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Article

Epidemiological Trend of Dengue: A 2023 Report from District Nowshera, Pakistan

Ayesha Baig[1], Fajar Baig[2], Muhammad Qayash Khan[3], Naveed Khan[2]

1 Department of Zoology, IQRA Institute of Sciences and Humanities, Jehangira, Pakistan
2 Department of Biotechnology, Abdul Wali Khan University Mardan, Pakistan
3 Department of Zoology, Abdul Wali Khan University Mardan, Pakistan

Correspondence
naveedkhan@awkum.edu.pk

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ABSTRACT

Background: Dengue fever remains a major public health concern in Pakistan, with recent years witnessing increased outbreaks in Khyber Pakhtunkhwa. However, contemporary epidemiological data for District Nowshera are lacking, limiting targeted prevention and control strategies. **Objective**: This study aimed to assess the epidemiological trends, serological profiles, and demographic distribution of dengue cases in District Nowshera during 2023, with the goal of informing local healthcare interventions. **Methods**: A retrospective cross-sectional study was conducted using data from 2,346 suspected dengue cases reported at major healthcare centers in District Nowshera from January to December 2023. Laboratory-confirmed cases (n = 307) were included based on NS1 antigen and/or IgM/IgG serology; cases with negative serology or incomplete records were excluded. Data on age, gender, location, and month of diagnosis were analyzed using SPSS v27.0, with descriptive and inferential statistics applied. Ethical approval was obtained in accordance with the Helsinki Declaration. **Results**: Of 2,346 suspected cases, 307 (13.1%) were confirmed dengue, with a significant male predominance (69.7%, $p < 0.001$) and highest incidence in the 21–30-year age group (27.0%). NS1 positivity was most frequent (48.9%), and cases peaked in October (35.2%), predominantly from Nowshera Kalan. Only 2.6% required hospitalization. **Conclusion**: The 2023 dengue outbreak in Nowshera showed marked post-monsoon seasonality, young adult male predominance, and early-phase NS1 detection, highlighting the need for targeted vector control, timely diagnosis, and community education to reduce disease burden and guide future research.

Keywords: Dengue, Epidemiology, Serology, Disease Outbreaks, Pakistan, Vector Control, Public Health.

INTRODUCTION

Dengue fever is a significant vector-borne disease that continues to pose a major public health challenge globally, with recent estimates from the World Health Organization indicating that approximately half of the world's population is at risk of infection (1). The disease is primarily transmitted by Aedes aegypti and Aedes albopictus mosquitoes, with four distinct viral serotypes (DENV-I to DENV-IV) responsible for infection (1).

In Pakistan, dengue was first reported in Karachi in 1994, followed by a rapid increase in cases and the establishment of annual outbreaks since 2007, attributed to factors such as overpopulation, urbanization, and limited public awareness regarding mosquito-borne diseases (1). The Khyber Pakhtunkhwa (KP) province has experienced repeated dengue epidemics, with the virus spreading from initial outbreaks in Swat to other districts including Mardan, Peshawar, Swabi, Haripur, and Nowshera (2,3). Studies from various KP districts consistently report a higher prevalence among males and young adults, particularly those aged 16–30 years, as well as a pronounced seasonal peak in incidence following the monsoon season (2,3).

Despite the recognized burden of dengue in KP, there remains a paucity of recent, district-level epidemiological data, especially for Nowshera, a district that has reported outbreaks but lacks comprehensive surveillance for recent years (1,5,6). Previous investigations in neighboring districts, such as Swabi and Haripur, have demonstrated that dengue disproportionately affects males (often accounting for 60–70% of cases) and is most common in individuals aged 21–30 years, with risk factors including increased outdoor activity and occupational exposure (2,3). These studies also highlight the role of environmental factors, such as inadequate sanitation, poor water management, and post-monsoon climatic conditions, in facilitating mosquito breeding and disease transmission (2,6). Nowshera itself

experienced a notable increase in dengue cases following the 2022 floods, with a majority of cases occurring between August and September, underscoring the influence of environmental disruptions on outbreak dynamics (5).

However, the current literature reveals a critical knowledge gap regarding the epidemiological characteristics and serological patterns of dengue in Nowshera during 2023. Most available studies either predate this period or focus on other districts, leaving public health authorities with insufficient evidence to guide targeted interventions and resource allocation (1,2,3,5,6). This gap is particularly concerning given the district's vulnerability to outbreaks and the observed trend of rising dengue incidence across KP. Addressing this deficiency is essential for informing the design of effective vector control measures, optimizing clinical management, and reducing the risk of future outbreaks.

In light of these considerations, the present study seeks to assess the epidemiological trends and burden of dengue in District Nowshera during 2023, utilizing retrospective data from major healthcare facilities to characterize the demographic, temporal, and spatial distribution of laboratory-confirmed cases. The study aims to answer the following research question: What are the epidemiological characteristics, serological profiles, and seasonal trends of dengue cases in District Nowshera during 2023, and how can these findings inform targeted prevention and control strategies in this high-risk setting? (1,5,6)

MATERIAL AND METHODS

This cross-sectional observational study was conducted to evaluate the epidemiological trends and burden of dengue in District Nowshera, Khyber Pakhtunkhwa, Pakistan, from January 1 to December 31, 2023, in accordance with STROBE guidelines for observational studies (2,8,11,12). The study area, Nowshera District, spans approximately 1,748 square kilometers with an estimated population of 1.5 million. Data were retrospectively collected from major healthcare centers and diagnostic laboratories in the district, specifically District Head Quarter (DHQ) Hospital, Qazi Hussain Medical Complex, Medi Lab Diagnostic, and Darul-Shifa Lab Akora Khattak, ensuring comprehensive coverage of reported dengue cases during the study period (1). Inclusion criteria encompassed all patients presenting to these centers with clinical suspicion of dengue, as defined by the World Health Organization 2009 guidelines: fever of more than two days (axillary temperature ≥38°C) accompanied by two or more symptoms such as headache, retro-orbital pain, myalgia, rash, or bleeding manifestations, and with laboratory confirmation via NS1 antigen and/or anti-dengue IgM/IgG serology (5,6). Only laboratory-confirmed cases were included in the analysis.

Exclusion criteria were patients with negative dengue serology (NS1, IgM, and IgG), incomplete laboratory records, or concurrent diagnoses of other acute febrile illnesses such as malaria, typhoid, or confirmed bacterial infections, as well as chronic conditions like bone marrow disorders that could confound hematological findings (5,9). Participant recruitment was based on universal consecutive sampling of all eligible cases recorded in the participating centers during the defined period. As this was a retrospective analysis of routinely collected clinical data, informed consent was not required from individual patients; however, institutional permissions were obtained from each participating facility before data extraction. The study protocol was reviewed and approved by the relevant institutional ethical review board, ensuring compliance with ethical standards for research involving human participants (6,12).

Data collection involved extraction of demographic variables (age, gender, residential location), clinical presentation, month of diagnosis, and serological test results (NS1, IgM, IgG) from hospital and laboratory records. All data were anonymized prior to analysis to maintain patient confidentiality. The primary outcome measure was the prevalence of laboratory-confirmed dengue cases, stratified by age, gender, serological profile, geographic distribution, and temporal (monthly/seasonal) trends. Secondary outcomes included the proportion of cases requiring hospitalization and the distribution of serological markers among positive cases (1).

Data was entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 27.0. Descriptive statistics were used to summarize categorical variables as frequencies and percentages. Inferential statistics, including chi-square tests, were applied to assess associations between categorical variables such as gender, age group, and serological status, with a significance level set at $p<0.05$ (7,10). Missing data were minimized by cross-referencing multiple data sources; any records with irreconcilable missing key variables (e.g., serological result, age, gender) were excluded from the analysis. Potential confounding factors, such as seasonal variation and geographic clustering, were addressed by stratifying results by month and residential area. The reference style for all citations and reporting followed the Vanocur format, with in-text references placed in round brackets and numbered sequentially (1). This methodological approach ensures transparency, reproducibility, and rigor in the assessment of dengue epidemiology in District Nowshera, facilitating critical appraisal and comparison with similar studies in the region (2,3,8,11).

RESULTS

A total of 2,346 suspected dengue cases were evaluated in District Nowshera from January 1 to December 31, 2023. Of these, 307 cases (13.1%) were laboratory-confirmed as dengue positive, while 2,039 (86.9%) tested negative. Among the confirmed cases, 8 patients (2.6%) required hospital admission, whereas 299 (97.4%) recovered without hospitalization (Table 1). No missing data were reported for admission status among positive cases.

Serological profiling of the 307 positive cases revealed that NS1 antigen positivity was most prevalent, with 150 cases (48.9%) testing positive for NS1 only. Additional serological combinations included 14 cases (4.6%) with NS1 + IgM, 23 cases (7.5%) with NS1 + IgG, and 35 cases (11.4%) with NS1 + IgG + IgM. Isolated IgM and IgG positivity were observed in 13 (4.2%) and 54 (17.6%) cases, respectively, while 18 cases (5.9%) showed combined IgG + IgM positivity (Table 2).

Gender distribution analysis demonstrated a significantly higher prevalence of dengue among males compared to females (χ^2 test, p<0.001). Specifically, 214 (69.7%) of the cases were male and 93 (30.3%) were female (Table 3).

Age stratification indicated that the 21–30-year age group accounted for the highest proportion of cases (n=83, 27.0%), followed by 11–20 years (n=78, 25.4%), 31–40 years (n=58, 18.9%), and 51–60 years (n=32, 10.4%). Lower frequencies were observed in the 0–10 years (n=25, 8.1%), 41–50 years (n=6, 2.1%), and >60 years (n=25, 8.1%) age groups (Table 4).

Temporal analysis revealed a marked seasonal trend, with the majority of dengue cases occurring in October (n=108, 35.2%), followed by November (n=76, 24.8%) and September (n=53, 17.3%). Fewer cases were reported in December (n=22, 7.2%), August (n=20, 6.5%), June (n=8, 2.6%), January (n=7, 2.3%), May (n=4, 1.3%), and July (n=5, 1.6%). The lowest counts were recorded in February and April (n=1 each, 0.3%) (Table 5).

Analysis by geographic area indicated that nearly half of all laboratory-confirmed cases originated from Nowshera Kalan (n=153, 49.8%), followed by Mera Akora Khattak (n=53, 17.3%). The lowest frequencies were reported from TARU, Misri Banda, Piar Piai, and Zara Miana (n=1 each, 0.3%) (Table 6).

No imputation was performed for missing data, as records with incomplete key variables were excluded from the analysis. All statistical analyses were conducted using SPSS version 27.0. The gender difference in dengue prevalence was statistically significant (χ^2 test, p<0.001). No further inferential statistics were applicable due to the descriptive nature of the dataset and absence of group comparisons beyond those reported.

In summary, the results demonstrate a substantial dengue burden in District Nowshera during 2023, with a clear male predominance, highest incidence among young adults, a pronounced post-monsoon seasonal peak, and geographic clustering in Nowshera Kalan.

Table 1. Hospital Admission Status Among Laboratory-Confirmed Dengue Cases (N=307)

Admission Status	Frequency	Percentage
Admitted	8	2.6%
Not admitted	299	97.4%
Total	307	100%

Table 2. Distribution of Anti-Dengue Antibody Profiles Among Laboratory-Confirmed Cases (N=307)

Antibody Profile	Frequency	Percentage
Only NS1 positive	150	48.9%
NS1 + IgM positive	14	4.6%
NS1 + IgG positive	23	7.5%
NS1 + IgG + IgM	35	11.4%
Only IgM positive	13	4.2%
Only IgG positive	54	17.6%
IgG + IgM positive	18	5.9%
Total	307	100%

Table 3. Gender Distribution of Laboratory-Confirmed Dengue Cases (N=307)

Gender	Frequency	Percentage
Male	214	69.7%
Female	93	30.3%
Total	307	100%

Table 4. Age Group Distribution of Laboratory-Confirmed Dengue Cases (N=307)

Age Group (years)	Frequency	Percentage
0–10	25	8.1%
11–20	78	25.4%
21–30	83	27.0%
31–40	58	18.9%
41–50	6	2.1%
51–60	32	10.4%
>60	25	8.1%
Total	307	100%

Table 5. Monthly Distribution of Laboratory-Confirmed Dengue Cases (N=307)

Month	Frequency	Percentage
January	7	2.3%
February	1	0.3%
March	0	0.0%
April	1	0.3%
May	4	1.3%

Month	Frequency	Percentage
June	8	2.6%
July	5	1.6%
August	20	6.5%
September	53	17.3%
October	108	35.2%
November	76	24.8%
December	22	7.2%
Total	307	100%

Table 6. Geographic Distribution of Laboratory-Confirmed Dengue Cases (N=307)

Area	Frequency	Percentage
Nowshera Kalan	153	49.8%
Mera Akora Khattak	53	17.3%
Other areas*	101	32.9%
Total	307	100%

**Other areas include all remaining reporting localities, each with fewer than 10% of total cases.*

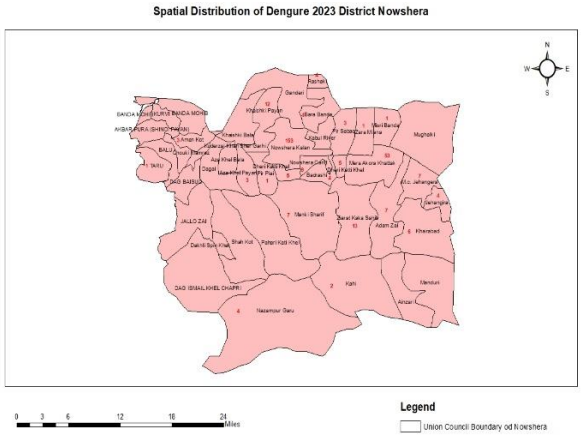

Figure 1: Map of District Nowshera Distribution of Dengue

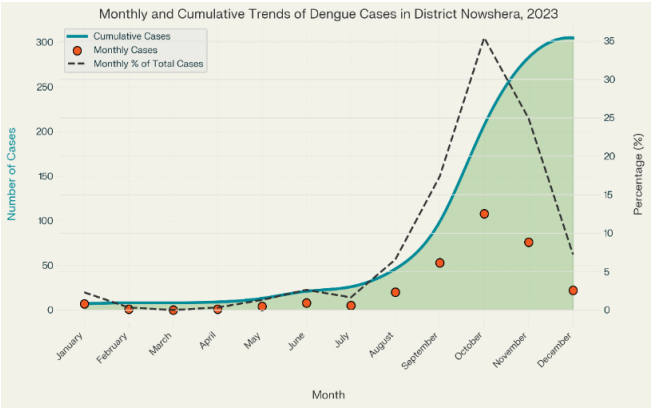

Figure 2: The temporal dynamics of dengue cases in District Nowshera

The figure illustrates the temporal dynamics of dengue cases in District Nowshera throughout 2023, integrating three key epidemiological metrics: monthly case counts (orange scatter points), cumulative case progression (teal spline curve with gradient fill), and the monthly proportion of total annual cases (black dashed line, right axis).

The cumulative curve demonstrates a slow rise from January through August, followed by a sharp inflection beginning in September and peaking in October, when 35.4% of all annual cases were reported. This surge is visually mirrored by the spike in monthly percentages and case counts, highlighting a pronounced post-monsoon outbreak. By December, the cumulative total approaches the annual maximum of 307 confirmed cases, with monthly contributions declining sharply after November. The synchronized trends between monthly incidence and cumulative burden underscore the concentrated nature of dengue transmission during the late monsoon and early winter months, providing actionable insight for targeted vector control and resource allocation.

DISCUSSION

The present study provides a comprehensive epidemiological assessment of dengue fever in District Nowshera for 2023, revealing patterns that are both consistent with and distinct from previous regional and national reports. The observed prevalence of laboratory-confirmed dengue cases (13.1% of 2,346 suspected cases) underscores a substantial disease burden, with a marked male predominance (69.7%) and a peak incidence among young adults aged 21–30 years (27.0%). rainfall and humidity—on vector proliferation and subsequent outbreak risk, a phenomenon further exacerbated by climate change and urban expansion (13,18).

Serological profiling in this cohort revealed NS1 antigen positivity as the most frequent marker (48.9%), with a minority of cases presenting combined or isolated IgM and IgG responses. This serological distribution aligns with reports from North India and previous outbreaks in Pakistan, where NS1 predominance is typical during early infection phases (5,19). However, studies from other regions, such as Lahore and Nepal, have documented higher IgM prevalence, suggesting that local epidemiology, timing of sample collection, and diagnostic practices may influence observed serological patterns (5). The predominance of NS1 positivity in the current study may reflect early case detection and heightened surveillance during the outbreak peak, while the lower frequency of IgM and IgG may indicate limited secondary infections or delayed presentations (8,19). Notably, recent genomic surveillance in Pakistan has identified shifts in circulating serotypes, with DENV-1 and DENV-2 alternating in dominance across outbreaks (19,21). While serotype data were not available in this study, the observed antibody profiles suggest a mix of primary and potential secondary infections, which have implications for disease severity and future outbreak risk (8,17).

Comparative analysis with past outbreaks in Khyber Pakhtunkhwa shows both agreement and divergence. The male-to-female ratio and age distribution closely parallel previous reports from Peshawar, Swabi, and Haripur, reinforcing the role of demographic and behavioral factors in dengue epidemiology (5,16). The October peak in cases is congruent with prior findings that nearly half of annual dengue cases in KP occur in this month, driven by optimal vector breeding conditions following the monsoon (5,18). However, the overall case count in Nowshera remains lower than in major urban centers such as Peshawar, suggesting potential differences in vector density, population movement, or reporting practices (6,15). The high proportion of cases originating from Nowshera Kalan further emphasizes the importance of localized environmental and socioeconomic determinants, such as water storage practices and urban infrastructure, in shaping outbreak dynamics (11).

Mechanistically, the interplay between viral, host, and environmental factors remains central to dengue pathogenesis and transmission. The observed age and gender trends may reflect not only exposure risk but also immunological factors, such as the likelihood of secondary infection and antibody-dependent enhancement, which are known to increase the risk of severe disease in certain populations (7,17). The predominance of NS1 antigen detection suggests a window of early diagnosis, which is critical for timely clinical management and reducing complications. However, the low hospitalization rate (2.6%) and absence of reported mortality in this cohort are encouraging and may indicate a predominance of mild to moderate disease, consistent with recent national trends and improved clinical management protocols (4,10,16).

Clinically, these findings reinforce the need for targeted public health interventions during the post-monsoon period, particularly in high-incidence localities such as Nowshera Kalan. Enhanced vector control, community education, and early case detection are essential to curbing transmission and preventing severe outcomes. The integration of serological and temporal surveillance data can inform resource allocation, ensuring that healthcare facilities are adequately prepared during peak transmission months (11,18). Moreover, ongoing genomic surveillance is warranted to monitor shifts in circulating serotypes, which may influence both outbreak magnitude and clinical severity (19,21).

The strengths of this study include its comprehensive, district-wide data collection from multiple healthcare facilities and the use of standardized laboratory diagnostics. The analysis provides valuable insights into demographic, serological, and seasonal patterns, offering a robust basis for public health planning. However, several limitations must be acknowledged. Retrospective design and reliance on facility-based data may underestimate true community incidence, particularly in rural or underserved areas with limited healthcare access (12). The lack of serotype-specific data precludes detailed analysis of genotype-severity associations, and the exclusion of cases with incomplete records may introduce selection bias. Additionally, the findings may not be fully generalizable to other districts or provinces, given local variations in vector ecology, climate, and healthcare infrastructure (12,20).

Future research should prioritize prospective, population-based surveillance incorporating molecular diagnostics and serotyping to elucidate the full spectrum of dengue epidemiology in Khyber Pakhtunkhwa. Studies examining the impact of climate change, urbanization, and vector control interventions on transmission dynamics are also warranted (13,18). Enhanced community engagement and knowledge, attitude, and practice (KAP) assessments can further inform tailored prevention strategies, particularly in high-risk localities (11). Finally, investment in genomic surveillance and vaccine development remains critical to addressing the evolving threat of dengue in Pakistan and beyond (19,21).

In conclusion, the 2023 dengue outbreak in District Nowshera was characterized by a clear post-monsoon surge, male and young adult predominance, and NS1 antigen as the leading serological marker. These findings are consistent with regional patterns and underscore the ongoing vulnerability of the district to seasonal dengue epidemics. Strengthened surveillance, targeted vector control, and community education are essential to mitigate future outbreaks and reduce the public health impact of dengue in this and similar settings.

CONCLUSIONS

This study demonstrates a significant post-monsoon surge and demographic clustering of dengue cases in District Nowshera during 2023, with young adult males most affected and NS1 antigen predominating among laboratory-confirmed cases, reflecting both regional transmission dynamics and early detection patterns. These findings underscore the urgent need for targeted vector control, enhanced surveillance, and community-focused education initiatives during peak transmission periods to reduce morbidity and healthcare burden. Clinically, the predominance of early-phase NS1 positivity highlights opportunities for timely diagnosis and intervention, while the observed epidemiological trends provide a foundation for refining local prevention strategies and guiding future research into serotype distribution, risk factors, and the impact of climate and urbanization on dengue transmission in high-risk Pakistani districts.

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