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Research Article

Ten Years of Dengue (2013–2022): Epidemiology and Predictors of Outbreaks in Sarawak

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Dengue is a major public health problem in Sarawak, Malaysia. Since 2011, the Ministry of Health of Malaysia has created an electronic database (e-Dengue) for all dengue cases in Malaysia. This database of cases includes socio-demographic and locality data, clinical symptoms and signs, and results from rapid dengue assays. This study analyses data extracted from this database to describe the epidemiology and determine which factors are more likely to indicate or predict an outbreak of dengue. A total of 14,020 cases from 2013 to 2022 were extracted, with 4,636 cases reported from outbreaks. The highest incidence was 112.22 per 100,000 population in 2016, with 2,773 cases. Over this period, there were 37 deaths, with the highest in 2016 with seven deaths. The case fatality rate ranged from 0.12% to 0.75%. Predictors of outbreaks include younger age (0.984 (0.980–0.989)), female (1.584 (1.387–1.821)), cases from rural areas (0.398 (0.346–0.458)), unemployed (1.179 (1.005–1.383)), students (1.450 (1.163–1.808)). For clinical markers, rash (1.315 (1.056–1.638)) and NS1 antigen test positivity (3.474 (2.952–4.088)) were a predictor of outbreaks, while diarrhoea (0.160 (0.055–0.465)) was a predictor for single cases. Although rainfall, climate change, and population density are known predictors of dengue, socio-demographic factors, clinical signs, and NS1 antigen are additional predictors of dengue that will allow for early detection and control.

1. Introduction

Dengue is the predominant arboviral disease and the leading cause of morbidity and mortality. Nearly 100 million infections are reported yearly, with 70% from Asia [1]. In Malaysia, it was estimated that around 2 million people are infected yearly, with an incidence rate of between 69.9 and 93 per 1,000 population from 2001 to 2013 [2]. Sarawak, a region of Malaysia on the island of Borneo, also has a high incidence of dengue, with 2,773 reported cases and an incidence rate of 122.2 per 1,000 population in 2016 [3].

In Malaysia, dengue is endemic, and sporadic single cases are common. Dengue diagnosis in Malaysia in mainly clinical, with supportive evidence from serology and the NS1 antigen rapid test. Since 2017, it has been mandatory in Malaysia for all cases clinically suspected to be dengue to be tested with a rapid test (NS1 combo), a lateral flow immunoassay of the NS1 antigen, and IgG and IgM antibodies. Notification of clinically suspect dengue is still mandatory in Malaysia, even if the NS1 combo test is fully negative, as a strong clinical suspicion remains the cornerstone of dengue diagnosis [4]. When there is more than one case in a 200-meter radius within 14 days of the index case, it is defined as an outbreak. This allows for more targeted control activities to prevent more cases of dengue in a locality.

Dengue is endemic in Sarawak, with periodic outbreaks over the past 10 years [5, 6]. Sarawak has a tropical climate with an average annual rainfall of 3,300 and 4,600 mm, with the highest rainfall from October to January [7]. Due to the availability of breeding sites, dengue outbreaks in Sarawak are affected by this seasonal rainfall, with an increase following a rainy season [8]. Epidemics of dengue and its environmental and entomological predictors have been well documented [9], with an increase in cases and outbreaks following periods of heavy rainfall and higher temperatures. Climate change and global warming are essential factors of dengue outbreaks in areas hitherto without dengue infections, such as Europe [10] and North America [11]. With global warming and increased rainfall, *Aedes aegypti* has spread to these areas.

Besides climate and rainfall, other factors that affect an increase in dengue cases is a serotype change. Four distinct strains or serotypes of dengue virus are circulating worldwide (DEN1–DEN4). Although a fifth serotype has been reported [12], it is not circulating widely. Serotype change refers to the changes in the predominant serotype circulating in the country or community. The sequential dominance and oscillations in the circulating serotype of dengue (DEN1–DEN4) lead to variations in incidence rates in the community that had high immunity to the previous circulating serotype [13].

Another factor in the increase of dengue cases is population density. Population density was reported to be related to increased dengue by Colón-González et al. [11], which used pipe water access as an indicator of increasing urbanisation, and Rodrigues et al. [14], who reported higher *Aedes* mosquitos in high population density areas. Poor housing and dense population condition due to migration create conditions that allow for outbreaks of dengue [15]. Increasing urbanisation, even in Sarawak, has led to increased dengue outbreaks. Sarawak is facing increasing urbanisation due to its rapidly growing economy, with its gross domestic product (GDP) increasing from RM30,318 per capita in 2009 [16] to RM53,552 in 2019 [17]. This has led to several dengue outbreaks in Sarawak.

Dengue often presents with fever, rash, or retro-orbital pain. Clinical features of dengue have been well documented and range from asymptomatic and sub-clinical infections to mortality in severe dengue. Asymptomatic cases can account for up to 92% in an outbreak of dengue [18]. These large numbers of asymptomatic and viraemic cases contribute to spread of dengue and causing endemicity in many parts of the world. It presents a challenge in terms of preventing this spread by controlling the movement of ill host, and hence, its control must shift towards controlling the vector responsible. Besides sub-clinical dengue as a cause of dengue outbreaks, sylvatic cycles of dengue can also lead to outbreaks as well [19].

The mainstay of dengue control is source reduction and integrated vector management (IVM) [15]. However, in light of multifactorial events leading to spread of *Aedes* mosquitos, a "One Health" approach that includes environmental management [20] as well as mosquito reduction provides a way forward for dengue control.

Predictors of dengue, such as rainfall, climate, and population density, are well established. However, other variables, such as socio-demographic factors, clinical symptoms and signs, and dengue rapid test positivity, are not often reported as predictors of dengue. The objective of this study is to present the epidemiology of dengue in Sarawak over a 10-year period as well as analyse predictors based on a dataset of variables of cases entered into the e-Dengue system. Information on these predictors of outbreaks could better inform stakeholders to initiate early targeted controls to reduce mortality and morbidity of dengue.

2. Methodology

Dengue is a mandatory notifiable disease in Malaysia. Any physician diagnosing or suspecting a dengue patient must notify the nearest public health office within 24 hr. Previously, this notification was carried out using a handwritten form, but since 2011, an electronic notification system (e-Dengue system) was created (http://edenguev2.moh.gov.my), and every case of dengue was notified into this system. Permission was obtained from the Director General of Health Malaysia and Sarawak State Health Director for usage of the data. Data were extracted from the "e-Dengue" case registration system as line listing format and adapted to SPSS version 26 for analysis.

Extracted data were checked, and missing data were coded. This dataset was checked for normality using the variable "age" as a continuous variable as age of cases of dengue should be reflective of general population. Residuals were also checked, and extreme outliers were removed from the final database.

Incidence rates were calculated based on the 2010 Sarawak state population census up to 2019 cases, while the 2020 population census was used for 2020 cases onwards. Additionally, incidence rates were also calculated using 2010 and 2020 population data for the various districts of Sarawak. QGIS was used to map incidence rates by districts in Sarawak over the 10 years.

Socio-demographic variables (age, gender, ethnicity, occupation, nationality, and locality of residence) were recoded into numeric data for univariate (using the independent samples *t*-test and binary logistic regression using the single independent variable) directly comparing between outbreak and non-outbreak cases. Significant variables ($p \leq 0.01$) were included into the multivariate model using binary logistic regression. This included clinical symptoms recorded at time of notification, which was coded into yes and no and analysed as well. The difference in days between onset and notification was indicative of patient health-seeking behaviour. Since dengue must be notified by the physician within 24 hr after seeing a suspected dengue, the difference between the time of notification and onset of the symptoms reflects the seriousness of the symptoms as well. Although progression of the disease is dynamic and symptoms change over the course of the infection, symptoms reported at notification are useful because it is likely similar to time of first presentation to a healthcare provider. Immunoassay results (NS1, IgG, and IgM) were also analysed for associations with outbreaks or single cases.

Binary logistic regression analysis was carried out using the "Enter" method in SPSS version 26. Multicollinearity and outliers were checked during data cleaning earlier. Significant variables ($p \leq 0.01$) were included into the multivariate model. The same variables mentioned in the former paragraph were entered into the model, and model validity was checked and was acceptable. However, due to exclusion of missing variables and outliers, only 4,863 cases (3,063 single cases and 1,800 outbreak cases) were included in the final model.

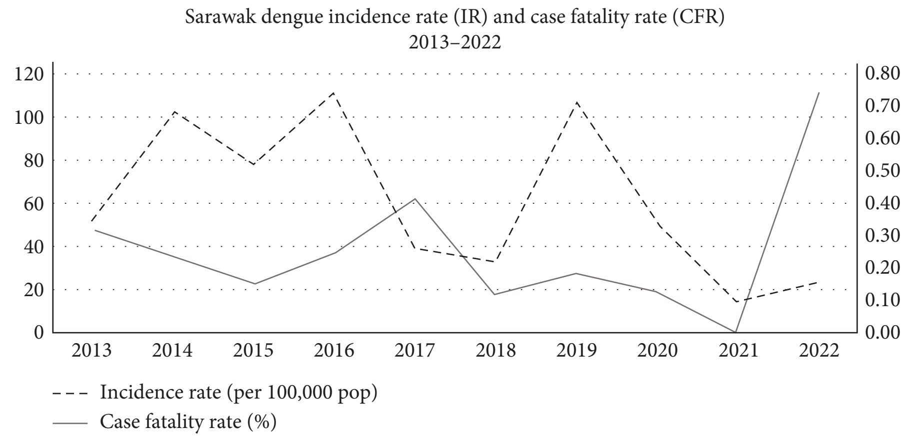

Figure 1: Dengue incidence and case fatality rate for Sarawak 2013–2022.

3. Results

A total of 14,344 dengue cases from whole Sarawak from 2013 to 2022 in the e-Dengue system were extracted. After data cleaning, a total of 14,020 cases were used for analysis. Single cases accounted for 9,384, while those from outbreaks amounted to 4,636 cases. The highest number of cases over the 10-year period was in 2016 with 2,773 cases, and the lowest was 426 cases in the year 2021.

The incidence rate for Sarawak ranged from 14.65 per 100,000 population in 2021 to 112.22 per 100,000 population in 2016. Over this 10-year period, there were 37 deaths, with the highest in 2016 with seven deaths. The case fatality rate ranged from 0.12% in to 0.75%. The incidence rate and the case fatality rate for the whole state are presented in Figure 1. Figure 2 shows the yearly incidence rate by district in the form of a choropleth map generated from QGIS. Some districts in central Sarawak showed high incidence from 2014 to 2017, while northern Sarawak showed an increase in incidence from 2019 to 2020.

Table 1 shows a summary of socio-demographic data as well as clinical and rapid test results of all the cases from 2013 to 2022. For the whole group, the mean age was 36.2 (±18.1) years, with more males (58%) as well as most were working (58.1%). Most of the cases were of Chinese (34.6%) and Iban (26.1%) ethnicity, and 95.4% were Malaysians. Majority of the cases (58.7%) were from rural districts.

Table 2 reports comparison between cases from outbreaks and single cases. The independent samples *t*-test shows cases from outbreak areas were significantly younger in the mean age compared to single cases ($p < 0.01$). Age is a negative predictive factor (significant with $p \leq 0.01$) in which younger age groups were more likely to be part of outbreaks compared to single cases. Other significant variables in univariate analysis include gender, nationality, ethnicity, occupation, and place of dwelling (rural or urban). However, in the multivariate model, nationality was not a significant predictor of outbreaks. Female sex had a significant ($p \leq 0.01$) odds ratio of 1.589 with a confidence interval (CI) of 1.480–1.706 in univariate and similarly significant odds (CI) of 1.584 (1.387–1.821) in the multivariate model. This indicates female sex is a significant predictor of being part of an outbreak. Similarly, those cases from rural areas have higher odds of being part of an outbreak. Within occupation groups, cases among students and housewives had higher odds of being part of an outbreak, significant even in the multivariate model. In terms of ethnicity, when compared to Iban ethnic, Malay/Melanau, Bidayuh, and other Sarawakian natives all had higher risk of being in an outbreak compared to Chinese and others.

Table 3 shows the clinical symptoms commonly reported for dengue at the time of case notification. For univariate analysis, headache, body ache/joint pain, and diarrhoea were more likely from single cases, while rash, nausea/vomiting, and retro-orbital pain had higher odds of being from outbreaks. However, multivariate analysis was significant from rash and diarrhoea. Those with rash had higher odds of being from outbreaks, while those with diarrhoea had lower odds, meaning they were likely from single cases. For serology results from rapid tests, NS1 positivity was significantly higher odds from outbreaks than from single cases in multivariate analysis as well as univariate test. For IgM and IgG, both were significantly lower odds in univariate but not significant in multivariate analysis. Time taken before seeking treatment was significantly lower in outbreak areas compared to single cases (Table 4).

4. Discussion

The incidence rate of dengue was high from 2014 to 2016 in Sarawak. This follows closely the high incidence in Malaysia during that time, with a reported incidence of greater than 300 per 100,000 population for the whole country [21]. In Sarawak, around 60% of the cases were reported from Sibu district and the central region of Sarawak [22]. The circulating strains from 2014 to 2016 were reported to be a nearly equal mix of DEN-1, DEN-2, and DEN-3 among 27 dengue isolates in Kuching [23]. This could explain the high incidence due to the three different circulating serovars to which cross-immunity is transient. However, by 2016, DEN-2 was the main circulating serotype in Sibu and Miri divisions [24].

The incidence rate of dengue reduced in 2017 and 2018 due to the outbreak being well controlled in Sibu and central Sarawak, while incidence was still high (>200 per 100,000

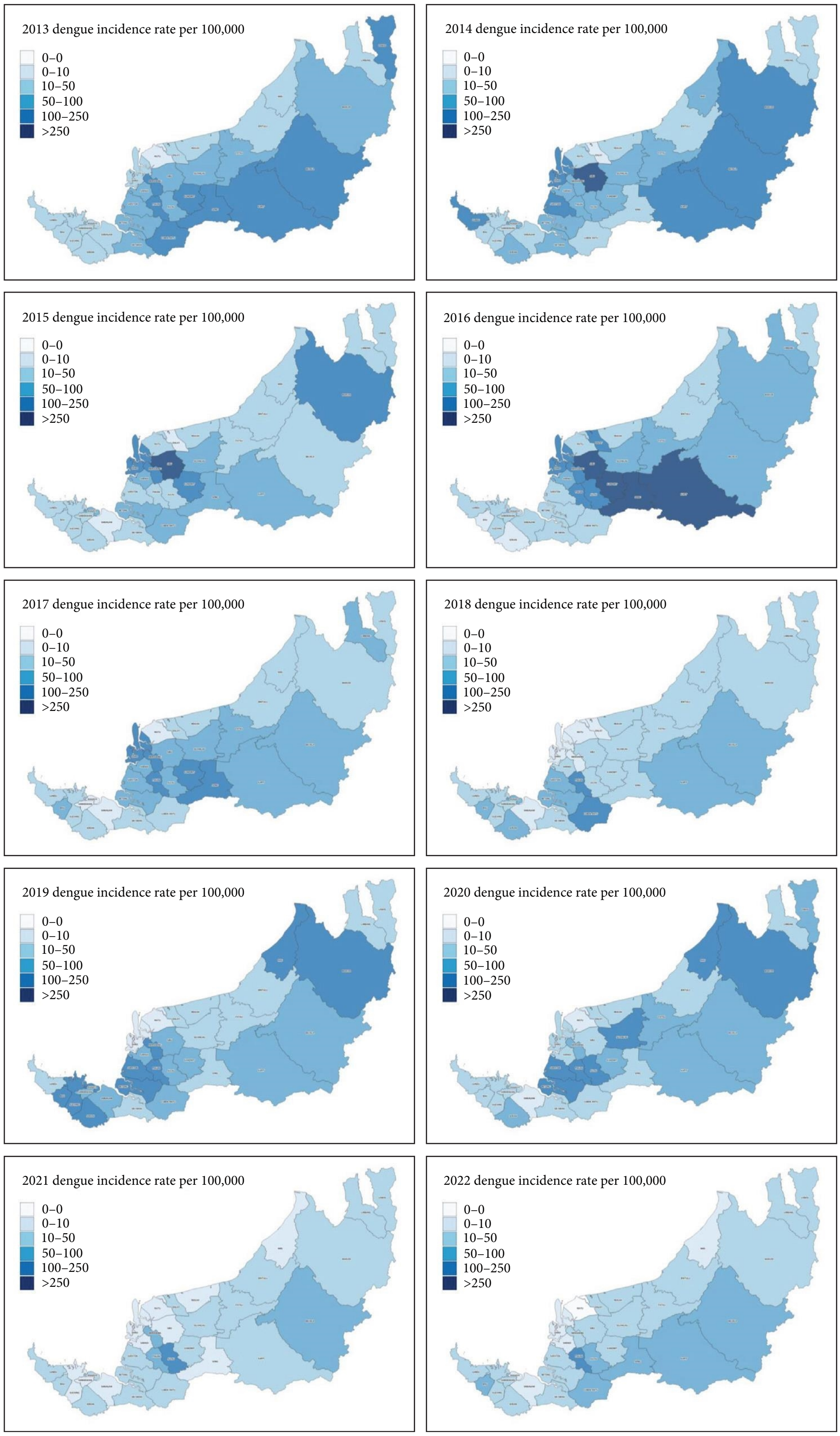

Figure 2: Dengue incidence rates 2013–2022 by district for Sarawak.

Table 1: Details of cases from 2004 to 2013.

Variable	$N = 14{,}020$ (%)
Age	
Mean (SD) (years)	36.21 (0.153)
Median (years)	34
0–20	3,076 (21.9)
21–59	9,302 (66.3)
60 and above	1,642 (11.7)
Gender	
Male	8,130 (58.0)
Female	5,890 (42.0)
Nationality	
Malaysian	13,372 (95.4)
Non-Malaysian	598 (4.6)
Ethnicity	
Iban	3,658 (26.1)
Chinese	4,849 (34.6)
Malay/Melanau	2,507 (17.9)
Bidayuh	685 (4.9)
Other Sarawakian natives	1,520 (10.8)
Others	801 (5.7)
Occupation ($n = 5{,}478$)	
Working	3,180 (22.7)
Non-working	1,557 (11.1)
Student	741 (5.3)
Unknown	8,542 (60.9)
Place of dwelling ($n = 13{,}841$)	
Rural	8,126 (58.0)
Urban	5,715 (40.8)
Days before seeking treatment	
Mean (SD) (day)	3.89 (4.44)
Median (day)	4
Classification of cases	
Cases from outbreaks	4,636 (33.1)
Single sporadic cases	9,384 (66.9)
Clinical sign/symptoms	
Fever	13,999 (99.9)
Headache	12,640 (90.2)
Retro-orbital pain	1,412 (10.1)
Bodyache/joint pain	11,006 (78.5)
Nausea/vomiting	6,360 (45.4)
Rash	1,648 (11.8)
Abdominal pain/discomfort	536 (3.8)
Haemorrhage	145 (1.0)
Diarrhoea	215 (1.5)
Rapid test ($n = 5{,}227$) (%)	
NS1 positive	3,111 (59.5)
IgM positive	1,693 (32.3)
IgG positive	2,592 (49.5)

population) in the rest of Malaysia. In 2019, dengue picked up again but in the Northern region of Sarawak as can be seen in the dengue incidence map in Figure 2. Subsequently with the onset of COVID-19 in 2020 and implementation of movement restriction, dengue cases reduced in 2020 and 2021. The opening of the economy and lifting of travel restrictions saw cases rise again in 2022. Unfortunately, 2022 also saw the highest number of mortality likely due to late presentation and diagnosis, with many healthcare practitioners having a low index of suspicion for dengue due to the low number of cases in the years during the pandemic. This low index of suspicion actually led to similar late diagnosis and increased mortality in 2017, when cases were fewer compared to previous years.

Referring to the incidence rate maps in Figure 2, initially the highest incidence rate was in Sibu district in central Sarawak from 2014 to 2016. In 2016, the high incidence was also seen in adjacent divisions especially the rural divisions of Kapit, Song, and Kanowit in the central part of Sarawak. However, control measures using *Bacillus thuringiensis* wide area spraying in Sibu seemed effective in controlling dengue, and cases reduced markedly in 2017 and 2018 [25]. In 2019, cases spiked in Northern Sarawak especially in Miri and Marudi districts, although the central region did seem to have some increased incidence in 2020.

The mean age among those from outbreak areas was significantly lower than among those in single cases. This younger mean age (32.2 ± 18.2) is similar to those from other reported studies. A pooled global study reported a mean age of 30.1 among dengue cases from outbreaks [26]. A possible reason for a younger age group is that outbreaks happen in the community and affect mainly children and younger populations. This will affect the mean age due to larger numbers of young dengue cases. According to 2013 data from the National Dengue Surveillance System, children aged 0–4 years were the most affected by dengue, followed by those aged 10–15 years [21].

Males predominate among the overall cases of dengue, and this is concurrent with other studies. A global systematic review in 2017 reported males predominate with 54.5% [26]. The proportion of male gender among those from outbreaks was nearly equal to female, while among single cases, the proportion was significantly higher for males. This is likely due to many parts of Sarawak still in rural areas where men predominate in work, while many women are housewives. This is concurrent with the data on occupation, with 62.8% from single cases with work, compared to 49.9% workers from outbreaks. Dengue outbreaks are defined as more than one case in a locality of 200 m, and if it occurs in a village or urban housing, the numbers affected will include many non-working populations staying at home, which in Sarawak are mostly females.

In terms of ethnicity, the results were affected by a few large outbreaks in rural areas especially near coastal areas in rural districts. Majority of cases from urban areas are ethnic Chinese, with Sibu being the highest incidence from 2014 to 2016, and subsequently spread to rural districts of Sarikei and Kapit division. Results from analysis found cases from rural areas have higher odds of being from outbreaks. This is contrary to traditional thoughts that dengue is an urban disease [27]. In Malaysia, it has been reported that in 2011, seroprevalence was equal between those from rural or urban

Table 2: Socio-demographic characteristics of dengue cases of Sarawak 2013–2022 and comparison between those from outbreak or single cases (univariate and multivariate).

	Single case, *n* (%) ($n = 9,384$)	Outbreak, *n* (%) ($n = 4,636$)	Univariate OR (95% CI)	Multivariate OR (95% CI)
Age				
Mean (SD) (years)	38.13 (17.8)	32.22 (18.2)	0.982 (0.980–0.985)**	0.984 (0.980–0.989)**
Median (years)	37	29.5	—	—
Range (years)	<1−97	<1−93	—	—
Gender				
Male	5,794 (61.7)	2,336 (50.4)	ref	ref
Female	3,590 (38.3)	2,300 (49.6)	1.589 (1.480–1.706)**	1.584 (1.387–1.821)**
Nationality				
Malaysian	8,879 (94.6)	4,493 (96.9)	ref	ref
Non-Malaysian	505 (5.4)	143 (3.1)	1.787 (1.479–2.159)**	1.340 (0.646–2.777)ns
Ethnicity				
Iban	2,748 (29.3)	910 (19.6)	ref	ref
Chinese	3,082 (32.8)	1,767 (38.1)	1.731 (1.574–1.904)**	1.179 (0.961–1.446)ns
Malay/Melanau	1,375 (14.7)	1,132 (24.4)	2.486 (2.230–2.771)**	2.533 (2.088–3.072)**
Bidayuh	462 (4.9)	223 (4.8)	1.458 (1.222–1.789)**	1.402 (1.048–1.874)*
Other Sarawakian natives	1,084 (11.6)	436 (9.4)	1.215 (1.062–1.389)**	1.347 (1.101–1.648)**
Others	633 (6.7)	168 (3.6)	0.801 (0.666–0.965)**	0.596 (0.312–1.141)ns
Occupation	**(*n* = 3,459)**	**(*n* = 2,019)**	—	—
Working	2,172 (62.8)	1,008 (49.9)	ref	ref
Non-working	982 (28.4)	575 (28.5)	1.262 (1.111–1.433)**	1.179 (1.005–1.383)*
Student	305 (8.8)	436 (21.6)	3.080 (2.614–3.630)**	1.450 (1.163–1.808)**
Place of dwelling	**(*n* = 9,254)**	**(*n* = 4,587)**	—	—
Rural	4,837 (52.3)	3,289 (71.7)	ref	—
Urban	4,417 (47.7)	1,298 (28.3)	0.432 (0.401–0.466) **	0.398 (0.346–0.458)**

Bold values indicate numerical, *n*, that is different from other variables in the table. ref = reference category. *Significant at $p < 0.05$; **Significant at $p \leq 0.01$.

Table 3: Clinical symptoms experienced at time of notification and rapid test results.

	Single case, *n* (%)	Outbreak, *n* (%)	Univariate OR (95% CI)	Multivariate OR (95% CI)
Clinical symptoms	**(*n* = 9,384)**	**(*n* = 4,636)**	—	—
Fever	9,372 (99.9)	4,627 (99.8)	0.658 (0.277–1.563)	—
Headache	8,493 (90.5)	4,147 (89.5)	0.890 (0.792–1.000)*	—
Body ache/joint pains	7,423 (79.1)	3,583 (77.3)	0.899 (0.826–0.978)*	—
Nausea/vomiting	4,186 (44.6)	2,174 (46.9)	1.096 (1.022–1.177)*	—
Rash	1,051 (11.2)	597 (12.9)	1.172 (1.053–1.305)**	1.315 (1.056–1.638)**
Retro-orbital pain	908 (9.7)	504 (10.9)	1.139 (1.015–1.277)*	—
Abdominal pain/discomfort	375 (4.0)	161 (3.5)	0.864 (0.716–1.043)	—
Haemorrhage	89 (0.9)	56 (1.2)	1.277 (0.912–1.787)	—
Diarrhoea	171 (1.8)	44 (0.9)	0.516 (0.370–0.720)**	0.160 (0.055–0.465)**
Rapid test				
NS1 positive ($n = 5,227$)	1,576 (48.2)	1,535 (78.5)	3.921 (3.451–4.456)**	3.474 (2.952–4.088)**
IgM positive ($n = 5,120$)	1,119 (34.5)	574 (30.7)	0.841 (0.745–0.951)**	1.062 (0.915–1.234)
IgG positive ($n = 5,141$)	1,887 (57.8)	705 (37.6)	0.440 (0.391–0.494)**	1.032 (0.887–1.201)

Bold values indicates the total numerical, *n* of the two groups. *Significant at $p < 0.05$; **Significant at $p < 0.01$.

areas [28]. The findings presented here have a serious implication for dengue control, especially in Sarawak, with logistics challenges and resources limitation in rural areas.

Days between onset and notification indicates how fast they present themselves to any health facility and also the awareness of clinicians to test or diagnose dengue. During outbreaks, awareness campaigns are carried out as part of public health risk communications [29]; hence, clinicians and public would have heightened awareness, leading to faster diagnosis and notification. Similarly, due to increased awareness, cases

Table 4: Average days between onset and notification.

	Single case ($n = 9{,}384$)	Outbreak ($n = 4{,}636$)	Univariate OR (95% CI)	Multivariate OR (95% CI)
Average days between onset and case notification (SD)	4.03 (5.19)	3.63 (2.24)	0.941 (0.926–0.956)**	0.993 (0.973–1.014)

**Significant at $p < 0.01$.

often present early during outbreaks, and this is reflected in the clinical symptoms and high NS1 positivity (78.5%). Reported early clinical features associated with NS1 positivity include retro-orbital pain, myalgia, arthralgia, rashes, and bleeding [30, 31]. Although diarrhoea was an uncommon symptom among dengue cases in Sarawak, it was a significant in multivariate analysis as being more common among single cases. Abdominal symptoms are usually among those with severe dengue [32]. This is most likely due to delayed treatment as diarrhoea could be mistaken for other illness. IgG and IgM positivity is also lower among cases from outbreaks as mostly present early when NS1 is still positive and IgM is slowly rising. IgG among diagnosed single cases could be indicative of old infection, especially if IgM or NS1 was negative.

5. Conclusion

Dengue is endemic in Sarawak with 14,020 reported cases from 2013 to 2022, with outbreaks contributing to the rise in incidence from 2014 to 2016 and in 2019. Among these reported cases, those reported during outbreaks were more likely to be younger, females, not working, and from rural areas compared with reported sporadic single cases. Rash, diarrhoea, and NS1 positivity were significant predictors of reported cases during outbreaks as compared to sporadic cases. Although other predictors such as heavy rainfall and population density are well established, these new data-driven predictors are easily accessible from the database and can be utilised by district healthcare personnel to guide dengue control activities, by predicting potential outbreaks from reported cases or indicate that outbreaks are already occurring but undetected in a certain locality. This will allow for better resource utilisation and more targeted control to be implemented effectively, leading to lower dengue-associated morbidity and mortality.

6. Recommendations

This database provides invaluable insights into predicting dengue outbreaks in Sarawak and could be utilised by stakeholders to better target dengue control activities. These predictors should also be included as a monitoring tool to predict potential surge in dengue and allows earlier control interventions to reduce dengue-associated morbidity and mortality.

Data Availability

Data are not publicly available but can be made available with permission from the Director General of Health of Malaysia.

Additional Points

Limitations. Dengue serotypes are not routinely analysed for all dengue cases, although sampling is carried out to determine the circulating strain periodically. NS1 and serology IgM and IgG test results were mostly available only from 2017 onwards, and the numbers analysed for the logistic regression model were reduced markedly but still adequate for logistic regression analysis (5,227 cases). Additionally, the data could not account for sub-clinical cases which may affect the data for outbreaks, as many would be sub-clinical and undiagnosed.

Ethical Approval

Ethical clearance was obtained from the Malaysian Research Ethics Committee (MREC) of the Ministry of Health Malaysia. Permission from the Director General of Health Malaysia was received for the publication of this article (NMRR-17-478-35069 (IIR)).

Conflicts of Interest

All authors declare no competing interest.

Authors' Contributions

Jo Hun Teh was responsible for writing the original draft and formal analysis. Johnny Pangkas was responsible for reviewing and editing. Hamidi Mohamad Sharkawi was responsible for investigation and resources. Irwilla Ibrahim was responsible for data curation. Euphrasia Bari was responsible for project administration. Kung Yee Wong was responsible for software and formal analysis. Choo Huck Ooi was responsible for conceptualisation and supervision.

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