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Seroprevalence of anti-dengue virus antibodies and associated factors among adults in five communes and wards of Dak Lak Province in 2026

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ABSTRACT: Objective: To estimate the seroprevalence of immunoglobulin M (IgM) and immunoglobulin G (IgG) antibodies to dengue virus and examine associated factors among adults in five communes and wards in Dak Lak Province in 2026.

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Methods: This descriptive cross-sectional study included 588 adults aged ≥18 years from Buon Ma Thuot Ward, Tan An Ward, Krong Pak Commune, Ea Knop Commune, and Phu Xuan Commune. Data and serum samples were collected between June and August 2026. Participants were selected by random cluster sampling, with one eligible adult selected per household. Anti-dengue virus IgM and IgG antibodies were detected by enzyme-linked immunosorbent assay (ELISA). Demographic data were obtained using a questionnaire. Data were analyzed using descriptive statistics and chi-square (χ^2) tests.

Results: IgM seroprevalence was 10.9% (64/588; 95% confidence interval [CI], 8.6–13.7%), and IgG seroprevalence was 43.9% (258/588; 95% CI, 39.9–47.9%). Equivocal results accounted for 6.6% and 17.0% of IgM and IgG results, respectively. Concurrent IgM and IgG positivity was observed in 42 participants (7.1%). IgM seroprevalence was highest in Krong Pak (21.7%) and lowest in Phu Xuan (4.2%), whereas IgG seroprevalence was highest in Buon Ma Thuot (61.5%) and lowest in Ea Knop (21.9%). The distribution of IgM test results differed significantly by ethnicity, educational attainment, occupation, and study site ($p < 0.05$). The distribution of IgG test results differed significantly by sex, age group, ethnicity, educational attainment, occupation, and study site ($p < 0.05$). IgG seroprevalence increased from 29.5% among participants aged 18–29 years to 55.3% among those aged ≥60 years.

Conclusions: Anti-dengue virus antibodies were detected among adults at all five study sites, with seroprevalence varying by location and population group. These findings may inform serological surveillance and the development of locally appropriate communication strategies for dengue prevention and control in the surveyed communities.

Keywords: *dengue virus; seroprevalence; IgM; IgG; adults; Dak Lak.*

INTRODUCTION

Dengue is a mosquito-borne viral disease and a public health concern in Vietnam. Dengue virus is transmitted primarily by *Aedes aegypti* and *Aedes albopictus* and comprises four serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. The circulation of multiple serotypes, together with environmental conditions conducive to vector proliferation, complicates surveillance and disease prevention and control [1], [2]. In the Central

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Highlands, a study spanning 2000–2020 documented 132,247 cases and 32 deaths; Dak Lak and Gia Lai reported more cases and deaths than the other provinces in the region [3].

Case-based surveillance provides essential information on dengue occurrence but does not fully capture the extent of dengue virus exposure in the community. Serological surveys measuring IgM and IgG antibodies provide complementary evidence of exposure. IgM seropositivity suggests recent infection, whereas IgG generally indicates previous exposure. Nevertheless, serological findings must be interpreted cautiously because of potential cross-reactivity with other flaviviruses, and antibody detection does not imply complete protective immunity [2], [4]. Seroprevalence studies can therefore contribute to the characterization of dengue epidemiology and guide community-based surveillance.

The prevalence of antibodies to dengue virus varies across geographical settings and population groups. A study in Yucatan, Mexico, reported an overall seroprevalence of 73.6%, with prevalence increasing with age [5]. In Vietnam, antibody prevalence was 65.7% among primary schoolchildren in Binh Thuan Province, whereas a community survey in Khanh Hoa in 2018 reported IgM and IgG seroprevalences of 6.7% and 20.5%, respectively [6], [7]. Variation in study populations, settings, and survey periods underscores the need for locally relevant serological data. Examining demographic correlates may also help identify population groups that warrant greater attention in surveillance and prevention communication.

Dak Lak has experienced several large dengue outbreaks. The provincial Center for Disease Control reported 7,421 cases and four deaths in 2025 [8]. However, up-to-date data on the prevalence of antibodies to dengue virus among adults in the province remain limited. This study aimed to estimate IgM and IgG seroprevalence and examine associated factors among adults in five communes and wards in Dak Lak Province in 2026, thereby informing dengue surveillance, prevention, and control in the surveyed communities.

METHODS

1. Study participants

Adults aged ≥18 years were eligible if they had resided in a surveyed community for at least one month and agreed to participate.

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Individuals who declined participation or were unable to communicate the information required for the study were excluded.

2. Study period and setting

The study period extended from April to December 2026. Data and serum samples were collected between June and August 2026 in five administrative units in Dak Lak Province: Buon Ma Thuot Ward, Tan An Ward, Krong Pak Commune, Ea Knop Commune, and Phu Xuan Commune.

3. Study design

A descriptive cross-sectional study was conducted.

4. Sample size and sampling procedure

The required sample size was calculated using the formula for estimating a single population proportion, with adjustment for the sampling design:

$$n = \frac{Z^2_{(1-\frac{\alpha}{2})} p(1-p)}{d^2} \times DE$$

The standard normal deviate $Z_{(1-\alpha/2)}$ was set at 1.96 for a 95% confidence level. The expected proportion (p) was set at 0.5 to maximize the required sample size, and the allowable absolute margin of error (d) was set at 0.05. The sample size before adjustment was approximately 384. Applying a design effect (DE) of 1.5 for cluster sampling yielded a target of 576 participants. A further 10% allowance increased the planned sample size to 634. The final sample comprised 588 participants from 588 households, all of whom completed the survey and serological testing.

A random cluster sampling procedure was used. In each commune or ward, a list of villages and hamlets was compiled, from which five were randomly selected. A household list was then prepared for each selected village or hamlet, and households were randomly sampled. One eligible adult was randomly selected from each household. If a selected household was unavailable, declined participation, or had no eligible member, a replacement household was randomly selected.

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5. Study variables

Demographic variables included sex; age group (18–29, 30–44, 45–59, and ≥60 years); ethnicity (Kinh, Ede, and other ethnic groups); educational attainment (illiterate, primary school, lower secondary school, and upper secondary school or higher); occupation (farming, civil servants and public-sector employees, industrial workers, and other occupations); and place of residence.

The outcome variables were anti-dengue virus IgM and IgG antibody status. Results were classified as positive, negative, or equivocal according to the assay manufacturer's instructions. Seroprevalence for each antibody class was calculated as the number of participants testing positive divided by the total number tested, multiplied by 100.

6. Data collection and laboratory testing

Demographic data were collected through face-to-face interviews using a standardized questionnaire. The study objectives and procedures were explained to all participants, and written informed consent was obtained before interviews and blood collection.

Approximately 4 mL of venous blood was collected from each participant into a tube containing a clot activator and separator gel. Samples were centrifuged to obtain serum, stored at 2–8°C, and transported to the laboratory within 24 hours.

Anti-dengue virus IgM and IgG antibodies were detected using SERION ELISA classic Dengue Virus assay kits (Germany). Testing procedures and result classification followed the manufacturer's instructions. Sample optical density values were compared with the specified cutoffs. Results were classified as positive if above the upper cutoff, negative if below the lower cutoff, and equivocal if between the two cutoffs.

Laboratory quality control included control samples and internal quality control procedures for each assay run. Laboratory personnel were trained in ELISA procedures, and the laboratory participated in an external quality assessment program for dengue ELISA testing.

7. Data management and statistical analysis

Data were managed and analyzed using Microsoft Excel 2013, SPSS version 27.0, and Epi Info 7. Categorical variables were summarized as frequencies and percentages. IgM and IgG seroprevalence estimates were reported with 95% CIs.

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Chi-square tests were used to compare the distributions of test-result categories across demographic groups and study sites. A p value <0.05 was considered statistically significant.

8. Ethical considerations

As specified in the research protocol, study implementation was contingent on review and approval by the Scientific and Technological Council of the Department of Health. Participants received a full explanation of the study objectives and procedures and provided written informed consent voluntarily. Personal information was kept confidential, and data were used exclusively for research purposes. Participants received testing at no cost and were counseled on disease prevention.

RESULTS

1. Participant characteristics

Table 1. Characteristics of the study participants (n = 588)

Characteristic		Number	Percentage (%)
Sex	Male	264	44.9
	Female	324	55.1
Age group (years)	18 – 29	61	10.4
	30 – 44	160	27.2
	45 – 59	188	32.0
	≥ 60	179	30.4
Ethnicity	Kinh	424	72.1
	Ede	38	6.5
	Other	126	21.4
Educational attainment	Illiterate	24	4.1
	Primary school	131	22.3
	Lower secondary school	203	34.5
	Upper secondary school or higher	230	39.1

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Characteristic		Number	Percentage (%)
Occupation	Farming	362	61.6
	Civil servants and public-sector employees	32	5.4
	Industrial workers	49	8.3
	Other	145	24.7
Study site	Buon Ma Thuot Ward	135	23.0
	Tan An Ward	114	19.4
	Krong Pak Commune	106	18.0
	Ea Knop Commune	114	19.4
	Phu Xuan Commune	119	20.2
Total		588	100.0

The study included 588 adults from 588 households in five communes and wards of Dak Lak Province. Women accounted for 55.1% of participants. The largest age groups were 45–59 years and ≥60 years, accounting for 32.0% and 30.4%, respectively. Participants of Kinh ethnicity comprised 72.1%, and farming was the predominant occupation (61.6%). Overall, 39.1% had completed upper secondary education or higher. The number of participants at each site ranged from 106 to 135.

2. Anti-dengue IgM and IgG test results

Table 2. Anti-dengue IgM and IgG test results (n = 588)

Antibody	Result	Number	Percentage (%)	95% CI (%)
IgM	Positive	64	10.9	8.6–13.7
	Negative	485	82.5	79.2–85.3
	Equivocal	39	6.6	4.9–8.9
IgG	Positive	258	43.9	39.9–47.9
	Negative	230	39.1	35.2–43.2
	Equivocal	100	17.0	14.2–20.3

CI: confidence interval.

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IgM seroprevalence was 10.9% (95% CI: 8.6–13.7%), and IgG seroprevalence was 43.9% (95% CI: 39.9–47.9%). Equivocal results accounted for 6.6% of IgM results and 17.0% of IgG results.

Table 3. Joint distribution of IgM and IgG test results (n = 588)

IgM result	**IgG**			
	positive, n (%)	**negative, n (%)**	**equivocal, n (%)**	**Total, n**
Positive	42 (65.6)	14 (21.9)	8 (12.5)	64
Negative	192 (39.6)	207 (42.7)	86 (17.7)	485
Equivocal	24 (61.5)	9 (23.1)	6 (15.4)	39
Total	258	230	100	588

Percentages are presented by row. Pearson $\chi^2 = 21.684$; degrees of freedom = 4; $p < 0.001$.

Of the 64 IgM-positive participants, 42 were also IgG-positive (65.6%). A total of 207 participants tested negative for both antibody classes, accounting for 35.2% of the study sample. There was a statistically significant association between IgM and IgG test-result categories ($p < 0.001$).

3. Seroprevalence by demographic characteristics

Table 4. IgM and IgG seroprevalence by demographic characteristics

Characteristic	n	IgM positive, n (%)	χ^2	p*	IgG positive, n (%)	χ^2	p*
Sex							
Male	264	21 (8.0)	5.31	0.070	101 (38.3)	8.52	0.014
Female	324	43 (13.3)			157 (48.5)		
Age group (years)							
18–29	61	4 (6.6)	5.9	0.435	18 (29.5)	18.5	0.005
30–44	160	20 (12.5)			61 (38.1)		
45–59	188	16 (8.5)			80 (42.6)		
≥ 60	179	24 (13.4)			99 (55.3)		
Ethnicity							

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Kinh	424	52 (12.3)	14.97	0.005	215 (50.7)	30.9	< 0.001
Ede	38	6 (15.8)			13 (34.2)		
Other	126	6 (4.8)			30 (23.8)		
Educational attainment							
Illiterate	24	5 (20.8)	13.74	0.033	10 (41.7)	13.88	0.031
Primary school	131	7 (5.3)			41 (31.3)		
Lower secondary school	203	22 (10.8)			96 (47.3)		
Upper secondary school or higher	230	30 (13.0)			111 (48.3)		
Occupation							
Farming	362	33 (9.1)	13.13	0.041	134 (37.0)	22.92	< 0.001
Civil servants and public-sector employees	32	7 (21.9)			18 (56.3)		
Industrial workers	49	7 (14.3)			28 (57.1)		
Other	145	17 (11.7)			78 (53.8)		

Seroprevalence was calculated using the total number of participants in each subgroup as the denominator. *p values are from χ^2 tests comparing the distribution of all three test-result categories (positive, negative, and equivocal); they do not represent separate tests of positive versus negative results.

IgM seroprevalence was highest among participants of Ede ethnicity (15.8%), those who were illiterate (20.8%), and civil servants and public-sector employees (21.9%). The distribution of IgM results differed significantly by ethnicity, educational attainment, and occupation ($p < 0.05$); no statistically significant differences were observed by sex or age group.

IgG seroprevalence was 48.5% in women and 38.3% in men. It increased across age groups, from 29.5% among participants aged 18–29 years to 55.3% among those aged ≥60 years. Participants of Kinh ethnicity had an IgG seroprevalence of 50.7%, compared with 34.2% among Ede participants and 23.8% among other ethnic groups. By occupation,

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seroprevalence was highest among industrial workers (57.1%) and lowest among farmers (37.0%). The distribution of IgG results differed significantly across all demographic characteristics examined ($p < 0.05$).

4. Seroprevalence by study site

Table 5. IgM and IgG seroprevalence in the five communes and wards

Study site	Number	IgM positive, n (%)	IgG positive, n (%)
Buon Ma Thuot Ward	135	20 (14.8)	83 (61.5)
Tan An Ward	114	11 (9.6)	67 (58.8)
Krong Pak Commune	106	23 (21.7)	54 (50.9)
Ea Knop Commune	114	5 (4.4)	25 (21.9)
Phu Xuan Commune	119	5 (4.2)	29 (24.4)
χ^2		42.23	84.42
p*		< 0.001	< 0.001
Total	588	64 (10.9)	258 (43.9)

*Chi-square tests compared the distribution of all three test-result categories across study sites.

IgM seroprevalence was highest in Krong Pak Commune (21.7%), followed by Buon Ma Thuot Ward (14.8%) and Tan An Ward (9.6%), and lowest in Phu Xuan Commune (4.2%). IgG seroprevalence was highest in Buon Ma Thuot Ward (61.5%), followed by Tan An Ward (58.8%) and Krong Pak Commune (50.9%), and lowest in Ea Knop Commune (21.9%). The distributions of both IgM and IgG test results differed significantly across the five study sites ($p < 0.001$).

DISCUSSION

1. Dengue antibody seroprevalence

Among 588 adults from five communes and wards in Dak Lak Province, IgM seroprevalence was 10.9% (95% CI, 8.6–13.7%) and IgG seroprevalence was 43.9% (95% CI, 39.9–47.9%). These findings document the presence of antibodies to dengue virus in the surveyed population and complement information obtained through local case-based surveillance.

The IgM seroprevalence observed in this study exceeded the 6.7% reported in a community survey in Khanh Hoa in 2018 [7] and was comparable to the 11.2% reported

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among healthy adults in a rural community in southern Malaysia [9]. Between-study differences may reflect survey timing, the intensity of dengue virus circulation, participant characteristics, and assay selection. Sampling in the present study took place from June to August, during the rainy season in Dak Lak. Studies in the Central Highlands have documented seasonal increases in dengue case numbers and vector indices during the rainy season [3], [10]. However, because no corresponding survey was conducted during the dry season, the contribution of seasonality to IgM seroprevalence could not be determined.

IgM seropositivity is suggestive of recent infection but does not, by itself, establish acute dengue infection at the time of sampling. Antibody persistence and potential cross-reactivity with other flaviviruses must be considered when interpreting these findings [2], [4]. The observed prevalence of 10.9% should therefore be interpreted as the proportion of participants with detectable IgM antibodies according to the assay criteria, rather than as the prevalence of acute dengue disease in the community.

IgG seroprevalence in this study (43.9%) exceeded the 20.5% reported in Khanh Hoa in 2018 [7] but was lower than the 65.7% reported among primary schoolchildren in Binh Thuan Province [6] and the 73.6% reported across three urban settings in Yucatan, Mexico [5]. These findings illustrate variation in dengue antibody prevalence across populations. Nevertheless, direct comparisons should be made cautiously because the studies differed in participant age, geographical setting, survey period, and laboratory methods. IgG seropositivity generally indicates previous exposure but does not imply complete protective immunity against all four dengue virus serotypes [2].

2. Joint distribution of IgM and IgG antibodies

Of the 64 participants who tested positive for IgM, 42 also tested positive for IgG (65.6%). The significant association between IgM and IgG test-result categories indicates the coexistence of different serological response patterns within the study population.

Although concurrent IgM and IgG positivity may occur in secondary dengue infection, testing a single serum sample at one time point does not provide sufficient evidence to estimate the proportion of secondary infections. Differentiating primary from secondary infection requires additional information on antibody kinetics and the timing of infection,

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together with appropriate laboratory investigations [2]. Potential serological cross-reactivity must also be considered [4].

Both IgM and IgG were undetectable in 35.2% of participants. This finding indicates that neither antibody class was detected by the assays at the time of sampling; it does not establish that all these participants had never been infected with dengue virus or lacked immunity entirely. This distinction should be considered when serological data are used to characterize community exposure.

3. Demographic characteristics associated with serological results

IgG seroprevalence increased across age groups, from 29.5% among participants aged 18–29 years to 55.3% among those aged ≥60 years. This pattern is consistent with findings from Yucatan, Mexico, and among children in southern Vietnam, where antibody prevalence increased with age [5], [11]. A plausible explanation is that older individuals have had more time to accumulate exposure to dengue virus. However, the cross-sectional design precludes assessment of changes in antibody status within individuals over time.

Women had a higher IgG seroprevalence than men (48.5% vs. 38.3%). IgM seroprevalence was also numerically higher among women, although the difference in the distribution of IgM test results was not statistically significant. These differences may reflect variation in daily activities, occupation, and exposure environments. In the absence of validated adjusted analyses, the findings do not establish sex as an independently associated factor.

IgG seroprevalence was highest among participants of Kinh ethnicity, whereas IgM seroprevalence was highest among Ede participants. These patterns may reflect differences in residential location, living conditions, and exposure across ethnic groups. Ethnicity should not be interpreted as a direct cause of the observed serological differences. Furthermore, the Ede subgroup comprised only 38 participants, and its estimates should be interpreted cautiously.

The distribution of test results also differed by educational attainment and occupation. IgM seroprevalence was highest among participants who were illiterate and among civil servants and public-sector employees, whereas IgG seroprevalence was highest among industrial workers. Some subgroups were small, notably participants who were illiterate (n

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= 24) and civil servants and public-sector employees (n = 32). The observed differences may be confounded by age and place of residence. Adjusted analyses are therefore needed to determine whether these characteristics are independently associated with higher exposure.

4. Differences across study sites

IgM seroprevalence was highest in Krong Pak (21.7%), whereas IgG seroprevalence was highest in Buon Ma Thuot (61.5%) and Tan An (58.8%). These differing geographical patterns suggest that IgM and IgG provide complementary information on recent and previous exposure.

Geographical variation in serological findings may reflect historical patterns of dengue virus circulation, environmental conditions, vector distribution, and residents' daily activities. Research in northern and central Vietnam has demonstrated that population immunity and climate shape patterns of dengue virus invasion and maintenance [12]. Nevertheless, the present findings are insufficient to establish sustained transmission at any particular site or to predict future outbreak risk. Such assessments require integration with case surveillance data and observations collected at multiple time points.

5. Study limitations

The cross-sectional design provides a snapshot of antibody status and cannot establish the timing of infection or causal relationships. The study included adults from only five communes and wards; the findings therefore cannot be generalized to children or the entire population of Dak Lak Province.

The proportion of equivocal results, particularly for IgG (17.0%), is an additional limitation. Potential cross-reactivity and the lack of confirmatory testing also complicate interpretation of exposure status [2], [4]. Furthermore, the reported p values describe differences in the distribution of all three test-result categories rather than separate tests of seropositivity. Associations were assessed only in bivariate analyses. Multivariable analyses require verification and supplementation, and the effects of the cluster sampling design should be considered before conclusions are drawn regarding independently associated factors.

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CONCLUSIONS

Among 588 adults from five communes and wards in Dak Lak Province in 2026, anti-dengue virus IgM and IgG seroprevalences were 10.9% and 43.9%, respectively. IgM seroprevalence was highest in Krong Pak Commune (21.7%), whereas IgG seroprevalence was highest in Buon Ma Thuot Ward (61.5%). IgG seroprevalence increased across age groups, from 29.5% among participants aged 18–29 years to 55.3% among those aged ≥60 years.

Bivariate analyses identified significant differences in the distribution of IgM test results by ethnicity, educational attainment, occupation, and study site, and in the distribution of IgG test results by sex, age group, ethnicity, educational attainment, occupation, and study site. These findings may inform serological surveillance and locally appropriate communication strategies for dengue prevention and control in the surveyed communities.

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