiological investigations are conducted for all confirmed cases, leveraging modern information technology to trace infection sources and transmission chains [39,70].

Health education and risk communication play a crucial role in dengue control [51,52]. China disseminates easily understandable dengue prevention materials through multiple channels to raise public awareness and promote self-protection. A transparent information release mechanism ensures timely and accurate communication with the public regarding the epidemic's status and control progress, addressing societal concerns and gaining public trust and support.

3.3.4. Vector surveillance and control: key strategy

Current vector surveillance methods for *Aedes* mosquitoes are diverse, including traditional methods like human landing catch (HLC) and light traps to more modern technologies such as remote sensing and geospatial analysis (Fig. 2). Each method has its unique applications and has been selected based on the specific needs and resources available in different locations. Combining multiple methods often provide a more comprehensive understanding of mosquito populations and their behavior, aiding in the implementation of effective control measures [38,60].

Controlling *Aedes* mosquito vectors remains the primary method of preventing dengue transmission. Modeling studies show that mosquito elimination is the most critical measure for controlling dengue outbreaks. However, in many dengue-endemic countries, vector control measures and other short-term interventions are often initiated only after an outbreak, lacking sustainability and risking epidemic recurrence. Sustainable vector control requires balancing routine prevention with emergency response, integrating environmental, biological, and chemical methods to maintain mosquito density at levels that do not threaten public health [38,39,60].

Routine vector control is essential for preemptive action in targeted regions and times, incorporating mosquito population monitoring, insecticide resistance tracking, and integrated control methods for breeding sites and adult mosquitoes. Reducing reliance on chemical insecticides and mitigating their risks to humans and the environment are key objectives of these comprehensive control efforts.

3.3.5. Community participation: critical support

Mosquito control requires broad participation from both government and the public (Fig. 2). Varied socio-economic and environmental conditions influence mosquito breeding, necessitating health promotion campaigns to raise public awareness. It is important to emphasize that mosquito control is a shared responsibility, not just the task of professionals. Field studies show that ineffective vector control at the grassroots level, such as within neighborhoods and residential committees, hinders the reduction of mosquito density, thereby impacting the overall effectiveness of dengue prevention efforts.

Community development theories highlight resident-centered approaches, with public participation functioning as a bottom-up mechanism that balances interests and reflects social work policies. Community organizations, such as neighborhood committees, are instrumental in transitioning from passive to proactive governance, fostering self-management, education, and service among residents. In community-based vector control projects, understanding public needs and mobilizing resident participation are critical to sustaining vector control efforts and ensuring successful dengue prevention [52,71].

Research has established community-based intervention models with specific procedures for community engagement. Effective community public health interventions for dengue prevention rely on these engagement strategies, with behavioral intervention theories such as the knowledge-attitude-practice (KAP) model and the information-motivation-behavioral skills (IMB) model proving essential [72]. Self--efficacy—the belief in one's ability to achieve specific outcomes—has been shown to be a decisive factor in promoting preventive behaviors.

3.3.6. Application of the One Health framework: a holistic approach

Investigating potential animal hosts: Understanding dengue transmission pathways has led China to conduct serological studies on animals such as monkeys, bats, pigs, and sheep in areas like Hainan, Yunnan, and Guangxi Zhuang Autonomous Region [73–75]. These studies, conducted between 1980 and 1999, aimed to identify potential animal reservoirs of the dengue virus. For example, in 1986, studies in Yunnan detected high rates of dengue antibodies in rhesus monkeys, pigs, and bats, indicating their role as possible virus reservoirs. More recent research in Hainan has confirmed bats and domestic animals as storage hosts for dengue virus, highlighting the importance of controlling these potential reservoirs to prevent future outbreaks (Fig. 3) [76,77].

Environmental management: China has adopted a series of environmental modification strategies as part of its dengue control framework [78]. These include eliminating mosquito breeding sites in households, communities, and public spaces, such as discarded tires and plant trays, and remediating stagnant water bodies like ponds and ditches through drainage and filling (Fig. 3). Enhanced environmental management and greening, along with the planting of mosquito-repelling plants, have contributed to reducing mosquito activity naturally [79]. Waste management is also strengthened to prevent garbage accumulation from becoming breeding grounds for mosquitoes [80].

Cross-departmental and international cooperation: China's dengue prevention efforts demonstrate a deeply integrated approach, featuring collaboration across sectors and international cooperation. Multiple stakeholders, including government agencies, patriotic health campaigns, hospitals, CDCs, customs authorities, communities, pest control companies, and residents, participate in integrated vector management [13,81]. The National Health Commission leads the development of prevention strategies and coordinates stakeholders, ensuring the optimization of policy development and implementation. CDCs provide technical support and ensure the standardization of disease surveillance and reporting, which is critical for early detection and prompt intervention. Meanwhile, patriotic health campaigns committees and pest control companies (urban areas), township health center and village clinics (rural areas), have also actively participated. Through environmental remediation, mosquito eradication, and other measures, they have effectively cut off the transmission routes of dengue fever [82]. Medical institutions are responsible for disease diagnosis and reporting, forming a complete prevention and control chain from the grassroots to the central level [83,84].

At the international level, China has established cooperative networks with organizations and dengue-endemic countries to share information, exchange experiences, and enhance preparedness. Through such collaborations with nations like Singapore and Myanmar, China has improved early warning systems and informed action plans, contributing to global dengue prevention efforts.

3.3.7. Transferability and limitations of China's dengue fever prevention and control experience

China's experience in dengue fever prevention and control offers valuable insights globally, yet its application elsewhere faces challenges. Firstly, the robust government management and resource allocation capabilities that underpin China's success are difficult to replicate in low-income and politically unstable countries. Secondly, cultural background and social structural differences affect the transferability of prevention and control experiences. In China, community mobilization benefits from strong organizational capabilities and residents' acceptance of public policies, whereas in areas with low social trust, public health measures often encounter resistance. Furthermore, climatic and ecological conditions pose limitations to the generalization of China's prevention and control experiences. Mosquito control strategies in China, particularly those involving environmental management and biological control measures, are mostly tailored to specific subtropical and tropical climatic zones and may have limited effectiveness in temperate or arid climates.

In summary, China's experience in dengue fever prevention and control provides a useful reference globally, particularly in terms of policy support, mosquito control, and community mobilization. However, the application of these experiences in other countries and regions requires adaptation to local social, economic, and climatic characteristics. In the future, the international community should strengthen experience exchange and cooperation to explore dengue fever prevention and control measures suitable for their respective national conditions in response to the increasingly severe global dengue fever epidemic.

4. Challenges, gaps and future research directions

4.1. Challenges and gaps

4.1.1. Severe global epidemic and increased risk of imported cases

In recent years, the global dengue epidemic has intensified, with incidence rates significantly exceeding those of previous years. As of 2023,

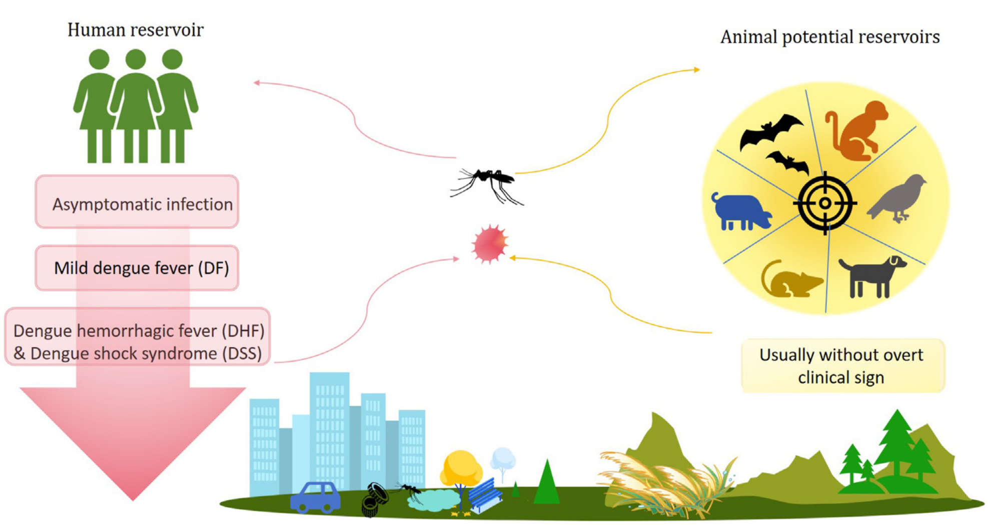

Fig. 3. Dengue fever from a One Health perspective.

over 80 countries and regions reported more than 10 million dengue cases and over 6000 related deaths, tripling the number from previous periods. This global surge increases the risk of imported cases into China.

Multiple factors influence dengue transmission in China, with climate change being a critical driver. Climate conditions, particularly temperature, significantly constrain the geographical distribution of *Aedes* mosquitoes. Over the past century, global average temperatures have risen by approximately 0.8 °C, showing a warming trend. This has expanded the habitable range for *Aedes* mosquitoes [37]. *A. albopictus* has even spread to northern Europe, including the United Kingdom [38]. In China, *A. albopictus* is extending its distribution westward and northward, and continued global warming will further expand their range to higher latitudes [39]. Rising temperatures affect mosquito population growth and virus transmission by extending mosquito activity periods, increasing biting frequencies, shortening egg-laying cycles, and reducing the virus's incubation period. Increased precipitation and more frequent natural disasters due to climate change create favorable breeding environments, further influencing dengue epidemics.

Population movement is another significant factor. With increased domestic and international travel, the risk of cross-border dengue importation has risen markedly [10]. For example, Yunnan Province, bordering Southeast Asian countries, frequently reports cases imported from Myanmar and Laos [7]. This adds to the local disease burden and presents new challenges for controlling virus transmission.

Urbanization has profoundly impacted dengue transmission. Rapid urbanization leads to higher population density and environmental changes, creating favorable conditions for mosquito vectors [11,12,42]. Studies show that urban water bodies and discarded containers provide abundant breeding sites, exacerbating dengue spread [40]. Urbanization alters land use patterns, affecting *Aedes* mosquito habitats and transmission risks. Research in Malaysia found significantly higher dengue incidence in residential areas compared to commercial and industrial zones. Urbanization also influences mosquito ecology, such as vertical flight patterns due to high-rise buildings and altered biting rhythms from light pollution. Densely populated urban areas with inadequate environmental management have become high-risk zones for frequent outbreaks [41,43].

Globalization and modern transportation have accelerated dengue spread. While *Aedes* mosquitoes have limited natural flight distances, human movement significantly contributes to widespread urban transmission. Mosquitoes can be passively transported over long distances through various means at different life stages (adults, pupae, larvae, and eggs). Studies show that *A. albopictus* initially spread from Southeast Asia to the Americas and Europe via global trade in used tires and aquatic plants like lucky bamboo. Globalization and urbanization increase imported cases through international trade and population movement involving both humans and mosquitoes.

In summary, factors such as climate change, population movement, and urbanization contribute to dengue transmission in China (Table 1). These factors affect the seasonal characteristics of epidemics and promote cross-border transmission and viral diversity, posing greater challenges for future control efforts.

4.1.2. Limitations of traditional monitoring methods and rising vector resistance

Monitoring *Aedes* mosquitoes is fundamental for risk assessment and early warning, but current methods have their advantages and limitations. Few highly efficient methods exist for *Aedes* monitoring. The human landing catch method is sensitive but unsuitable during epidemics. The double-net method protects monitors but is cumbersome and inefficient. Biogents BG-Sentinel (BG-traps) and oviposition traps (ovitraps) are among the few sensitive tools available. Mosquito monitoring requires significant human resources for equipment operation and species identification. Results are often delayed, failing to reflect real-time density changes.

Table 1
Gap analysis in dengue control and prevention in China.

Aspect	Current Situation	Gaps identified	Recommendations
Surveillance, response and risk assessment	Monitoring systems are in place but technologically outdated in some aspects, such as integrated surveillance systems among different sectors, vector distribution and insecticide-resistance surveillance	Limited early detection capabilities	Increase technological investment in monitoring and early warning systems
		Insufficient rapid response mechanisms	Utilize advanced biological monitoring technologies
		Limited application of modern information technology	Deploy IoT devices and AI for data analysis to achieve accurate risk prediction
Multi-sectoral collaboration	Some collaboration mechanisms are in place but not fully optimized	Lack of clear responsibilities and tasks across departments	Establish efficient collaboration mechanisms
		Limited information sharing and joint action	Clarify responsibilities and tasks
		Inefficient communication and coordination	Implement cooperation agreements and data-sharing platforms
			Ensure continuous optimization of collaboration mechanisms
Public education and community involvement	Public education and community involvement exist but could be strengthened	Limited reach and impact of health education programs in rural areas	Strengthen health education through various channels
		Insufficient community involvement and participation	Increase community involvement through health promotion projects
		Behavior change interventions need to be improved	Implement behavior intervention programs tailored to specific populations
Research and technological innovation	Research investment and technological advancements are ongoing but more can be done	Limited investment in emerging pathogens and control technologies	- Increase research investment, especially in emerging pathogens
		Insufficient interdisciplinary research	Encourage interdisciplinary research
		Slow progress in vaccine and drug development	Accelerate vaccine and drug development
			Improve diagnostic technologies and control strategies
International cooperation and exchange	Collaboration with international organizations exists but could be expanded	Insufficient knowledge sharing and control experience exchange	Strengthen collaboration with WHO, WOAH, FAO, and other organizations
		Lack of joint research projects	Share epidemic information and control experiences
			Conduct joint research projects and technology transfers

Abbreviations: IoT, internet of things; AI, artificial intelligence; WHO, World Health Organization; WOAH, World Organisation for Animal Health; FAO, Food and Agriculture Organization of the United Nations.

Insecticide resistance among *Aedes* mosquitoes poses a severe challenge globally. Research indicates that in dengue-endemic regions of the Americas and Asia, primary vectors like *A. aegypti* and *A. albopictus* have developed widespread resistance to commonly used insecticides, including pyrethroids and organophosphates. Limited studies in West Africa suggest similar trends. In China, data from 2009 showed significant resistance to deltamethrin and chlorpyrifos in cities like Beijing, Qingdao, and Zhengzhou. Monitoring in Zhanjiang, Guangdong Province, in 2010 indicated resistance levels 13.0, 6.7, and 7.9 times higher for deltamethrin, permethrin, and cypermethrin, respectively. The 2002 dengue outbreak in Taiwan, China was linked to *A. aegypti* resistance to permethrin. High resistance and cross-resistance impact existing control strategies, making insecticide resistance a critical issue as epidemics persist.

4.1.3. Lack of effective vaccines and therapeutics

Dengue vaccine development faces challenges, primarily in addressing the four virus serotypes (DENV1–4). Each serotype can cause disease independently, but secondary infection with a different serotype may lead to more severe illness due to antibody-dependent enhancement (ADE). The existing vaccine, Dengvaxia®, is approved in some countries but has varying efficacy among different age groups and serostatus populations, particularly offering poor protection for children under nine and those not previously infected. Additionally, Dengvaxia® provides lower protection against DENV2, increasing the risk of severe dengue. New vaccines, such as mRNA and live attenuated vaccines, have made technical progress but still face issues like uneven efficacy and insufficient long-term immunity. Key challenges include balancing immune responses against all serotypes and preventing ADE-induced exacerbation. The lack of suitable animal models further complicates development. Effective, safe, and widely applicable vaccines remain an urgent need (Table 1).

No specific antiviral drugs are available to treat dengue fever; treatment relies on symptomatic and supportive therapy. Without agents that directly target the virus, preventing progression to severe stages is challenging. Diverse symptoms and uneven immune responses make treatment complex, especially with the risk of ADE. Managing severe forms like dengue hemorrhagic fever requires advanced medical resources, often lacking in endemic regions, complicating responses to large-scale epidemics.

4.2. Recommendations and future research directions

4.2.1. Strengthening early warning systems

By integrating big data, the Internet of Things (IoT), and mobile network technologies, real-time collection and sharing of epidemic data can be achieved, ensuring its timeliness and accuracy. Furthermore, early warning models should be optimized by incorporating various factors such as climate, vector distribution, insecticide resistance, and human mobility. Leveraging artificial intelligence (AI) and big data analytics enhances prediction accuracy and lead times. Actively drawing on international best practices will continuously refine the early warning systems, thereby enhancing prevention and control effectiveness through scientific approaches.

4.2.2. Enhancing inter-departmental collaboration and information sharing

A unified information sharing platform should be established to break down departmental barriers and facilitate data flow and resource integration among departments such as health, meteorological, and environmental protection. A routine inter-departmental coordination mechanism should be put in place, with regular collaborative meetings held to formulate and implement more effective joint prevention and control measures. This will enhance epidemic response speed and control efficiency through efficient collaboration.

4.2.3. Deepening community mobilization and long-term effect assessment

Long-term follow-up studies should be conducted to assess the practical effects of community mobilization and health education in different socio-economic contexts, providing data support for formulating more targeted community participation strategies. Additionally, AI and machine learning technologies can be utilized to conduct in-depth analysis of epidemic data, improving the accuracy of predicting epidemic trends and identifying potential high-risk areas to optimize the allocation of prevention and control resources.

4.2.4. Strengthening scientific translational research

Attention should be given to the genetic variation and epidemiological patterns of dengue virus in different regions of China, with in-depth research on its transmission characteristics and interactions (Table 1). This provides a scientific basis for formulating more targeted vaccine strategies and prevention and control measures. Moreover, exploring the impact of climate change on mosquito behavior and virus transmission dynamics will allow for more accurate predictions of seasonal variations and long-term trends in dengue fever epidemics. Furthermore, increased investment in basic research on dengue fever vaccines and promoting international cooperation to accelerate vaccine clinical trials and approval processes will aim for early vaccine universalization and effective control of dengue fever epidemics.

4.2.5. Adopting the One Health approach

In dengue prevention and control efforts, adopting the One Health approach—acknowledging the interconnectedness of human, animal, and environmental health—is crucial (Table 1). Besides enhancing mosquito vector control and managing human infections, attention should also be paid to environmental governance, eliminating mosquito breeding sites, and improving community sanitation. Furthermore, exploring ecological-friendly control methods, such as biological control, can help maintain ecological balance. Strengthening epidemic information sharing and cooperation with neighboring countries and regions is essential to address cross-border transmission risks and bolster global response capacity.

5. Conclusion

This review systematically summarizes China's successful experiences and key measures in dengue prevention and control, offering important insights for global public health efforts. First, the government has established a comprehensive surveillance and early warning system in dengue-endemic regions, enabling early detection and rapid response to outbreaks. This has allowed control measures to be implemented promptly during the initial stages of outbreaks. Second, China has adopted an integrated vector control strategy, combining environmental management, chemical control, and biological interventions, which has effectively reduced mosquito density. Moreover, community mobilization and public health education have played a crucial role in China's dengue prevention efforts. By raising awareness and encouraging public participation, these initiatives have facilitated the successful implementation of mosquito control measures. From a One Health perspective, China's multi-sectoral collaboration and its focus on environmental and ecological interventions align well with the One Health framework, offering valuable lessons for global public health governance. These experiences have not only strengthened China's own capacity to manage dengue but also provide critical references for global collaboration and innovation in addressing climate change and the cross-border spread of infectious diseases.

CRediT authorship contribution statement

Xinyu Feng: Data curation, Conceptualization. **Na Jiang:** Methodology, Investigation, Formal analysis, Data curation. **Jinxin Zheng:** Visualization, Validation, Resources. **Zelin Zhu:** Methodology, Investigation. **Junhu Chen:** Methodology, Investigation, Conceptualization. **Lei Duan:** Formal analysis, Data curation. **Peng Song:** Software, Resources, Formal analysis. **Jiahui Sun:** Visualization, Investigation, Data curation, Conceptualization. **Xiaoxi Zhang:** Methodology, Investigation. **Lefei Hang:** Methodology, Data curation. **Yang Liu:** Resources, Methodology, Investigation. **Renli Zhang:** Resources, Methodology, Investigation. **Tiejian Feng:** Visualization, Methodology, Investigation, Formal analysis, Data curation. **Binbin Xie:** Software, Resources, Data curation. **Xiaonen Wu:** Formal analysis, Data curation. **Zhiying Hou:** Data curation, Conceptualization. **Muxin Chen:** Writing – original draft, Visualization, Validation, Supervision. **Jinyong Jiang:** Writing – review & editing, Visualization. **Shizhu Li:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision.

Funding

This work was supported by the National Parasitic Resources Center, the Ministry of Science and Technology fund (grant number NPRC-2019-194-30), the International Joint Laboratory on Tropical Diseases Control in Greater Mekong Subregion (grant number 21410750200), Hainan Province Health Technology Innovation Joint Project (grant number WSJK2024MS226), the Three-Year Public Health Action Plan (No. 2023-2025) of Shanghai (grant numbers GWVI-11.1-12, GWVI-11.2-XD33), Science & Technology Fundamental Resources Investigation Program (grant numbers 2022FY100900, 2022FY100904), Shenzhen Medical Research Fund (grant number B2404002).

Declaration of competing interest

The authors declare that they have no competing interests.

Acknowledgements

We would like to express our sincere gratitude to the senior experts from the Chinese Center for Disease Control and Prevention (CDC), the National Animal Disease Control Center, Kunming Medical University, and the Lanzhou Veterinary Research Institute for their valuable consultations and suggestions in various fields. Their expertise and insights have greatly contributed to the improvement of this work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.soh.2024.100087.

References

[1] H. Feldmann, M. Czub, S. Jones, D. Dick, M. Garbutt, A. Grolla, et al., Emerging and re-emerging infectious diseases, Med. Microbiol. Immunol. 191 (2) (2002) 63–74, https://doi.org/10.1007/s00430-002-0122-5.

[2] M.G. Bertram, M.P. Costi, E.S.J. Thoré, T. Sabo-Attwood, B.W. Brooks, One health, Curr. Biol. 34 (11) (2024) R517–r519, https://doi.org/10.1016/j.cub.2024.04.025.

[3] G. Bizzaro, A.K. Vatland, D.M. Pampanin, The One-Health approach in seaweed food production, Environ. Int. 158 (2022) 106948, https://doi.org/10.1016/j.envint.2021.106948.

[4] The Lancet, One Health: a call for ecological equity, Lancet (London, England) 401 (10372) (2023) 169, https://doi.org/10.1016/S0140-6736(23)00090-9.

[5] K.G. Scholthof, The greening of one health: plants, pathogens, and the environment, Annu. Rev. Phytopathol. 62 (1) (2024) 401–421, https://doi.org/10.1146/annurev-phyto-121423-042102.

[6] A.C. Procopio, S. Colletta, E. Laratta, M. Mellace, B. Tilocca, C. Ceniti, et al., Integrated one health strategies in dengue, One Health (Amsterdam, Netherlands) 18 (2024) 100684, https://doi.org/10.1016/j.onehlt.2024.100684.

[7] A.A. Cunningham, P. Daszak, J.L.N. Wood, One Health, emerging infectious diseases and wildlife: two decades of progress? Phil. Trans. Roy. Soc. Lond. B Biol. Sci. 372 (1725) (2017) 20160167, https://doi.org/10.1098/rstb.2016.0167.

[8] J.M. Wong, L.E. Adams, A.P. Durbin, J.L. Muñoz-Jordán, K.A. Poehling, L.M. Sánchez-González, et al., Dengue: a growing problem with new interventions, Pediatrics 149 (6) (2022) e2021055522, https://doi.org/10.1542/peds.2021-055522.

[9] J. Bigio, L. Braack, T. Chea, S. Set, S. Suon, P. Echaubard, et al., Entomological outcomes of cluster-randomised, community-driven dengue vector-suppression interventions in Kampong Cham province, Cambodia, PLoS Neglected Trop. Dis. 16 (1) (2022) e0010028, https://doi.org/10.1371/journal.pntd.0010028.

[10] T. Wu, Z. Wu, Y.P. Li, Dengue fever and dengue virus in the People's Republic of China, Rev. Med. Virol. 32 (1) (2022) e2245, https://doi.org/10.1002/rmv.2245.

[11] R. Sarker, A.S.M. Roknuzzaman, M.A. Haque, M.R. Islam, E.R. Kabir, Upsurge of dengue outbreaks in several WHO regions: public awareness, vector control activities, and international collaborations are key to prevent spread, Health Sci. Rep. 7 (4) (2024) e2034, https://doi.org/10.1002/hsr2.2034.

[12] M.X. Tong, A. Hansen, S. Hanson-Easey, J. Xiang, S. Cameron, Q. Liu, et al., Perceptions of capacity for infectious disease control and prevention to meet the challenges of dengue fever in the face of climate change: a survey among CDC staff in Guangdong Province, China, Environ. Res. 148 (2016) 295–302, https://doi.org/10.1016/j.envres.2016.03.043.

[13] Y.H. Guo, S.J. Lai, X.B. Liu, G.C. Li, H.J. Yu, Q.Y. Liu, Governmental supervision and rapid detection on dengue vectors: an important role for dengue control in China, Acta. Trop. 156 (2016) 17–21, https://doi.org/10.1016/j.actatropica.2015.12.011.

[14] T. Liu, G. Zhu, J. He, T. Song, M. Zhang, H. Lin, et al., Early rigorous control interventions can largely reduce dengue outbreak magnitude: experience from Chaozhou, China, BMC Publ. Health 18 (1) (2017) 90, https://doi.org/10.1186/s12889-017-4616-x.

[15] J. Spiegel, S. Bennett, L. Hattersley, M.H. Hayden, P. Kittayapong, S. Nalim, et al., Barriers and bridges to prevention and control of dengue: the need for a social–ecological approach, EcoHealth 2 (4) (2005) 273–290, https://doi.org/10.1007/s10393-005-8388-x.

[16] H. Ni, X. Cai, J. Ren, T. Dai, J. Zhou, J. Lin, et al., Epidemiological characteristics and transmission dynamics of dengue fever in China, Nat. Commun. 15 (1) (2024) 8060, https://doi.org/10.1038/s41467-024-52460-w.

[17] S. Sang, Q. Liu, X. Guo, D. Wu, C. Ke, J. Liu-Helmersson, et al., The epidemiological characteristics of dengue in high-risk areas of China, 2013-2016, PLoS Neglected Trop. Dis. 15 (12) (2021) e000997, https://doi.org/10.1371/journal.pntd.0009970.

[18] X. Zhu, S. Wang, Y. Li, Y. Cao, X. Su, X. Zhao, Epidemiological characterization of dengue fever - yunnan province, China, 2010-2021, China CDC Wkly 6 (20) (2024) 457–462, https://doi.org/10.46234/ccdcw2024.088.

[19] L. Jiang, Y. Liu, W. Su, W. Liu, Z. Dong, Y. Long, et al., Epidemiological and genomic analysis of dengue cases in Guangzhou, China, from 2010 to 2019, Sci. Rep. 13 (1) (2023) 2161, https://doi.org/10.1038/s41598-023-28453-y.

[20] G.F. Xu, Q.J. Zhang, Y.H. Zhang, X.F. Meng, G.K. Li, Y.H. Guo, et al., Epidemic situation of dengue fever in Puyang city in 2019 and molecular tracing of pathogens, Chin. J. Prev. Med. 55 (8) (2021) 978–982, https://doi.org/10.3760/cma.j.cn112150-20200818-01131.

[21] R.J. Oidtman, S. Lai, Z. Huang, J. Yang, A.S. Siraj, R.C. Reiner Jr., et al., Inter-annual variation in seasonal dengue epidemics driven by multiple interacting factors in Guangzhou, China, Nat. Commun. 10 (1) (2019) 1148, https://doi.org/10.1038/s41467-019-09035-x.

[22] Q.L. Jing, Z.C. Yang, L. Luo, X.C. Xiao, B. Di, P. He, et al., Emergence of dengue virus 4 genotype II in Guangzhou, China, 2010: survey and molecular epidemiology of one community outbreak, BMC Infect. Dis. 12 (2012) 87, https://doi.org/10.1186/1471-2334-12-87.

[23] L. Jiang, X. Wu, Y. Wu, Z. Bai, Q. Jing, L. Luo, et al., Molecular epidemiological and virological study of dengue virus infections in Guangzhou, China, during 2001-2010, Virol. J. 10 (2013) 4, https://doi.org/10.1186/1743-422X-10-4.

[24] D. Chen, Y. Zhang, X. Wu, J. Wu, F. Gong, L. Qiao, et al., A survey of clinical and laboratory characteristics of dengue fever epidemic from 2014 to 2018 in Guangzhou, China, Ann. Palliat. Med. 9 (1) (2020) 70–81, https://doi.org/10.21037/apm.2019.12.11.

[25] B. Sun, X. Zhang, H. Zhang, H. Liu, L. Sun, Q. Tan, et al., Genomic epidemiological characteristics of dengue fever in Guangdong province, China from 2013 to 2017, PLoS Neglected Trop. Dis. 14 (3) (2020) e0008049, https://doi.org/10.1371/journal.pntd.0008049.

[26] L. Wang, G. Yang, L. Jia, J. Zhu, J. Xie, P. Li, et al., Epidemiologic characteristics of dengue in China (2010-2014), J. Infect. 71 (3) (2015) 397–399, https://doi.org/10.1016/j.jinf.2015.04.018.

[27] H. Ren, W. Ning, L. Lu, D. Zhuang, Q. Liu, Characterization of dengue epidemics in mainland China over the past decade, J. Infect. Develop. Countr. 9 (9) (2015) 970–976, https://doi.org/10.3855/jidc.5998.

[28] M.G. Guzman, D.J. Gubler, A. Izquierdo, E. Martinez, S.B. Halstead, Dengue infection, Nat. Rev. Dis. Prim. 2 (2016) 16055, https://doi.org/10.1038/nrdp.2016.55.

[29] Z. Liu, Q. Zhang, L. Li, J. He, J. Guo, Z. Wang, et al., The effect of temperature on dengue virus transmission by Aedes mosquitoes, Front. Cell. Infect. Microbiol. 13 (2023) 1242173, https://doi.org/10.3389/fcimb.2023.1242173.

[30] T. Jiang, X.D. Yu, W.X. Hong, W.Z. Zhou, M. Yu, Y.Q. Deng, et al., Co-circulation of two genotypes of dengue virus serotype 3 in Guangzhou, China, 2009, Virol. J. 9 (2012) 125, https://doi.org/10.1186/1743-422X-9-125.

[31] X. Zhu, W. Chen, C. Ma, X. Wang, J. Sun, J. Nie, et al., Whole genome analysis identifies intra-serotype recombinants and positive selection sites of dengue virus in mainland China from 2015 to 2020, Virus Res. 311 (2022) 198705, https://doi.org/10.1016/j.virusres.2022.198705.

[32] J.X. Meng, Q.M. Hu, L.M. Zhang, N. Li, Y.W. He, Z.X. Yang, et al., Isolation and genetic evolution of dengue virus from the 2019 outbreak in Xishuangbanna, Yunnan province, China, Vector Borne Zoonotic Dis. 23 (6) (2023) 331–340, https://doi.org/10.1089/vbz.2022.0091.

[33] J. Zhao, Y.Z. Zhou, S.L. Chen, J.S. Qiu, X.W. Yang, Dengue incidence trends and spatio-temporal distribution characteristics in China, Chin. J. Trop. Med. 24 (8) (2024) 920–924, https://doi.org/10.13604/j.cnki.46-1064/r.2024.08.06.

[34] H. Ren, W. Ning, L. Lu, D. Zhuang, Q. Liu, Characterization of dengue epidemics in mainland China over the past decade, J. Infect. Develop. Countr. 9 (9) (2015) 970–976, https://doi.org/10.3855/jidc.5998.

[35] Y. Jing, X. Wang, S. Tang, J. Wu, Data informed analysis of 2014 dengue fever outbreak in Guangzhou: impact of multiple environmental factors and vector control, J. Theor. Biol. 416 (2017) 161–179, https://doi.org/10.1016/j.jtbi.2016.12.014.
[36] L. Huang, X. Luo, J. Shao, H. Yan, Y. Qiu, P. Ke, et al., Epidemiology and characteristics of the dengue outbreak in Guangdong, Southern China, in 2014, Eur. J. Clin. Microbiol. Infect. Dis. Off. Pub. Eur. Soc. Clin. Microbiol. 35 (2) (2016) 269–277, https://doi.org/10.1007/s10096-015-2540-5.
[37] S. Lai, Z. Huang, H. Zhou, K.L. Anders, T.A. Perkins, W. Yin, et al., The changing epidemiology of dengue in China, 1990-2014: a descriptive analysis of 25 years of nationwide surveillance data, BMC Med. 13 (2015) 100, https://doi.org/10.1186/s12916-015-0336-1.
[38] S. Wu, H. Ren, W. Chen, T. Li, Neglected urban villages in current vector surveillance system: evidences in Guangzhou, China, Int. J. Environ. Res. Publ. Health 17 (1) (2019), https://doi.org/10.3390/ijerph17010002.
[39] J. Sun, D. Wu, H. Zhou, H. Zhang, D. Guan, X. He, The epidemiological characteristics and genetic diversity of dengue virus during the third largest historical outbreak of dengue in Guangdong, China, in 2014, J. Infect. 72 (1) (2016) 80–90, https://doi.org/10.1016/j.jinf.2015.10.007.
[40] D. Wu, X. Zhang, A. Deng, H. Zhang, Y. Zhang, Q. Tan, et al., Dengue fever outbreaks caused by varied serotype dengue virus - Guangdong province, China, 2019, China CDC Week. 2 (38) (2020) 740–743, https://doi.org/10.46234/ccdcw2020.137.
[41] F. Cui, F. He, X. Huang, L. Tian, S. Li, C. Liang, et al., Dengue and dengue virus in Guangdong, China, 1978-2017: epidemiology, seroprevalence, evolution, and policies, Front. Med. 9 (2022), https://doi.org/10.3389/fmed.2022.797674.
[42] B. Wang, Y. Liang, S. Yang, Y. Du, L.N. Xiong, T. Zhao, et al., Co-circulation of 4 dengue virus serotypes among travelers entering China from Myanmar, 2017, Emerg. Infect. Dis. 24 (9) (2018) 1756–1758, https://doi.org/10.3201/eid2409.180252.
[43] Q. Liu, J. Wang, J. Hou, Y. Wu, H. Zhang, D. Xing, et al., Entomological investigation and detection of dengue virus type 1 in Aedes (Stegomyia) albopictus (Skuse) during the 2018-2020 outbreak in Zhejiang province, China, Front. Cell. Infect. Microbiol. 12 (2022) 834766, https://doi.org/10.3389/fcimb.2022.834766.
[44] C. Zhao, X. Zhou, C. Xue, X. Lun, W. Li, X. Liu, et al., Knockdown resistance mutations distribution and characteristics of Aedes albopictus field populations within eleven dengue local epidemic provinces in China, Front. Cell. Infect. Microbiol. 12 (2023) 981702, https://doi.org/10.3389/fcimb.2022.981702.
[45] M. Zhao, X. Ran, D. Xing, Y. Liao, W. Liu, Y. Bai, et al., Evolution of knockdown resistance (kdr) mutations of Aedes aegypti and Aedes albopictus in Hainan Island and Leizhou Peninsula, China, Front. Cell. Infect. Microbiol. 13 (2023) 1265873, https://doi.org/10.3389/fcimb.2023.1265873.
[46] Z. Guo, W. Liu, X. Liu, B. Abudunaibi, L. Luo, S. Wu, et al., Model-based risk assessment of dengue fever transmission in Xiamen City, China, Front. Public Health 11 (2023) 1079877, https://doi.org/10.3389/fpubh.2023.1079877.
[47] Y. Wei, J. Wang, Y.H. Wei, Z. Song, K. Hu, Y. Chen, et al., Vector competence for DENV-2 among Aedes albopictus (Diptera: Culicidae) populations in China, Front. Cell. Infect. Microbiol. 11 (2021) 649975, https://doi.org/10.3389/fcimb.2021.649975.
[48] Y. Hu, Z. Xi, X. Liu, J. Wang, Y. Guo, D. Ren, et al., Identification and molecular characterization of Wolbachia strains in natural populations of Aedes albopictus in China, Parasites Vectors 13 (1) (2020) 28, https://doi.org/10.1186/s13071-020-3899-4.
[49] D. Zhang, X. Zhan, X. Wu, X. Yang, G. Liang, Z. Zheng, et al., A field survey for Wolbchia and phage WO infections of Aedes albopictus in Guangzhou City, China, Parasitol. Res. 113 (1) (2014) 399–404, https://doi.org/10.1007/s00436-013-3668-9.
[50] Y. Hu, Z. Xi, X. Liu, J. Wang, Y. Guo, D. Ren, et al., Identification and molecular characterization of Wolbachia strains in natural populations of Aedes albopictus in China, Parasites Vectors 13 (1) (2020), https://doi.org/10.1186/s13071-020-3899-4.
[51] Y. Zhang, L. Wang, G. Wang, J. Xu, T. Zhang, An ecological assessment of the potential pandemic threat of Dengue Virus in Zhejiang province of China, BMC Infect. Dis. 23 (1) (2023) 473, https://doi.org/10.1186/s12879-023-08444-0.
[52] H. Liu, C.J. Fang, J.W. Xu, The health perceptions, dengue knowledge and control willingness among Dai ethnic minority in Yunnan Province, China, BMC Publ. Health 21 (1) (2021) 1843, https://doi.org/10.1186/s12889-021-11864-9.
[53] X. Lun, R. Yang, L. Lin, Y. Wang, J. Wang, Y. Guo, et al., Effects of the source of information and knowledge of dengue fever on the mosquito control behavior of residents of border areas of Yunnan, China, Parasites Vectors 16 (1) (2023) 311, https://doi.org/10.1186/s13071-023-05916-9.
[54] T. Abdalgader, Z. Zheng, M. Banerjee, L. Zhang, The timeline of overseas imported cases acts as a strong indicator of dengue outbreak in mainland China, Chaos 34 (8) (2024), https://doi.org/10.1063/5.0204336.
[55] J. Du, L. Zhang, X. Hu, R. Peng, G. Wang, Y. Huang, et al., Phylogenetic analysis of the dengue virus strains causing the 2019 dengue fever outbreak in Hainan, China, Virol. Sin. 36 (4) (2021) 636–643, https://doi.org/10.1007/s12250-020-00335-x.
[56] X. Meng, Study on the Disease Burden of Dengue Fever in China [D], Chinese Center for Disease Control and Prevention, 2021.
[57] J.W. Huang, Q.F. Kong, Y.N. Feng, Y.R. Xie, X.X. Huang, W.Q. Bai, et al., Risk assessment of public health emergencies concerned in China, October 2023, Dis. Surveill. 38 (10) (2023) 1157–1162, https://doi.org/10.3784/jbjc.202310240558.
[58] L. Bai, L.C. Morton, Q. Liu, Climate change and mosquito-borne diseases in China: a review, Glob. Health 9 (2013) 10, https://doi.org/10.1186/1744-8603-9-10.
[59] R. Chen, G.-Z. Han, Dengue in China: comprehensive phylogenetic evaluation reveals evidence of endemicity and complex genetic diversity, Am. J. Trop. Med. Hyg. 94 (1) (2016) 198–202, https://doi.org/10.4269/ajtmh.15-0546.
[60] J. Sun, H. Zhang, Q. Tan, H. Zhou, D. Guan, X. Zhang, et al., The epidemiological characteristics and molecular phylogeny of the dengue virus in Guangdong, China, 2015, Sci. Rep. 8 (1) (2018) 9976, https://doi.org/10.1038/s41598-018-28349-2.
[61] Y. Wang, X. Wang, X. Liu, R. Ren, L. Zhou, C. Li, et al., Epidemiology of imported infectious diseases, China, 2005-2016, Emerg. Infect. Dis. 25 (1) (2019) 33–41, https://doi.org/10.3201/eid2501.180178.
[62] E.J. Carlton, S. Liang, J.Z. McDowell, H. Li, W. Luo, J.V. Remais, Regional disparities in the burden of disease attributable to unsafe water and poor sanitation in China, Bull. World Health Organ. 90 (8) (2012) 578–587, https://doi.org/10.2471/BLT.11.098343.
[63] M. Xu, N. Chang, T. Tu, J. Sun, J. Jiang, Y. Xia, et al., Economic burden of dengue fever in China: a retrospective research study, PLoS Neglected Trop. Dis. 16 (5) (2022) e0010360, https://doi.org/10.1371/journal.pntd.0010360.
[64] T.-P. Wu, J.-H. Tian, R.-D. Xue, Y.-L. Fang, A.-H. Zheng, Mosquito (Diptera: Culicidae) habitat surveillance by android mobile devices in Guangzhou, China, Insects 7 (4) (2016), https://doi.org/10.3390/insects7040079.
[65] X. Chen, T. Wu, J. Liang, L. Zhou, Urban mosquito management administration: mosquito (Diptera: Culicidae) habitat surveillance and questionnaire survey in Wuhan, Central China, PLoS One 15 (5) (2020), https://doi.org/10.1371/journal.pone.0232286.
[66] M.T. Li, G.Q. Sun, L. Yakob, H.P. Zhu, Z. Jin, W.Y. Zhang, The driving force for 2014 dengue outbreak in Guangdong, China, PLoS One 11 (11) (2016) e0166211, https://doi.org/10.1371/journal.pone.0166211.
[67] S. Guo, F. Ling, J. Hou, J. Wang, G. Fu, Z. Gong, Mosquito surveillance revealed lagged effects of mosquito abundance on mosquito-borne disease transmission: a retrospective study in Zhejiang, China, PLoS One 9 (11) (2014) e112975, https://doi.org/10.1371/journal.pone.0112975.
[68] S. Sang, S. Gu, P. Bi, W. Yang, Z. Yang, L. Xu, et al., Predicting unprecedented dengue outbreak using imported cases and climatic factors in Guangzhou, 2014, PLoS Neglected Trop. Dis. 9 (5) (2015) e0003808, https://doi.org/10.1371/journal.pntd.0003808.
[69] B. Zhang, Q.Q. Zhang, Y.Y. Cai, X.T. Yan, Y.Q. Zhai, Z. Guo, et al., Environmental emissions and pollution characteristics of mosquitocides for the control of dengue fever in a typical urban area, Sci. Total Environ. 867 (2023) 161513, https://doi.org/10.1016/j.scitotenv.2023.161513.
[70] H. Liang, L. Luo, Z. Yang, B. Di, Z. Bai, P. He, et al., Re-emergence of dengue virus type 3 in Canton, China, 2009-2010, associated with multiple introductions through different geographical routes, PLoS One 8 (2) (2013) e55353, https://doi.org/10.1371/journal.pone.0055353.
[71] Y. Chen, Z. Zhao, Z. Li, W. Li, Z. Li, R. Guo, et al., Spatiotemporal transmission patterns and determinants of dengue fever: a case study of guangzhou, China, Int. J. Environ. Res. Publ. Health 16 (14) (2019) 2486, https://doi.org/10.3390/ijerph16142486.
[72] H. Liu, X. Huang, X. Guo, P. Cheng, H. Wang, L. Liu, C. Zang, et al., Climate change and Aedes albopictus risks in China: current impact and future projection, Infect. Dis. Pover. 12 (1) (2023) 26, https://doi.org/10.1186/s40249-023-01083-2.
[73] H.L. Zhang, H.F. Shi, D.Y. Zi, Z.X. Li, Z.M. Guo, X.N. Li, et al., Serologic survey of dengue fever host animals in Yunnan Province, China, Chin. J. Zoon. 1 (1989) 56–58.
[74] J.R. Chen, F.M. Zhao, D.X. Zhao, S.X. Zhu, B.W. Wu, G.Q. Zhang, et al., Investigation on serology of dengue fever animal hosts, Guangdong Med. J. 2 (1984) 30–31, https://doi.org/10.13820/j.cnki.gdyx.1984.02.017.
[75] J.R. Chen, F.M. Zhao, D.X. Zhao, S.X. Zhu, B.W. Wu, G.Q. Zhang, et al., Research on dengue fever host animals investigation and experimental infection studies in chickens, J. Guang. Pharmaceut. Univ. 1 (1985) 96–99, https://doi.org/10.16809/j.cnki.1006-8783.1985.01.022.
[76] H.Y. Zhang, X.K. Yang, G.Y. Li, Detection of Dengue virus genome RNA in some kinds of animals caught from Dengue fever endemic areas in Hainan Island with reverse transcription - polymerase chain reaction, Chin. J. Exp. Clin. Virol. 12 (3) (1998) 29–31, https://doi.org/10.3760/cma.j.issn.1003-9279.1998.03.006.
[77] X.X. Tao, L. Han, Z.L. Li, Y.B. Chen, Serologic investigation of dengue fever in human and livestock in Hainan province in 1999, Chin. J. Vector Biol. Control (5) (2002) 369–370, https://doi.org/10.3969/j.issn.1003-4692.2002.05.018.
[78] Z.J. Li, X.H. Mao, SWOT analysis of dengue fever prevention and control in Yunnan province, Trop. Dis. Parasitol. 17 (1) (2019) 43, https://doi.org/10.3969/j.issn.1672-2302.2019.01.01.
[79] H. Ren, W. Wu, T. Li, Z. Yang, Urban villages as transfer stations for dengue fever epidemic: a case study in the Guangzhou, China, PLoS Neglected Trop. Dis. 13 (4) (2019) e0007350, https://doi.org/10.1371/journal.pntd.0007350.
[80] H. Tian, S. Huang, S. Zhou, P. Bi, Z. Yang, X. Li, et al., Surface water areas significantly impacted 2014 dengue outbreaks in Guangzhou, China, Environ. Res. 150 (2016) 299–305, https://doi.org/10.1016/j.envres.2016.05.039.
[81] W. Wu, H. Ren, L. Lu, Increasingly expanded future risk of dengue fever in the Pearl River Delta, China, PLoS Neglected Trop. Dis. 15 (9) (2021) e0009745, https://doi.org/10.1371/journal.pntd.0009745.
[82] C. Jiang, J.S. Schieffelin, J. Li, W. Sun, Dengue fever: a new challenge for China? Glob. Health Action 7 (2014) 26421, https://doi.org/10.3402/gha.v7.26421.
[83] Q. Gao, P.E. Li, Current status and prospects of dengue fever prevention and control, Chin. J. Trop. Med. 24 (1) (2024) 40–48, https://doi.org/10.13604/j.cnki.46-1064/r.2024.01.08.
[84] Chinese Society of Tropical Disease and Parasitology, Society for Vector Biology and Control of the Chinese Preventive Medicine Association, Basic Research Committee, China Association for Vaccines, Expert consensus on the burden of dengue disease and prevention and control strategies in China, Chin. J. Zoonoses 40 (6) (2024) 489–497, https://doi.org/10.3969/j.issn.1002-2694.2024.00.090.