**Seroepidemiology of Chikungunya, Dengue and Rift valley fever viruses in Kenya**

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**Abstract**

**Background and Objective**: Many arbovirus outbreaks have been documented in Kenya. However, there is evidence that the extent of exposure in the population is unknown. We described the seroepidemiology of Chikungunya (CHIKV), Dengue (DENV), and Rift Valley Fever (RVF) viruses in five Health Demographic Surveillance Sites (HDSS) in Kenya in 2022.

**Methods**: Serum samples were obtained through a cross-sectional survey in five HDSS of Asembo PBIDS, Kilifi HDSS, Manyatta HDSS, Kibera PBIDS, and Nairobi Urban HDSS.

**Results:** Of the samples tested, 1867 were IgG positive for at least one of the arboviruses (44.8%, 95% confidence interval (CI) 43.3 – 46.4%). Virus-specific crude seroprevalence for CHIKV, DENV, and RVFV was 33.1%, 8.9%, and 2.9% respectively. Population-weighted, test-adjusted seroprevalence across the HDSS was---- for CHIKV, --- for DENV and --- for RVFV and was highest in ---.

**Conclusion:** Chikungunya virus exposure is more to the western part and Dengue virus to the southeastern parts of the country. These results will help to guide the pandemic response in Kenya.

**Introduction**

Arboviral infections pose a major global health challenge, causing explosive outbreaks that can lead to severe and life-threatening conditions (1). The global burden of arboviruses has been estimated to account for more than 700,000 deaths annually (2,3). The burden is attributed to climate change, urbanization and increased global travel (4,5). However, there is evidence of limited active surveillance, particularly in low-resource settings, leading to **significant data gaps** about their true prevalence and distribution (5,6).

Among the arboviral diseases, Dengue virus (DENV) is most prevalent arbovirus, with an estimated burden of 390 million cases annually, of which 100 million are symptomatic cases (7). Chikungunya virus (CHIKV) is associated with considerable morbidity and socio-economic burden, with an estimated 18.7 million cases accounting for 1.95 million disability adjusted life years (DALYs) between 2011 and 20220 (8). A large outbreak of Rift valley fever virus (RVFV) was reported in Garissa district in December 1997 with a prevalence of 18% and an estimate of 27,500 infections (9). The virus has been recognized as a priority pathogen for research and development; however, its burden remains poorly characterized, and transmission between outbreaks are not well understood (10).

In Kenya, arbovirus outbreaks have occurred periodically across the country during inter-epidemic periods (3). Since the first documented DENV outbreak in 1982 in Kenya, the virus re-emerged between 2011 and 2014 causing several outbreaks and between2017 and 2018 (11,12). The first outbreaks of CHIKV infection were reported in Kenya along the coast in Lamu and Mombasa in 2004 where 1,300 cases were documented (13). A considerable number of studies have been done to determine seroprevalence of the arboviral infections in Kenya. A study by Sergon et al. reported a 75% prevalence of CHIKV in Lamu (13),

This study will describe the seroepidemiology of DENV, CHIKV and RVFV providing evidence of the circulation of the arboviruses in the country. A clear understanding of the geographical distribution of chikungunya, dengue and Rift valley fever virus infections in Kenya is necessary to help make decisions on the appropriate use of existing and emerging strategies to prevention and control further spread.

**Methods**

Study sites

A cross-sectional serosurvey was conducted in 2022 at 5 sites located in the western (Manyatta HDSS and Asembo PBIDS), south-Eastern (Kilifi HDSS), and central (Kibera PBIDS and Nairobi urban HDSS) parts of Kenya. The Kilifi HDSS, Nairobi Urban HDSS, Kibera PBIDS and Asembo PBIDS have been described elsewhere (14–18). The sites represented both urban (Manyatta, Nairobi Urban, Kibera) and rural (Kilifi and Asembo). The population resident within the counties in which the HDSS sites were located comprised 17% of Kenya’s total population. The sites were also representative of a typology of premature disease-related mortality I Kenya, represented by clusters of high or low mortality, though excluded clusters of high mortality in sparsely populated northern Kenya.



Figure 1: Kenya showing the five study sites

Study population and sample collection

For Kilifi and Nairobi HDSS sites, using respective HDSS sites census as a sample frame, samples were randomly selected and stratified by age in each site with a target of 850 individuals. The sample included about 100 children in each five-year age category below 14 years, about 50 individuals in each five-year age category between 15-64 years and about 50 adults aged 65 years and more. The sample size was sufficient to measure seroprevalence of 50% with a precision (95% CI of 47-53%). For Manyatta HDSS, Kibera PBIDS and Asembo PBIDS sites, a random sample of 225 households were selected targeting about 900 members in the sampled households. The sample was sufficient to measure seroprevalence of 50% with the associated 95% CI of ±5% assuming a design effect of 2. Written informed consent for participation was obtained from selected participants. The consent was obtained from guardians of children below 18 years while children aged 13-17 years provided written assent as per local ethical guidelines. Approximately 2ML of venous blood sample were collected from participating children of age below 5 years and approximately 5ML from individuals aged 5 years and above. Blood samples were collected either at home or at a nearby health facility using heparinized or serum separator tubes.

Laboratory Testing procedures

Statistical analysis

Ethical considerations

Ethical approval to conduct the serosurveys was obtained from Kenya Medical Research Institute Scientific and Ethics Review Unit (4085, 4168), the Oxford Tropical Research Ethics Committee (44-20), and the London School of Hygiene and Tropical Medicine Research Ethics Committee (26950) and the Charite... Kibera, Asembo and Manyatta serosurveys were also reviewed by US CDC and were conducted consistent with the applicable federal law and CDC policy as provided for the Code of Federal Regulations (45 C.F.R part 46 and 21 C.F.R. part 56).

Results

Demographic and laboratory data were collected for 4165 samples in five HDSS sites (Asembo PBIDS n = 853, Manyatta HDSS n = 801, Kibera PBIDS n = 813, Nairobi urban HDSS n = 849, Kilifi HDSS n=849).. Of the 4165 samples, 55.2% were female. The median age of the sampled participants was 27.5 years (interquartile range, 26.9 – 28.1 years) (supplementary Table 1).

Table 1: Demographic characteristics of study population

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Site | Asembo  n = 853 | Manyatta  n = 801 | Kibera  n = 813 | Nairobi  n = 849 | Kilifi  n=849 | Total  n=4165 |
| **Sex**  Female  Male | 478(56.0)  375(44.0) | 478(60.0)  323(40.0) | 472(58.1)  341(41.9) | 403(47.5)  446(52.5) | 466(54.6)  383(45.1) | 2297(55.2)  1868(44.8) |
| **Age**  <5  5-17  18-45  46-64  65+ | 72(8.4)  349(40.9)  269(31.5)  103(12.1)  60(7.1) | 47(5.9)  257(32.0)  426(53.2)  60(7.5)  11(1.4) | 44(5.4)  297(36.5)  378(46.5)  89(11.0)  5(0.6) | 91(10.7)  226(26.6)  291(34.3)  190(22.4)  51(6.0) | 96(11.3)  238(28.0)  271(31.9)  194(22.9)  50(5.9) | 350(8.4)  1367(32.8)  1635(39.3)  636(15.3)  177(4.2) |

Table 2: Crude, Bayesian population-weighted, test adjusted seroprevalence

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Virus | Characteristic | N | Seropositive | %Crude  Seroprevalence 95% CI | Population  (2022) | Bayesian population-weighted, test-adjusted  Seroprevalence 95% Cr I |
| Chikungunya | Sex  Female  Male | 2297  1868 | 810  568 | 35.3 (33.3 - 3 7.3)  30.4 (28.3 – 32.6) |  |  |
| Age  <5  5-17  18-45  46-64  65+ | 350  1367  1635  636  177 | 53  366  604  267  88 | 15.1 (11.6 – 19.3)  26.8 (24.4 – 29.2)  36.9(34.6 - 39.3)  42.0 (38.1 - 45.9)  49.7(42.1 – 57.3) |  |  |
| Asembo  Manyatta  Kilifi  Kibera  Nairobi | 853  801  849  813  849 | 608  229  226  241  74 | 71.3 (68.1 – 74.3)  28.6 (25.5 – 31.9)  26.6 (23.7 – 29.7)  29.6 (26.5 – 32.9)  8.7(6.9 – 10.8) |  |  |
| Dengue | Sex  Female  Male | 2297  1868 | 205  164 | 8.9 (7.8 – 10.2)  8.8 (7.5 – 10.2) |  |  |
| Age  <5  5-17  18-45  46-64  65+ | 350  1367  1635  636  177 | 7  49  120  145  48 | 2.0 (0.8 – 4.1)  3.6 (2.7 – 4.7)  7.3 (6.1 – 8.7)  22.8(19.6 – 26.3)  27.1(20.7 – 34.3) |  |  |
| Asembo  Manyatta  Kilifi  Kibera  Nairobi | 853  801  849  813  849 | 6  19  320  14  10 | 0.7 (0.2 – 1.5)  2.4(1.4 – 3.8)  37.7(34.4 – 41.0)  1.7(0.9 – 2.9)  1.2(0.6 – 2.2) |  |  |
| Rift valley fever | Sex  Female  Male | 2297  1868 | 54  66 | 2.4(1.8 – 3.1)  3.5(2.7 – 4.5) |  |  |
| Age  <5  5-17  18-45  46-64  65+ | 350  1367  1635  636  177 | 5  42  51  21  1 | 1.4(0.5 – 3.3)  3.1(2.2 – 4.1)  3.1(2.3 – 4.1)  3.3(2.1 – 5.0)  0.6(0.0-3.1) |  |  |
| Asembo  Manyatta  Kilifi  Kibera  Nairobi | 853  801  849  813  849 | 38  12  29  25  16 | 4.5 (3.2 – 6.0)  1.5 (0.8 – 2.6)  3.4 (2.3 – 4.9)  3.1 (2.0 – 4.5)  1.9 (1.1 – 3.0) |  |  |
| Overall | CHIKV  DENV  RVFV | 4165  4165  4165 | 1378  369  120 | 33.1(31.7 – 34.5)  8.9(8.0 – 9.8)  2.9(2.4 – 3.4) |  |  |

Table 3: Factors associated with seroprevalence

|  |  |  |  |
| --- | --- | --- | --- |
| Virus | Characteristic | Crude OR 95% CI | Adjusted OR 95% Cr I |
| Chikungunya | Sex  Male  Female | Reference  1.2 (1.1 – 1.4) |  |
| Age  <5  5-17  18-45  46-64  65+ | Reference  2.1 (1.5 – 2.8)  3.3(2.4 – 4.5)  4.1(2.9 – 5.7)  5.5(3.7 – 8.4) |  |
| site  Nairobi  Asembo  Manyatta  Kilifi  Kibera | Reference  26.0(19.7 – 34.6)  4.2(3.2 – 5.6)  3.8(2.9 – 5.1)  4.4(3.3 – 5.9) |  |
| Dengue | Sex  Male  Female | Reference  1.0(0.8 – 1.3) |  |
| Age  <5  5-17  18-45  46-64  65+ | Reference  1.8(0.9-4.4)  3.9(1.9-9.3)  14.5(7.2-34.5)  18.2(8.6-45.1) |  |
| Site  Nairobi  Asembo  Manyatta  Kilifi  Kibera | Reference  0.6(0.2 – 1.6)  2.0(1.0 – 4.6)  50.8(28.3 – 102.9)  1.5(0.7 – 3.4) |  |
| Rift valley fever | Sex  Male  Female | Reference  0.7(0.5 – 0.9) |  |
| Age  <5  5-17  18-45  46-64  65+ | Reference  2.2(0.9-6.4)  2.2(1.0-6.4)  2.4(1.0-7.1)  0.4(0.0-2.5) |  |
| Site  Nairobi  Asembo  Manyatta  Kilifi  Kibera | Reference  2.4(1.4 – 4.5)  0.8(0.4 – 1.7)  1.8(1.0 – 3.5)  1.7(0.9 – 3.2) |  |

**Discussions**

**Conclusion**

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