eDenguev2 Database: Factors associated with the occurrence of dengue hotspot localities in the Selangor State in 2022

Siti Farhana Binti Mohamad Yusof, MPH, Mohamad Ikhsan Bin Selamat, McommMed (Environmental Health), Mariam Bt. Mohamad, M.CommHlth (Epidemiology & Biostat)

Department of Public Health Medicine, Faculty of Medicine, Universiti Teknologi MARA (UiTM), Selangor, Malaysia

ABSTRACT

Introduction: The dengue outbreak in Selangor, Malaysia, has been a significant concern in recent years. Selangor has reported the highest number of dengue cases in the country, with over 22,000 cases in 2023 alone. The outbreak in Selangor has been overwhelming, and the outbreak was divided into controlled outbreaks, uncontrolled outbreaks, and hotspots according to the onset of the outbreak. Multiple factors have contributed to the occurrence of dengue hotspots in Selangor. This study aims to determine the factors associated with the occurrence of dengue hotspot localities in Selangor for the year 2022.

Materials and Methods: This is a cross-sectional study among dengue outbreak localities in Selangor that utilized data from the eDenguev2 database from the Selangor State Health Department for the year 2022. Data collection and analysis were conducted from April 2024 until June 2024. The first (index) case from each dengue outbreak localities of controlled outbreak and hotspot localities in Selangor for 2022 were identified and analyzed to determine the factors associated with the occurrence of hotspot localities.

Results: 391 (14%) out of 2751 dengue outbreak localities as hotspot localities. According to the demographic analysis of patients in these hotspot localities, the majority were adults aged 26–35 years old (24.04%), with a mean age of 33 years. The majority were female (57.30%), employed (58.57%), Malaysian nationals (93.09%), and of Malay ethnicity (62.15%). Geographically, the Petaling District reported a significant portion of hotspot localities (40.4%). A large number of cases originated in strata housing (67.8%) and urban areas (93.5%), with a delay of more than 48 hours for the commencement of source elimination activities. Notably, most hotspot areas did not have any possible breeding sites (99.2%), had low entomological parameters: Aedes Index (AI), Bruteu Index (BI), and Container Index (CI), and there were no delays in reporting cases, investigating them, verifying them, and registering them. The occurrence of hotspot localities was significantly associated with cases originating from urban areas, with a p-value of 0.048 and an adjusted odds ratio (aOR) of 2.343 (95% CI: 1.006, 5.456).

Conclusion: Urban areas are significantly more likely to become a hotspot for dengue outbreaks. Public health implications highlight the need for urban-focused interventions and rapid response. Broader strategies, such as GIS mapping and community engagement, remain relevant, though not directly assessed here.

KEYWORDS:
Dengue, dengue outbreak, hotspot localities, Selangor

INTRODUCTION

Dengue fever is escalating as a critical global health challenge, particularly in tropical and subtropical urban regions.[1] In 2023, it caused over 5 million reported infections and 5,500 deaths worldwide, with record highs continuing into 2024 over 12 million cases reported to date.[2] The disease spread primarily by Aedes aegypti and Aedes albopictus, concentrated in dense human habitats and is intensified by climate change and rapid urbanization.[3] Without a specific antiviral treatment, dengue management relies heavily on vector control, early detection, and proper clinical care to reduce fatalities. In Southeast Asia, especially Malaysia, dengue remains endemic with significant public health consequences. In 2023, Malaysia recorded 123,133 dengue cases an 86% increase compared to 2022, with approximately 100 deaths.[4] Selangor state consistently bears the national burden of dengue, characterized by persistently high incidence and challenges in outbreak control.[5] Despite efforts under the National Dengue Control Plan 2022–2026, Selangor has struggled to meet the goal of containing 95% of outbreaks within 14 days.[6]

In Malaysia, a dengue outbreak is defined as two or more cases occurring within 200 meters and 14 days; localities are subsequently classified as controlled (no new cases after 14 days), uncontrolled (cases persist beyond 14 days), or hotspots (cases continue for at least 30 days).[7] In Selangor in 2021 alone, there were 2,888 controlled, 492 uncontrolled, and 434 hotspot outbreak localities.[5] Several recent studies have examined factors contributing to dengue outbreaks. Timeliness of notification and response is key, as delays in initiating vector control can allow wider transmission.[8] Urban ecological factors, such as high-rise living and dense residential clusters, have been shown to facilitate breeding of Aedes mosquitoes.[9-11] Additionally, land-use practices like unmanaged open spaces, stagnant water areas, and construction zones are frequently associated with prolonged outbreaks.[5,12] Human-related factors such as gender and

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Corresponding Author: Mohamad Ikhsan Selamat
Email: mohamadikhsan@uitm.edu.my

activity patterns also play a role. Studies show that adult males, particularly those involved in outdoor or mobile occupations, are more likely to be exposed to infected mosquitoes, contributing to transmission in certain localities.[5,13]

Despite this growing body of literature, few studies focus specifically on the localities where outbreaks persist beyond the national control threshold of 14 days. Understanding what differentiates short-duration outbreaks from long-lasting hotspot localities can inform targeted public health responses. Therefore, this study aims to investigate the characteristics that differentiate hotspot localities in Selangor during 2022. By evaluating variables across four domains which are patient demographics, vector control practices, environmental conditions, and land-use patterns, it can explain why some localities rebound from outbreaks swiftly, while others continue long-term transmission beyond 30 days.

MATERIALS AND METHODS

Study design and study population

This is retrospective case-control design study used Selangor eDenguev2 database. The eDenguev2 database is an online system consisting of patient data, vector control data, and environmental data that was developed in January 2009. It aims to systematically and in real-time manage dengue case registrations in Malaysia, ensuring effective surveillance at district, state, and national levels.

The study population consisted of localities with the status of controlled outbreaks and hotspots in Selangor for the year 2022. The sampling unit included is the first (index) case of controlled outbreak localities and hotspot localities in Selangor for the year 2022 that were thoroughly investigated by the district health offices, with complete investigation reports submitted to the Selangor State Health Department. The study period was from 1 March 2024 until 1 July 2024, which was the most recent data available at the time of the research permission application.

Sample size

Based on the study by Priya et al. (2023), which noted that the odds ratio for students to contribute to the dengue outbreak was 1.729 compared to the unemployed population.[14] The estimated sample size using an odds ratio sample size calculator (Fleiss with continuity correction) was 310 cases and 310 controls. This calculation assumed a significance level of 0.05 (two-tailed analysis) and 80% power. Adjusting for a 20% data loss due to redundant or missing data, the required sample size for this study was 372 per group. Universal sampling was employed to select eligible cases for hotspots, and simple random sampling was employed to select eligible cases from controlled outbreaks. Within controlled outbreak localities, simple random sampling was done using SPSS, and the amount yielded was as large as the hotspot localities.

Data collection and data management

According to National Dengue Strategic Plan 2022-2026, the controlled outbreak was defined as the localities where there is no dengue case is notified after the 14th day from the notification date of the second case, while hotspot is a locality that lasts for more than 30 days from the date the outbreak started.[15]

The independent variables in this study were grouped into four domains: patient factors, which include age group, gender, occupational status, and the time taken to seek treatment; vector control factors, consisting the time taken for case notification, the initiation of case investigation, and the start of source reduction activities; environmental factors, involving the type of housing and population density in the outbreak areas; and land use factors, focusing on the presence of high-risk breeding sites. The operational definitions of the variables studied are presented in Table I. Data management procedures are illustrated in Figure 1.

Statistical analysis

All statistical analyses were conducted using IBM SPSS Statistics version 29. Continuous variables were described using means and standard deviations, while categorical variables were summarized as frequencies and percentages. Group comparisons were performed using independent t-tests for continuous variables and Chi-square or Fisher's exact tests for categorical variables, where appropriate.

To identify factors associated with hotspot localities, simple logistic regression was first applied to calculate crude odds ratios (cORs) and 95% confidence intervals (CIs). Variables with a p-value < 0.25 in the univariate analysis were included in the multivariable logistic regression model. A backward stepwise selection approach was used, and variables with a p-value < 0.05 were retained in the final model. Adjusted odds ratios (aORs) with 95% CIs were reported. Multicollinearity among predictor variables was assessed using collinearity diagnostics, with no evidence of multicollinearity observed. Interaction terms were tested but found to be non-significant. Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test (p=0.499), and explanatory power was assessed using the Pseudo R^2 (Cox & Snell). Model discrimination was evaluated using the area under the receiver operating characteristic (ROC) curve, which was 52.3%. No influential outliers were identified based on Cook's distance.

Ethics Application

This study was registered with the National Medical Research Register (Ref. No: NMRR ID- 24-00237-IF2). Ethical approval was obtained from Medical Research Ethics Committee (Ref. No: NMRR ID- 24-00237-IF2) and the Faculty Research Ethics Committee (Ref. No: 100 - FPR (PT.9/19) (FERC-EX-24-09)). Selangor State Health Department granted permission to utilise data in eDenguev2 registry for this study. This study adhered to the Malaysian Code of Responsible Conduct in Research to ensure data confidentiality and compliance with ethical standards throughout the research. This study utilized anonymized, de-identified secondary data, aggregated to prevent re-identification. This method preserves confidentiality and aligns with ethical research standards, eliminating the need for informed consent.

Table I: Operational Definition

No.	Variables	Definition
1.	District Population Density	a) Less density population district Districts of less than 500,000 population which are Hulu Selangor, Kuala Selangor, Kuala Langat,Sepang, Sabak Bernam. b) High density population district Districts of more than 500,000 population which are Petaling, Hulu Langat, Klang, Gombak
2.	Duration taken to seek treatment	Data is determined by subtracting the date of diagnosis from the date of onset.
3.	Duration taken for case notification	Data is determined by subtracting the notification date to the date of diagnosis
4.	Duration taken for initiation of case investigation, case verification and case registration in eDengueV2	Data is determined by subtracting the date of case investigation to the date of case notification
5.	Duration taken for commencement of vector control activities	Data is determined by subtracting the date of first source elimination activity to the date of case registered in eDengueV2 database
6.	Aedes Index (AI)	Is defined as the percentage of premises positive for Aedes larval breeding in a locality with < 1 % (low transmission and ≥ 1% (high transmission). Number of house positive dengue breeding divided with number of house inspected x 100 %
7.	Bruteau Index (BI)	Number of container positive with dengue breeding divided with number of house inspected x 100 house
8.	Container Index (CI)	Number of container positive with dengue breeding divided with number of container inspected x 100%
9.	Presence of potential breeding sites	Presence of places that have the potential to become breeding ground - construction site, abandoned housing project, cemetery, dumping ground, land/empty land, recreational park
10.	Residential Area	Urban area: Gazette areas with their adjoining built-up areas, which had a combined population of 10,000 or more 16

RESULTS

Of the 782 dengue outbreak localities reported in Selangor in 2022, 50.8% were classified as hotspot areas. Most cases involved individuals aged 26–35 years (24.0%), with a mean age of 33 years. Most patients were female (57.3%), employed (58.6%), and of Malay ethnicity (62.2%). Geographically, a significant proportion of cases originated from the Petaling district (37.2%), with a high concentration in urban localities (93.5%) and strata housing areas (67.8%). Although entomological indicators such as the Aedes Index and Container Index were generally low across all localities, hotspot areas were more frequently associated with delays in case notification and vector control activities.

Univariable logistic regression identified three variables with statistically significant associations with hotspot classification. Urban residential areas exhibited higher odds of being classified as hotspots (COR=2.29, 95% CI: 0.99–5.34, p=0.048). Delayed case notification, defined as notification occurring more than 24 hours after diagnosis, was also associated with an increased likelihood of hotspot status (COR=0.33, 95% CI: 0.11–1.02, p=0.055). In the multivariable logistic regression model, urban residential areas remained a significant predictor (aOR=2.34, 95% CI: 1.01–5.47, p=0.048), and delayed notification continued to show a negative association with controlled outbreak classification (aOR=0.32, 95% CI: 0.10–1.00, p=0.052), indicating potential weaknesses in timely outbreak response.

These findings show the influence of urbanisation and the timeliness of public health response on the persistence of dengue transmission in hotspot areas. While demographic and entomological characteristics did not show significant associations with hotspot classification, operational delays which particularly in case notification and initiation of vector control activities, emerged as critical contributing factors. These results highlight the need for targeted interventions in urban settings, with an emphasis on strengthening early detection and rapid response mechanisms to mitigate the escalation of dengue outbreaks.

DISCUSSION

This study examined factors associated with dengue hotspot localities in Selangor for the year 2022. Urban residence emerged as the only statistically significant predictor in the multivariable model (aOR=2.34, 95% CI: 1.01–5.47, p=0.048). However, the significance was marginal, and the model demonstrated poor discrimination (ROC AUC=52.3%), indicating limited predictive utility. These findings should therefore be interpreted with caution and are unlikely to serve as robust predictors across different settings or time periods.

The association between urban residence and dengue hotspot classification is consistent with prior evidence in Malaysia and Southeast Asia, where dengue is disproportionately concentrated in urban and densely populated areas. Urban environments provide abundant vector breeding habitats and facilitate human–mosquito contact, amplifying transmission risk [17,18]. In Malaysia, urbanization has been consistently linked to dengue transmission, but other determinants have also been highlighted. Similar patterns were observed in Singapore, where neighbourhood-level urban density was a strong determinant of dengue clustering[19,20]. However, other Malaysian studies identified additional key predictors. For instance, Abdullah et al. (2022) reported significant associations between rainfall, temperature, and dengue incidence [21], while Mohd-Zaki et al. (2014) emphasized the role of notification delays in

Table II: Patient's Factors Characteristics with Hotspots and Controlled Outbreak Localities in Selangor for the year 2022 (N:782)

Variables	Total (n=782) n (%) [a]	Hotspot Localities (n=391) n (%) [b]	Controlled Outbreak Localities (n=391) n (%) [b]	p-value
Patient's Factors				
Age (in years)[d]				
<15 year old	134 (17.1)	62 (15.9)	72 (18.4)	0.211
16 to 25 years old	138 (17.6)	63 (16.1)	75 (19.2)	
26 to 35 years old	181 (23.1)	94 (24.0)	87 (22.3)	
36 to 45 years old	155 (19.8)	89 (22.8)	66 (16.9)	
≥46 years old	174 (22.3)	83 (21.2)	91 (23.3)	
Gender[d]				0.424
Female	459 (58.7)	224 (57.3)	235 (60.1)	
Male	323 (41.3)	167 (42.7)	156 (39.9)	
Occupation Status[d]				0.725
Unemployed	175 (22.4)	83 (21.2)	92 (23.5)	
Employed	449 (57.4)	229 (58.6)	220 (56.3)	
Student	158 (20.2)	79 (20.2)	79 (20.2)	
Nationality[d]				0.585
Malaysian	724 (92.6)	364 (93.1)	360 (92.1)	
Non-Malaysian	58 (7.4)	27 (6.9)	31 (7.9)	
Ethnicity[d]				0.837
Chinese	140 (17.9)	66 (16.9)	74 (18.9)	
Indian	102 (13.0)	51 (13.0)	51 (13.0)	
Malay	475 (60.7)	243 (62.1)	232 (59.3)	
Others	65 (8.3)	31 (7.9)	34 (8.7)	
District[d]			< 0.001*	
Sabak Bernam	1 (0.0)	0 (0.0)	1 (0.3)	
Gombak	24 (3.1)	1 (0.3)	23 (5.9)	
Hulu Langat	234 (29.9)	108 (27.6)	126 (32.2)	
Hulu Selangor	26 (3.3)	16 (4.1)	10 (2.6)	
Klang	154 (19.7)	78 (19.9)	76 (19.4)	
Kuala Langat	25 (3.2)	13 (3.3)	12 (3.1)	
Kuala Selangor	10 (1.3)	5 (1.3)	5 (1.3)	
Petaling	291 (37.2)	158 (40.4)	133 (34.0)	
Sepang	17 (2.2)	12 (3.1)	5 (1.3)	
District Population Density[d]				
Less Density Population District	79 (10.1)	46 (11.8)	33 (8.4)	0.123
High Density Population District	703 (89.9)	345 (88.2)	358 (91.6)	
Notification Source[d]				
Private hospital	220 (28.1)	118 (30.2)	102 (26.1)	0.517
Government Hospital	111 (14.2)	57 (14.6)	54 (13.8)	
GP Clinic	262 (33.5)	128 (32.7)	134 (34.3)	
Government Health Cinic	189 (24.2)	88 (22.5)	101 (25.8)	
Duration Taken To Seek Treatment (days)[e]	782 (100)	2.91 ± 1.670	3.19 ± 3.02	0.111
Environmental Factors				
Type of Housing[d]				0.394
Landed	241 (30.8)	126 (32.2%)	115 (29.4)	
Strata	541 (69.2)	265 (67.8%)	276 (70.6)	
Residential Area[d]				0.048*
Rural	28 (3.6)	10 (2.6 %)	18 (4.6)	
Urban	754 (96.4)	381 (97.4 %)	373 (95.4)	
Land Use Factor				**0.477**
Presence of Total Potential Breeding Sites[d]				
No	774 (99.0)	388 (99.2 %)	386 (98.7)	
Yes	8 (1.0)	3 (0.77%)	5 (1.28)	
Vector Control Factors				0.043*
Duration taken for case notification[d]				
≤ 24 hours	766 (98.0)	387 (99 %)	379 (96.9)	
> 24 hours	16 (2.0)	4 (1 %)	12 (3.1)	
Duration Taken for Initiation of case investigation, case verification and case registration[d]				0.808
≤ 24 hours	575 (73.5)	286(73.1)	289(73.9)	
> 24 hours	207 (26.5)	105(26.9)	102(26.1)	
Duration Taken for Commencement of Source Elimination Activity[d]				0.243
≤ 48 hours	237 (30.3)	111(28.4)	126(32.2)	
> 48 hours	545 (69.7)	280(71.6)	265(67.8)	

Table II: Patient's Factors Characteristics with Hotspots and Controlled Outbreak Localities in Selangor for the year 2022 (N:782)

Variables	Total (n=782) n (%) [a]	Hotspot Localities (n=391) n (%) [b]	Controlled Outbreak Localities (n=391) n (%) [b]	p-value
Aedes Index[d]				0.362
< 1 %	771 (98.6)	387 (99)	384 (98.2)	
≥ 1 %	11 (1.4)	4 (1.02)	7 (1.79)	
Bruteau Index (BI)[d]				0.563
< 5 %	448 (57.3)	228 (58.3)	220 (56.3)	
≥ 5 %	334 (42.7)	163 (41.7)	171 (43.7)	
Container Index (CI)[d]				.
< 10 %	782 (100)	391 (100)	391 (100)	
≥ 10 %	0 (0)	0 (0)	0 (0)	

[a]Within total sample.
[b]Within the hotspot localities and controlled outbreak localities
[c]Mean±Standard Deviation
*level of significance at α = 0.05
[d]Chi-Square test was used to calculate the p-value
[e]Independent t-test was used to calculate the p-value

Table III: Univariable analysis of factors associated with hotspot localities in Selangor for the year (n:782)

Variables	β (SE)	Wald (df)	cOR (95% CI) [a]	p-value [b]
Patient's Factors				
Age (in years)				
<15 year old	0.39(0.22)	3.09	1.478(0.96,2.29)	0.079
16 to 25 years old	0.17(0.21)	0.64	1.185 (0.78,1.80)	0.425
26 to 35 years old	-0.08(0.23)	0.13	0.921 (0.59,1.44)	0.719
36 to 45 years old	-0.06(0.23)	0.37	0.944 (0.60,1.48)	0.803
≥46 years old			1	ref.
Gender				
Female			1	ref.
Male	0.12(0.15)	0.69	1.13 (0.85,1.50)	0.407
Occupation Status				
Unemployed			1	ref.
Employed	0.14(0.18)	0.6	1.15 (0.81,1.63)	0.437
Student	0.10(0.15)	0.22	1.11 (0.72,1.71)	0.639
Nationality				
Malaysian	0.15(0.27)	0.29	1.16 (0.68,1.98)	0.592
Non-Malaysian			1	ref.
Ethnicity				
Chinese			1	ref.
Indian	0.13 (0.26)	0.24	1.14 (0.68,1.90)	0.623
Malay	0.17 (0.19)	0.82	1.19 (0.82,1.73)	0.365
Others	0.04 (0.30)	0.01	1.04 (0.58,1.87)	0.906
District Population Density				
Less Density Population District	0.37(0.24)	2.36	1.45 (0.90,2.32)	0.124
High Density Population District			1	ref.
Notification Source				
Private Hospital	0.09(0.19)	0.23	1.10 (0.75,1.60)	0.63
Government Hospital	0.19(0.24)	2.03	1.21 (0.76,1.94)	0.423
GP Clinic	0.28(0.20)	2.03	1.33(0.90,1.97)	0.154
Government Health Clinic		2.27	1	ref.
Duration Taken To Seek Treatment (days) [c]	-0.05	2.41	0.95(0.89,1.01)	0.121
Environmental Factors				
Type of Housing				
Landed			1	ref
Strata	0.14 (0.16)	0.77	1.15 (0.85,1.55)	0.381
Residential Area				
Rural			1	ref
Urban	0.83(0.43)	3.7	2.29 (0.99,5.34)	0.054

Table III: Univariable analysis of factors associated with hotspot localities in Selangor for the year (n:782)

Variables	β (SE)	Wald (df)	cOR (95% CI) [a]	p-value [b]
Land Use Factor				
Presence of Total Potential Breeding Sites				
No			1	ref
Yes	-0.52(0.73)	0.49	0.60 (0.14,2.52)	0.482
Vector Control Factors				
Duration taken for case notification				
≤ 24 hours			1	ref
> 24 hours	-1.12 (0.58)	3.69	0.33 (0.11,1.02)	0.055
Duration Taken for Initiation of case investigation, case verification and case registration				
≤ 24 hours			1	ref
> 24 hours	0.03 (0.16)	0.03	1.03 (0.75,1.42)	0.855
Duration Taken for Commencement of Source Elimination Activity				
≤ 48 hours			1	ref
> 48 hours	-0.18 (-0.156)	1.31	1.20 (0.88,1.62)	0.253
Aedes Index				
< 1 %			1	ref
≥ 1 %	-0.57(0.63)	0.8	0.57 (0.17,1.96)	0.371
Bruteau Index (BI)				
< 5 %			1	ref
≥ 5 %	-0.08(0.15)	0.3	0.92 (0.70, 1.23)	0.584

Note: COR = crude odds ratio, AOR = adjusted odds ratio, CI = confidence interval, [a]simple logistic regression, [b]multiple logistic regression, *level of significance at α = 0.05. Variables with p-value < 0.25 in [a]simple logistic regression were further analyzed in [b]multiple logistic regression.

Table IV: Multivariable analysis of factors associated with hotspot localities in Selangor for the year (n:782)

Variables	β (SE)	Wald (df)	aOR (95% CI) [a]	p-value [b]
Patient's Factors				
Age (in years)				
<15 year old	-0.413(0.241)	2.93	0.443 (0.221,0.892)	0.087
16 to 25 years old	-0.425(0.241)	3.121	0.654 (0.408,1.048)	0.077
26 to 35 years old	-0.228(0.224)	1.041	0.796 (0.513,1.234)	0.307
36 to 45 years old	-0.387(0.225)	2.947	0.679 (0.437,1.056)	0.086
≥46 years old		0.4731	1	ref
District Population Density				
Less Density Population District	-0.389(0.246)	2.504	0.678 (0.418,1.097)	0.114
High Density Population District			1	ref
Notification Source				
Private Hospital	-0.260(0.206)	1.588	0.771 (0.514,1.155)	0.208
Government Hospital	0.001(0.245)	0	1.001 (0.620,1.619)	0.995
GP Clinic	-0.223(0.189)	1.391	0.800 (0.553,1.159)	0.238
Government Health Clinic		2.566	1	ref
Duration Taken To Seek Treatment (days) [c]	-0.051(0.033)	2.442	0.950 (0.892,1.013)	0.118
Environmental Factors				
Residential Area				
Rural			1	ref
Urban	0.852(0.431)	3.899	2.343 (1.006,5.456)	0.048
Vector Control Factors				
Duration taken for case notification				
≤ 24 hours			1	ref
> 24 hours	-1.139(0.582)	3.831	0.320 (0.102,1.002)	0.05

Notes: No interaction. No multicollinearity among variables was detected in the final model. The Hosmer-Lemeshow goodness-of-fit test signified a good model fit (p = 0.499). Pseudo R square (Cox & Snell) = 1.1%. The area under the Receiver Operating Characteristic (ROC) curve was 52.3%.

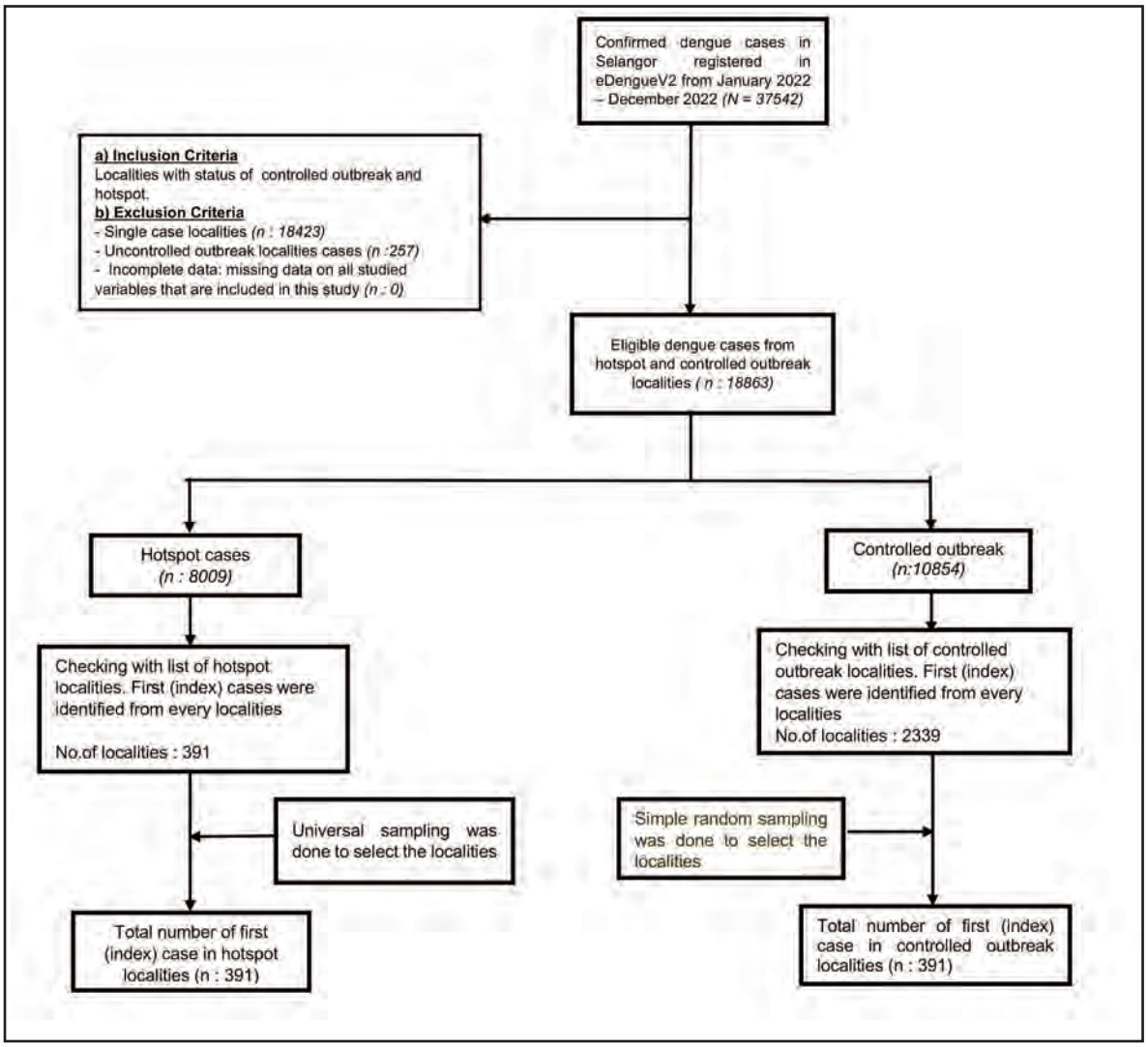

Fig. 1: Flow diagram of data extraction process and sampling

sustaining outbreaks.[22] Whereas another study has further demonstrated that larval population dynamics strongly influence epidemic potential.[23] These findings suggest that dengue hotspots are shaped by multiple interacting ecological, operational, and social factors, which may explain the modest performance of the present model.

Operationally, delayed case notification (>24 hours) showed a borderline association with hotspot classification, indicating potential gaps in outbreak response timeliness. This aligns with earlier research that highlighted prompt reporting as critical to effective vector control and containment.[24,25] Other factors, such as strata housing, male gender, and student status, exhibited elevated odds ratios but were not statistically significant. These should be interpreted as unconfirmed trends rather than established predictors and require further investigation before being integrated into policy or practice.

On the other hand, the public health implications of this study emphasize two priorities: (i) urban-focused interventions and (ii) timely outbreak response. Strengthening case notification systems, accelerating early vector control deployment, and tailoring dengue control to high-density environments are directly supported by the present findings. Broader strategies such as GIS-based risk mapping, community engagement, and resource optimization remain relevant but were not directly assessed here and should therefore be considered supplementary recommendations, guided by previous literature.[26-28]

Finally, the findings should be viewed within the context of post-COVID-19 dengue surveillance. The data analyzed were from 2022 but reviewed in 2024, a period during which surveillance operations, health system priorities, and dengue transmission patterns may have shifted. Moreover, the one-year observation period offers only a snapshot of dengue dynamics and may not capture seasonal or inter-annual variations that are critical in dengue epidemiology.

Strengths and Limitations

A notable strength of this study is the use of statewide eDengueV2 surveillance data, which integrates epidemiological, entomological, and operational

information. This comprehensive database enabled a multifactorial exploration of dengue hotspots in Selangor. The case–control design with standardized outbreak classification criteria also enhanced methodological consistency and reduced potential misclassification between hotspot and non-hotspot localities. Another strength lies in the statewide coverage, which provides a population-level perspective rather than being limited to a single district. This enhances the relevance of the findings for public health planning and resource allocation at the state level.

Nonetheless, several limitations must be acknowledged. The model showed only marginal significance for the main predictor and poor discriminatory capacity (ROC AUC=52.3%), which limits its value for prediction. Some potentially relevant environmental and operational variables, such as rainfall, temperature, entomological indices, and vector control response time, could not be included due to data constraints. Their absence may have contributed to the modest model performance. In addition, reliance on routine surveillance data introduces risks of underreporting, delayed reporting, and potential misclassification of cases. Finally, the study was limited to a one-year period (2022), which may not adequately capture seasonal or inter-annual variations in dengue epidemiology. The time lag between data collection and analysis (2022–2024) also means that the results may not fully reflect the most current outbreak dynamics in the post-COVID-19 context.

CONCLUSION

Dengue outbreaks are still worrying in Selangor despite all prevention and control measures being conducted as per ministry guidelines. Identifying factors that contribute to the occurrence of dengue hotspot localities helps to understand the overall impact of dengue outbreaks on public health and helps future interventions to be more targeted, proactive, and cost-effective, which eventually lead to a better dengue control plan in the future.

CONFLICT OF INTEREST

The authors did not have a conflict of interest.

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