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Coronavirus Pandemic

Impact of COVID-19 on dengue: a twofold challenge to public health in Sabah, Malaysia

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Abstract

Introduction: The dengue epidemic poses a significant public health challenge in Malaysia, and the concurrent presence of dengue and SARS-CoV-2 infections has further strained its healthcare system. Sabah, the second largest state in Malaysia, located in the northern part of Borneo Island, has been particularly hard-hit by both dengue and SARS-CoV-2 outbreaks. This study aims to analyze the status of dengue infections in Sabah over the past decade and understand the impact of the COVID-19 pandemic on dengue virus transmission.

Methodology: This study compared the annual dengue cases and associated deaths in Sabah from 2012 to 2022. Systematic data and information were collected from PubMed, the World Health Organization, the Centers for Disease Control and Prevention, and the official government reporting system of Malaysia.

Results: Dengue cases in Sabah increased overall with slight fluctuations over the years, marked by new outbreaks approximately every 3-5 years. The number of deaths did not consistently correlate with reported dengue cases. Early in the COVID-19 pandemic in 2020, dengue cases remained high; however, as COVID-19 cases surged, dengue cases experienced a significant decline. Conversely, from mid-2022, dengue cases surged in Sabah despite COVID-19 cases remaining relatively low and well-controlled. Particularly noteworthy is the 99% increase in dengue cases in Sabah, contrasting sharply with Malaysia's overall 36% decrease in 2022 compared to 2015 to 2019.

Conclusions: Monitoring and prioritizing efforts to prevent COVID-19 and control dengue transmission is crucial. The dual challenges posed by these diseases offer valuable lessons that should be incorporated into future pandemic-preparedness strategies.

Key words: COVID-19; dengue; Sabah; public health.

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Introduction

The global community is recovering from the setbacks caused by the coronavirus disease 2019 (COVID-19) outbreak, which was first reported in China's Hubei Province in December 2019 [1]. COVID-19 transmission has been recognized as one of the most significant public health threats due to its high morbidity and mortality rates worldwide. The World Health Organization (WHO) declared COVID-19 a pandemic in March 2020 and published global guidelines to control and prevent the occurrence of the disease in all countries. History has documented the identification of six coronaviruses that infect humans prior to the emergence of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) [2]. Previous epidemics were notably caused by severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), which originated in Guangdong Province, China, and Saudi Arabia, respectively [3,4]. The complete and partial genome sequence of SARS-CoV-2 was determined immediately after its identification, followed by an increasing number of viral genome deposits in online databases facilitating molecular and epidemiological studies of the virus. SARS-CoV-2 is a beta coronavirus that belongs to the family Coronaviridae, a large group of viruses that primarily infect mammals and avian species, resulting in severe gastrointestinal, respiratory, neurological, and systemic illness syndromes [5]. According to WHO, in 2023, more than 685 million confirmed cases of COVID-19 have been reported worldwide, with over six million deaths. Approximately 10% of the reported COVID-19 cases originated from Southeast Asia. Thailand was the first country outside China to report a COVID-19 case, in January 2020. The first three cases of COVID-19 in Malaysia were imported from Singapore [6]. The first wave of COVID-19 in Malaysia occurred from January to February 2020, with 22 confirmed cases [6]. By the end of 2022, after four consecutive COVID-19

outbreaks, Malaysia had recorded over 5 million confirmed cases of COVID-19, resulting in 36,853 deaths [7]. Sabah, the second largest state in Malaysia, located in the northern part of Borneo, has been severely affected by SARS-CoV-2 infection, contributing nearly 10% to the national death toll as of April 2023 [8].

Nevertheless, health authorities should pay attention to other emerging and remerging diseases that are constantly threatening. Excessive resources and efforts on COVID-19 have led to a healthcare downturn as surveillance for other diseases is overlooked. Dengue infection is a significant public health issue affecting the state. Dengue infection remains the world's fastest-growing tropical infectious disease, with an estimated 390 million annual cases [9]. Dengue virus (DENV) is transmitted by *Aedes* mosquitoes between humans in the tropical and subtropical regions, with 75% of cases occurring in Southeast Asia and the Western Pacific regions [10,11]. Before the COVID-19 outbreak, dengue was endemic in Malaysia, and peak transmission was usually recorded during the late monsoon season [12]. Four serotypes of DENV were known to be co-circulating in Malaysia [13,14]. The country faced significant outbreaks in 1974, 1978, 1982, 1990, 1996 and 2015, with switching of different serotypes likely associated with significant outbreaks [15,16]. In 2022, 64,078 cases were reported, compared to 25,794 cases in 2021, a notable increase of 148.8% in one year. Fifty deaths were reported in 2022, compared to 19 deaths in 2021 over the same period. The Peninsular states of Malaysia are most affected by dengue; Selangor, in particular, has the highest incidence and number of deaths [17-20]. However, this pattern is changing rapidly as urbanization in East Malaysia, particularly in Sabah, contributes to the rising number of dengue incidences in urban and rural settings [21-23]. This necessitates further research on transmission and associated risk factors from different regional perspectives. In 2015, Sabah reported 2,904 cases of dengue, followed by an increase to 3,668 cases in 2016. However, cases dropped to 2,560 in 2017 and increased to 3,423 in 2018 [22]. Dengue cases in Sabah following the COVID-19 pandemic are scarce, and this study aims to address this matter. The assumption that fewer dengue cases were reported in Sabah compared to Peninsular Malaysia is challenged [22], indicating a need to reevaluate public health policies and resource allocation. This suggests that the pandemic may have influenced health-seeking behaviors, surveillance efforts, and healthcare delivery systems, affecting the reporting and management of dengue cases. Therefore, this emphasizes the importance of maintaining vigilance against other infectious diseases like dengue, even amidst the COVID-19 pandemic. It underscores the need for comprehensive research, surveillance, and public health interventions to address the evolving challenges posed by diseases like dengue, especially in regions where it remains a significant public health concern.

The interconnectedness between the COVID-19 pandemic and the transmission dynamics of vector-borne diseases like dengue fever presents a significant challenge, particularly in regions like Sabah, Malaysia. The imposition of a nationwide lockdown and quarantine measures to curb the spread of COVID-19 can inadvertently impact the prevalence and spread of other diseases, such as dengue, due to changes in human behavior and environmental factors. Here are some key points to consider regarding the relationship between COVID-19 and dengue fever in Sabah: (1) Increased risk of dengue transmission – movement restrictions and social-distancing measures during a lockdown can lead to changes in human behavior, such as spending more time indoors or in close proximity to potential mosquito-breeding sites. This increased indoor activity may inadvertently create more breeding grounds for mosquitoes, thereby elevating the risk of dengue transmission within households. (2) Overburdened healthcare system – the simultaneous occurrence of COVID-19 and dengue fever can strain the healthcare system as both diseases may require medical attention and resources. The influx of patients seeking medical care for either COVID-19 or dengue fever can overwhelm hospitals and healthcare facilities, potentially leading to challenges in providing adequate treatment and care. Further studies and interdisciplinary research efforts are essential to understand the complex interactions between COVID-19 and dengue fever, particularly in regions like Sabah, where both diseases pose significant public health challenges. The impact of the COVID-19 pandemic on the transmission dynamics of vector-borne diseases like dengue fever cannot be overlooked, particularly in regions where such diseases are endemic.

Previous studies on the impact of the COVID-19 pandemic Movement Control Order (MCO) on dengue cases have been reported [24,25]. However, the study is generally limited to Peninsular Malaysia and the detailed status in East Malaysia is lacking. Moreover, the study was focused on 2020, and the status of dengue cases is still unclear once the community resumes normal post-pandemic activities. Therefore, this study was formulated based on several objectives: To analyze

the distribution of dengue cases during pre-pandemic, pandemic, and endemic phases of COVID-19 exclusively in Sabah, Malaysia, covering the years 2012-2022. To determine mortality rates associated with dengue fever and compare them before and after the COVID-19 pandemic to identify any patterns or changes. To compare the number of COVID-19 and dengue cases reported each month from January 2020 to December 2022, aiming to predict future dengue trends and assess the effectiveness of vector control and management measures in Sabah. Therefore, this study aims to fill gaps in the existing literature by providing comprehensive data on dengue fever cases in Sabah over a longer time frame. It also seeks to understand how the COVID-19 pandemic may have influenced dengue incidence and mortality rates. Additionally, the study could inform public health authorities in Sabah about potential strategies for efficiently managing dengue outbreaks in the future. Overall, the study is designed to contribute valuable insights into the dynamics of dengue fever in Sabah, Malaysia, in the context of the COVID-19 pandemic.

Methodology

Data collection

A retrospective descriptive study was conducted using dengue and COVID-19 notification data from the official Malaysian Ministry of Health (MOH) websites, including the official Github account at https://github.com/MoH-Malaysia/covid19-public, an open-source software containing all relevant information. The data collected covered the entire Sabah region: West Coast, Interior, Kudat, Sandakan and Tawau. The data collected correspond to the cases reported annually in each division, so there is no discrimination by administrative district. In addition, available literature and secondary data from 2012 to 2022, including from PubMed, the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC) and the official government reporting system (Malaysia), were reviewed to assess the impact of the COVID-19 outbreak on dengue in Sabah, Malaysia. Information bias can occur when systematic errors affect the accuracy or completeness of measuring the condition or risk factor of interest. Using non-validated scales or unclear thresholds to define cases can bias the estimated prevalence of the condition. Additionally, misclassification can occur when calculating the prevalence of SARS-CoV-2 in contacts of diagnosed cases if not all contacts are tested, and it is assumed that untested individuals were also uninfected.

Patient and public involvement consent

No patient, hospital or hospital-centric data were included in this research. This study used only secondary aggregate data from open sources, the public domain and available literature. Therefore, no ethical approval and clearance are required in this study.

Statistical analysis

Data analysis was carried out using descriptive statistics. The impact was evaluated by comparing the absolute numbers of notifications from 2019 to 2022 and the average of notifications from 2015 to 2019. Data were organized into graphs and tables, and statistical analysis was performed using GraphPad Prism 9 (GraphPad Software, San Diego, CA, U.S.A.). Any missing values were estimated using the average number of weekly cases or deaths for each month.

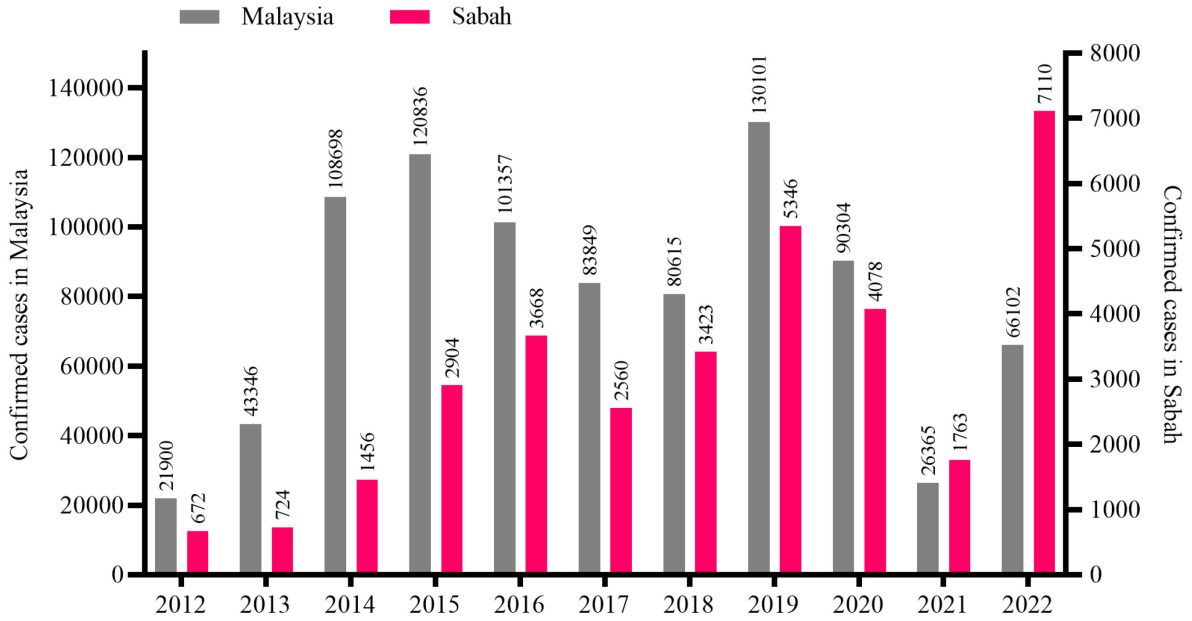
Results

Before the COVID-19 pandemic (2012-2019), Sabah recorded 20,753 dengue cases compared to 12,951 cases during the COVID-19 pandemic (2020-

Table 1. Comparison of dengue cases reported in 2019-2022 and to means for 2015-2019 in Sabah and the national level.

Dengue cases	Sabah	Malaysia
By year		
2019	5,346	130,101
2020	4,078	90,304
2021	1,763	26,365
2022	7,110	66,102
Mean 2015-2019	3,580.2 ± 964.21	10,3351.6 ± 19,608.76
Year-on-year change		
2019 vs 2020	-24%	-31%
2020 vs 2021	-57%	-71%
2021 vs 2022	+303%	+151%
Mean 2015-2019 vs		
2020	+14%	-13%
2021	-51%	-74%
2022	+99%	-36%

Figure 1. Epidemiology of dengue cases in Malaysia and Sabah from 2012 to 2022.



2022). The highest number of dengue cases in Sabah's history was recorded in 2022, with 7,110 cases (Figure 1). In general, the number of dengue cases in Sabah increased from 2012 to 2022, with some fluctuations. Notably, the national (Malaysia) number of cumulative dengue cases from all states, including Sabah, observed a slightly different pattern of dengue trend compared to Sabah cases alone. For instance, the highest number of dengue cases was recorded in Malaysia in 2019 (n = 130,101), while Sabah recorded the highest number of cases in 2022 (n = 7110). The trend of dengue cases in Sabah showed a positive correlation with those reported in Malaysia from 2012 to 2015, 2016 to 2017, and 2018 to 2022, but a negative correlation with those from 2015 to 2016 and 2017 to 2018 (Figure 1). The number of Sabah dengue cases in 2021 decreased by 57% compared to 2020, while it increased by 303% in 2022 compared to 2021 (Table 1). It is also worth noting that the increase in Sabah dengue cases in 2022 was twice the increase in overall dengue cases in Malaysia (151%), as shown in Table 1. A total of 118 deaths associated with dengue were reported in Sabah from 2012 to 2022 (Figure 2). The highest number of fatalities was registered in 2018, followed by 2019 and 2018 with 29, 23 and 17, respectively. Notably, only two deaths were recorded in 2012 and 2016. The trend in dengue-related deaths has not consistently followed the trend in reported dengue cases. For example, between 2015 and 2016, the number of dengue cases increased from 2,904 to 3,668, while the number of deaths fell from 10 to 2. In contrast, deaths increased from 2 to 9 between 2016 and 2017, while dengue cases fell from 3,668 to 2,560 (Figure 2). Focusing on the COVID-19 pandemic, the number of deaths dropped to 17 and subsequently to 5 in 2020 and 2021 but rose again to 10 in 2022.

As shown in Figure 3, the number of dengue cases was high in the first 3 months of 2020, with 1,893 cases, followed by a decrease to around 200 cases each in April and May 2020. Then, from June to August 2020, cases began to rebound, followed by a fall in cases, and they remained relatively low through April 2022. During that period, 100 to 250 cases were reported monthly in Sabah. In comparison, COVID-19 remained low and under control, reporting 2,826 cases from January to September 2020. Then, COVID-19 cases have drastically increased, recording more than 10,000 cases monthly through January 2021. During the reference period, the highest number of cases in Sabah

Figure 2. Dengue cases and associated deaths in Sabah from 2012 to 2022.

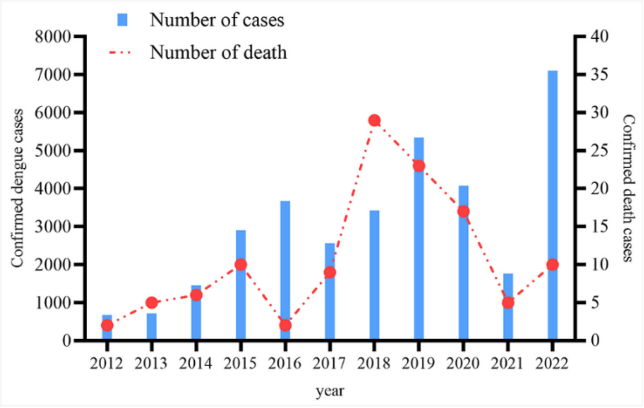


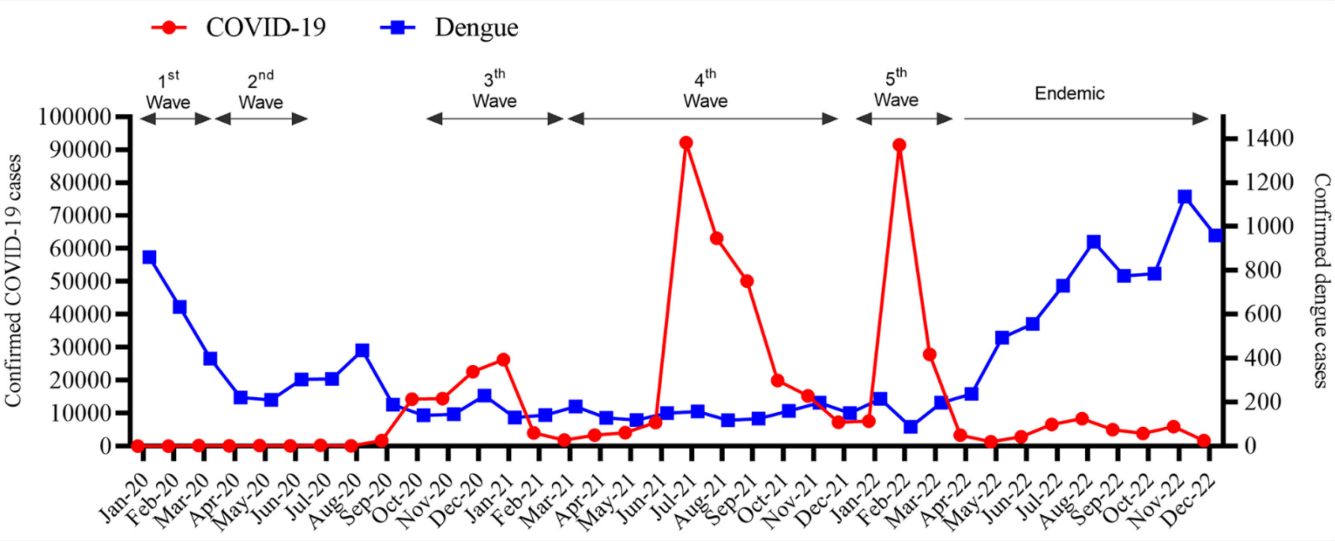
Table 2. Comparison of dengue deaths reported in 2019-2022 and to means for 2015-2019 in Sabah and the national level.

Dengue deaths	Sabah	Malaysia
By year		
2019	23	182
2020	17	145
2021	5	20
2022	10	56
Mean 2015–2019	14.6 ± 9.89	215.8 ± 66.75
Year-on-year change		
2019 vs 2020	-26%	-20%
2020 vs 2021	-71%	-86%
2021 vs 2022	+100%	+180%
Mean 2015–2019 vs		
2020	+16%	-33%
2021	-66%	-91%
2022	-32%	-74%

was recorded in January 2021 at 26,274. The number of COVID-19 cases fell below 10,000 cases per month for several months after February 2021. Cases have been ramped up from July 2021 to March 2022 to aggravate the situation, with 374,800 cases registered in Sabah (Figure 3). The highest cases of COVID-19 in Sabah were recorded in July 2021 and February 2022, with 92,112 and 91,435, respectively. From April 2022 onwards, COVID-19 cases fell well below 10,000 cases per month, and only 1723 cases were recorded in December 2022. On the other hand, dengue cases started to surge even higher than in early 2020, and the highest dengue incidence (n = 1137) was registered in November 2022 (Figure 3).

A summary of dengue cases and associated deaths during the COVID-19 pandemic compared to the mean years 2015 to 2019 in Sabah and Malaysia are presented in Tables 1 and 2, respectively. The number of Sabah dengue cases increased by 14% in 2020 and decreased by 51% in 2021 compared to the mean cases in 2015-2019 (Table 1). Notably, dengue cases in Sabah increased by 99% in 2022 compared to the mean cases in 2015-2019. In contrast, dengue cases in Malaysia fell by 74% and 36% in 2021 and 2022, respectively. The death rates in Sabah related to dengue decreased by 26% in 2020 compared to the previous year (Table 2). In addition, the number of deaths was reduced more in 2021 compared to 2020, reporting a fall of 71%. However, the death toll accelerated in 2022, registering a 100% increase compared to 2021 (Table 2). In 2020, Sabah had a 16% increase in deaths compared to the mean of 2015-2019, while Malaysia had a 33% drop. In 2021 and 2022, deaths appeared to have decreased in both Sabah and Malaysia compared to the mean 2015-2019. However, the decrease in the percentage of dengue deaths in 2021 and 2022 was lower in Sabah than in Malaysia (Table 2).

Figure 3. Trend of dengue and COVID-19 cases reported in Sabah between 2020 and 2022.



Discussion

Mosquito-borne diseases continue to be an enormous burden in tropical and subtropical regions, infecting 10% of the human population and killing millions worldwide [26]. Notably, dengue infection has established its transmission in Southeast Asian countries since the temperature, relative humidity, rainfall, and degree of urbanization are apt for their transmission [27]. This study has several strengths. First, the present study is the first to access notification data on dengue cases in Sabah and across Malaysia in all phases of the COVID-19 outbreak [pre-pandemic (2015-2019), pandemic (2020-2021) and endemic (2022)]. Second, the death rate due to dengue cases in Sabah from 2012 to 2022 was reviewed. Then, detailed cases of COVID-19 and dengue cases were compared every month from 2020 to 2022, and the trend was analyzed during the pre- and post-pandemic COVID-19 periods. This study could provide insight into the status of infectious diseases, particularly dengue, and assess the effectiveness of countermeasures against COVID-19. Furthermore, it is essential to understand how the containment of COVID-19 transmission can impact the epidemiology of dengue incidence. During the first wave of the COVID-19 outbreak in the country, which began in January 2020, no cases were recorded in Sabah due to the Malaysian government's successful transmission containment.

In the early months of 2020, there was a high number of reported dengue cases in Sabah (1,494 cases), continuing from the outbreak in 2019. This led to a total of 5,346 cases in Sabah and 130,101 cases in Malaysia, with a national incidence rate of 399 cases per 100,000 population [28,29]. The outbreak was not limited to Malaysia but also affected neighboring countries like Thailand, Indonesia, Lao PDR, Vietnam, and Cambodia, which have been experiencing high dengue incidence since 2015 [20,30].

There was a downward trend in dengue cases in Sabah from January to May 2020, followed by a slight increase from June to August 2020, and this period coincided with the implementation of the MCO in Malaysia due to the COVID-19 pandemic. The MCO significantly decreased human movement, particularly in dengue hotspots, which likely reduced vector-host interactions and the geographic spread of dengue fever. However, it also posed challenges in accessing healthcare services, especially in rural areas of Sabah, where healthcare facilities were transformed to combat COVID-19. Limited access to healthcare services during the pandemic and the transformation of healthcare facilities could have led to underreporting of dengue cases nationally, including in Sabah. Overall, dengue incidence in Malaysia (including Sabah) peaked in 2015 and 2019 and showed similar trends in neighboring countries such as Thailand, Vietnam, Indonesia, the Philippines and Cambodia [30]. In 2022, there was a notable decrease of 36% in dengue cases in Malaysia, consistent with trends reported in other regions like Latin America and Southeast Asia during the COVID-19 pandemic, where decreases ranged from 30% to 70% [31]. However, the situation in Singapore contrasts with this trend. Dengue cases increased by more than 37.2% in 2020 [32] despite the implementation of various measures to control the spread of the virus. The increase in cases in Singapore may be attributed to increased mosquito activity in residential areas compared to workplaces and public spaces. This heightened vector–host interaction in residential settings may have facilitated dengue transmission, leading to the surge in cases. In addition, factors such as local weather conditions, environmental parameters, mosquito vector distribution, and the population's immunity to circulating dengue strains need further study to fully understand dengue transmission dynamics during the COVID-19 pandemic. These factors can influence the spread of the virus and contribute to variations in dengue trends observed across different regions. Therefore, conclusive statements about the impact of COVID-19-related measures on dengue transmission should consider these factors and undergo further investigation. [33].

During the MCO period (March to May 2020), COVID-19 cases were successfully reduced, and the Malaysian government imposed a conditional MCO (CMCO) by easing restrictions in May 2020. Consequently, dengue cases increased significantly from June to August 2020, followed by a decrease from September 2020, and remained relatively low through February 2022. Another possible reason for the low reporting of dengue cases during this period could be the diagnostic challenge, where both viruses manifest similar clinical symptoms such as fever, skin rash, myalgia, fatigue and laboratory abnormalities, including thrombocytopaenia, lymphopaenia, elevated liver enzymes and increased inflammatory markers. Accurate diagnosis and treatment for this purpose are challenging, especially in regions where both diseases are prevalent. This can lead to misdiagnosis or delayed diagnosis, potentially impacting patient outcomes [34]. To mitigate this challenge, healthcare providers must remain vigilant and consider both dengue fever and COVID-19 in differential diagnoses, especially in areas where both diseases are endemic. Public health efforts

to control mosquito populations and raise awareness about preventive measures for both diseases remain crucial in reducing their impact on communities. In addition, a cross-reaction between DENV and SARS-CoV-2 could mislead the interpretation of serological findings. Therefore, the situation severely limits dengue-endemic countries' healthcare systems' ability to differentiate infections. For example, a patient in Sabah was initially diagnosed as COVID-19-positive and hospitalized for treatment. However, his health worsened after day 3 with bleeding gums, decreases in platelet and white blood cell counts, and increases in liver enzymes [35]. Eventually, the patient tested positive for Dengue NS1. In Singapore, two patients first tested false positive for dengue IgM and later positive for COVID-19 [36].

Interestingly, dengue cases were recorded more frequently for a shorter period from February to May 2021 compared to COVID-19. A study by Zaki et al. 2022 showed a similar trend nationally, reporting an overall positive correlation between dengue and COVID-19 in 2021[33]. One of the findings of this study showed that the number of dengue cases rebounded after the lockdown was fully lifted in 2022, with cases remaining relatively high from April through the end of the year. In contrast, cases of COVID-19 were relatively low and under control over the same period. This sheds light on the importance of the dengue control strategy employed by the Malaysian government, including vector control and management, enforcement, and community participation as three interrelated entities. Firstly, during the MCO, vector control and management were disrupted, which lasted almost two years, with varying conditions in different states. Public spaces such as shops, educational institutions, workplaces, malls, construction sites, and airports were largely deserted during the lockdown. This created a conducive environment for *Aedes aegypti* mosquitoes to breed due to a lack of proper maintenance, resulting in rainwater and stagnant water on hard surfaces. Increasing the number of mosquitoes produced would accelerate the transmission of the dengue virus in the human population once the virus–host interaction becomes more feasible after the lockdown in 2022. In Sabah, warm and humid weather conditions could also escalate dengue transmission in the community. Secondly, during the COVID-19 pandemic, law-enforcement agencies needed help entering the premises for inspections and to conduct fogging due to the absence of occupants and the complete closure of the premises. Public health agencies and vector-control resources were also diverted to the pandemic response. Finally, community involvement in dengue intervention programs was suspended during movement restrictions, and less attention was paid to the routine cleaning and drainage of stagnant water around residential areas. Therefore, it is fair to surmise that the number of dengue cases reported in the state will increase as it recovers from the impact of COVID-19.

In 2012, 672 dengue cases were reported in Sabah, and the number increased exponentially to 2904 (332%) and 7110 (958%) in 2015 and 2022, respectively. This is not surprising given that increases in population density, urbanization, rural-urban migration, herd immunity associated with circulating dengue serotypes arise in domestic and international air travelling and vector control systems are the driving factors behind a 10-fold increase in cases over the decade [37,38]. Climate change, including high temperatures and high rainfall fueling the transmission rate of mosquitoes, further exacerbates the situation [39,40]. Comparing the pattern of reported dengue cases to the average number from 2015 to 2019, Sabah saw a 14% increase in cases and a 51% decrease in cases in 2020 and 2021, respectively. However, the numbers increase tremendously by about 99% in 2022. In contrast, the number of dengue cases across Malaysia appears to have decreased by 36% in 2022 compared to cases from 2015 to 2019. This is surprising given that it differs from the situation in Sabah, which increased, underscoring the importance of analyzing dengue incidence in each state to comprehend the current situation. Another possible explanation for the increase in COVID-19 and dengue cases in Sabah could be attributed to behavioral factors among the population, such as non-compliance with movement-control measures in Kota Kinabalu district, as previously reported [41]. In addition, inadequate monitoring of population mobility for various internal reasons could also have worsened the situation in that state. The resurgence of dengue cases following COVID-19 has been reported in various countries. For example, more than 50,000 cases occurred in Nepal in 2022, and an unprecedented outbreak was reported in Bangladesh in 2023 [42,43].

The trend in dengue deaths in Sabah has fluctuated between 2012 and 2022, unlike the national trend in Malaysia. Sabah's dengue incidence does not align with the national pattern, indicating unique factors at play. For instance, while Malaysia experienced its highest number of dengue cases in 2019, Sabah peaked in 2022. Similarly, while Malaysia recorded its highest number of dengue deaths in 2015, Sabah's peak was in 2018.

One potential explanation for these discrepancies is the geographical separation between West and East Malaysia. Most dengue hotspots are concentrated in the Peninsula, which could skew the national trend, neglecting the unique dynamics in Sabah. Additionally, the circulation of different dengue serotypes in various regions can lead to variations in case numbers and fatalities. Current study noted a 16% increase in fatalities in Sabah compared to Malaysia, which witnessed a 33% decrease in 2020 compared to the 2015-2019 average. This disparity could be attributed to Sabah's healthcare system being overstretched during the COVID-19 pandemic, potentially affecting its ability to handle dengue cases efficiently. Although both Sabah and Malaysia experienced decreased death rates in 2021 and 2022 compared to the 2015-2019 average, Sabah's decrease was less pronounced than Malaysia's overall rates. This suggests ongoing challenges within Sabah's healthcare system and highlights the need for targeted interventions to address dengue control and healthcare capacity in the region.

However, the number of deaths does not necessarily correlate with the number of reported dengue cases. To illustrate, in 2022, Sabah witnessed the highest number of dengue cases in its history, with a total of 7,110 cases reported, yet only ten deaths were recorded. On the other hand, in 2018 and 2019, despite fewer cases reported than in 2022, the death toll was significantly higher at 29 and 23, respectively. Likewise, in 2019, Malaysia experienced its highest number of dengue cases, with a total of 130,101 reported, but the number of deaths was much lower at 182. Nevertheless, the highest dengue-related death toll in Malaysia occurred in 2015, when there were 120,836 new infections due to the outbreak. It is noteworthy that the presence of different serotypes in Malaysia is associated with specific geographic regions. For instance, DENV-4 is predominant in Selangor and Kuala Lumpur, while Negeri Sembilan is home to DENV-1, DENV-2, and DENV-3 [44, 45]. Multiple cases of DENV-2 and DENV-4 have been identified in Sarawak, while DENV-3 has been found in Sabah [46-48]. It is important to note that the predominant serotypes can change during different outbreaks and years in certain regions. However, the claim that this affects the severity of the disease is still speculative. In Sabah, DENV-4 was the predominant serotype in 2013, and DENV-1 took over in 2014. In 2015, DENV-2 became the predominant serotype [49]. Additionally, it should not be overlooked that the DENV-5 serotype was first announced in 2013 after being isolated in Sarawak, Malaysia. [50]. As of April 2023, no cases of DENV-5 have been detected in Sabah. The potential emergence of new DENV serotypes can be understood by considering genetic changes caused by genetic recombination, genetic bottleneck and natural selection [50,51]. Since DENV is an RNA virus, its high mutation rate, heightened by increasing human activity, may lead to the development of additional DENV serotypes and genotypes in the future.

Combating COVID-19 and dengue requires comprehensive policies that encompass various aspects of healthcare infrastructure, public health, and community engagement. One effective approach is to utilize Geographic Information System (GIS) technology to map high-risk dengue cases by monitoring real-time data on dengue cases and mosquito populations. It is crucial to strengthen the healthcare system's capacity to manage a surge in COVID-19 cases, but it is equally important to prioritize an adequate supply chain for addressing dengue cases in endemic countries. In today's digital era, providing educational materials and information to the public is imperative, promoting community engagement in preventing dengue infections during future outbreaks. Municipalities are also responsible for removing rainwater that accumulates on the ground during the rainy season to prevent mosquito breeding. Additionally, the government should allocate more funding and support to improve sanitation and sewage systems while also introducing newer testing technologies to rapidly distinguish between DENV and SARS-CoV-2 in laboratories. In summary, coordinated efforts by policymakers, health authorities, healthcare providers and communities are necessary to address the challenges of COVID-19 and dengue fever.

It is important to note the statistical limitations of this study. To accurately analyze disease trends and their reversals, a statistical method that evaluates time series with more precision regarding the pandemic's impact on dengue infection is required. However, as a preliminary study, the descriptive statistics used here adequately highlight important facts supporting government public health interventions.

Conclusions

In conclusion, amidst the national efforts to combat COVID-19, it is imperative to maintain vigilance over vector-borne diseases. This study aims to offer insights into the prevalence of dengue cases in Sabah before and after the COVID-19 pandemic, thereby bolstering public health measures and fortifying preparedness against future outbreaks while acknowledging existing endemic diseases. Focusing specifically on Sabah

allows for a more nuanced understanding of the disease landscape instead of a broader national analysis that may obscure regional nuances. Moreover, further research is warranted to evaluate the pandemic's impact on the epidemiology of both infectious diseases (e.g., tuberculosis, leprosy, chikungunya and Zika) and non-communicable diseases (e.g., diabetes, cancer, cardiovascular disease and chronic respiratory diseases) in the state. Such endeavors are crucial for informing targeted interventions and ensuring comprehensive healthcare strategies in Sabah.

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Authors' contributions

KNB, collecting data and statistical analysis, drafting the original manuscript; PCL, conceptualization, supervision and writing – review and editing.

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Ethical statement

No patient, hospital or hospital-centric data were included in this research. This study used only secondary aggregate data obtained from open sources, public domain and available literature. Therefore, no ethical approval and clearance is required in this study.

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