The impact of COVID-19 on dengue cases in low- and middle-income countries: a systematic review

Ajeng Rahastri, Sulistyawati Sulistyawati
Faculty of Public Health, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

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ABSTRACT

The WHO declared the COVID-19 pandemic on March 11, 2020, impacting infectious disease surveillance in low-resource, low-income countries, low- and middle-income countries (LMICs). Governments are focusing on COVID-19 reduction, including healthcare workers and epidemiological teams. A comprehensive literature review was conducted to assess this impact. After examining over 19,000 studies, only six were found to provide relevant data. Our analysis revealed that the pandemic substantially affected dengue incidence. The total number of articles obtained was 19,382. Out of the 136 articles screened based on their abstracts, only six were selected for data extraction. The databases utilized in this article were Pubmed and NCBI. Based on the chosen papers, we discovered that the COVID-19 pandemic has had a notable impact on the occurrence of dengue compared to the period before the pandemic emerged. The occurrence of dengue varied in several nations, such as Peru, Brazil, Sri Lanka, India, and Malaysia. This variation can be attributed to factors such as reliance on traditional approaches, for example community health volunteers in epidemiological investigations. Additionally, misdiagnoses by healthcare professionals due to the similarity of symptoms with COVID-19 have been reported during the pandemic. While the prevalence of dengue fever cases has generally declined in low- and middle-income countries (LMICs), one country has experienced an increased case. This trend is possibly linked to heightened pandemic surveillance and changes in mosquito populations. To improve monitoring and surveillance, a digital approach is proposed.

Corresponding Author:

Sulistyawati Sulistyawati
Faculty of Public Health, Universitas Ahmad Dahlan
Prof. DR. Soepomo Sh Street, Umbulharjo, Yogyakarta, Special Region of Yogyakarta, Indonesia
Email: sulistyawati.suyanto@ikm.uad.ac.id

1. INTRODUCTION

Dengue fever is a vector-borne disease that regularly occurs in tropical or sub-tropical countries due to the susceptible habitat for *Aedes* breeding [1]. Between 2000 and 2019, the World Health Organization (WHO) recorded a ten-fold increase in reported cases globally, rising from 500,000 to 5.2 million. In 2019, there was an exceptional surge, with documented occurrences expanding to 129 countries [2].

Previous research indicates that vaccines have limited effectiveness against most mosquito-borne diseases. However, a combined approach involving mosquito control, early diagnosis, proper medical care, and robust surveillance systems can help to manage these illnesses [3]. The WHO framework for national vector-borne disease explains that two essential elements in controlling dengue are vector control and vector surveillance, as presented in Figure 1 [4]. Vector management is a highly efficacious and proficient strategy for dengue control, complemented by community empowerment [5]. In numerous nations, implementing dengue vector control involves using surveillance to monitor dengue mosquitoes to break the chain of *Aedes* reproduction. In typical situations, vector surveillance is typically conducted through the monitoring efforts of designated individuals responsible for conducting door-to-door surveillance twice a week [6]. For instance, in Indonesia, they employed health cadres to improve community outreach using household surveys to perform door-to-door monitoring of the larvae's presence in society twice a week [5], [7].

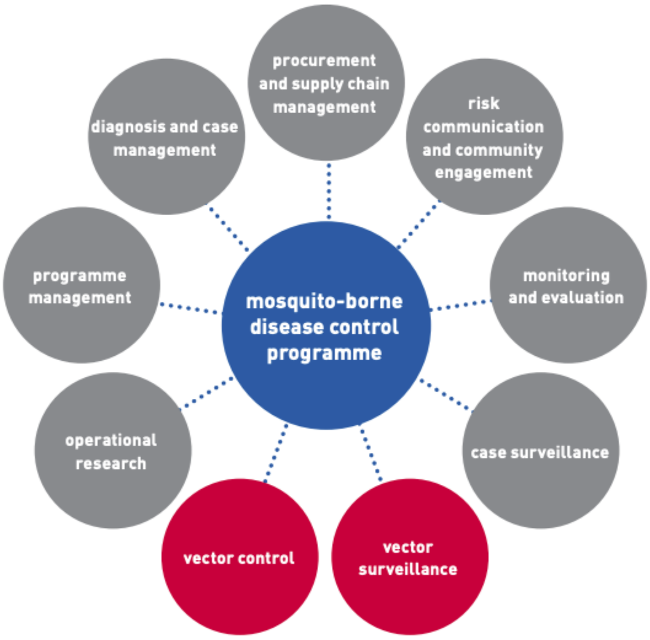

Figure 1. Critical elements for the national vector-borne disease control program [4]

WHO states that implementing efficient vector control strategies is crucial for attaining and maintaining a decrease in dengue illness. Preventive and vector control actions aim to minimize dengue transmission, hence reducing the occurrence of infection and averting disease outbreaks [8]. Developing nations face significant challenges in managing Dengue fever and related vector control [9]. One factor that necessitates their increased effort is the public's understanding of the significance of their involvement in dengue vector monitoring [5]. In addition, LMICs countries are crucial to ensuring the sustainability of dengue vector management, particularly in countries with inadequate governance and financial limitations [10]. The dengue situation in (LMICs) appears to be growing more unpredictable during the COVID-19 pandemic.

Numerous dengue control measures may be hampered and movement restricted due to health policies such as contact restrictions or even lockdowns [11]–[13]. Previous studies have explained how to manage dengue cases before and after the COVID-19 pandemic [14]. However, the researcher found a limited review article that assessed and discussed the impact of COVID-19 on the Dengue cases. Previous research explained the connection between COVID-19 in a particular country and some social factors [15]. In this study, we attempted to find the dynamic of dengue cases and their factors during the COVID-19 pandemic. Some LMICs provide evidence of the changing dengue situation during the COVID-19 pandemic as a lesson for future pandemics.

2. METHOD

This is a descriptive and descriptive-analytic systematic review of the Prisma protocol [16], [17]. Prisma guidelines were used to report the data collection and screening of the article [17]. The inclusion criteria in this study consist of language selection (English based journal and Bahasa Indonesia), the article was published from March 2020 to May 2023 considering the pandemic duration, the paper discussed COVID-19 effect on dengue, and conducted in low and middle countries or LMICs settings [18]–[20]. The author chose the LMICs because they generally have limited resources and weak laboratory capacity, poor health systems governance, and inadequate health information systems that potentially get worse during the pandemic [21]. Hence, the researcher would understand how far this condition affected the incidence of dengue in the LMICs setting.

The exclusion criteria were i) non original research publications, including proceeding, case report, book review, and full text are not available; ii) article topics were not chosen were infectious diseases not related to dengue and COVID-19; and articles that did not discuss dengue case. Article assessment for this research used Office of Health Assessment and Translation (OHAT) to assess bias risk in human environmental and epidemiology studies [22].

The literature search and analysis were initiated in October 2023, starting with protocol development, article screening from November 10, 2023, to December 1, 2023, and manuscript writing afterward. The keywords used for this study were: "COVID-19 Impact" and "Dengue" in three databases. The researcher did use the medical subject heading (MeSH) because the articles were not from the database.

All the articles were screened manually by the author and using Rayyan software. Rayyan was used to simplify the screening process by the inclusion criteria of this research. First, the author quarried the articles from the database. Second, the author saved and exported all articles to the Rayyan website. Those articles must be uploaded using specified formats such as CSV, ENW, RIS, PubMed, BibTeX, and CIW.

3. RESULTS AND DISCUSSION

3.1. Result

Our search yielded a total of 19.382 articles from three databases: NIH (n=146), Pubmed (n=136), and Google Scholar (n=19,100). Among them, only 136 articles were screened through the PRISMA flowchart because the type of study was not classified as original research (e.g., expert opinion, case report, and literature review), not full-text paper, and not relevant to the topic. Finally, we included six articles in the analysisas shown in Figure 2. Two independent authors did the data extraction to incorporate the design study, the research objective, the impact of the exposure variable, and the conclusion.

The 6 articles are from LMICs, including Peru (n=1), Brazil (n=1), Sri Lanka (n=1), India (n=2), and Malaysia (n=1). The design study was most likely ecological (n=3) and retrospective observational (n=1). However, the other articles needed to state the design study clearly. These articles use secondary data from each country's surveillance databases and meteorological ministries. The duration for statistical analysis began in 2014 to 2021, both the dengue cases and climatology data. Related to the climate condition, the dengue cases experienced a reduction in wet and dry zones [23]. We controlled the article bias using OHAT to appraise the article to evaluate a study quality with a variation study design consisting of some questions with categorical answers [24].

3.1.1. How was the dengue incidence during COVID-19 pandemic?

Our finding in Figure 1 shows that during the pandemic, most LMICs reported decreased dengue cases or lower cases compared to before the pandemic [23], [25]–[29]. At the same time, Peru reported an increase in several endemic regions, with Piura as an exception, where the incidence decreased due to the temperature and humidity. However, some endemic areas such as Huanuco, Ucaly, and Ica showed the highest incidence. It clearly showed that dengue incidence in Peru has changed before and after the COVID-19 pandemic [24]. The number of dengue fever cases in Peru and its endemic areas during the 2018-2020 period was influenced by seasonal factors. This rise coincides with the rainy season in the Amazon region and summer along the shore [30]. Since the first case of COVID-19 was reported in Peru, there has been a decrease in the number of dengue fever cases reported in several endemic regions of the country. This is most likely due to increased epidemiological alertness in response to the increase in COVID-19 cases in Peru, which may impact epidemiological surveillance of dengue fever. The impact is that cases of dengue fever are under-reported, a pattern also seen in recent epidemics, where intensive prevention efforts against new diseases have resulted in a lack of attention to pre-existing endemic diseases [31]. The dengue fever virus is generally carried by infected travelers. Therefore, the social quarantine and other preventive measures implemented in Peru to fight COVID-19 may have resulted in a significant reduction in dengue cases. However, difficulties in obtaining timely diagnosis and public concerns regarding the risk of contracting COVID-19 in health facilities may also be other factors that led to a decrease in the number of dengue fever cases reported at the start of the COVID-19 pandemic [32].

Although only one article showed the variability of cases in Peru, some endemic regions showed dengue increased caseS due to the rainy season; Ica is the region with the highest dengue number, Piura has the lowest increased COVID-19 number [23]. The incidence of dengue has risen in all areas of Peru, and a more significant increase has been experienced in Huanuco, Peru. However, if adjusted to climate data, Piura showed the lowest rise case. This pandemic changed the data collection or investigation surveillance process that addressed under-reporting and data fallacy. From the findings, only Malaysia clearly explained that they used conventional epidemiological investigation, such as community health volunteers, to observe larvae from house to house.

Apart from that, dengue fever cases in Malaysia have decreased. This is influenced by the dengue surveillance system which uses conventional methods such as house-to-house surveillance [26]. Community mobility also influences the transmission of *Aedes Aegypti* to the human body due to social restriction policies [26], [28]. An article explains that Malaysia uses conventional surveillance systems, such as visits to people's homes, and health volunteers such as cadres who help check and record cases, which cannot be done during the pandemic [26], [28]. Dengue fever cases are lower than before the pandemic [15], [26], [28], [29]. Malaysia experienced a reduction in dengue fever of up to 75% during the lockdown period in 2020 [26]. Unlike other countries that reported increasing dengue cases, Brazil saw a decline in dengue infections since the start of the pandemic [25]. India experienced a higher decline in dengue fever cases during COVID-19 than before the pandemic, while in Mumbai, dengue fever cases fell to 0.83% [15], [29]. Another study in Sri Lanka found a decrease in the incidence of dengue fever in dry and wet areas [28]. To simplify readers' understanding of dengue fever cases during the COVID-19 pandemic in LMICs regions of Peru, Brazil, Malaysia, India, Sri Lanka, we compiled these results.

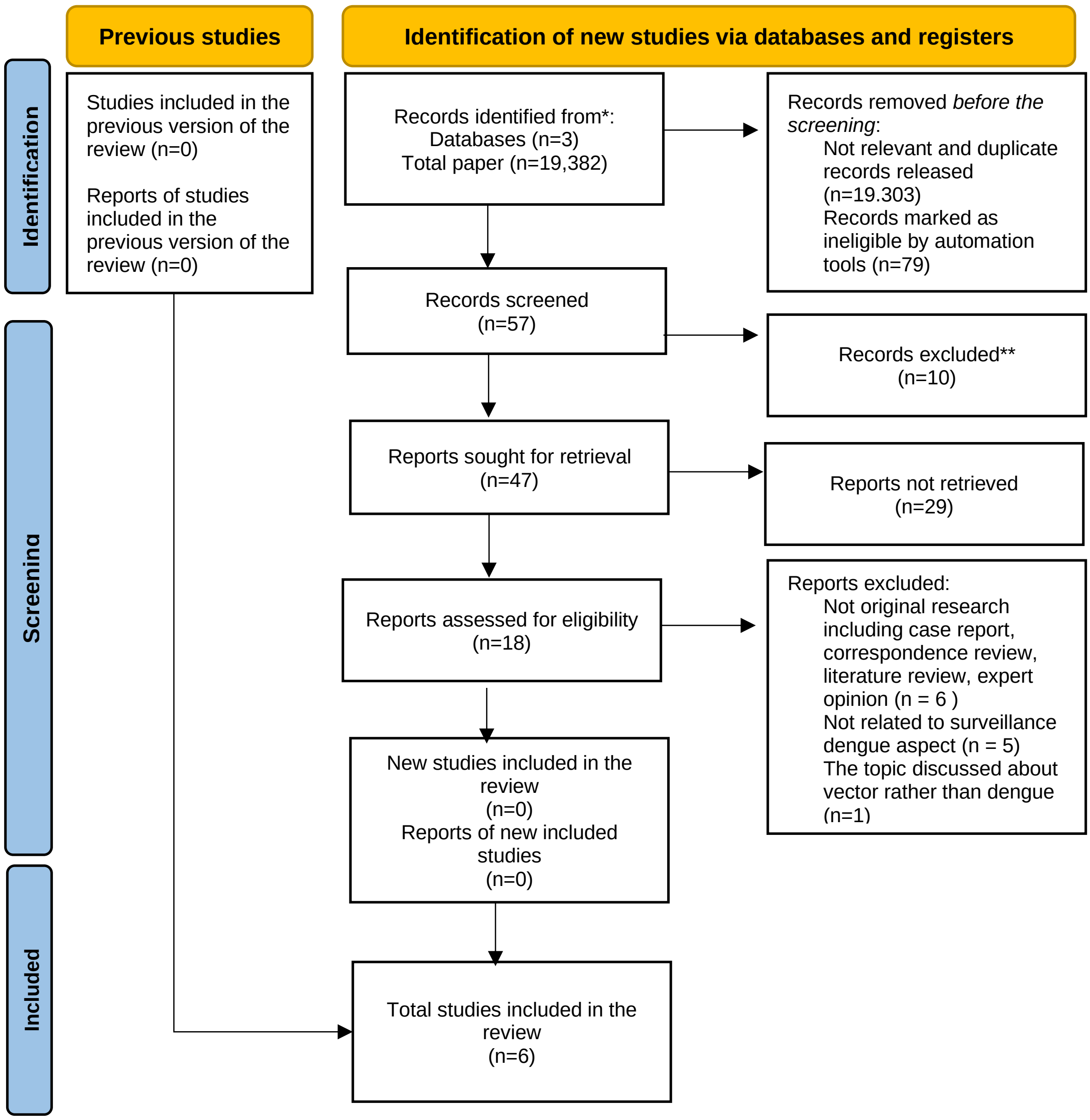

Figure 2. PRISMA Diagram for Article Selection

3.2. Discussion

The dengue cases from LMICs countries decreased during the COVID-19 pandemic [28], [33]. Other previous research found that the overburdened public health system, including health financing and limited diagnostic laboratories, stimulates a lower dengue occurrence [34]. Besides the barriers found in

Bangladesh, a dengue epidemic country in Southeast Asia, they declared the under-reporting and under-ascertainment supported by the lack of a surveillance system [35]. In addition, mobility restriction and human behavior affected lower dengue cases [36]. The limited investigation of health surveillance through community health volunteers or cadres during the COVID-19 pandemic significantly impacted decreased dengue cases, specifically for countries that implemented conventional vector control [37].

In contrast with Malaysia, India, Brazil, and Sri Lanka, Peru has increased cases during the COVID-19. Some factors influenced this situation, such as the community's need for proper water sanitation. Thus, people save water using containers outside the home, which could be a place for *Aedes Aegypti* to live [38]. Another study supported that a population with lower access to tap water would have a higher risk of dengue [39]. Another study showed that LIMCs with high population density, improper healthcare programs, and global warming or climate change contribute to higher dengue exposure or cases like Peru as well as Bangladesh [35]. Besides, the study showed that many misbeliefs about dengue infection and prevention in community support the dynamic cases [40].

The two results above have their factor in stimulating dengue cases in LMIC countries during the COVID-19 pandemic. However, it is not only environmental factors that most likely affect dengue but also health policy and economic aspects. Studies showed that healthcare infrastructure, resource competence, and health finance in LMICs were not proportional to organized dengue surveillance [41], [42]. To mitigate the upcoming pandemic, WHO suggests some preparedness and response programs started with risk mapping country categories, developing a strategic plan including country needs and required funding, strengthening the epidemiological and entomological surveillance, laboratory diagnosis and genomic surveillance, clinical management, risk communication and community engagement (RCCE), vector surveillance and provide technical support to all ongoing outbreaks [2]. Another study showed that healthcare authorities should distribute healthcare resources in hospitals for diagnostic test inpatient [43]. According to a previous study, excellent surveillance could be influenced by human resources and funding to develop a properly integrated surveillance system [44].

COVID-19 indirectly strengthens health digitalization in all aspects of life, starting from education, economics, and health. Telemedicine is an alternative to long-distance treatment in the health sector during the pandemic. Meanwhile, mobile internet use for reporting and surveillance, including vector control, is considered very helpful and necessary due to limited direct interaction during the pandemic [13]. Indonesia emphasized the importance of health technology experts in its plans to develop and integrate health data and application systems, as well as foster a thriving health technology environment [45]. Indonesia has implemented systems like SILIRA and SILANTOR to monitor dengue cases, but these systems are hindered by inadequate staff training and unreliable data. Despite these challenges, there's room for improvement in how these systems are used and accepted by the public [46], [47]. Malaysia has successfully implemented a system called AIME, which utilizes artificial intelligence to predict dengue outbreaks based on collected epidemiological data. [48]. Integrating technology into these systems significantly improves data accuracy and allows for the prediction of unforeseen crises like pandemics.

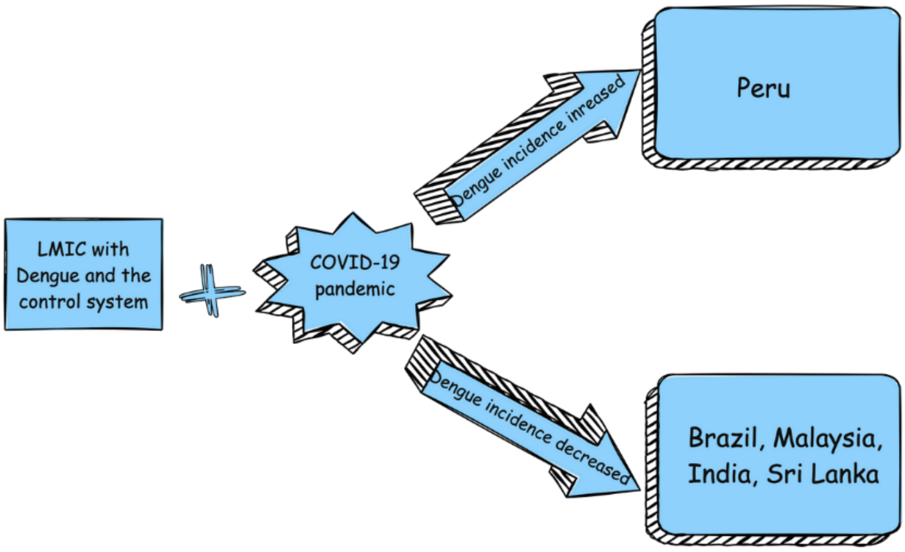

Figure 3. Dengue case situasion during COVID-19 pandemic in LMICs

4. CONCLUSION

Our study reveals a general trend of decreasing dengue cases across many low- and middle-income countries (LMICs). However, some, like Peru, are experiencing a rise. This decline might be partially due to heightened awareness during the pandemic, which may have unintentionally reduced routine dengue surveillance activities like community worker field visits and healthcare services focusing on COVID-19. Conversely, factors promoting mosquito breeding likely contributed to the increase in specific areas. To gain a deeper understanding of these trends, we propose implementing a digital surveillance system alongside traditional method. This system could effectively capture real-time notifications of dengue cases.

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BIOGRAPHIES OF AUTHORS

Ajeng Rahastri was graduated from Master of Public Health program who has adequate interest in planetary health including air pollution and mental health issue. Currently she is assisting an associate professor at Universitas Ahmad Dahlan Yogyakarta. Her publications are focus on health promotion, dengue modelling, and waste management. She can be contacted at email: ajengrahastri@mail.ugm.ac.id.

Sulistyawati Sulistyawati is associate professor of Public Health and Epidemiology at Universitas Ahmad Dahlan, Yogyakarta, Indonesia. She has published many peers reviewed article in reputable journal such as BMC and Iranian Journal of Public Helth. She can contact at email: sulistyawati.suyanto@ikm.uad.ac.id.