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Evaluation of the dengue surveillance information systemas a strategic tool for epidemiological control

Avaliação do sistema de informação de vigilância da dengue como ferramenta estratégica para o controle epidemiológico

Evaluación del sistema de información de vigilancia del dengue como herramienta estratégica para el control epidemiológico

ABSTRACT

Dengue is an acute, systemic, and dynamic febrile disease, typically with benign clinical progression but potentially evolving into severe forms, including fatalities. This study evaluated the Dengue Surveillance System in Ceará from 2019 to 2023, using the Centers for Disease Control and Prevention (CDC) methodology to assess data quality, consistency, and representativity. The completeness of mandatory variables was excellent, with over 90% filled in. However, essential variables such as education level, hospitalization, and likely infection site scored below expectations. Data consistency was high, with less than 5% errors in critical variables. Comparing hospital data between Sinan and SIH systems revealed a strong positive correlation, highlighting the system's representativity. The study concludes that the surveillance system is of excellent quality and is representative enough to describe dengue in the state.

Keywords: *Dengue; Health Surveillance System; Health Information Systems.*

RESUMO

A dengue é uma doença febril aguda, sistêmica e dinâmica, geralmente de evolução clínica benigna, mas podendo evoluir para formas graves, inclusive óbitos. O presente estudo avaliou o Sistema de Vigilância da Dengue no Ceará, de 2019 a 2023. Foi utilizado um método avaliativo baseado na metodologia do *Centers for Disease Control and Prevention* (CDC), focando nos atributos de qualidade dos dados, consistência e representatividade. A completude das variáveis obrigatórias

foi excelente, com mais de 90% de preenchimento. No entanto, variáveis como escolaridade, hospitalização e local de infecção ficaram abaixo do esperado. A consistência foi elevada, com menos de 5% de erros em variáveis cruciais. A comparação entre os dados hospitalares do Sinan (Sistema de Informação de Agravos de Notificação) e SIH (Sistema de Informações Hospitalares) mostrou forte correlação, evidenciando a representatividade do sistema. Disso, conclui-se que o sistema é de boa qualidade e representativo para descrever a doença no estado.
Descritores: *Dengue; Sistema de Vigilância em Saúde; Sistema de Informação em Saúde.*

RESUMEN

El dengue es una enfermedad febril aguda, sistémica y dinámica, generalmente con una evolución clínica benigna, pero que puede progresar a formas graves, incluso fatales. Este estudio evaluó el Sistema de Vigilancia del Dengue en Ceará, de 2019 a 2023. Se utilizó un enfoque basado en la metodología del Centers for Disease Control and Prevention (CDC) para evaluar la calidad de los datos, la consistencia y la representatividad. La completitud de las variables obligatorias fue excelente, con más del 90% completadas. Sin embargo, variables esenciales como el nivel educativo, la hospitalización y el lugar probable de infección obtuvieron resultados por debajo de lo esperado. La consistencia de los datos fue alta, con menos del 5% de errores en variables críticas. Al comparar los datos hospitalarios entre los sistemas Sinan y SIH, se observó una fuerte correlación, lo que destaca la representatividad del sistema. Se concluye que el sistema tiene buena calidad y es representativo para describir el dengue en el estado.

Descriptores: *Dengue; Sistema de Vigilancia Sanitaria; Sistemas de Información en Salud.*

INTRODUCTION

Dengue is an acute, systemic, and dynamic febrile disease transmitted by the Aedes aegypti mosquito[1]. This infectious disease is caused by a flavivirus, DENV (Dengue Virus), and there are four serotypes, DENV-1, DENV-2, DENV-3, and DENV-4, in simultaneous circulation in the country[2].

Currently, the disease is endemic in Brazil, with frequent episodes of epidemics, establishing itself as a chronic and growing challenge[3,4]. In 2023, Brazil recorded an incidence of 753.9 cases per 100,000 inhabitants, representing a 16.5% increase in the number of cases when compared to the year 2022[5].

Ceará stands as one of the most affected states due to the high number of cases recorded annually[6] with the circulation of all four virus serotypes. According to data from the Health Secretariat of the State of Ceará (SESA-CE), in the year 2023, eight deaths from dengue were confirmed, being the lowest record in the period, with a case fatality rate of 36.4%[7]. However, climatic and socioeconomic characteristics can influence the incidence and sustained transmission of this arbovirus. Coupled with this, socioeconomic disparities and geographic diversity can increase the complexity of epidemiological surveillance of the disease in the state[8].

Local studies reinforce this perspective. Silva and Lima[9], when analyzing the infestation by Aedes aegypti and the transmission of dengue in the municipality of Russas-Ceará, observed a strong association between environmental conditions and the occurrence of cases, highlighting the importance of integration between entomological and epidemiological surveillance to confront the disease. These findings evidence that, even at the municipal level, the quality and integration of information are essential to guide effective control actions.

On the other hand, according to the Centers for Disease Control and Prevention (CDC), health surveillance systems are fundamental public health tools, as they support rapid decisions and timely interventions in situations of epidemiological relevance, making it necessary to regularly evaluate these systems to ensure that public health problems are monitored efficiently and effectively[10].

In this context, marked by the endemicity of dengue, the epidemic potential, and the continuous impact of the disease on the population of Ceará over the years, added to the absence of studies evaluating the attributes of the dengue surveillance system in the state, it becomes essential to analyze its performance. Furthermore, it is important to highlight that the dengue surveillance system in Ceará integrates the guidelines of the National Dengue Control Program (PNCD), which guides the organization of epidemiological and entomological surveillance actions in the country, reinforcing the need for robust and responsive information systems for the timely monitoring of cases. Thus, evaluating this system is crucial to identify gaps, understand its functioning, and verify its capacity to support disease prevention and control actions.

In this way, the study becomes relevant since the evaluation of the dengue surveillance system may improve health surveillance practice, as well as ensure that the health problem is being monitored appropriately, in addition to contributing to the strengthening of the response capacity to the disease in Ceará. This study aimed to evaluate the Dengue Surveillance Information System in Ceará as a strategic tool for epidemiological control and monitoring, in the period from 2019 to 2023.

METHODS

This is an evaluative, observational, cross-sectional, and retrospective study, based on the methodology proposed by the Centers for Disease Control and Prevention (CDC)[10], which aimed to analyze the data quality (completeness and consistency) and representativeness attributes of the Dengue Surveillance System in Ceará.

The Centers for Disease Control and Prevention (CDC) methodology for evaluating health surveillance systems is a structured set of criteria, steps, and attributes created to analyze the quality, effectiveness, and utility of epidemiological surveillance systems. It is internationally recognized and used by ministries of health, researchers, and managers to evaluate systems such as those for dengue, Covid-19, tuberculosis, and influenza.

Secondary data from the Notifiable Diseases Information System (Sinan) were used, referring to the period from 2019 to 2023, collected from the DATASUS website.

Data analysis was performed using descriptive statistics tools in Microsoft Excel and Epi Info 7.4 software. Completeness was evaluated based on the filling of mandatory and essential variables, while consistency was analyzed by checking for filling errors and inconsistencies in dates. Representativeness was evaluated by comparing the number of dengue hospitalization records notified in Sinan with the number of dengue hospitalizations identified with code A90 or A91 of the International Classification of Diseases and Related Health Problems (ICD-10) in the Hospital Information System (SIH/SUS) from 2019 to 2023. In order to verify if a linear correlation existed between the Sinan and SIH/SUS systems, Pearson's linear correlation coefficient was calculated.

Table 1 presents the evaluation of the variables for the data quality attribute (completeness and consistency) and the representativeness attribute. Sinan parameters were used as a basis for the completeness analysis.

For the evaluation of consistency, the parameters from Lara, J.M. et al.[11] were used, whereas, to calculate representativeness, the percentage of variables between the evaluated periods was used, with a subjective criterion defined by the observer. The final classification of the system's representativeness was performed considering the result found as representative if it was less than or equal to 10% in both categories (person and place), according to Table 2.

Table 1 – Variables used to measure the data quality (completeness and consistency) and representativity, with the respective metrics.

Components	Variables	Rating criteria
Completeness	*Obligatory variables:* ▪ Age, sex, classification, discard criteria, preexisting illnesses	○ Excellent ≥ 90% ○ Regular > 70% and < 90% ○ Bad < 70%
	Essential variables: ▪ Race, scholarity, case evolution, hospitalização, local provável de infecção	
Consistency	*Intervalos de datas:* ▪ Closing date < Notification date ▪ Notification date < Date where the symptoms started	○ Excellent < 10% ○ Regular > 10% and < 30% ○ Bad> 30%
	Variables: ▪ Males with filled YES for pregnancy forms ▪ Classification with no valid information ▪ Isolated serotype result without the seclusion date ▪ Negative lab exam results, classified as positive	
Representativity	▪ Sex, age range, race, scholarity, body part of the infection	○ Representative when ≤ 10% ○ Not representative when >10%
	▪ Internations	○ Very strong ±0.9 to ±1 ○ Strong ±0.7 to ±0.9 ○ Moderate ±0.5 to ±0.7 ○ Weak ±0.5 to ±0.3 ○ Negligible ±0.3 to 0

Source: Author, 2024.

Table 2 – Final ranking of the representativeness of the dengue surveillance system according to person and place.

Final Classification	Number of categories
High representativity	2
Low representativity	1

Source: Author, 2024.

RESULTS

It was observed that the mandatory variables showed results characterized as excellent, with more than 90% completion of the evaluated fields. However, essential variables such as education level, hospitalization, and

probable site of infection showed results below this parameter (90%) (Table 3).

Among the essential variables, education level stood out with approximately 53.00% (106,009), hospitalization with 43% (86,396), and the variable for probable site of infection with more than 80% of the fields filled as "unknown" or left blank, being characterized as having poor completeness (Table 3). Thus, considering that more than 50% of the evaluated variables showed an excellent parameter, it can be concluded that the dengue surveillance system in Ceará presented good data completeness.

Regarding data consistency, all selected variables, with the exception of the viral serotype variable without the date of viral isolation collection, presented less than 5% filling errors. Thus, the dengue surveillance system proved to be consistent in data records during the analyzed period (Table 4). In view of the above, the dengue surveillance system in Ceará, in the evaluated period, can be considered adequate regarding the attributes of data quality, completeness, and consistency.

Regarding the representativeness attribute, the dengue surveillance system in Ceará proved to be representative for the analyzed variables of person and place, considering the comparison of data recorded in Sinan across different periods (Table 5), where the difference between the variables was less than or equal to 10%. Thus, it was observed that the distribution result of the variables was similar between the evaluated periods, with the exception of the variable for the probable site of infection. In the period from 2019 to 2023, there was no completion in 75.74% of this variable, unlike the period from 2014 to 2018, which had more than 60% completion of the field, noting that 53.09% of the cases were autochthonous, meaning that viral transmission occurred in the municipality of residence (Table 5).

It was also observed that confirmed cases of dengue were more frequent in females (57.13% / 55.98%), in the age group of 20 to 29 years (22.66% / 23.53%), and among those of mixed race/color (parda) (67.57% / 76.77%) in the evaluated periods (Table 5).

In addition to this description, the representativeness of dengue cases in Sinan was also evidenced when comparing the number of hospitalized cases in Sinan with the hospitalizations recorded in the SIH. The data showed a strong and positive correlation, presenting a Pearson linear correlation coefficient of 0.9. In this way, it was found that the dengue surveillance system in Ceará has high representativeness, since the final classification of representativeness was less than 10% in both categories (person and place). The system also proved capable of describing the event over time.

Table 3 – Completeness of mandatory and essential variables in the notification and investigation form of the dengue surveillance system in Ceará, 2019 to 2023. (N=200.852).

Variable	Filled fields		Rating
	N	%	
Sex	200.738	99,94	Excellent

Age	200.852	100,00	Excellent
Discard criteria	193.740	96,46	Excellent
Classification	200.784	99,97	Excellent
Preexisting illnesses	199.510	99,33	Excellent
Race	182.799	91,01	Excellent
Scholarity	94.843	47,22	Bad
Case evolution	189.482	94,33	Excellent
Hospitalization	114.456	56,98	Bad
Probable infection position	30.811	15,34	Bad

Source: SINAN, TABNET (DATASUS), 2024.

Table 4 – Consistency of mandatory and essential variables in the notification and investigation form of the dengue surveillance system in Ceará, 2019 to 2023 (N=200.852)

Inconsistency	N	n	%	Rating
Closing<Notification	200.852	1.922	0,95	Excellent
Notification<Start of symptoms	200.852	1	0,00	Excellent
Males with YES for pregnancy	200.852	0	0,00	Excellent
Invalid classification	200.852	7.827	3,90	Excellent
Serotype without isolation date	798	743	93,00	Bad
Negative lab results classified as positive	48.723	11	0,02	Excellent

Source: SINAN, TABNET (DATASUS), 2024.

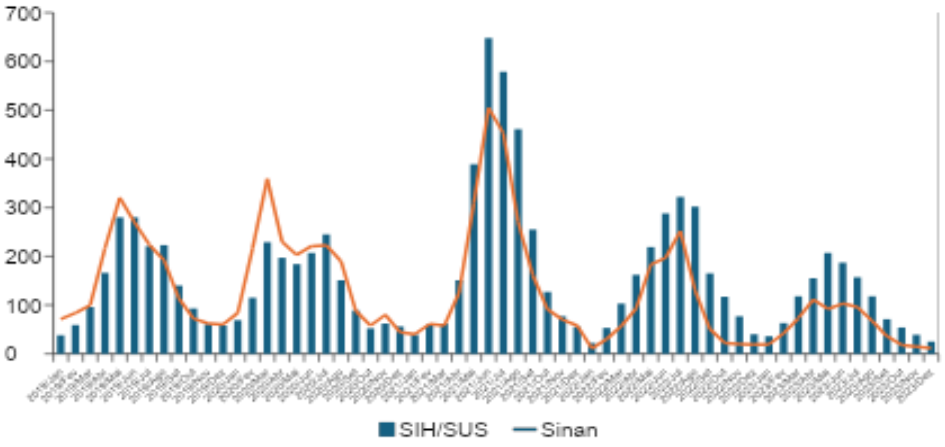
Table 5 – Sociodemographic characteristics of confirmed cases in the Ceará dengue surveillance system, 2014 to 2018 (N= 146.736) and 2019 to 2023 (N=123.415)

Sociodemographic characteristics	Sinan confirmed cases 2014 to 2018		Sinan confirmed cases 2019 to 2023		Rating between periods (%)
	n	%	n	%	
Sex					
Female	83.835	57,13	69.086	55,98	1,15
Male	62.864	42,84	54.232	43,94	1,1
Ignored	25	0,02	97	0,08	0,06
Blank	12	0,01	0	0.,00	0,01
Age range					
Less than 1 year	2.311	1,57	1.674	1,36	0,21
1 to 4 years	3.899	2,66	3.717	3,01	0,35
5 to 9 years	7.509	5,12	7.365	5,97	0,85
10 to 14 years	11.772	8,02	9.727	7,88	0,14
15 to 19 years	17.062	11,63	11.828	9,58	2,05
20 to 29 years	33.250	22,66	29.038	23,53	0,87
30 to 39 years	25.810	17,59	22.524	18,25	0,66
40 to 49 years	18.781	12,80	16.148	13,08	0,28
50 to 59 years	13.318	9,08	11.653	9,44	0,36
60 to 69 years	7.661	5,22	5.785	4,69	0,53
70 to 79 years	3.766	2,57	2.879	2,33	0,24
80 years or more	1.597	1,09	1.077	0,87	0,22
Race					
White	15.208	10,36	11.979	9,71	0,65

Black	2.858	1,95	2.564	2,08	0,13
Yellow	1.437	0,98	794	0,64	0,34
Brown	99.146	67,57	94.746	76,77	9,2
Indigenous	289	0,20	350	0,28	0,08
Ignored	13.086	8,92	12.982	10,52	1,6
Blank	14.712	10,0	0	0	10,0
Scholarity					
Analphabet	1.536	1,05	1.280	1,04	0.01
1st to 4th year of incomplete elementary school	5.771	3,93	4.784	3,88	0,05
4th year of complete elementary school	3.353	2,29	2.584	2,09	0,2
5th to 8th year of incomplete elementary school	9.198	6,27	7.378	5,98	0,29
Complete elementary school	5.023	3,42	4.500	3,65	0,23
Incomplete high school	6.794	4,63	6.303	5,11	0,48
Complete high school	12.065	8,22	17.781	14,41	6,19
Incomplete higher education	1.797	1,22	1.836	1,49	0,27
Complete higher education	2.309	1,57	3.484	2,82	1,25
Ignored	40.742	27,77	34.730	28,14	0,37
Doesn't apply	10.265	7,00	9.511	7,71	0,71
Blank	47.883	32,63	29.244	23,70	8,93
Probable infection position					
Yes	77.895	53,09	27.383	22,19	30,19
No	2.996	2,04	670	0,54	1,5
Indeterminate	8.037	5,48	1.912	1,55	3,93
Blank	84.259	39,40	93.450	75,72	36,32

Source: SINAN, TABNET (DATASUS), 2024.

Figure 1 – Number of hospitalization records for dengue fever, in the information systems Sinan and SIH/SUS, from 2019 to 2023



Source: SINAN, TABNET (DATASUS), 2024.

DISCUSSION

Interest in evaluating the quality of health information has gained increasing prominence in Brazil. Quality data are fundamental both for planning and for supporting decisions related to disease control actions, in addition to being essential for the promotion and protection of the population's health.

In this sense, the systematic monitoring of Sinan becomes fundamental for following the epidemiological situation of the diseases included in the system. Inadequate completion of the notification and investigation form can compromise the quality and reliability of surveillance data.

The present study, by applying the methodology of the Centers for Disease Control and Prevention (CDC)[10], demonstrated that the Dengue Surveillance System in Ceará (2019–2023) has good utility but presents critical weaknesses in data quality for essential investigation variables, which compromises the analytical capacity to support disease control.

The completeness findings indicate that mandatory variables, such as sex (99.87%) and age (99.99%), maintained a high standard of completion, confirming the basic robustness of the Notifiable Diseases Information System (Sinan) in this aspect, as observed in other national evaluations[12].

However, fundamental variables for the analysis of the epidemiological profile and the investigation of social inequities demonstrated poor completeness, notably education level (47.22%) and the race/color field (48.01%). In fact, the deficient completeness of non-mandatory sociodemographic variables is a historical and systemic weakness in Sinan, which limits the analysis of health inequities and prevents the development of public policies focused on more vulnerable groups and territories[13,14]. The failure to record this information restricts the system's ability to describe the real profile of the disease.

The low completeness of the variable for the probable site of infection (15.34% filled) is particularly serious for dengue surveillance. More than 80% of the fields were blank or marked as "unknown." This deficiency directly impacts the timeliness of field investigations and prevents the proper classification of cases as autochthonous. Given that arbovirus surveillance must be strongly integrated with spatial and territorial analysis[15], the lack of this information in Sinan prevents geolocation and the mapping of foci, hindering focused and territory-based vector control actions.

Regarding consistency, the system proved to be robust, with less than 5% error in most of the variables evaluated. However, the filling error in the viral serotype variable without the date of viral isolation collection (93% error) is a critical failure that compromises the timeliness of information. Ceará, as a tropical region, faces the endemicity of dengue and the simultaneous circulation of multiple DENV serotypes, a factor that increases the risk of epidemics and severe cases[16]. Incomplete or delayed notification of the serotype prevents Epidemiological Surveillance from identifying the circulation of a new serotype in time to organize the healthcare network and intensify vector control.

The discussion regarding data quality must consider the perception of the health professional. Literature suggests that many professionals perceive the completion of notification forms as a merely bureaucratic activity, disconnected from decision-making[17]. This perception is an obstacle that may be the underlying cause of the incompleteness of non-mandatory variables. Furthermore, poor data

quality is closely linked to failures in information flows between different levels of care (basic unit, laboratory, and surveillance), reinforcing the need for continuous training and sensitization regarding data use[18].

Finally, the dengue surveillance system in Ceará demonstrated high representativeness, evidenced by the strong positive correlation ($\rho = 0.9$) between the hospitalization data notified in Sinan and those recorded in the SUS Hospital Information System (SIH/SUS). This finding serves as an external validation of Sinan's utility in capturing disease trends over time. It is known that the integration and correlation of data from different sources, such as the SIH, is the future of arbovirus surveillance[19]. This agreement between systems suggests that, despite specific incompleteness, the magnitude of the most severe cases (hospitalizations) is being monitored consistently, which is a strong point of the system. However, this consistency must be constantly monitored, as inconsistencies in information systems can lead to the underestimation of vital indicators, such as the case fatality rate, emphasizing the importance of continuous quality surveillance[20].

CONCLUSION

The study presented limitations such as possible selection and outcome biases due to the use of a secondary database like Sinan; these biases may have influenced the quality, consistency, and representativeness of the analyzed data, affecting the precision of the conclusions obtained.

The Dengue Surveillance System in Ceará proved to be robust and efficient, with excellent quality in terms of completeness and consistency, in addition to being representative. It is recommended to integrate automated validation tools and provide continuous training for health professionals to improve data quality and strengthen epidemiological surveillance of dengue in the state.

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Conflicts of Interest

The authors declare no conflicts of interest.

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