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RESEARCH ARTICLE

Dengue Trends and the Landscape of NGO-Led IEC/SBCC Engagement: A Five-State Descriptive Comparison from India (2021–2025)

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Abstract

Dengue is India's most rapidly expanding vector-borne disease, yet unlike malaria, supported by a centrally financed Global Fund NGO Sub-Recipient architecture, no equivalent NGO-partnership model exists for dengue control. This retrospective, ecological, descriptive comparison examined dengue trends (2021–2025) and mapped civil-society Information, Education and Communication/Social and Behaviour Change Communication (IEC/SBCC) engagement across India's five highest-burden states: Uttar Pradesh, Karnataka, Maharashtra, Tamil Nadu, and Rajasthan. Uttar Pradesh recorded the highest absolute burden, approximately 110,047 cases, but, being India's most populous state, the lowest population-adjusted incidence (45.6/100,000); Karnataka, smallest in population among the five, recorded the highest incidence (113.4/100,000). Maharashtra recorded the highest case-fatality ratio (0.254%). States with more intensive interpersonal or mass-media IEC/SBCC engagement showed steeper case decline, though the design precludes causal inference. India's dengue civil-society landscape remains fragmented and disproportionate to population-adjusted burden, an equity concern warranting a structured, centrally coordinated NGO/IEC-SBCC partnership framework with standardised monitoring and evaluation.

Keywords: *Dengue; India; IEC/SBCC; NGO partnership; vector-borne disease; health communication; NVBDCP; health equity*

Key Points

- India's dengue civil-society landscape is fragmented and state-specific, lacking the centrally financed NGO partnership model that supports malaria elimination in India.
- Population-adjusted incidence reverses the absolute burden ranking: Karnataka, not Uttar Pradesh, carries the highest per-capita dengue burden among the five study states, an equity concern.
- States with more intensive interpersonal or mass-media IEC/SBCC engagement showed steeper case decline; a structured, centrally coordinated NGO partnership framework is recommended.

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1 Introduction

Dengue fever is India's most rapidly expanding vector-borne disease, with the country contributing a substantial share of the global burden [1]. Transmitted primarily by *Aedes aegypti* and, to a lesser extent, *Aedes albopictus*, it has evolved from a seasonal urban nuisance into a year-round, geographically expanding threat, driven by unplanned urbanisation, inadequate water-storage practices, and climate variability that lengthens vector breeding seasons [2, 3].

National surveillance data from the National Centre for Vector Borne Diseases Control (NCVBDC) illustrate this scale: India recorded 193,245 dengue cases in 2021, rising to a five-year peak year, despite all operating under the same National Vector Borne Disease Control Programme (NVBDCP), delivered through State Vector-Borne Disease Cells under the National Health Mission (NHM) [4, 5, 6, 7]. Uttar Pradesh, Karnataka, Maharashtra, Tamil Nadu, and Rajasthan together accounted for a substantial share of the national burden – approximately 33.5% of India's 289,235 cases in the 2023 peak year.

A distinguishing feature of India's dengue response, relative to malaria, is the absence of a structured, centrally financed non-governmental organization (NGO) partnership architecture. Malaria elimination is substantially supported through Global Fund (GFATM)-financed NGO Sub-Recipients operating under multi-year grant cycles [8]. No equivalent mechanism exists for dengue; civil-society engagement instead follows fragmented, state-specific lines: international NGO partnerships in Uttar Pradesh and Maharashtra [9], corporate-NGO IEC campaigns originating in Rajasthan [10, 11], research-institute-led citizen-science partnerships in Karnataka [12], and legacy community organisations and women's self-help groups in Tamil Nadu [13, 14].

This fragmentation raises an underexamined ques-

tion: does the type and intensity of Information, Education and Communication (IEC)/Social and Behaviour Change Communication (SBCC) engagement, whether interpersonal, mass-media, technology-enabled, or institutionalised, co-occur with more favourable dengue trends? Community-level evidence is suggestive: a Delhi intervention reduced House Index from 21.65% to 4.45% ($P < 0.05$) after a two-session IEC intervention [15]; a Chennai cluster-randomised eco-health trial reduced vector pupal indices through community-based IEC engaging schoolchildren alongside municipal vector-control units [13]; and a Jodhpur KABP study found awareness of mosquito breeding sources rising from 3% to 78% after targeted IEC [11]. Whether such findings translate into state-level epidemiological patterns remains unexamined.

This study undertakes a descriptive comparison of dengue trends (2021–2025) across India's five highest-burden states, and maps the corresponding IEC/SBCC landscape. It aims to: (i) characterise state-wise case and mortality trends in absolute and population-adjusted terms; (ii) map the nature, scale, and evidentiary strength of NGO/civil-society IEC-SBCC interventions; and (iii) descriptively examine whether IEC/SBCC channel-type co-occurs with epidemiological trajectories, contributing a policy-relevant evidence base on whether the NGO partnership model underpinning India's malaria gains offers lessons for dengue control.

2 Materials and Methods

2.1 Study Design

This retrospective, ecological descriptive comparison synthesises secondary data on state-level dengue trends alongside a structured mapping of IEC/SBCC interventions in India's five highest-burden states (2021–2025). As the study uses aggregate secondary data without individual-level exposure ascertainment or inferential testing, reporting follows applicable elements of the STROBE checklist, adapted for a multi-state ecological design.

2.2 State Selection

States were selected by ranking cumulative dengue case counts (2021–2025) for all 36 Indian states and Union Territories from NCVBDC surveillance records; the five highest-burden states, Uttar Pradesh, Karnataka, Maharashtra, Tamil Nadu, and Rajasthan, were selected. West Bengal was excluded owing to incomplete, non-comparable reporting for 2023–2025.

2.3 Data Sources

Annual case and death counts (2021–2025) were obtained from the NCVBDC, Ministry of Health & Family Welfare – the designated national nodal authority for vector-borne disease surveillance under the NVBDCP [4]. The source dataset spans January 2021 to April 2026, but only complete calendar-year totals for 2021–2025 were used. Population denominators for incidence calculation were drawn from official 2025 state population projections [16]. IEC/SBCC and civil-society programme data were compiled through a structured search of peer-reviewed literature (PubMed/PMC, Scopus-indexed journals), official government documentation, and, where peer-reviewed evidence was unavailable, cross-checked organisational and news reporting; each entry in Table 3 is labelled by evidence-source type. Programme start-dates for Uttar Pradesh, Maharashtra, and Rajasthan are drawn from dated sources predating the epidemiological trends analysed; Karnataka's and Tamil Nadu's recent-intensification timing could not be independently dated, and this is addressed as a limitation below.

2.4 Variables and Analytical Framework

Indicators included annual case and death counts, cumulative case burden, case-fatality ratio (CFR), timeliness of diagnosis, population-adjusted cumulative incidence per 100,000, and percentage case decline between each state's peak year and 2025, calculated systematically for all states. No inferential statistical testing (e.g., correlation, regression) was performed. IEC/SBCC engagement was classified into four non-mutually-exclusive channel types: interpersonal/household-based, mass-media/corporate-sponsored, technology-enabled citizen science, and institutionalised community structures. With $n = 5$ states and unquantified exposure intensity, the design does not support formal hypothesis testing.

2.5 Limitations

Key limitations include: the ecological design precludes causal inference; publicly available programme documentation likely under-represents smaller civil-society actors; case-reporting completeness may vary across states, potentially confounding cross-state comparisons; no district-level linkage between IEC/SBCC exposure and outcomes was available; the timing of Karnataka's and Tamil Nadu's programmes could not be independently dated, creating a risk of post hoc alignment with observed case trends (Table 3); and, with $n = 5$ states and unquantified exposure, duration, and reach, the comparisons reported are descriptive juxtapositions rather than a formal comparative analysis, not intended to support statements of statistical association.

3 Results

3.1 State-wise Dengue Trends, 2021–2025

Uttar Pradesh recorded the highest single-year count (35,402 in 2023) and the highest cumulative burden (110,047), declining to 9,206 by 2025. Karnataka peaked later, in 2024 (32,886), consistent with municipal (BBMP) data describing 2024 as a record year for Bengaluru, then declined sharply to 7,325 in 2025. Maharashtra showed a moderate, fluctuating trend, peaking at 19,385 in 2024. Tamil Nadu each evolved, demonstrating a sustained rise through 2021–2024 (27,378), remaining elevated at 23,407 in 2025. Rajasthan's highest value was 20,749 in 2021, the first study year, declining to 4,348 by 2025.

Table 1 presents annual case and death counts [4].

Figure 1 illustrates the state-wise annual dengue case

Table 1. State-wise annual dengue cases (deaths in parentheses), cumulative cases, population, and cumulative incidence, 2021–2025.

State	2021	2022	2023	2024	2025	Cumulative Cases	Pop. (M) 2025 [16]	Incidence (per 100k)
Uttar Pradesh	29,750 (29)	19,821 (33)	35,402 (36)	15,868 (9)	9,206 (3)	110,047	241.3	45.6
Karnataka	7,393 (7)	9,889 (9)	19,300 (11)	32,886 (27)	7,325 (0)	76,793	67.7	113.4
Maharashtra	12,720 (42)	8,578 (27)	19,034 (55)	19,385 (40)	14,168 (24)	73,885	126.4	58.5
Tamil Nadu	6,039 (8)	6,430 (8)	9,121 (12)	27,378 (13)	23,407 (12)	72,375	76.9	94.1
Rajasthan	20,749 (96)	13,491 (10)	13,924 (14)	12,514 (5)	4,348 (3)	65,026	81.0	80.3

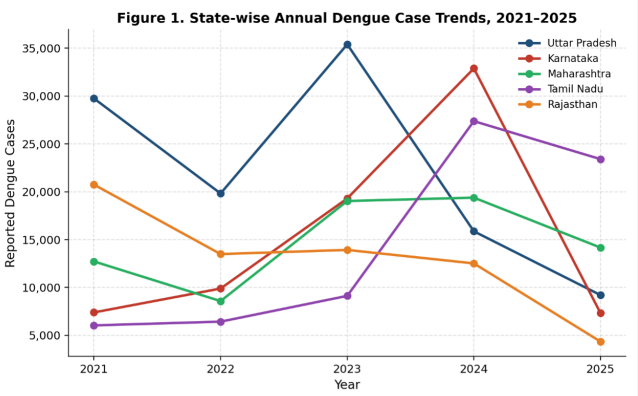


Figure 1. State-wise annual dengue case trends, 2021–2025 (source: NCVBDC surveillance data [4]).

trends from 2021 to 2025.

Table 2 reports the percentage decline between each state's peak year and 2025 for systematic comparison. Rajasthan (79.0%) and Karnataka (77.7%) showed the largest declines, followed by Uttar Pradesh (74.0%); Maharashtra (26.9%) and Tamil Nadu (14.5%) showed markedly smaller declines.

3.2 Population-Adjusted Incidence and Case-Fatality Ratio

Absolute counts do not account for the states' very different populations. Karnataka, with under a third of Uttar Pradesh's population, carries the highest cumulative incidence (113.4 per 100,000); Tamil Nadu was second (94.1), followed by Rajasthan (80.3) and Maharashtra (58.5). Uttar Pradesh, with the largest population and lowest per-capita incidence, recorded 45.6 per 100,000.

Maharashtra recorded the highest case-fatality ratio (0.254%) despite mid-range case volume; Rajasthan's ratio (0.197%) reflected deaths concentrated early in the study period, with 96 of 128 cumulative deaths occurring in 2021 alone. Karnataka (0.070%) and Tamil Nadu (0.073%) recorded the lowest ratios.

Figure 2 presents the cumulative dengue case burden (Panel A) and case-fatality ratio (Panel B) by state.

Figure 3 displays the population-adjusted cumulative dengue incidence by state.

3.3 IEC/SBCC and NGO/Civil-Society Landscape

Table 3 summarises each state's dominant IEC/SBCC channel and evidence-source type. No mapped programme operates within a centrally financed NGO Sub-Recipient framework comparable to the GFATM architecture supporting malaria elimination [8]. Uttar Pradesh, Maharashtra, Rajasthan, and Tamil Nadu each have at least one peer-reviewed or dated organisational source; Karnataka's entry rests solely on organisational and news-media material, with no peer-reviewed evaluation identified.

3.4 Cross-Cutting Observations

Table 4 provides a qualitative characterisation of channel intensity and recency, since none of the mapped programmes publish quantified reach or dose data. Rajasthan, an episodic, mass-reach campaign, and Karnataka, recently intensified and city-focused, both show steep declines despite markedly different intensity profiles, while Maharashtra's modest decline despite sharing Uttar Pradesh's sustained programme indicates that channel type alone does not determine outcome.

Rajasthan's decline co-occurs with peer-reviewed KABP evidence of measurable awareness gains [11]; Uttar Pradesh's and Maharashtra's divergent declines under the same programme, and Karnataka's and Tamil Nadu's undated programme timing, mean these comparisons should be read as illustrative co-occurrence rather than evidence of a programme effect. With $n = 5$ states and no inferential testing, these patterns are descriptive and hypothesis-generating rather than causal.

4 Discussion

This descriptive comparison of India's five highest dengue-burden states highlights three policy-relevant findings. First, considerable heterogeneity in case trajectory, population-adjusted incidence, and case-fatality ratio exists across states operating under an identical national programmatic framework (NVBDCP/NHM), suggesting that state-level implementation capacity and civil-society engagement materially shape outcomes beyond what national policy architecture alone predicts, consistent with broader analyses of India's dengue epidemiology documenting substantial inter-state heterogeneity linked to climatic, socioeconomic, and health-system factors [6, 7, 17, 18].

Second, population adjustment materially changes which states appear to carry the greatest burden. Uttar Pradesh's dominance in absolute counts reflects, in substantial part, its position as India's most populous state; on a population-adjusted basis, Karnataka carries the highest cumulative incidence. Resource allocation

Table 2. Cumulative deaths, case-fatality ratio, and peak-year to 2025 case decline, by state, 2021–2025.

State	Cumulative Deaths	CFR (%)	Peak Year	Peak-Year Cases	% Decline, Peak Year to 2025
Uttar Pradesh	110	0.100	2023	35,402	74.0
Karnataka	54	0.070	2024	32,886	77.7
Maharashtra	188	0.254	2024	19,385	26.9
Tamil Nadu	53	0.073	2024	27,378	14.5
Rajasthan	128	0.197	2021*	20,749	79.0

*Rajasthan's peak-year value (2021) coincides with the first study year (see Section 3.1).

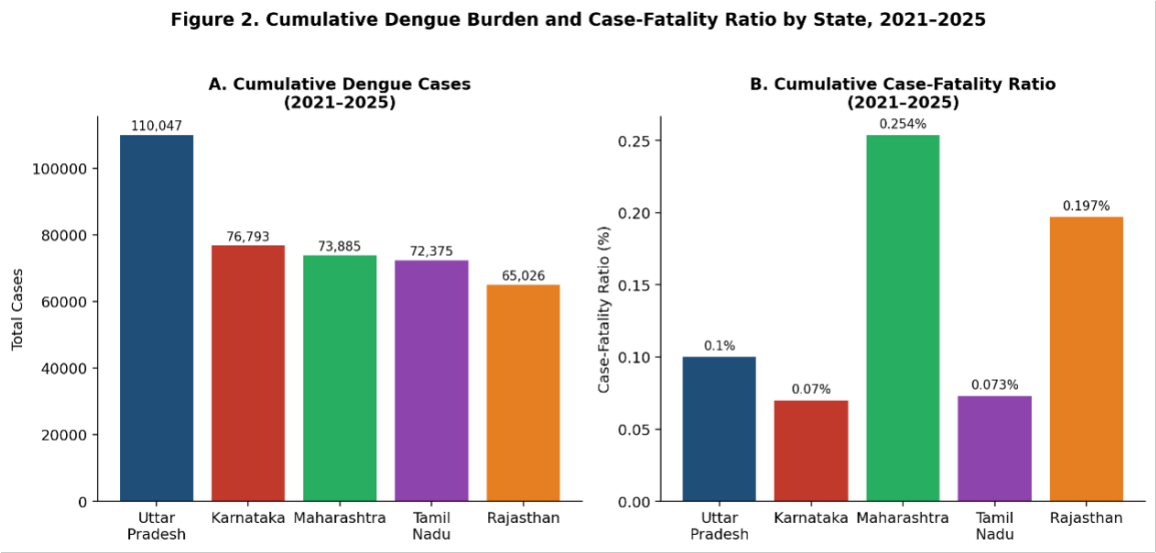


Figure 2. Cumulative dengue case burden (Panel A) and case-fatality ratio (Panel B) by state, 2021–2025 (source: NCVBDC surveillance data [4]).

Table 3. Mapped IEC/SBCC channel type, civil-society actors, and evidence-source type, by state.

State	Primary Channel	Key NGO / Actors	Nature of Engagement	Evidence Source
Uttar Pradesh	Interpersonal / household	PATH-CHRI [9]	Household surveillance, source-reduction education	Organisational
Maharashtra	Interpersonal / household	PATH-CHRI [9]	Household surveillance and IEC extension	Organisational
Rajasthan	Mass-media / corporate	VHAI + SC Johnson [10]	"Fight Dengue for Payal" national campaign	Peer-reviewed + org.
Karnataka	Technology citizen science	TIGS, Rotary, ATREE [12]	Citizen reporting tools, Ovitrap pilots	Org. / news media
Tamil Nadu	Institutionalised community	MCCSS, Karunalaya, SHGs [13, 14]	School dissemination, clean-ups, SHG engagement	Peer-reviewed (RCT)

and IEC/SBCC investment decisions based solely on absolute case counts risk under-prioritising states with a genuinely higher per-capita burden.

Third, and central to this study's contribution, India's dengue-control civil-society landscape is markedly fragmented compared with malaria, for which the GFATM-financed NGO Sub-Recipient model channels multi-year financing to civil-society actors [8]. The programmes mapped here, an international NGO partnership in Uttar Pradesh and Maharashtra, a corporate-sponsored mass-media campaign in Rajasthan, a research-institute-led technology partnership in Karnataka, and legacy community organisations in Tamil Nadu, each evolved independently, with no evident central coordination or standardised monitoring and evaluation framework.

The co-occurrence between more intensive interpersonal or mass-media IEC/SBCC engagement and steeper peak-to-2025 decline (Rajasthan, Uttar Pradesh, Karnataka), set against Maharashtra's and Tamil Nadu's comparatively modest declines, is broadly consistent with the wider IEC/SBCC literature, though it does not constitute a formal comparative test and should not be read as a statistical association. Evidence from Delhi [15] and Jodhpur [11] shows that structured IEC interventions can produce measurable improvements in household-level entomological indices and knowledge-practice gaps within months, though WHO's COMBI (Communication for Behavioural Impact) guidance emphasises that

Table 4. Qualitative characterisation of IEC/SBCC channel type, estimated intensity/recency, and peak-to-2025 dengue case decline.

State	IEC/SBCC Channel Type	Estimated Intensity and Recency (qualitative)	% Decline
Uttar Pradesh	Interpersonal / household	Sustained, multi-year engagement (since 2020); multi-district reach	74.0
Karnataka	Technology citizen science	Recently intensified (reported 2024–2025); volunteer-based, city-focused	77.7
Maharashtra	Interpersonal / household	Same programme as Uttar Pradesh, extended alongside it; unquantified	26.9
Tamil Nadu	Institutionalised community	Established model (from 2007–2009 trial); no post-2020 intensification	14.5
Rajasthan	Mass-media / corporate	Recurring national campaign (since 2013); episodic, mass-reach model	79.0

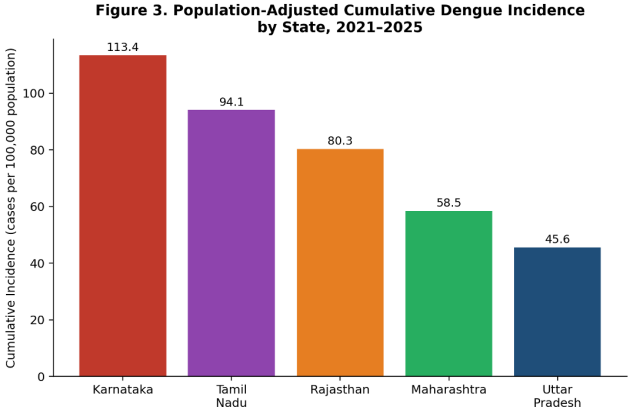


Figure 3. Population-adjusted cumulative dengue incidence by state, 2021–2025 (cases per 100,000 population, derived from NCVBDC surveillance data [4] and 2025 population projections [16]).

sustained, rather than episodic, investment is required to translate awareness into durable practice change [19]. Tamil Nadu each evolved, demonstrating a sustained rise through 2024.

The equity dimension of this fragmented landscape deserves explicit attention. Karnataka, despite the smallest population among the five states, recorded both the highest population-adjusted incidence and an IEC/SBCC channel resting on the weakest, undated evidence base (Table 3), while Uttar Pradesh has hosted a multi-year, internationally partnered intervention with clearly dated documentation. This suggests civil-society engagement may not currently be allocated in proportion to population-adjusted burden, an equity concern for any future NGO-partnership framework.

Maharashtra's disproportionately high case-fatality ratio relative to its case volume warrants attention. Because CFR reflects both disease severity and health-system factors, timeliness of diagnosis, access to supportive care, and case-management adherence, this finding cannot be attributed to IEC/SBCC engagement alone and may instead point to gaps in clinical case-management capacity. Prevention-oriented IEC/SBCC investment should therefore be paired with, not substituted for, parallel strengthening of case-management and referral systems in high-CFR states.

These findings should be read in the context of the study's ecological, descriptive design. Because exposure intensity, duration, and reach were not quantified, and case trends reflect the aggregate influence of vector-control intensity, climatic variation, reporting sensitivity, and health-system capacity, the patterns above are descriptive co-occurrences and hypothesis-generating observations rather than causal or statistically tested associations. State-specific confounding factors deserve mention: Uttar Pradesh's 2023 peak coincided with above-average monsoon rainfall, independently linked to transmission intensity [2, 3]; Karnataka's 2024 peak coincided with rapid construction-driven urban expansion in Bengaluru, which independently generates new breeding habitats [2]; Maharashtra's persistently elevated counts may partly reflect the dense, mixed urban-slum settlement patterns of Mumbai and Pune; Tamil Nadu's sustained rise through 2024 coincides with Chennai's continued urban expansion; and Rajasthan's unusually high 2021 death count (96 of 128 cumulative deaths) occurred during a year of substantial COVID-19-related healthcare disruption, which plausibly affected case ascertainment and management independently of any IEC/SBCC effect. None of these factors were independently measured or controlled for; their mention is illustrative rather than exhaustive. Future district-level linkage between documented, independently dated IEC/SBCC exposure and entomological or case outcomes, ideally through prospective or quasi-experimental designs with quantified exposure and appropriate denominators, would strengthen the evidence base considerably.

5 Conclusion and Recommendations

India's dengue-control civil-society landscape remains fragmented, state-specific, and largely uncoordinated at the national level, in marked contrast to the structured, centrally financed NGO partnership architecture underpinning the country's malaria elimination programme. This fragmentation may not be proportion-

ate to population-adjusted burden: Karnataka, with the smallest population among the five study states, carries the highest cumulative incidence while relying on the least well-documented IEC/SBCC channel. States engaging more intensive interpersonal or mass-media channels showed a pattern of co-occurrence with steeper peak-to-2025 decline, while a state relying on an established but less recently intensified institutional-community model showed the most modest decline; these patterns are descriptive rather than causal. Based on these findings, four recommendations are proposed.

First, NCVBDC and state Vector-Borne Disease Cells should consider developing a structured, centrally coordinated NGO/civil-society partnership framework for dengue analogous to the GFATM Sub-Recipient model for malaria, with resource allocation informed by population-adjusted incidence rather than absolute case counts alone. Any such framework should build in, from the outset, mandatory standardised monitoring and evaluation covering both process indicators (household or population reach, contact frequency, geographic coverage) and outcome indicators (entomological indices such as House/Container/Breteau Index, alongside incidence), so future evaluations are not limited to descriptive co-occurrence in the absence of quantified exposure data.

Second, states with predominantly institutionalised but not recently intensified community-engagement models, such as Tamil Nadu, may benefit from periodic reinvestment and refresh of IEC/SBCC campaign intensity, given evidence that sustained rather than episodic engagement is associated with durable behaviour change.

Third, states exhibiting disproportionately high case-fatality ratios relative to case volume, such as Maharashtra, warrant parallel investment in case-management and diagnostic-access strengthening alongside preventive IEC/SBCC activity.

Fourth, future research should prioritise district-level or programme-linked evaluation designs with quantified exposure intensity, duration, and reach, and appropriate population denominators, capable of establishing formally tested relationships between specific IEC/SBCC interventions and epidemiological outcomes, addressing the descriptive, hypothesis-generating limitations of the present comparison.

Declarations

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used Claude (Anthropic) to assist with organising, formatting, and language editing of the content. All data, analysis, interpretation, and scientific conclusions are the authors' own. The author(s) reviewed, verified, and edited all AI-assisted content as necessary, and take full responsibility for the accuracy and integrity of the published article.

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Conflict of interest

The authors declare no conflict of interest.

Ethics approval

Not applicable. This study used publicly available, aggregate, de-identified secondary surveillance data; no primary data collection involving human participants was undertaken.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material

The dengue case and death data analysed in this study are publicly available from the National Centre for Vector Borne Diseases Control (NCVBDC), Ministry of Health & Family Welfare, Government of India. The compiled dataset and IEC/SBCC programme-mapping table are available from the corresponding author upon reasonable request.

Code availability

The code used to compute population-adjusted incidence, case-fatality ratios, and to generate the figures is available from the corresponding author upon reasonable request.

Authors' contributions

Shantanu Shrivastava conceptualised the study, acquired and analysed the dengue surveillance and IEC/SBCC programme data, prepared the figures and tables, and wrote the initial version of the manuscript. Nimisha Bhatu jointly conceptualised the study, supervised the analytical framework, and critically reviewed the manuscript for important intellectual content. Both authors jointly wrote the final version of the manuscript and approved it for submission.

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