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Community Empowerment For Dengue Prevention Through Breeding Site Mapping And Kap-Based Behavioral Strengthening In A Hyperendemic Urban Area

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ABSTRAK

Dengue tetap menjadi masalah kesehatan masyarakat yang signifikan di wilayah perkotaan hiperendemik seperti Surabaya. Studi ini mengintegrasikan analisis host–agent–environment dan pemetaan tempat perindukan untuk mengidentifikasi faktor perilaku dan ekologis yang memengaruhi penularan dengue di Sambikerep. Pendekatan mixed-methods mencakup: (1) kuesioner KAP tervalidasi pada tujuh RW; (2) observasi tempat perindukan nyamuk di luar ruangan; dan (3) inspeksi dalam rumah untuk mendeteksi jentik dan menghitung House Index (HI). Analisis korelasi menilai hubungan antara skor KAP dan HI, sementara observasi kualitatif memberikan konteks temuan. Skor KAP menunjukkan korelasi negatif yang signifikan dengan HI ($r = -0.715$, $p < 0.05$), menunjukkan bahwa tingkat kesadaran yang lebih tinggi berkaitan dengan lebih rendahnya keberadaan jentik di dalam rumah. Namun, titik perindukan seperti water meter, pot tanaman, dan saluran drainase tetap ditemukan meskipun skor KAP relatif tinggi, mengindikasikan adanya hambatan struktural. Pendekatan multidimensional yang menggabungkan asesmen perilaku dan pemetaan lingkungan sangat penting. Pengendalian berkelanjutan memerlukan intervensi yang mengintegrasikan edukasi, keterlibatan komunitas, dan pengelolaan lingkungan di area perkotaan hiperendemik.

Kata kunci: Dengue, House Index, Knowledge Attitude Practice (KAP), Tempat Perindukan Nyamuk, Model Host–Agent–Environment.

ABSTRACT

Dengue remains a major public health concern in hyperendemic urban areas like Surabaya. This study integrates host–agent–environment analysis and breeding-site mapping to identify behavioral and ecological factors influencing dengue transmission in Sambikerep. A mixed-methods approach included: (1) a validated KAP questionnaire across seven RWs; (2) observation of outdoor breeding sites; and (3) indoor inspections to detect larvae and calculate the House Index (HI). Correlation analyses assessed links between KAP scores and HI, while qualitative observations contextualized findings. KAP scores showed a significant inverse correlation with HI ($r = -0.715$, $p < 0.05$), indicating higher awareness was associated with lower indoor larval presence. However, breeding hotspots—such as water meters, pots, and drainage—persisted despite relatively high KAP levels, suggesting structural barriers. A multidimensional approach combining behavioral assessment and environmental mapping is crucial. Sustainable control requires interventions integrating education, community engagement, and environmental management in hyperendemic urban settings.

Keyword: Dengue, House Index, Knowledge Attitude Practice (KAP), Mosquito Breeding Site, Host–Agent–Environment Model.

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INTRODUCTION

Dengue hemorrhagic fever (DHF) remains a significant public health threat in Indonesia, with East Java consistently ranking among the provinces with the highest case burdens (Harapan et al., 2019). Within East Java, Surabaya stands out as a densely populated urban center with a consistently high dengue incidence. According to local health authority surveillance data, Surabaya classifies its dengue-prone areas using a "zone system," with red zones representing the most critical dengue clusters (Devi et al., 2024). Based on 2023–2024 data, Sambikerep subdistrict remains a persistent red zone, marked by recurring outbreaks and a failure to reduce larval indices below the threshold despite routine intervention programs (Dinas Kesehatan Kota Surabaya, 2025).

The persistence of dengue in such red zones highlights critical gaps in current vector control strategies. While Indonesia's national program emphasizes 3M Plus (draining, closing, recycling, and adding preventive measures), its effectiveness is often undermined by behavioral, environmental, and vector-related factors that are not adequately addressed in a siloed approach (Lusno et al., 2020)[4]. The Host–Agent–Environment (HAE) framework offers a more comprehensive lens by integrating these three domains: the host, the agent, and the environment (California Department of Public Health, 2019; Lakes et al., 2025).

In practice, however, the application of the HAE framework in dengue-endemic urban settings like Sambikerep has been limited. Prior studies in Surabaya have demonstrated associations between low knowledge and poor preventive practices and increased larval indices, as well as the role of seasonal rainfall and urban microclimates in sustaining Aedes breeding habitats (Newman et al., 2024; Prastiani & Prasasti, 2020). Still, these domains are often analyzed in isolation rather than through an integrative approach. At the same time, fine-scale breeding site mapping—particularly at the container level—has proven effective in identifying high-risk environments, especially when linked to behavioral and climatic factors (Ferraguti et al., 2023).

Sambikerep's residential clusters consist largely of low-to-middle-income settlements with varied sanitation infrastructure and inconsistent participation in larva monitoring (Jumantik) programs. Field observations and health service reports indicate a high density of uncovered water containers, nonfunctional drainage systems, and improper waste management—conditions that favor year-round Aedes breeding. Yet, there is a lack of precise spatial data linking container types, household behavior, and environmental conditions to dengue incidence patterns.

This study proposes a mixed-methods design that integrates Host–Agent–Environment analysis with breeding site mapping at the household and neighborhood levels in Sambikerep. By combining quantitative surveys, entomological inspections, environmental assessments, and qualitative interviews, this research aims to uncover the key drivers behind the red zone status and identify actionable intervention points. The results are expected to inform evidence-based, geographically targeted dengue prevention strategies—filling a critical gap in the operationalization of the HAE framework within Indonesia's urban dengue control efforts.

METHODS

Study Design and Setting

This study adopted a cross-sectional mixed-methods approach, conducted in Sambikerep Subdistrict, Surabaya, East Java, Indonesia. Sambikerep was purposely selected based on its designation by the Surabaya City Health Office as a persistent red zone for dengue transmission. The designation was based on local epidemiological indicators, including a larval index exceeding 5%, a case incidence rate surpassing 55 per 100,000 population, and evidence of sustained transmission across consecutive months within the previous three years. Data collection was carried out between May and June 2025, coinciding with the seasonal peak of dengue vector activity in the region.

To comprehensively assess the multifactorial nature of dengue risk, this study utilized three integrated forms of data collection: a household-based survey on knowledge, attitudes, and practices

(KAP); structured environmental observation of outdoor breeding sites; and indoor entomological inspections to determine the house index and other vector-related indicators. Together, these instruments operationalized the Host–Agent–Environment (HAE) framework and enabled spatial and statistical triangulation of risk factors.

Sampling and Participant Recruitment

A multistage stratified random sampling technique was used to ensure representativeness across the ecological and demographic heterogeneity of Sambikerep. The subdistrict was stratified into risk zones based on historical dengue incidence and larval index data, and a proportional number of households were randomly selected from each zone. A total of 100 households were included in the final sample. Eligibility criteria included permanent residence in Sambikerep and provision of informed consent for participation in all aspects of the study, including indoor inspections.

KAP Survey for Host Factor Assessment

The assessment of host-related behavioral determinants was conducted using a structured questionnaire administered to one adult respondent per household. The instrument evaluated three domains: knowledge of dengue symptoms, transmission modes, and vector ecology; attitudes toward the disease's severity and community responsibility; and reported practices in relation to prevention behaviors, such as the 3M Plus strategy (draining, covering, recycling, and additional protective measures).

The questionnaire was adopted from a previously validated and widely used KAP tool developed for urban Indonesian contexts, with prior studies reporting Cronbach's alpha coefficients exceeding 0.80 for internal consistency (Prayitno et al., 2025). Responses were scored using both dichotomous and Likert-type scales, and cumulative scores were categorized into low, moderate, and high based on percentile cutoffs. Enumerators received standardized training to ensure consistency in administration.

Outdoor Observation for Environmental Factor Assessment

To assess environmental risk factors, local field officers in this setting by Kader Surabaya Hebat (KSH) conducted systematic observations of the peridomestic area surrounding each selected household. Observations were guided by a structured checklist adapted from World Health Organization (WHO) guidelines for Aedes surveillance. Field teams documented the presence, type, and condition of all water-holding containers located outdoors, including discarded items, storage vessels, plant pots, and drains. Each potential breeding site was examined for the presence of stagnant water and, where possible, for larvae or pupae using flashlight inspection and larval dipping techniques.

Indoor Entomological Inspection for Agent Assessment

To assess the presence of Aedes larvae within the household, indoor inspections were performed by local field officers in this setting by Kader Surabaya Hebat (KSH) in collaboration with local Jumantik (community-based larva monitoring volunteers). All accessible water storage containers inside the home were inspected, including bathtubs, storage drums, buckets, flower vases, and aquariums. Observers recorded whether each container was positive for mosquito larvae or pupae.

From these data, three entomological indices were calculated: the House Index (HI), defined as the percentage of inspected houses containing at least one positive container; the Container Index (CI), defined as the percentage of water-holding containers that were positive; and the Breteau Index (BI), defined as the number of positive containers per 100 houses inspected. These indices were calculated according to WHO standard formulas and are commonly used in dengue epidemiology for larval density surveillance.

Data Analysis

All data were entered and cleaned using Microsoft Excel 365 and subsequently analyzed using SPSS version 26.0. Descriptive statistics were used to summarize demographic characteristics, KAP scores, breeding container types, and larval index values. Associations between KAP categories and the presence of indoor or outdoor breeding sites were examined using chi-square tests for categorical variables and Spearman's rank correlation for ordinal data.

Multivariate logistic regression analyses were conducted to identify independent predictors of household larval positivity, with variables including KAP levels and specific environmental risk factors. Spatial clustering and visualization of outdoor container locations were performed using QGIS to identify high-risk geographic zones within Sambikerep. The three data sources—behavioral, environmental, and entomological—were integrated using spatial overlay analysis and narrative triangulation to identify overlaps in risk domains.

RESULT AND DISCUSSION

Participant Characteristics

A total of 100 residents of Sambikerep District, Surabaya, were included in this study. Participants' ages ranged from 22 to 72 years, with a mean age of 46.27 years (SD = 12.72), representing a broad distribution of adult age groups. The assessment of community knowledge, attitude, and practice (KAP) toward dengue prevention was conducted using a previously validated and reliable instrument. The knowledge scores ranged from 0 to 10, with a mean score of 5.70 (SD = 1.96), indicating a moderate level of awareness regarding dengue transmission, symptoms, and prevention strategies. The attitude scores ranged from 3 to 8, with a mean of 6.70 (SD = 0.99), reflecting generally positive attitudes toward dengue control measures. Meanwhile, the practice scores ranged from 1 to 10, with a mean of 7.12 (SD = 2.14), suggesting a relatively high level of adherence to preventive behaviors such as eliminating mosquito breeding sites and seeking prompt medical attention.

Tabel 1. Karakteristik Responden

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age	100	50	22	72	46.27	12.723
Total Knowledge Score	100	10	0	10	5.70	1.957
Total Attitude Score	100	5	3	8	6.70	.990
Total Practice Score	100	9	1	10	7.12	2.143
Valid N (listwise)	100					

In terms of educational attainment, the majority of participants (67.0%) had completed high school, followed by 24.0% with higher education qualifications. A smaller proportion had only completed middle school (6.0%) or elementary school (3.0%). Regarding income levels, 64.0% of participants reported monthly incomes below five million rupiah (classified as low income), whereas 36.0% were in the high-income category.

Based on Figure 1A, Analysis of knowledge regarding dengue and its transmission revealed that 25.0% of respondents exhibited low knowledge levels, 59.0% were classified in the moderate category, and only 16.0% demonstrated high knowledge. In contrast, in Figure 1B attitude levels toward dengue prevention were markedly favorable, with 75.0% of respondents categorized as having a high attitude score, 24.0% moderate, and only 1.0% low. With respect to preventive practices according to Figure 1C, 45.0% of respondents fell into the high practice category, 40.0% demonstrated moderate levels, and 15.0% had low levels of practice. This suggests that although knowledge on dengue transmission

remains moderate for the majority, there is a strong tendency toward positive attitudes and active preventive behaviors among the population.

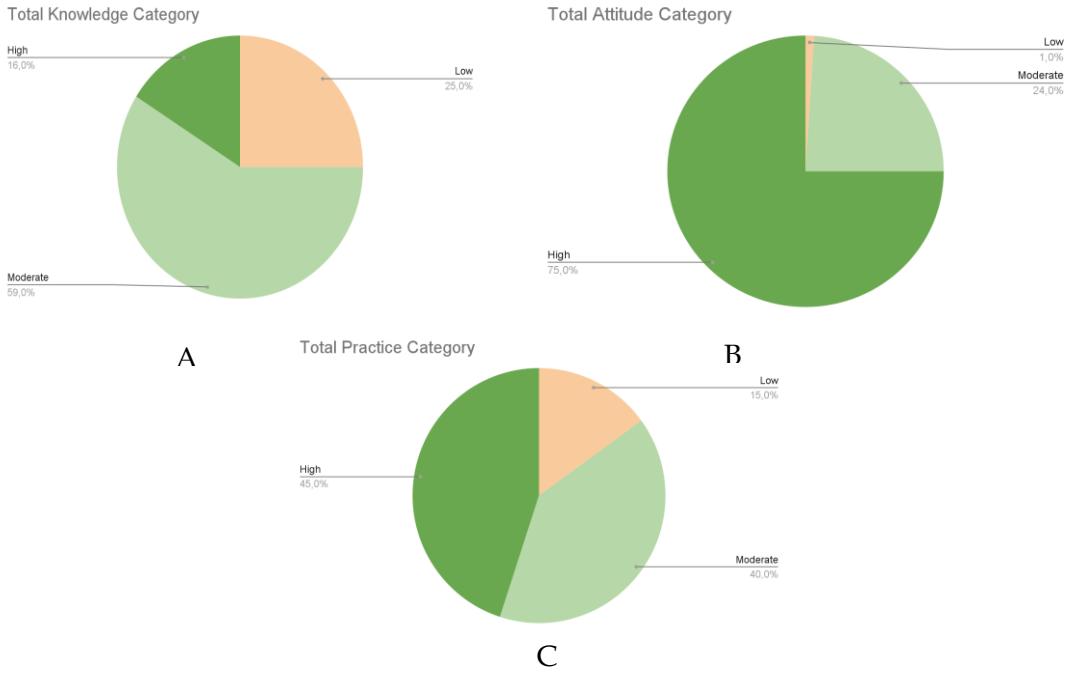


Figure 1 A. Total Knowledge Category, B. Total Attitude Category C. Total Practice Category

Correlation Between Community KAP Scores and House Index (HI)

A bivariate correlation analysis was conducted to assess the relationship between community knowledge, attitude, and practice (KAP) scores and the house index (HI) — an entomological metric reflecting the percentage of residences positive for Aedes mosquito larvae. The results demonstrated a very strong and statistically significant negative association between preventive practice scores and HI ($r = -0.944$, $p = 0.001$). This suggests that RWs exhibiting higher average scores in preventive behavior (e.g., regular draining of water containers, use of larvicides, and covering of water storage) tended to have significantly lower rates of larval-positive households.

Table 2. House Index Correlations

	Pearson Correlation	Sig. (2-tailed)
Practice Mean	.944	.001
Knowledge Mean	.816	.025
Attitude Mean	.875	.010

Similarly, mean knowledge scores exhibited a strong inverse correlation with HI ($r = -0.816$, $p = 0.025$), implying that communities with better understanding of dengue transmission, vector behavior, and prevention strategies were less likely to harbor larval habitats. Meanwhile, attitude scores also showed a strong negative association with HI ($r = -0.875$, $p = 0.010$), reinforcing the critical role of community beliefs and perceived responsibility in mitigating environmental risk. Taken together, these findings strongly support the hypothesis that heightened community KAP is associated with reduced entomological burden at the subdistrict level.

These results suggest that higher knowledge and more proactive attitudes toward dengue do not uniformly translate into effective household-level practices for vector control. Although practice demonstrated the highest correlation with HI, its dependence on knowledge and attitude further reinforces the behavioral cascade commonly discussed in health behavior theories such as the KAP

model and Health Belief Model (Liu et al., 2025). The mismatch between knowledge/attitude and actual practice may reflect the presence of contextual barriers—such as infrastructure, time availability, or sociocultural norms—that hinder the application of knowledge into behavior (Borges-Tiago et al., 2024).

This divergence underscores the need for policy interventions that not only provide education but also address structural and environmental enablers or constraints of preventive practices (Glasman & Albarracin, 2016). In contexts like Sambikerep, where dense housing and shared water utilities are common, improving practice requires more than just individual knowledge—it necessitates collective efficacy, community engagement, and infrastructural support. With all interplays together, better outcomes are expected in respect to decreased Dengue Infection.

Intercorrelations Among Knowledge, Attitude, and Practice Components

The second layer of analysis investigated the internal relationships between the components of the KAP model. Knowledge and attitude scores were extremely positively correlated ($r = 0.947$, $p = 0.001$), indicating that increased awareness about dengue and vector ecology tends to align closely with more favorable public health attitudes — such as perceiving dengue as a serious threat and believing in communal responsibility for prevention. In parallel, knowledge and practice scores showed a very strong correlation ($r = 0.836$, $p = 0.019$), highlighting the operational translation of knowledge into actionable behavior. Attitude and practice also correlated strongly ($r = 0.809$, $p = 0.028$), suggesting that positive belief systems — such as confidence in the effectiveness of source reduction or trust in local health campaigns — are pivotal in motivating consistent household-level interventions.

Table 3. Knowledge Mean Correlations

	Pearson Correlation	Sig. (2-tailed)
Practice Mean	.836	.019
Attitude Mean	.947	.001

Table 4. Attitude Mean Correlations

	Pearson Correlation	Sig. (2-tailed)
Practice Mean	.809	.028
Knowledge Mean	.947	.001

Table 5. Practice Mean Correlations

	Pearson Correlation	Sig. (2-tailed)
Knowledge Mean	.836	.019
Attitude Mean	.809	.028

This finding suggests that public health messaging should be simultaneously cognitive (imparting facts), affective (shaping beliefs), and behavioral (reinforcing actionability) (Albarracin et al., 2024). Programs that segment the audience based on their readiness to act—or that employ behavior change communication (BCC) tailored to local psychosocial dynamics—may yield stronger behavioral outcomes than generic awareness campaigns.

Qualitative Synthesis: KAP Scores, HI, and Observational Breeding Site Mapping

To further contextualize the quantitative findings, a qualitative triangulation was performed by integrating subdistrict-level KAP and HI data with direct observational findings of larval breeding sites in each RW. RW 2 emerged as a high-risk area with multiple breeding sites identified in RT 01 (e.g., water stagnation around meter boxes and puddles in front of homes) and RT 04 (open drainage systems adjacent to residences). These findings correlate with relatively low practice scores and high HI, revealing a behavioral–environmental mismatch that facilitates mosquito proliferation. RW 1 (RT 07) also presented elevated risk, with larval-positive containers such as flowerpots and open drainage channels. While bathroom inspections yielded no larvae, the presence of multiple outdoor breeding sites aligned with a moderate HI and intermediate KAP scores, suggesting partial but insufficient community engagement in vector control.

RW 3 had isolated findings of larval presence in potted plants, but no widespread infestation was observed. The area showed moderate practice scores and a modest HI, likely reflecting a need for targeted education on inconspicuous breeding habitats. RW 6 demonstrated a split profile. While RT 5 and RT 6 were larva-free, RT 3 revealed larval activity in the pond of the Al-Ikhlas prayer house, indicating localized environmental risk. This area exhibited variable KAP scores, emphasizing the importance of site-specific surveillance even within a single RW. In contrast, RW 4, RW 5, and RW 7 were classified as low-risk areas, with no larval habitats detected during inspection. These RWs also had high practice scores and low HI, demonstrating alignment between knowledge, attitude, behavior, and environmental outcomes. Particularly, RW 7 stood out as a behavioral exemplar, showing both high community engagement and entomological safety.

This qualitative synthesis reveals a microgeographic heterogeneity in dengue risk across subdistricts. High HI zones tended to exhibit concurrent environmental neglect and poor behavioral indicators, whereas low HI zones reflected effective translation of awareness and responsibility into action. These findings underscore the necessity of localized, behaviorally informed vector control strategies, particularly in peri-urban settings where larval habitats may be cryptic and maintenance practices vary widely across households and community facilities.

Collectively, the findings of this study advocate for a paradigm shift from knowledge-focused interventions to an integrated socioecological approach. In Sambikerep, the 'host', the 'agent', and the 'environment' interact in a complex, nonlinear manner (CDC, 2023). Public health initiatives must therefore embrace multi-pronged strategies—merging health education with environmental engineering, regulatory enforcement (e.g., periodic home inspections), and community-led monitoring mechanisms. Furthermore, leveraging geospatial tools in future studies to map breeding site density relative to HI and KAP gradients could yield more granular insights and inform targeted larviciding or source reduction efforts.

CONCLUSION

This study presents a multifaceted analysis of dengue control in a hyperendemic urban setting by integrating host-related knowledge, attitude, and practice (KAP) metrics with environmental surveillance data across seven sub-subdistricts in Sambikerep, Surabaya. The findings reveal a significant inverse correlation between KAP scores and the House Index, underscoring the vital role of community awareness and behavior in mitigating mosquito breeding and dengue transmission risk. Moreover, the robust intercorrelations among knowledge, attitude, and practice affirm that health education strategies targeting one domain can generate synergistic benefits across others. The qualitative mapping of outdoor and indoor breeding sites further enriches this perspective, revealing persistent ecological niches—such as plant pots, water meters, and neglected communal areas—that perpetuate vector presence even in communities with high awareness levels.

RECOMMENDATION

These findings highlight the need for a dual-front strategy in dengue prevention: enhancing behavioral competencies through education and addressing persistent environmental risks through community engagement and municipal support. Interventions should not only improve individual knowledge but also empower households with practical, actionable tools and facilitate environmental modifications at the neighborhood level. Local authorities should prioritize RW-specific breeding site elimination programs, leveraging these data to allocate resources where ecological risks converge with behavioral gaps. Future research should explore temporal dynamics through longitudinal designs, incorporate entomological surveillance to quantify vector density, and integrate spatial mapping tools (e.g., GIS) for real-time monitoring. Strengthening intersectoral collaboration between public health, urban planning, and environmental services will be crucial in transforming the knowledge-action gap into sustained, community-led vector control practices in Surabaya and other urban hyperendemic areas.

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