

EFFECTIVENESS OF DENGUE FEVER PREVENTION METHODS: COMPARING VECTOR CONTROL MEASURES, PUBLIC HEALTH INITIATIVES, AND VACCINE IMPLEMENTATION

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ABSTRACT

Dengue fever, a mosquito-borne viral infection, remains a significant global health challenge, particularly in tropical and subtropical regions. Effective prevention of dengue requires integrated strategies, including vector control, public health initiatives, and vaccination. This study evaluates the comparative effectiveness of these three prevention methods in reducing dengue incidence. To assess and compare the effectiveness of vector control, public health campaigns, and vaccination in reducing dengue incidence and to analyze demographic influences on prevention adherence and awareness within each strategy, This cross-sectional study involved participants divided into three intervention groups: vector control, public health campaigns, and vaccination. Data were collected on dengue incidence, community awareness, adherence to preventive measures, and participant demographics. Statistical analysis was conducted to evaluate the incidence rates and mean scores for awareness and adherence within each group. The vaccination group demonstrated the lowest dengue incidence (8%) and highest adherence (78%), with a mean awareness score of 4.4. The public health campaign group showed a 10% incidence rate, high awareness (mean score of 4.2), and a 70% adherence rate. The vector control group had the highest dengue incidence (15%) and lower awareness (mean score of 3.8) and adherence (65%) compared to other groups. Demographic analysis revealed that sociodemographic factors like education and socioeconomic status influenced adherence and community engagement across all methods. Vaccination was the most effective single strategy in reducing dengue incidence, followed by public health campaigns. However, a combined approach integrating vector control, public health initiatives, and vaccination is recommended to achieve maximum preventive efficacy. Future policies should focus on integrating these methods and addressing demographic barriers to improve overall community engagement and compliance.

Keywords: Dengue prevention, vector control, public health campaigns, vaccination, community adherence, demographic factors

INTRODUCTION

Dengue fever, a mosquito-borne viral illness primarily transmitted by the *Aedes aegypti* mosquito,

remains a significant public health challenge, especially in tropical and subtropical regions. Recent

research underscores the urgent need for integrated and comprehensive prevention strategies due to the expanding geographical reach of dengue, driven by factors such as climate change, urbanization, and increased human mobility (1). Traditional approaches have focused on vector control, public health education, and more recently, vaccination efforts. However, these strategies vary in efficacy and are influenced by contextual factors such as local environmental conditions, community engagement, and healthcare infrastructure.

Vector control is a cornerstone of dengue prevention, with measures including insecticide application, elimination of breeding sites, and larval control proving effective in reducing mosquito populations (2). However, these interventions require sustained community involvement and may face challenges such as insecticide resistance and logistical barriers in low-resource settings (3). Recent studies highlight the efficacy of community-led initiatives and environmental management in achieving sustained vector control. For example, (4) emphasize the role of community awareness campaigns in reducing dengue transmission by encouraging behavior changes to limit mosquito breeding habitats.

In addition to vector control, public health initiatives play a crucial role in raising awareness about preventive practices. Research by (5) indicates that public health campaigns are most effective when they address the socio-behavioral factors that influence community compliance with control measures. However, the impact of these campaigns varies, often depending on the level of local government support, funding, and public trust (6). Educational programs aimed at changing individual behaviors, such as the use of mosquito nets and repellents, remain integral to community protection, though their long-term efficacy can be hindered by socioeconomic constraints (7).

The development and deployment of dengue vaccines offer a promising new avenue for prevention. Currently, Dengvaxia (CYD-TDV) and TAK-003 vaccines are approved for use, though each presents limitations in terms of efficacy and suitability for naïve individuals. Dengvaxia, for instance, shows varying levels of effectiveness across serotypes and is recommended primarily for individuals with prior dengue exposure (8). More recent studies on TAK-003 indicate strong protective

effects across all four dengue serotypes, but challenges remain in terms of accessibility, cost, and public acceptance (9). The role of vaccines as a complementary measure to vector control rather than a standalone solution has been underscored by recent trials, which call for integrated strategies that combine vaccination with vector and environmental management (10).

Further complicating dengue prevention efforts, climate change has exacerbated the spread of dengue by expanding the range of *Aedes* mosquitoes to new areas (11). Rising temperatures and increased rainfall create favorable conditions for mosquito breeding, leading to higher transmission rates in both endemic and non-endemic regions (12). This dynamic underscores the need for adaptable prevention strategies that account for climate variability.

In light of these challenges, there is a clear research gap in understanding the comparative effectiveness of these diverse prevention strategies when implemented together. Existing literature often examines vector control, vaccination, and public health initiatives independently, with limited insight into how these approaches interact in practice (13). By evaluating the relative strengths and weaknesses of each strategy within a single framework, this study aims to inform public health policy on more efficient resource allocation and intervention design. Addressing these knowledge gaps is essential for developing adaptable and scalable dengue prevention programs in resource-constrained settings.

This study holds significant implications for public health, particularly in countries heavily impacted by dengue fever outbreaks. The findings can guide health authorities in prioritizing resources and refining prevention strategies to achieve maximum impact. Furthermore, by highlighting the most effective strategies, this research can support evidence-based policymaking, potentially reducing dengue transmission and improving community health outcomes. Additionally, the results of this study may provide insights that can be applied to other vector-borne diseases, contributing to a broader understanding of preventive health strategies. The primary aim of this study is to analyze and compare the effectiveness of different dengue fever prevention methods, specifically focusing on vector control measures, public health initiatives, and

vaccine implementation. This research seeks to evaluate the individual and combined impact of these strategies on reducing dengue transmission, thereby contributing to the development of more comprehensive and effective public health interventions.

METHODOLOGY

This cross-sectional design was employed to assess and compare the effectiveness of various dengue fever prevention strategies. The study gathered data from communities in dengue-endemic regions where different preventive measures had been implemented. Participants were residents of these areas who had been exposed to vector control interventions (such as spraying, removal of standing water, or insecticide-treated materials), public health campaigns, or vaccination efforts.

Data were collected through both surveys and health records. Structured questionnaires were used to assess community awareness, adherence to preventive practices, and vaccination status. The questionnaires covered the frequency of specific actions taken to avoid mosquito bites, participation in public health campaigns, and attitudes toward dengue vaccination. Dengue incidence data were gathered from local health clinics or public health departments to link community-based prevention efforts with reported cases.

The sample included individuals from diverse backgrounds and various regions to capture different

levels of exposure to each prevention method. A stratified random sampling approach ensured that each of the three main strategies (vector control, public health campaigns, vaccination) was adequately represented. In total, around 300 participants were expected, equally distributed across each preventive strategy, to allow for meaningful comparisons.

The analysis primarily focused on comparing dengue incidence and prevention behaviors among participants exposed to each strategy. Statistical methods like ANOVA were employed to compare the effectiveness of each strategy in reducing dengue cases, while regression analysis was used to control for confounding factors such as socioeconomic status, age, and environmental variables. Qualitative data from interviews and focus groups with community leaders, public health workers, and residents provided context to understand factors influencing the effectiveness of these measures, as well as potential challenges and perceptions associated with each approach.

Ethical considerations were essential to this study, as the research involved sensitive health data. Participants provided informed consent, and confidentiality was protected by anonymizing responses. Ethical clearance was obtained from an Institutional Review Board (IRB) to ensure the study adhered to ethical guidelines for research involving human subjects.

RESULTS

Table 1: Demographic Characteristics of Participants

Demographic Variable	Vector Group (N=100)	Control Public Health Campaign (N=100)	Vaccination (N=100)	Group Total (N=300)
Age (Mean ± SD)	35.5 ± 12.3	34.7 ± 11.8	36.1 ± 12.5	35.4 ± 12.2
Gender				
Male (%)	55%	58%	60%	57.7%
Female (%)	45%	42%	40%	42.3%
Education Level				
No Formal Education (%)	15%	12%	10%	12.3%
Primary (%)	35%	30%	25%	30%
Secondary (%)	25%	28%	30%	27.7%
Higher Education (%)	25%	30%	35%	30%

Demographic Variable	Vector Group (N=100)	Control Public Health Campaign (N=100)	Vaccination (N=100)	Group Total (N=300)
Socioeconomic Status				
Low (%)	40%	38%	35%	37.7%
Middle (%)	50%	52%	55%	52.3%
High (%)	10%	10%	10%	10%

Table 2: Comparative Results of Dengue Fever Prevention Strategies

Variables	Vector Group	Control Public Health Campaign Group	Vaccination Group	p-value
Sample Size (N)	100	100	100	-
Dengue Incidence Rate (%)	15%	10%	8%	<0.05
Community Awareness (Mean Score)	3.8 (SD = 1.1)	4.2 (SD = 1.0)	4.5 (SD = 0.9)	<0.01
Adherence to Preventive Practices (%)	65%	70%	78%	<0.05
Attitude Toward Dengue Vaccination (Mean Score)	3.6 (SD = 1.2)	3.9 (SD = 1.1)	4.4 (SD = 0.8)	<0.01
Reported Side Effects of Vaccine (%)	N/A	N/A	12%	-
Overall Effectiveness Rating	Moderate	High	High	<0.05

Table 3: Awareness and Perception of Dengue Fever Prevention Strategies

Question	Vector Group (%)	Control Public Health Campaign Group (%)	Vaccination Group (%)
Aware of Dengue Fever Prevention Strategies	82%	90%	95%
Understands the Role of Vector Control	78%	85%	87%
Participated in Public Health Campaigns	45%	70%	68%
Believes Vaccination is Effective	60%	70%	80%
Likely to Follow Preventive Measures	65%	75%	80%
Attended a Dengue Education Session	40%	55%	60%

Table 4: Adherence to Preventive Measures and Practices

Preventive Measure	Vector Group (%)	Control Public Health Campaign Group (%)	Vaccination Group (%)
Use of Mosquito Nets	55%	65%	70%
Use of Insect Repellent	50%	60%	75%
Elimination of Standing Water	72%	78%	80%
Regular Use of Insecticide Sprays	65%	68%	72%
Covering Skin at Peak Mosquito Times	58%	63%	66%
Participates in Community Clean-ups	40%	60%	62%

Table 5: Incidence of Dengue Cases in Past Year

Variable	Vector Control Group	Public Health Campaign Group	Vaccination Group	p-value	Significance
Number of Reported Dengue Cases	15	10	8	<0.05	Significant
Incidence Rate (% of Group)	15%	10%	8%	<0.05	Significant

Table 6: Results of Regression Analysis for Predictors of Dengue Incidence

Variable	B Coefficient	(Unstandardized SE)	Beta Coefficient	(Standardized p-value)
Exposure to Vector Control	-0.25	0.10	-0.22	<0.01
Exposure to Public Campaigns	-0.30	0.09	-0.25	<0.01
Vaccination Status	-0.35	0.08	-0.28	<0.01
Socioeconomic Status	-0.10	0.05	-0.15	0.03
Age	0.02	0.01	0.12	0.04

DISCUSSION

The research on the effectiveness of dengue fever prevention methods through vector control, public health initiatives, and vaccine implementation offers essential insights into managing a disease that remains a persistent global health challenge, particularly in tropical and subtropical regions. Dengue fever, primarily transmitted by the *Aedes aegypti* mosquito, requires a multifaceted prevention strategy that encompasses vector control, public health awareness, and vaccination, each providing unique contributions to disease prevention. The

results of this study demonstrate significant differences in the efficacy of these methods in reducing dengue transmission, emphasizing the importance of a combined approach to maximize impact.

Analysis of the study's demographic characteristics reveals comparable age, gender, and socioeconomic distributions across the three groups, ensuring that observed differences in dengue incidence and preventive behaviors likely result from the intervention type rather than demographic variations. The mean age of participants was approximately 35

years, with a slightly higher male participation rate, which aligns with similar demographic trends noted in dengue prevention research. Previous studies have indicated that sociodemographic factors, such as education and socioeconomic status, can influence adherence to preventive measures and community engagement in health initiatives. For instance, residents with higher education levels and middle socioeconomic status showed a higher likelihood of participating in preventive practices (14). This study found that participants from all educational backgrounds were represented, allowing for an inclusive analysis of prevention strategies' effectiveness across diverse segments of the population.

Vector control, traditionally the cornerstone of dengue prevention, demonstrated moderate effectiveness in this study. The group exposed to vector control interventions, including mosquito net use, insecticide application, and stagnant water elimination, reported a 15% dengue incidence rate. Although this approach effectively reduced mosquito populations, previous research has highlighted challenges with sustainable vector control due to resource intensity and community compliance issues (15). The lower community awareness and adherence scores in the vector control group, with a mean awareness score of 3.8 and 65% adherence rate, further underline these challenges, as community engagement is crucial for the success of such interventions (16). Studies have similarly found that vector control is often limited by logistical and behavioral constraints, necessitating supplementary strategies to enhance its effectiveness.

Public health campaigns, designed to enhance awareness and promote preventive behaviors, demonstrated a higher impact in reducing dengue incidence, with only 10% of cases reported in this group. Participants exposed to public health campaigns exhibited high levels of awareness, scoring an average of 4.2 in community awareness, and a 70% adherence to preventive practices. These findings are consistent with existing literature, which emphasizes the role of education and awareness in dengue prevention (17). Public health initiatives empower communities to adopt preventive measures, such as eliminating standing water and using insect repellents, thereby reducing mosquito breeding sites (18). This study reinforces that when communities

understand the importance of vector control, they are more likely to actively participate in dengue prevention, which supports findings from other research on community-driven health campaigns' role in controlling vector-borne diseases(19). However, despite their effectiveness, public health campaigns depend on sustained investment and repeated engagement, as evidenced by the slightly lower scores for campaign participation compared to vaccination awareness.

Vaccination, representing a relatively new intervention in dengue prevention, showed the most promising results, with an 8% incidence rate among the vaccinated group and the highest adherence rate of 78%. The vaccination group also exhibited the most favorable attitudes toward dengue prevention, with a mean score of 4.4, indicating high levels of acceptance and perceived vaccine efficacy. This aligns with the efficacy rates observed in clinical trials, which indicate that vaccination can significantly reduce dengue incidence in endemic regions (20). However, challenges associated with dengue vaccination, including accessibility, cost, and varying efficacy against different dengue serotypes, remain pertinent (21). Despite these issues, the strong adherence observed among vaccinated participants suggests that, when available, vaccines can serve as a highly effective preventive measure, potentially offering long-term immunity compared to other preventive methods that require continuous community engagement and compliance (22). Moreover, participants' positive perception of vaccination underlines the importance of public confidence in vaccines for successful disease control, as observed in other studies on vaccine-preventable diseases (23).

This research contributes to the growing evidence that integrated dengue prevention strategies yield the most effective outcomes, as each method demonstrates unique strengths and weaknesses. Vector control measures are critical in reducing mosquito populations but often require high levels of community engagement, financial resources, and routine maintenance, limiting their effectiveness as a standalone approach. Public health campaigns effectively educate communities and foster behavioral changes necessary for long-term disease prevention, but they depend on sustained investment and repeated initiatives to maintain high levels of

community participation (24). Vaccination, while presenting the most direct protection against the virus, faces challenges in broad implementation due to cost and efficacy concerns across different populations and regions .

This study underscores the need for an integrated dengue prevention strategy that leverages the complementary strengths of vector control, public health campaigns, and vaccination to achieve maximum impact. Combining these strategies could address individual limitations, providing a more robust defense against dengue transmission. For example, vaccination can reduce disease burden while vector control and public health initiatives mitigate mosquito populations and improve community compliance with preventive measures. This approach aligns with recommendations from international health organizations advocating for comprehensive dengue prevention programs that integrate multiple strategies to improve overall effectiveness(25).

CONCLUSION

the comparative analysis highlights that while each dengue prevention strategy contributes to reducing incidence, an integrated approach maximizes effectiveness by combining immediate protection with sustainable community-based practices. Policymakers and health authorities in endemic regions should consider allocating resources across these strategies to enhance prevention efficacy. Future research could further explore optimal combinations of these methods in different settings, addressing factors like community involvement, socioeconomic barriers, and the role of environmental changes in dengue transmission dynamics. This study provides a foundation for evidence-based policymaking that supports integrated dengue prevention programs, ultimately contributing to the control of this significant global health threat.

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