



Research Article

Infodemiology of Rabies in Indonesia and Neighboring Countries: Insights from Google Trends (2020–2024)

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ABSTRACT

Background: As Asian countries struggle to meet the global "Zero by 30" rabies target due to delayed and underreported conventional surveillance, digital infodemiology offers a complementary solution. This study analyzes rabies-related Google Trends search interest in Indonesia, Malaysia, the Philippines, Thailand, and Vietnam from 2020 to 2024 to evaluate its utility for public health monitoring and elimination strategies.

Method: Google Trends was queried for the term "rabies" across the five countries from January 2020 to December 2024. Monthly normalized scores (0–100) were collected and analyzed descriptively. Trends were examined at monthly and annual levels, including seasonal fluctuations and exceptional peaks. Relative growth between 2020 and 2024 was calculated to identify shifts in long-term public awareness.

Results: Thailand consistently demonstrated the highest baseline search interest, while Indonesia remained the lowest despite a dramatic spike in June 2023 (score 100). Seasonal increases were observed in Thailand and Vietnam during the second half of the year, coinciding with agricultural cycles and awareness campaigns. Annual mean scores rose in all countries, with the Philippines showing the largest relative increase (+164%), followed by Indonesia (+110%). Malaysia and Vietnam exhibited moderate growth, while Thailand's increase was more modest (+86%).

Conclusion: Rabies awareness in Southeast Asia is highly variable and largely event-driven, highlighting the need for integrated, sustained communication strategies tailored to each country's epidemiological and sociocultural context to support the achievement of the "Zero by 30" elimination goal.

Keywords: Rabies awareness; Infodemiology; Google Trends; Southeast Asia; Digital surveillance

INTRODUCTION

Rabies remains one of the most fatal yet preventable zoonotic diseases worldwide, causing an estimated 59,000 human deaths each year, predominantly in Asia and Africa.¹ Despite the availability of effective vaccines for both humans and animals, rabies continues to impose a substantial public health burden, particularly in low- and middle-income countries where access to post-exposure prophylaxis (PEP), animal vaccination programs, and healthcare services may be limited.² In Southeast Asia, rabies remains endemic in several countries, including Indonesia, Malaysia, the Philippines, Thailand, and Vietnam, posing persistent challenges to national and regional elimination efforts.³ In line with the global “Zero by 30” initiative led by the World Health Organization (WHO), the World Organization for Animal Health (WOAH), the Food and Agriculture Organization (FAO), and the Global Alliance for Rabies Control (GARC), countries across the region are strengthening their strategies to eliminate dog-mediated human rabies deaths by 2030.⁴

Achieving this target requires more than effective surveillance and vaccination programs. Public awareness plays a critical role in rabies prevention because timely healthcare-seeking behavior following animal exposure depends largely on an individual's knowledge and perception of disease risk. People who recognize the severity of rabies are more likely to seek immediate medical care, complete PEP regimens, and support animal vaccination programs. Conversely, insufficient awareness may contribute to delays in treatment and increase the risk of preventable deaths.⁵ Understanding how communities engage with rabies-related information is therefore an important component of elimination efforts.⁵

Traditionally, rabies monitoring has relied on routine surveillance systems, official case reports, and epidemiological investigations. While these approaches remain essential, they primarily capture disease occurrence and may not fully reflect public awareness, information needs, or behavioral responses to rabies-related events. In many settings, surveillance data may also be affected by reporting delays and underreporting, limiting their ability to provide timely insights into public attention and engagement.⁶ As internet access continues to expand across Southeast Asia, digital data sources have emerged as valuable complementary tools for understanding population responses to health issues.

One such approach is infodemiology, which examines the distribution and determinants of health information in digital environments. Online search behavior can provide indirect evidence of how people respond to disease threats, media reports, public health campaigns, or outbreak events. Increased search activity may indicate heightened awareness, growing concern, active information seeking, or intentions to seek healthcare services.⁷ Previous studies have shown that internet search data can be useful for monitoring public interest in infectious diseases such as influenza, dengue, and COVID-19, often reflecting changes in public attention that are not immediately captured through conventional surveillance systems.^{8–10}

Google Trends has become one of the most widely used tools in infodemiological research because it provides freely accessible and real-time information on population search behavior. Although its application has been extensively reported for several infectious and emerging diseases, studies examining rabies-related search behavior remain relatively limited, particularly in Southeast Asia. Existing rabies research in the region has largely focused on

epidemiological burden, vaccination coverage, outbreak management, and elimination programs. In contrast, evidence regarding regional patterns of public awareness and information-seeking behavior remains scarce. This represents an important knowledge gap because awareness and risk perception are key determinants of preventive behavior and community participation in rabies control efforts.^{11,12}

Furthermore, the implementation of the “Zero by 30” strategy has increased the importance of effective risk communication and community engagement as integral components of rabies elimination programs. Understanding how public interest in rabies evolves and differs across countries may provide useful insights for designing communication strategies and identifying opportunities to strengthen public engagement. Comparative analyses of digital search behavior may also help reveal variations in awareness patterns among countries facing similar epidemiological challenges but implementing different public health approaches.

Therefore, this study aimed to analyze temporal and geographical patterns of rabies-related Google search interest in Indonesia, Malaysia, the Philippines, Thailand, and Vietnam between 2020 and 2024. By examining trends in online search behavior, this study seeks to provide additional insights into public awareness and engagement related to rabies in Southeast Asia. To our knowledge, this is among the first regional comparative infodemiology studies evaluating rabies-related search behavior across multiple Southeast Asian countries during the ongoing implementation of the global “Zero by 30” rabies elimination strategy.

METHOD

Study Design

This study employed an ecological infodemiology design using Google Trends data to examine temporal and geographical patterns of rabies-related online search behavior in Southeast Asia between January 2020 and December 2024. The study was conducted as a digital epidemiology time-series analysis at the population level, using aggregated search activity as a proxy for public interest and awareness of rabies.

Country Selection

Five countries were included in the analysis: Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. These countries were selected because they represent rabies-endemic settings in Southeast Asia and have ongoing national commitments to the WHO-led “Zero by 30” rabies elimination strategy. In addition, they share geographic proximity, comparable public health challenges related to dog-mediated rabies, and sufficient internet penetration to enable meaningful Google Trends analyses. The study focused on these countries to provide a regional comparison among major Southeast Asian countries where rabies remains an important public health concern. Other countries within the WHO Western Pacific Region were not included because several are either non-endemic, have substantially different epidemiological contexts, or generate insufficient Google Trends search volumes for reliable longitudinal comparison.

Data Source and Search Strategy

Data were obtained from Google Trends (<https://trends.google.com>), a publicly accessible platform that provides normalized information on the relative popularity of search queries over time. Data extraction was performed on 15 January 2025.

The primary search term used was “rabies,” which was applied consistently across all countries to ensure comparability of search volumes between settings. Searches were conducted using the following Google Trends settings: Web Search, All Categories, country-specific geographic restriction, and a study period from 1 January 2020 to 31 December 2024. Google Trends reports relative search volume (RSV) on a scale from 0 to 100, where 100 represents the highest search interest observed for the selected location and time period (Table 1).

Although local-language terms may also be used by internet users when searching for rabies-related information, a single standardized keyword was selected to facilitate cross-country comparison and minimize inconsistencies arising from linguistic variation. The potential influence of language-specific search behavior is addressed as a study limitation.

Data Retrieval and Processing

To improve data reliability, Google Trends data were retrieved on three separate occasions within the same week, and the resulting monthly RSV values were compared for consistency. Monthly data were downloaded and compiled into a single dataset for analysis. Data cleaning included verification of country settings, removal of duplicate downloads, inspection for missing values, and confirmation of chronological completeness across the entire study period. Because Google Trends provides normalized rather than absolute search counts, no further transformation was performed.

Data Analysis

Descriptive analyses were conducted to summarize temporal patterns of rabies-related search interest across the five countries. Monthly RSV values were plotted to visualize fluctuations, peaks, and long-term trends over the study period. Annual mean RSV values were calculated to assess changes in search interest over time. Relative growth between 2020 and 2024 was calculated as the percentage change in annual mean RSV values.

In addition, temporal trends were evaluated using the Mann–Kendall trend test to detect statistically significant monotonic trends in rabies-related search interest over the study period. Seasonal patterns were assessed through visual examination of recurring monthly fluctuations across years. Given the exploratory nature of this infodemiological study and the use of aggregated Google Trends data, analyses were primarily intended to describe public search behavior rather than establish causal relationships with epidemiological outcomes. All analyses and visualizations were performed using Microsoft Excel® for Microsoft 365 (Version 2506 Build 16.0.18925.20076, Microsoft Corporation, Redmond, WA, USA). Statistical significance was defined as $p < 0.05$.

RESULTS

Monthly interest scores for rabies-related searches varied considerably across the five countries during the study period. Thailand consistently exhibited the highest relative search volume (RSV), whereas Indonesia generally showed the lowest levels of search interest. At baseline (January 2020), RSV values were highest in Thailand (68), followed by Vietnam (43), Malaysia (26), the Philippines (17), and Indonesia (5) (Figure 1).

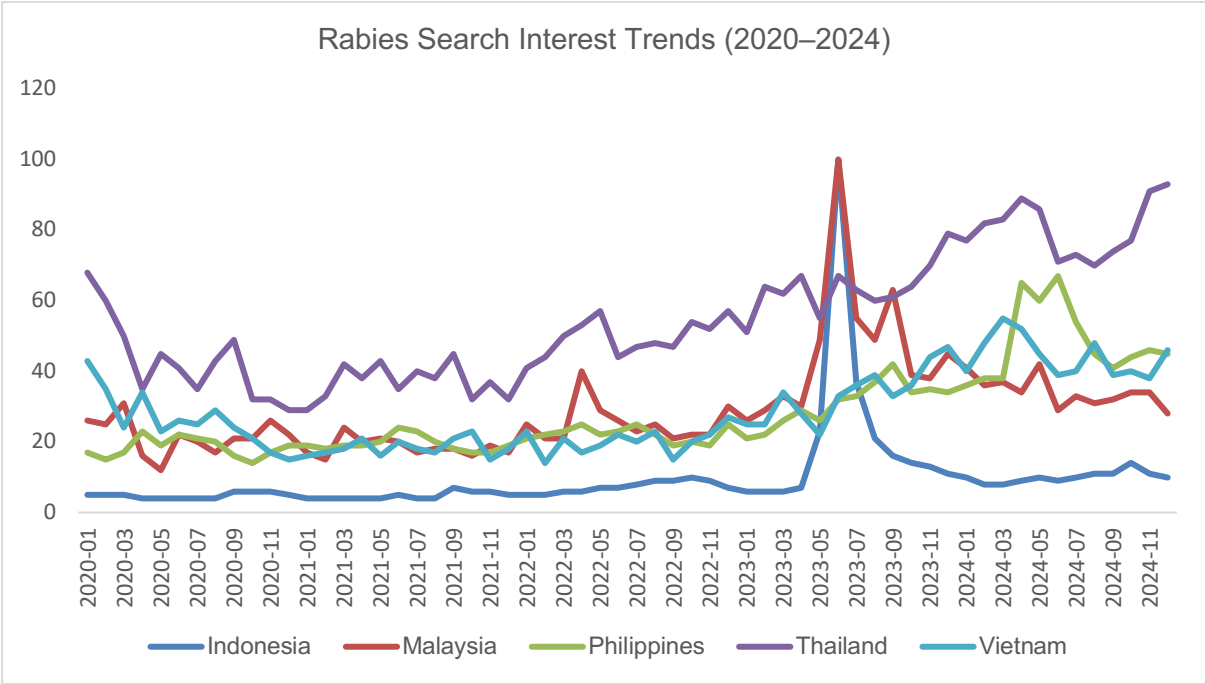


Figure 1. Monthly trends of rabies-related search interest. Monthly normalized interest scores (0–100) for rabies-related Google searches in Indonesia, Malaysia, Philippines, Thailand, and Vietnam, from January 2020 through December 2024. Lines represent each country with distinct colors, illustrating relative fluctuations and temporal trends over the study period. Peaks are observed in mid-2023 across all countries, most prominently in Indonesia.

Temporal fluctuations were observed in all countries throughout the study period. Thailand maintained relatively high RSV values across most months, while Malaysia, the Philippines, and Vietnam showed moderate search interest levels that gradually increased over time. Indonesia exhibited generally low RSV values but experienced a marked peak in June 2023, reaching the maximum normalized score of 100. Similar fluctuations of varying magnitude were observed in the other countries, indicating that rabies-related online search activity was dynamic throughout the observation period. Complete monthly RSV values are presented in Table 1.

Table 1. Relative growth in mean monthly rabies-related search interest, 2020–2024

Country	2020 Mean	2024 Mean	Relative Growth (%)
Indonesia	4.8	10.1	+110%
Malaysia	21.6	34.3	+59%
Philippines	18.3	48.3	+164%
Thailand	43.3	80.5	+86%

Country	2020 Mean	2024 Mean	Relative Growth (%)
Vietnam	26.3	44.2	+68%

Visual inspection of the monthly RSV data suggested recurring fluctuations in several countries, particularly Thailand and Vietnam. However, no formal seasonal decomposition or statistical analysis of seasonality was performed; therefore, these patterns should be interpreted with caution and cannot be considered evidence of true seasonal variation.

Annual mean RSV values increased in all five countries between 2020 and 2024 (Figure 2). Thailand consistently recorded the highest annual mean RSV throughout the study period, increasing from 43.3 in 2020 to 80.5 in 2024. The Philippines demonstrated a substantial increase from 18.3 to 48.3 over the same period, while Malaysia and Vietnam showed more moderate increases. Indonesia exhibited the lowest annual mean RSV values throughout the study period, although the annual mean increased from 4.8 in 2020 to 10.1 in 2024.

Relative growth analysis indicated increases in annual mean RSV values across all countries between 2020 and 2024 (Table 1). The Philippines exhibited the largest relative increase (+164%), followed by Indonesia (+110%), Thailand (+86%), Vietnam (+68%), and Malaysia (+59%). However, these percentages should be interpreted in the context of baseline values. Countries with lower initial RSV values may demonstrate large relative increases despite relatively small absolute changes in search interest. Therefore, both relative and absolute RSV values should be considered when comparing long-term changes across countries.

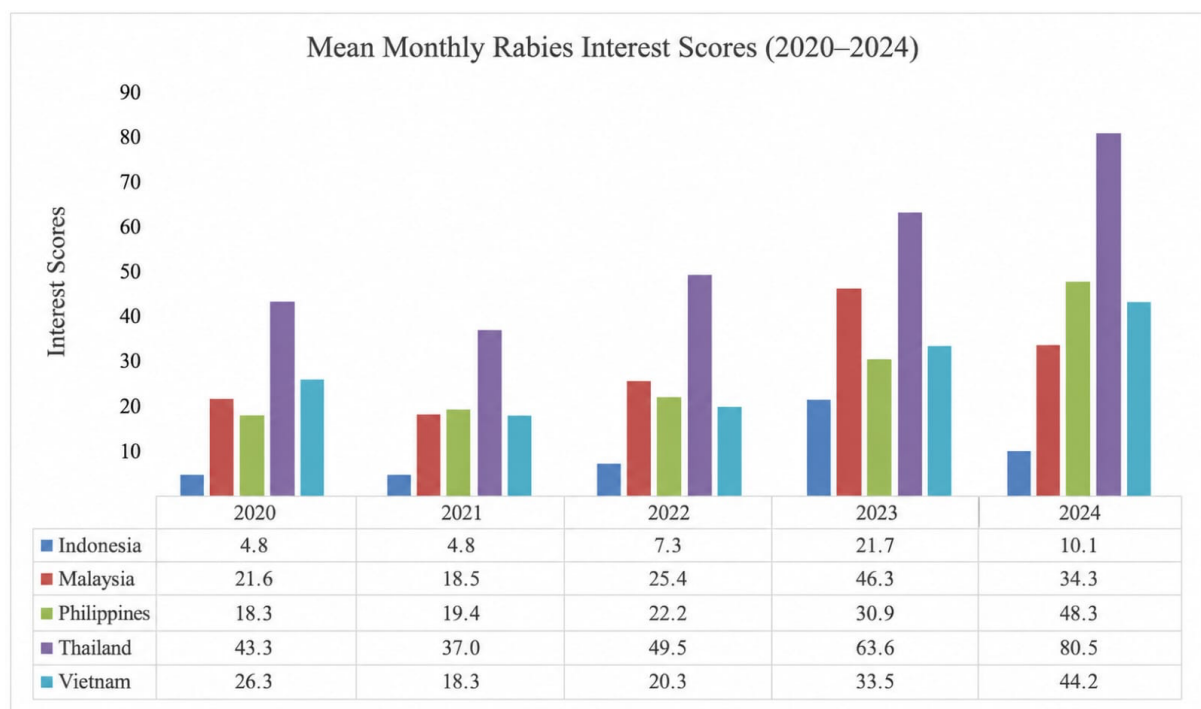


Figure 2. Mean monthly interest scores for rabies searches by country and year, 2020–2024

DISCUSSION

This study examined patterns of rabies-related online search behavior across five Southeast Asian countries using Google Trends data from 2020 to 2024. Overall, search interest increased across all countries during the study period, although substantial differences were observed in baseline levels, temporal fluctuations, and long-term growth trajectories. Thailand consistently demonstrated the highest relative search volume (RSV), whereas Indonesia showed the lowest baseline search interest despite several notable peaks. These findings indicate heterogeneity in rabies-related information-seeking behavior across the region and suggest that public attention toward rabies varies considerably among Southeast Asian countries.¹¹

The observed differences in search interest should be interpreted cautiously. Google Trends reflects online search behavior rather than direct measures of public awareness, disease burden, or healthcare-seeking behavior.^{21,22} Consequently, higher search volumes do not necessarily indicate greater knowledge about rabies, nor do lower search volumes imply poor awareness. Instead, search activity may be influenced by multiple factors, including media coverage, public health campaigns, internet accessibility, digital literacy, search engine usage patterns, and public interest generated by specific events.^{22–24}

The consistently higher search interest observed in Thailand may reflect a combination of factors, including widespread internet use, active public communication efforts, and sustained public engagement with rabies-related information.²⁰ However, caution is warranted when comparing RSV values across countries. Differences in search volumes may partly reflect variations in digital infrastructure, internet penetration, smartphone use, and online information-seeking behavior rather than actual differences in awareness or disease burden. Countries with lower search activity may still possess substantial knowledge regarding rabies through alternative information sources such as healthcare workers, schools, veterinary services, television, radio broadcasts, community-based programs, and local public health campaigns. Likewise, higher search activity may indicate a greater tendency to seek information online. Therefore, Google Trends data should be interpreted as indicators of relative online search interest rather than direct measures of awareness, knowledge, or public understanding of rabies.^{21–24}

Several countries demonstrated temporary increases in search activity during specific periods. Although such fluctuations may coincide with disease outbreaks, media reports, vaccination campaigns, World Rabies Day activities, or other awareness initiatives, the present study did not formally evaluate these associations. Therefore, the observed peaks should be interpreted as periods of increased information-seeking behavior rather than direct evidence of epidemiological events. Previous research has demonstrated that media coverage can substantially influence internet search activity, often generating large increases in public interest independent of actual disease occurrence.^{22–24} Future studies integrating surveillance data, media-event timelines, vaccination campaign records, and awareness activities may help clarify the factors underlying these temporal changes.

The findings of this study are broadly consistent with prior infodemiology research showing that online search activity can yield valuable insights into population responses to health-related issues. Studies involving influenza, dengue, COVID-19, and other infectious diseases

have found that internet search behavior often reflects shifts in public attention and information demand.^{9,23} Similar observations have been reported in Google Trends analyses, where increases in search activity often coincide with periods of heightened public concern, extensive media coverage, or intensified public discussion.^{22–24} However, previous studies have also emphasized that multiple contextual factors influence online search behavior and should not be interpreted as a direct proxy for disease incidence, disease burden, or public awareness.^{21–24} The present findings support this perspective and extend existing infodemiology literature by providing a comparative regional assessment of rabies-related search behavior across multiple Southeast Asian countries during the implementation period of the global “Zero by 30” rabies elimination strategy.

Another important finding was the substantial relative growth in search interest observed in several countries. However, these increases should be interpreted in the context of baseline RSV values. Countries with relatively low initial search volumes may exhibit large percentage increases despite modest absolute changes in search activity. Therefore, relative growth rates should be considered alongside absolute RSV values when evaluating changes over time. This consideration is particularly important when comparing countries with differing levels of digital engagement and internet utilization.

From a public health perspective, digital search data may serve as a complementary source of information for monitoring public interest in rabies and identifying periods of increased demand for information. While Google Trends cannot replace conventional surveillance systems, it may provide additional insights into communication needs, information-seeking behavior, and public engagement.^{6,22} Integrating digital epidemiology approaches with traditional surveillance and risk communication strategies could support ongoing rabies elimination efforts under the “Zero by 30” framework.⁴ Nevertheless, public health decision-making and rabies control policies should continue to rely primarily on epidemiological surveillance data rather than online search behavior alone.

Strength and Limitation

This study has several strengths. First, it provides a multi-country comparison of rabies-related online search behavior across Southeast Asia during the active implementation of the “Zero by 30” rabies elimination strategy.⁴ Second, the use of Google Trends enabled the examination of temporal patterns over five years using publicly accessible data.^{22,23} Third, the study contributes to the limited literature on rabies-related infodemiology in the region.

Several limitations should also be acknowledged. First, the analysis relied primarily on the English search term “rabies,” which may not fully capture searches conducted in local languages. Second, Google Trends provides normalized relative search volume rather than absolute search counts, limiting direct comparisons across countries and over time.^{23,24} Third, the study cannot establish causal relationships between search activity and actual rabies incidence, public awareness, healthcare-seeking behavior, media coverage, or public health interventions.^{21,22} Fourth, Google Trends does not provide information regarding user characteristics, preventing differentiation between searches performed by members of the general public, healthcare professionals, students, researchers, or media personnel.²³ Finally, internet access, digital literacy, and search engine preferences vary across countries and may influence observed search patterns independently of rabies-related factors.^{22–24}

CONCLUSION

Rabies-related online search interest increased across five Southeast Asian countries between 2020 and 2024, although substantial differences in search patterns were observed among countries. These findings suggest that Google Trends may provide useful complementary insights into population-level information-seeking behavior related to rabies and may help identify periods of increased public interest. However, Google Trends data should not be interpreted as a direct proxy for public awareness, healthcare-seeking behavior, or epidemiological burden, as multiple contextual factors, including media coverage, internet accessibility, digital literacy, and public health campaigns, may influence search activity. Future studies integrating digital search data with epidemiological surveillance and communication indicators are needed to understand better the role of online search behavior in supporting rabies control and elimination efforts.

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Declarations

Authors' contributions

A.W.W. contributed to research design, data collection, data analysis, and manuscript writing. F.K. contributed to research design, supervision, and manuscript revision. D.I. contributed to research design and manuscript revision.

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Conflict of interest

The authors declare no conflict of interest.

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