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Epidemiological Patterns Of Dengue Fever In Medina, Saudi Arabia: A Cross-Sectional Analysis, 2023

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Abstract

Background: Dengue fever is a major public health challenge in the western coastal areas of Saudi Arabia, such as the Medina. Religious gatherings in this area increase the risk of transmission. The city's unique demographic composition and environmental factors create distinctive challenges for dengue surveillance and control.
Objective: To analyze the epidemiological characteristics and laboratory findings of dengue fever cases in Medina from January to November 2023, examining demographic patterns, geographical clustering, seasonal variations, and key laboratory parameters.
Methodology: A cross-sectional study was conducted to analyze 202 dengue cases. Laboratory confirmation utilized Reverse Transcription-Polymerase Chain Reaction (RT-PCR), Non-Structural Protein 1 (NS1) antigen, and Immunoglobulin M (IgM) antibody testing. Data analysis included demographic characteristics, geographical distribution, seasonal patterns, and laboratory parameters including White Blood Cell (WBC), Platelet (PLT), Hematocrit (HCT), and Liver Function Tests (LFTs) comprising Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT). Statistical analysis was performed using R version 4.0.3.
Results: Demographic analysis revealed male predominance. Temporal analysis revealed significant summer predominance. Diagnostic evaluation demonstrated Reverse Transcription-Polymerase Chain Reaction (RT-PCR) yielding highest sensitivity, followed by Non-Structural Protein 1 (NS1) and Immunoglobulin M (IgM). Age-stratified analysis revealed optimal diagnostic response across all testing modalities in patients aged < 20 years, while those aged $20 - 35$ years exhibited superior RT-PCR and NS1 performance. Diagnostic efficacy in advanced age demonstrated NS1 and IgM superiority among patients aged > 65 years. Hematological evaluation revealed characteristic White Blood Cell count reduction, Platelet count reduction, and preserved Hematocrit levels. Hepatic enzyme analysis demonstrated elevated median values for Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT).
Conclusion: The study demonstrated distinctive epidemiological and laboratory patterns, characterized by demographic heterogeneity, temporal-spatial clustering, differential diagnostic sensitivities, and

characteristic hematological-hepatic profiles. These comprehensive findings advocate for integrated surveillance strategies during peak transmission periods.

Keywords: Dengue fever; Epidemiology; Laboratory diagnosis; Saudi Arabia; Disease surveillance; Liver function tests; Hematological parameters; Geographic distribution.

1. Introduction

Current global estimates indicate that approximately 390 million dengue infections occur annually, with around 96 million cases manifesting clinically, contributing significantly to worldwide morbidity and mortality [1]. This global health challenge is particularly significant in regions with suitable vector habitats and high population mobility [2]. Among these regions, Saudi Arabia has emerged as an area of growing concern, especially in the western coastal cities of Jeddah, Makkah, and Medina [3, 4]. The disease is caused by four distinct serotypes of the dengue virus—DENV−1, DENV−2, DENV−3, and DENV−4 [5]. Importantly, infection with one serotype does not confer immunity to the others, complicating the epidemiological landscape of the disease [6].

Clinical Manifestations

The clinical manifestations of dengue virus infection exhibit a wide spectrum of presentations with varying degrees of severity and prevalence rates [7, 8]. Classical dengue fever (DF), the most common manifestation, accounts for approximately 75% of symptomatic cases and is characterized by pyrexia, severe cephalgia, myalgia, arthralgia, cutaneous eruptions, and mild hemorrhagic manifestations [9, 10]. A more severe clinical entity, dengue hemorrhagic fever (DHF), comprises about 20% of cases and is marked by significant complications, including increased vascular permeability, pronounced thrombocytopenia, and notable hemorrhagic phenomena [11]. The most severe form, dengue shock syndrome (DSS), seen in approximately 5% of cases, is associated with cardiovascular compromise and shock; without prompt treatment, DSS demonstrates a mortality rate of up to 20% [12, 13]. The disease typically progresses over7 − 10 days, with the critical phase occurring between days 3 − 7 of illness [14].

Epidemiological Surveillance and Temporal Trends in Saudi Arabia

Epidemiological surveillance has documented significant dengue virus transmission patterns in Saudi Arabia's western region, with marked heterogeneity in disease burden across urban centers [15, 16]. In Jeddah, the incidence of cases surged fivefold, rising from 2,000 documented cases in 2015 to approximately 12,000 cases in 2019 [17]. Parallel epidemiological patterns have emerged in Medina, where reported cases increased from 1,000 − 7,000 during the same period [18]. Makkah experienced an intermediate disease burden, reporting 5,000 cases in 2019 [19]. The urban environments of these metropolitan areas present optimal climatological conditions that support the proliferation of Aedes aegypti, the primary arthropod vector responsible for DENV transmission [20]. Additionally, the annual mass gatherings for religious pilgrimages (Hajj and Umrah) introduce significant demographic shifts that can amplify transmission risks in these endemic regions, with peak dengue incidence correlating with periods of heightened pilgrim influx [21, 22].

Diagnosis

Diagnosing dengue fever presents significant challenges, with an approximate diagnostic accuracy rate of 80% in the early stages due to symptom overlap with other mosquito-borne illnesses such as Zika and Chikungunya [23, 24]. Laboratory confirmation relies on multiple diagnostic tools: RT-PCR testing, which is most effective during the first five days of infection and has a sensitivity of 98% and specificity of 99% [25]; NS1 antigen detection, with a sensitivity range of 85% − 95%; and IgM antibody tests, offering a specificity range of 90% − 95% [26, 27]. Molecular detection through RT-PCR not only confirms infection but also enables serotype identification, which is crucial for epidemiological surveillance and clinical management [28].

Laboratory analysis has revealed characteristic blood composition changes associated with dengue infection [29]. Typically, patients present with a low WBC count, with WBC levels dropping below 4,000 cells per microliter in 68% of cases [30]. Although the HCT generally remains within the normal range (35% − 47%), daily monitoring is essential due to the risk of hemoconcentration, where the blood becomes too concentrated [31]. Additionally, PLT counts often show a significant decline, frequently falling below 100,000 per microliter during the acute phase of infection [31]. Furthermore, liver function tests often indicate elevated liver enzymes, with ALT and AST levels exceeding normal ranges in approximately 75% of cases, particularly during the critical phase of infection [33, 34].

Vulnerable populations face disproportionate risks: children under 15 years account for 35% of severe cases, while elderly patients over 65exhibit a mortality rate three times higher than the general population [34, 35]. These demographics require targeted preventive measures, including enhanced vector control in schools and residential areas, which have been shown to reduce transmission rates by up to 60%when implemented [36, 37].

Management and Treatment

The cornerstone of dengue management remains supportive care, with specific protocols based on disease severity [38, 39]. Early-stage treatment focuses on fluid management and fever control, with 80% of patients responding well to oral rehydration and acetaminophen [40]. However, aspirin and ibuprofen are contraindicated due to a 40% increased risk of bleeding complications [41]. While theDengvaxia™ vaccine is available for individuals previously infected, its effectiveness varies significantly: it provides 73% protection against severe dengue in seropositive individuals but may increase the risk in seronegative persons [42, 43]. Hospital admission criteria have been standardized, with approximately 25% of symptomatic cases requiring inpatient care [44].

Economic Impact

The economic burden of dengue fever presents a significant challenge to Saudi Arabia's healthcare system and economy. For instance, in Jeddah, the annual costs associated with dengue fever amount to approximately 26 million SAR (USD 6.9 million) [45]. Additionally, the costs for outpatient care range from 4,000 − 7,000 SAR, while inpatient treatment can vary from 15,000 − 25,000 SAR [46, 47]. Indirect costs, such as productivity losses due to workforce absenteeism (9 − 12 days per case), further exacerbate the economic burden, contributing an additional 30% [48]. Furthermore, outbreaks during religious gatherings lead to revenue losses of 40 − 50 million SAR, underscoring the urgent need for effective prevention and control measures [49].

Public Health Initiative

Saudi Arabia's comprehensive dengue control program has shown varying success rates across different regions [50, 51]. The Ministry of Health's annual investment of 50 million SAR(USD 13.3 million) in vector control has led to a 40% reduction in mosquito density in treated areas [52]. A comparative analysis with similar programs in neighboring countries reveals that Saudi Arabia's intervention effectiveness rate is65%, compared to 75%in theUAEand 70%in Qatar [53]. Community engagement initiatives have reached 70% of the target population, with a 50% improvement in the adoption of preventive behaviors [54]. The national surveillance system now captures 95% of cases within 24 hours of presentation, a significant improvement from 60% coverage in 2015 [55].

Implications for Future Research and Public Health

Epidemiological analysis of dengue virus transmission in Saudi Arabia reveals a concerning trend of escalating incidence, particularly in urban centers such as Medina. Between 2018 and 2023, Medina experienced annual incidence increases ranging from 15% − 20% [56], with reported cases rising from 3,500 in 2018 to approximately 7,000 in 2023 [57].This increase represents a compound annual growth rate (CAGR) of 18.9% over the five-year period, highlighting the urgent need for effective public health interventions [58, 59]. Such rapid acceleration demands swift and decisive public health interventions to halt this increase and reverse its trajectory. While CAGR provides a valuable metric for analyzing these health trends, it also emphasizes our pressing need to implement effective strategies that will reduce future cases.

Study Objective

The primary objective of this study was to analyze the epidemiological characteristics and laboratory findings of dengue fever cases in Medina from January to November 2023. The study aimed to examine demographic patterns, including distributions by age, gender, and nationality, evaluate geographical clustering across districts, assess seasonal variations, and investigate key laboratory parameters such as hematological profiles and liver function tests. This comprehensive analysis was designed to enhance the understanding of dengue fever patterns in Medina, contribute to the existing knowledge of dengue epidemiology in Saudi Arabia, and inform evidence-based strategies for disease surveillance and control in the region.

2. Methodology

Study Setting

This cross-sectional study was conducted from January to November 2023 at Medina General Hospital, a key facility within KSAMC, located in Medina, Saudi Arabia. Medina, a city of historical and religious significance, has an estimated population of 2.2 $million$ and serves as a major pilgrimage destination [60, 61]. KSAMC, a 1,200 $-$bed tertiary care hospital, serves as a primary healthcare provider in the western region of Saudi Arabia, with an annual patient volume exceeding 300,000 visits [62, 63].

The study population included patients seeking care at the Emergency and Internal Medicine departments of KSAMC. These departments serve a demographically diverse patient population, encompassing residents from central Medina and surrounding districts such as Shuran, Al Hijrah, Al Khalidiyyah, and neighboring areas. The patient population also includes individuals from outside the region, particularly those visiting Medina for religious purposes.

Data Sources and Laboratory Methods

The study encompassed all diagnosed dengue patients, with data extraction performed through the Health Electronic Surveillance Network (HESN) system of KSAMC, which integrates with the Ministry of Health's comprehensive electronic surveillance infrastructure.

Laboratory confirmation followed a standardized diagnostic protocol utilizing RT-PCR, NS1, and IgM antibody testing [64-67]. Clinical monitoring included complete blood count parameters (WBC, PLT, HCT) and liver function tests (AST and ALT), adhering to International Federation of Clinical Chemistry (IFCC) guidelines [68-72].

Inclusion and Exclusion Criteria

The inclusion criteria for this study were carefully designed based on established protocols for identifying dengue virus infections, following similar methods used in regional studies. The main requirements were patients presenting with a fever higher than $38.5°C$, along with symptoms commonly associated with dengue, such as headache, joint pain, muscle pain, pain behind the eyes, vomiting, swollen lymph nodes, or skin rash [73, 74].Additionally, patients were required to have positive results from laboratory tests, such as PCR, NS1 antigen detection, or IgM antibody testing, to confirm the presence of dengue infection [75-77].

Exclusion criteria were applied to ensure a more focused patient group. These included patients with a fever of $38.5°C$ or lower, a history of cancer, individuals under the age of 15 (as pediatric care was not available), those receiving outpatient care, and cases with incomplete clinical records [78, 79]. Symptoms were recorded using standardized forms developed in accordance with World Health Organization guidelines, ensuring consistency and thoroughness in data collection [80, 81].

Data Collection and Statistical Analysis

Statistical analyses were performed using R version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria) to analyze data from 117 laboratory-confirmed dengue cases. To assess associations between categorical variables, Pearson's chi-square (χ^2) tests were employed. The chi-square test statistic was calculated as:

$$\chi^2 = \Sigma\,[(O - E)^2/E]$$

where O represents observed frequencies and E represents expected frequencies. A significance threshold of $p < 0.05$ was established, where the p-value indicates the probability of obtaining test results at least as extreme as those observed under the null hypothesis of no association. For categorical variables, proportions ($\hat{p}$) were computed using:

$$\hat{p} = n/N$$

where n represents the number of cases in each category and N represents the total sample size. To estimate population parameters, 95% confidence intervals (CIs) were calculated using Wilson score method:

$$CI = (\hat{p} + z^2/2n \pm z\sqrt{[\hat{p}(1-\hat{p})/n + z^2/4n^2]})\,/\,(1 + z^2/n)$$

where $\hat{p}$ denotes the sample proportion, n is the sample size, and z equals 1.96 (critical value from the standard normal distribution for 95% CI). The Wilson score method was selected for its superior coverage properties, particularly for small samples and proportions near 0 or 1. This interval estimation provides a range of plausible values for the true population proportion with 95% confidence. For continuous variables, descriptive statistics were applied to analyze laboratory parameters, with results presented as mean ± standard deviation, and confidence intervals computed according to standardized methods. This comprehensive statistical methodology aligns with established research protocols, particularly those employed by Ibrahim et al. [82, 83], ensuring consistency and comparability with existing literature in dengue research.

3. Results

A comprehensive observational study conducted at KSAMC in Medina, Saudi Arabia, from January to November 2023, documented 202 dengue cases. Of these, 117 cases (57.9%) were laboratory-confirmed dengue infections, while 85 cases (42.1%) were classified as suspected dengue fever based on clinical presentation pending laboratory confirmation.

The investigation analyzed 117 laboratory-confirmed dengue cases, defined as patients who tested positive through at least one of the following tests: PCR, NS1 antigen detection, or IgM antibody testing, using R version 4.0.3 statistical software.Statistical evaluations included chi-square tests for categorical variables ($p < 0.05$), Wilson's score method for calculating proportions with 95% confidence intervals, and descriptive statistics for laboratory parameters, presented as mean ± standard deviation. These analyses offered a comprehensive examination of dengue patterns and associations within the dataset.

Demographic analysis of laboratory-confirmed dengue cases revealed a significant gender distribution, as shown in Table 1. Males represented 64.1% (75 cases) of confirmed cases, while females accounted for 35.9% (42 cases). The gender disparity was statistically significant ($\chi^2 = 7.6818, df = 1, p = 0.005578$), with males comprising 64.1% (95% CI: 55.09% − 72.22%) and females 35.9% (95% CI: 27.78% − 44.91%), as detailed in Table 2.

The age distribution among confirmed dengue cases ranged from 15 to 97 years, with a median age of 39.5 years and a mean age of 41.07 years. Age-stratified analysis revealed that working-age adults constituted the majority of cases, with the 36 − 50 years age group representing the highest proportion at 29.9% (35 cases, 95% CI: 22.36% − 38.74%), followed by the 20 − 35 years age group at 26.5% (31 cases, 95% CI: 19.34% − 35.15%),as shown in Table 1.

The remaining age groups showed varying distributions: individuals under 20 years comprised 14.5% (17 cases, 95% CI: 9.27% − 22.04%), those over 65 years represented 12.0% (14 cases, 95% CI: 7.26% − 19.09%), while the 51 − 55, 56 − 60, and 61 − 65 age groups showed lower proportions of 6.8% (95% CI: 3.51% − 12.91%), 6.0% (95% CI: 2.93% − 11.84%), and 4.3%

(95% CI: 1.84% − 9.62%) respectively, as detailed in Table 1. These age-related variations were statistically significant, as indicated in Table 2 ($\chi^2 = 57.435, df = 6, p = 1.491e-10$).

Analysis of nationality distribution among dengue cases showed that Saudi nationals constituted 73.5% (86 cases, 95% CI: 64.85% − 80.66%) of confirmed cases, while non-Saudi residents accounted for 26.5% (31 cases, 95% CI: 19.34% − 35.15%), as detailed in Table 1. Chi-square analysis revealed a significant relationship between nationality and dengue infection ($\chi^2 = 37.121, df = 1, p = 1.11e-09$), as shown in Table 2.

Analysis of confirmed dengue cases across Medina districts, as illustrated in Figure 3, demonstrated varying frequencies. Shuran recorded 22 confirmed cases, followed by Al Hijrah (15 cases) and Al Hezam (12 cases). Al Harm and Quba districts showed moderate numbers with 8 and 7 confirmed cases respectively. Lower frequencies were observed in Al Sharqiah (6 cases), Al Khalidiyyah (6 cases), and Al Aziziyah (4 cases). Several districts including Al Rawabi, Al Badrani, and Ad Duwaimah reported 3 confirmed cases each. The lowest frequencies were noted in peripheral districts such as Al Iskan, Al Hait, and Al Nasr, each recording only 1 confirmed case. Chi-square analysis revealed a significant non-random distribution of cases across districts ($\chi^2 = 188.5385, df = 35, p < 0.0001$), indicating substantial geographical heterogeneity in case occurrence (Table 2).

Seasonal trends in confirmed cases are illustrated in Figure 2, which highlights a pronounced concentration of cases during the summer months (June to August), accounting for 92.3% (108 cases) of the total confirmed cases. The autumn months (September to November) recorded six cases (5.1%), while the spring months (March to May) recorded three cases (2.6%). No cases were reported during the winter months (December to February).

The diagnostic testing analysis presented in Table 3highlights differential detection rates across the three testing methodologies employed. PCR testing demonstrated superior sensitivity, identifying 107 cases (91.4%, 95% CI: 86.1% − 96.7%), with a gender distribution of 67 males and 40 females. The NS1 antigen assay detected 89 cases (76.1%, 95% CI: 70.8% − 81.4%), including53males and 36females. IgM antibody testing identified 81 cases (69.2%, 95% CI: 63.7% − 74.7%), with 53 males and 28 females testing positive.

Analysis of diagnostic test performance across age groups, as demonstrated in Table 4, revealed distinct patterns of effectiveness. PCR, NS1, and IgM testing demonstrated optimal sensitivity in patients under 20 years, with consistently higher positive results across all three methods. In the 20 − 35 years cohort, PCR and NS1 exhibited superior performance, while IgM showed lower sensitivity. The 36 − 50 years group demonstrated high positivity rates across all tests, with PCR showing particularly strong performance.

The diagnostic patterns shifted in older age groups. In patients aged 51 − 55 years, PCR and NS1 maintained moderate sensitivity despite lower overall positivity rates, while IgM showed reduced effectiveness. The 56 − 60 − and 61 − 65 −years cohorts demonstrated lower positivity rates across all methods, though PCR and NS1 retained higher sensitivity. In patients over 65 years, NS1 and IgM demonstrated superior diagnostic utility compared to PCR (Table 4).

Analysis of hematological parameters among confirmed dengue cases revealed characteristic alterations, as detailed in Table 5. WBC counts showed notable reduction at 4,000 ± 2,000 cells per microliter relative to the normal range of 4,500 − 11,000 cells per microliter. Similarly, PLT counts decreased at 140,000 ± 80,000 platelets per microliter, falling below the normal range of 150,000 − 450,000 platelets per microliter. In contrast, HCT levels remained within normal parameters at 38 ± 8% (normal range: 35% − 45%).

Analysis of hepatic enzymes demonstrated elevated levels of hepatic parameters, as illustrated in Figure 3. AST exhibited pronounced elevation with a median value of 58 units per liter (interquartile range [IQR]: 34.0 − 97.0), while ALT showed moderate elevation with a median value of 41 units per liter (IQR: 23.8 − 72.5).

4. Discussion

Case Confirmation Rate

The comprehensive epidemiological analysis of dengue fever cases in Medina from January–November 2023 revealed distinct patterns of disease distribution and transmission dynamics. The laboratory confirmation rate of 57.9% (117/202 cases) offers crucial insights into regional dengue trends.

Data Collection and Statistical Approach

The analysis encompassed 117 laboratory-confirmed dengue cases, validated through PCR, NS1 antigen assay, or IgM antibody testing. Statistical analyses were conducted using R version 4.0.3 software, employing chi-square tests for categorical variables ($p < 0.05$), Wilson's score method for confidence intervals, and descriptive statistics for laboratory parameters. This comprehensive approach enabled robust detection and statistical validation of epidemiological patterns.

Gender Distribution

Analysis of gender distribution revealed male predominance (64.1%) among confirmed dengue cases, consistent with previous findings from urban Saudi settings including Jeddah (61.3%) [84] and Makkah (58.7%) [85]. This persistent gender disparity across multiple Saudi cities suggests the influence of occupational and behavioral factors, particularly increased outdoor exposure among males. These findings emphasize the importance of implementing gender-specific preventive measures, especially in occupational settings with higher vector exposure risk.

Age Distribution

Analysis of age distribution demonstrated peak incidence among working-age adults, with the $36 - 50$ years cohort representing 29.9% (35/117 cases) and the $20 - 35$ years group accounting for 26.5% (31/117 cases) of confirmed cases. These findings align with previous studies from Riyadh (mean age 38.9 years) [86] and the Eastern Province (peak occurrence in $35 - 45$ age group) [87], suggesting occupation-related exposure as a significant factor in dengue transmission. This consistent age-specific pattern across Saudi regions emphasizes the need for targeted preventive strategies in occupational settings with elevated vector exposure risk.

Nationality Distribution

Analysis of nationality distribution revealed a marked disparity in dengue confirmation rates, with Saudi nationals representing 73.5% of cases compared to 26.5% among non-Saudi residents. Despite shared environmental exposure within the same geographical location, this significant variation ($\chi^2 = 37.121, df = 1, p = 1.11e-09$) suggests the influence of healthcare accessibility factors. The lower confirmation rate among non-Saudi residents may reflect disparities in healthcare access, insurance coverage, and health-seeking behaviors. These findings emphasize the necessity for investigating healthcare accessibility patterns and implementing equitable diagnostic and treatment strategies across both demographic groups.

Geographical Distribution

The geographical distribution of confirmed dengue cases across Medina districts revealed significant clustering patterns. Shuran emerged as the primary area of high dengue frequency, followed by considerable case clustering in Al Hijrah and Al Hezam districts. Higher frequency in these central districts suggests potential environmental and demographic factors influencing transmission patterns. This clustering in specific districts indicates possible urban risk factors such as population density, water storage practices, and construction activities that may contribute to vector breeding sites. Understanding these geographical patterns is crucial for implementing targeted vector control strategies and public health interventions in high-risk areas.

Seasonal Patterns

Analysis of temporal distribution revealed pronounced case clustering during summer months, with 92.3% of confirmed dengue cases occurring between June and August. This pattern correlates with optimal environmental conditions for vector proliferation, characterized by elevated temperatures and increased rainfall [88]. The marked reduction in cases during autumn, spring, and winter months further substantiates the seasonal nature of dengue transmission [89]. Studies from Saudi Arabia demonstrate similar temporal patterns, particularly noting increased transmission risks during periods of mass religious gatherings such as Hajj and Umrah [90]. These findings align with global research from Southeast Asia and Latin America, confirming the relationship between climatic conditions and dengue transmission rates [91]. The observed seasonality emphasizes the necessity for targeted vector control interventions and enhanced public health surveillance during high-risk periods.

Diagnostic Methods

Analysis of diagnostic methodologies revealed variations in detection patterns, with PCR demonstrating superior effectiveness. These findings align with studies from Jeddah and Makkah that established PCR as the primary diagnostic tool for dengue detection in Saudi healthcare settings [92]. The multi-test approach employed in this study provided comprehensive detection capabilities across different phases of infection, consistent with current national diagnostic protocols [93].

The age-stratified analysis highlighted distinct patterns in test performance. While middle-aged adults showed optimal responses across all testing methods, particularly PCR, variations were observed in other age groups. These findings parallel recent Eastern Province and Riyadh studies that documented similar age-related diagnostic patterns [94,95]. The results suggest age-specific variations in diagnostic test effectiveness, with PCR and NS1 showing optimal performance in younger populations, while NS1 and IgM demonstrated greater utility in elderly patients. The observed gender distribution in test positivity, predominantly affecting males across all diagnostic methods, aligns with similar findings from studies conducted in Jeddah (61.3%) and Makkah (58.7%) [96, 97], suggesting consistent regional epidemiological patterns.

Hematological Manifestations

Analysis of hematological parameters demonstrated specific dengue-associated changes, most notably leucopenia and thrombocytopenia. These findings align with comprehensive studies from Jeddah and Makkah, where similar patterns of reduced blood cell count characterized dengue infections [98, 99]. Research from Riyadh documented comparable hematological alterations, establishing these as consistent manifestations of dengue infection within Saudi healthcare settings [100, 101].

The maintenance of normal hematocrit levels, despite marked changes in other blood parameters, mirrors findings from Eastern Province studies [102]. This pattern suggests effective clinical management protocols and aligns with established dengue monitoring guidelines in Saudi Arabia [103,104]. The consistency of these hematological patterns across different Saudi regions provides valuable benchmarks for clinical assessment and management of dengue cases.

Biochemical Manifestations

In this study, analysis of hepatic enzymes demonstrated significant elevation of aminotransferases, with AST levels notably higher than ALT. These biochemical alterations align with studies from Makkah Regional Laboratory, where similar patterns of liver enzyme elevations were documented in dengue patients [105]. Research from King Abdulaziz Medical City reported comparable hepatic manifestations, with AST typically showing higher elevation than ALT [106,107]. The elevated enzyme levels likely reflect liver dysfunction, contributing to the clinical manifestations observed in these patients.

The observed pattern of liver enzyme elevation aligns with findings from studies in the Western Region of Saudi Arabia [108,109], where dengue-associated hepatic involvement showed similar characteristics. These biochemical patterns, consistent across Saudi healthcare settings, provide important markers for monitoring disease progression [110,111]. These similarities underscore the need for collaborative public health initiatives and interventions to mitigate the impact of dengue fever in high-risk areas and populations.

5. Conclusion

This cross-sectional study provides comprehensive insights into the epidemiological patterns of dengue fever in Medina during 2023. The analysis revealed significant demographic patterns, with male predominance (64.1%) and higher incidence among working-age adults ($36-50$ years). Geographical distribution showed distinct clustering in central districts, particularly Shuran, while seasonal analysis demonstrated peak transmission during summer months (92.3% of cases). Diagnostic testing effectiveness varied by age group, with PCR showing highest overall sensitivity (91.4%). Laboratory findings consistently showed characteristic alterations in hematological and hepatic parameters, aligning with regional dengue patterns.

These findings have important implications for public health strategies in Medina, emphasizing the need for targeted interventions in high-risk districts, age-specific diagnostic approaches, and enhanced surveillance during peak seasons. Furthermore, the observed disparities in case distribution across demographic groups suggest the importance of ensuring equitable healthcare access. This study contributes valuable data to the understanding of dengue epidemiology in Saudi Arabia and provides an evidence base for improving dengue prevention and control measures in urban settings with similar demographic and environmental characteristics.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Distribution of Confirmed Dengue Fever Cases by Gender, Age, and Nationality

Category	Subcategory	Reported Cases (N=202)	Confirmed Count (n=117)	Percentage (%) (95% CI)
Gender	Male	126	75	64.1 (51.09, 72.22)
	Female	76	42	35.9 (27.78, 44.91)
Age (Years)	<20 years	28	17	14.5 (9.27, 22.04)
	20–35 years	55	31	26.5 (19.34, 35.15)
	36–50 years	60	35	29.9 (22.36, 38.74)
	51–55 years	13	8	6.8 (3.51, 12.91)
	56–60 years	15	7	6.0 (2.93, 11.84)
	61–65 years	10	5	4.3 (1.84, 9.62)
	>65 years	21	14	12 (7.26, 19.09)
Nationality	Saudi	148	86	57.43 (49.63, 64.01)
	Non-Saudi	54	31	57.41 (43.51, 71.07)

Table 2: Chi-Square Test Results for Confirmed Dengue Fever Cases

Category	Chi-Squared Statistic	Degrees of Freedom (df)	p-value
Gender	7.6818	1	0.005578
Age Groups	57.4350	6	1.491e-10
Nationality	37.1210	1	1.11e-09
District	188.5385	35	6.113086e-23

Table 3: Diagnostic Test Results and Gender Distribution for Dengue Fever

Diagnostic Test	Male Positive Results	Female Positive Results	Total Positive Cases	Percentage (%) (95% CI)
PCR	67	40	107	91.4 (86.1, 96.7)
NS1	53	36	89	76.1 (70.8, 81.4)

Diagnostic Test	Male Positive Results	Female Positive Results	Total Positive Cases	Percentage (%) (95% CI)
IgM	53	28	81	69.2 (63.7, 74.7)

Table 4: Distribution of Negative and Positive PCR, NS1, and IgM Results by Age Group

Age Group	PCR Negative (0)	PCR Positive (1)	NS1 Negative (0)	NS1 Positive (1)	IgM Negative (0)	IgM Positive (1)
<20 years	10	15	12	13	11	14
20–35 years	29	26	33	22	34	21
36–50 years	23	39	34	28	38	24
51–55 years	5	6	7	4	9	2
56–60 years	11	3	10	4	10	4
61–65 years	3	9	3	9	4	8
>65 years	14	9	14	9	15	8

Table 5: Hematological and Liver Function Test Parameters

Parameter	Mean ± SD	Reference Range
WBC	4,000 ± 2,000 cells/microliter	4,500–11,000 cells/microliter
PLT	140,000 ± 80,000 platelets/microliter	150,000–450,000platelets/microliter
HCT	38 ± 8 %	35%–45%

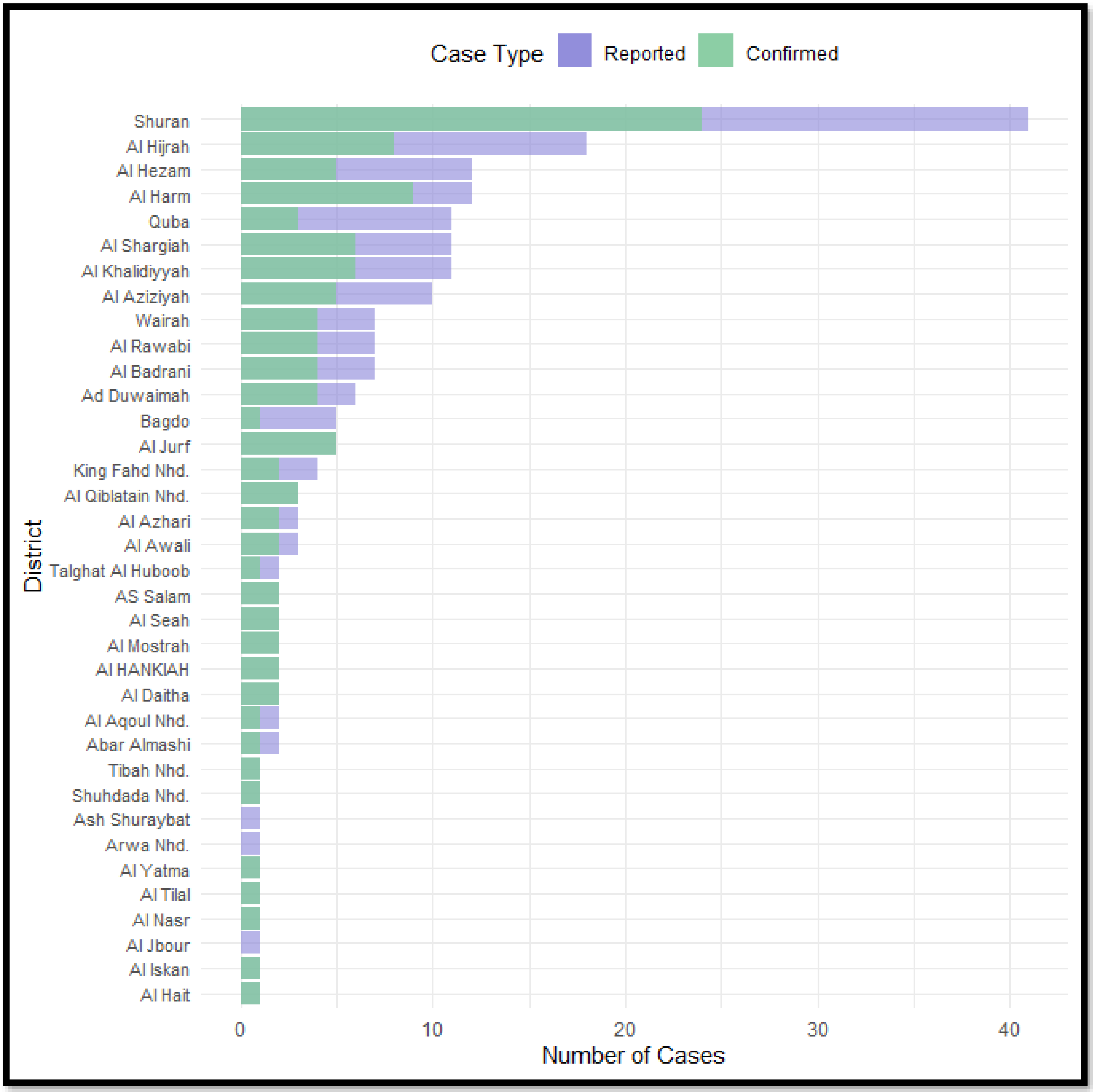

Figure 1: District Cases: Reported vs. Confirmed

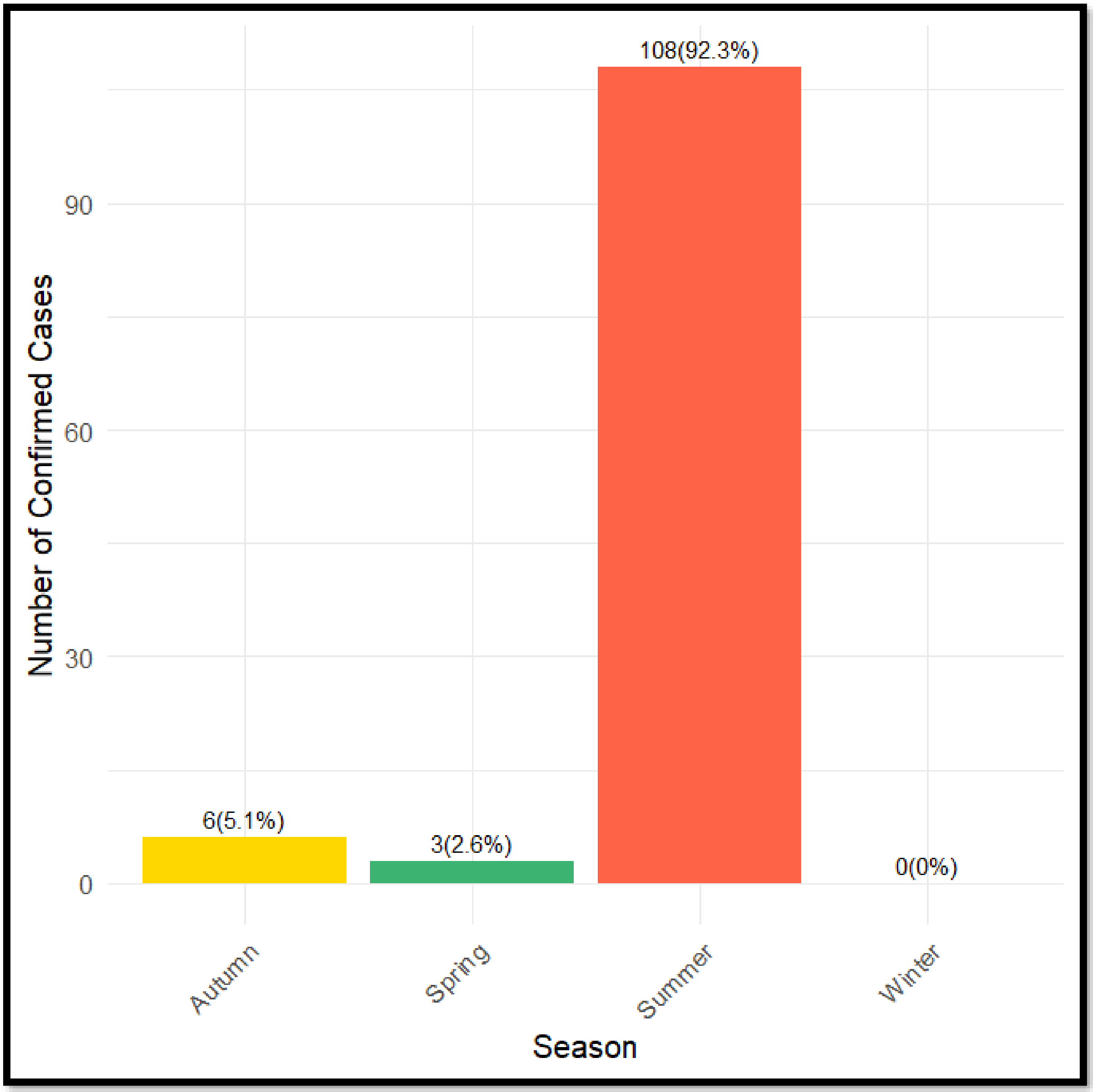

Figure 2: Distribution of Confirmed Dengue Cases by Season

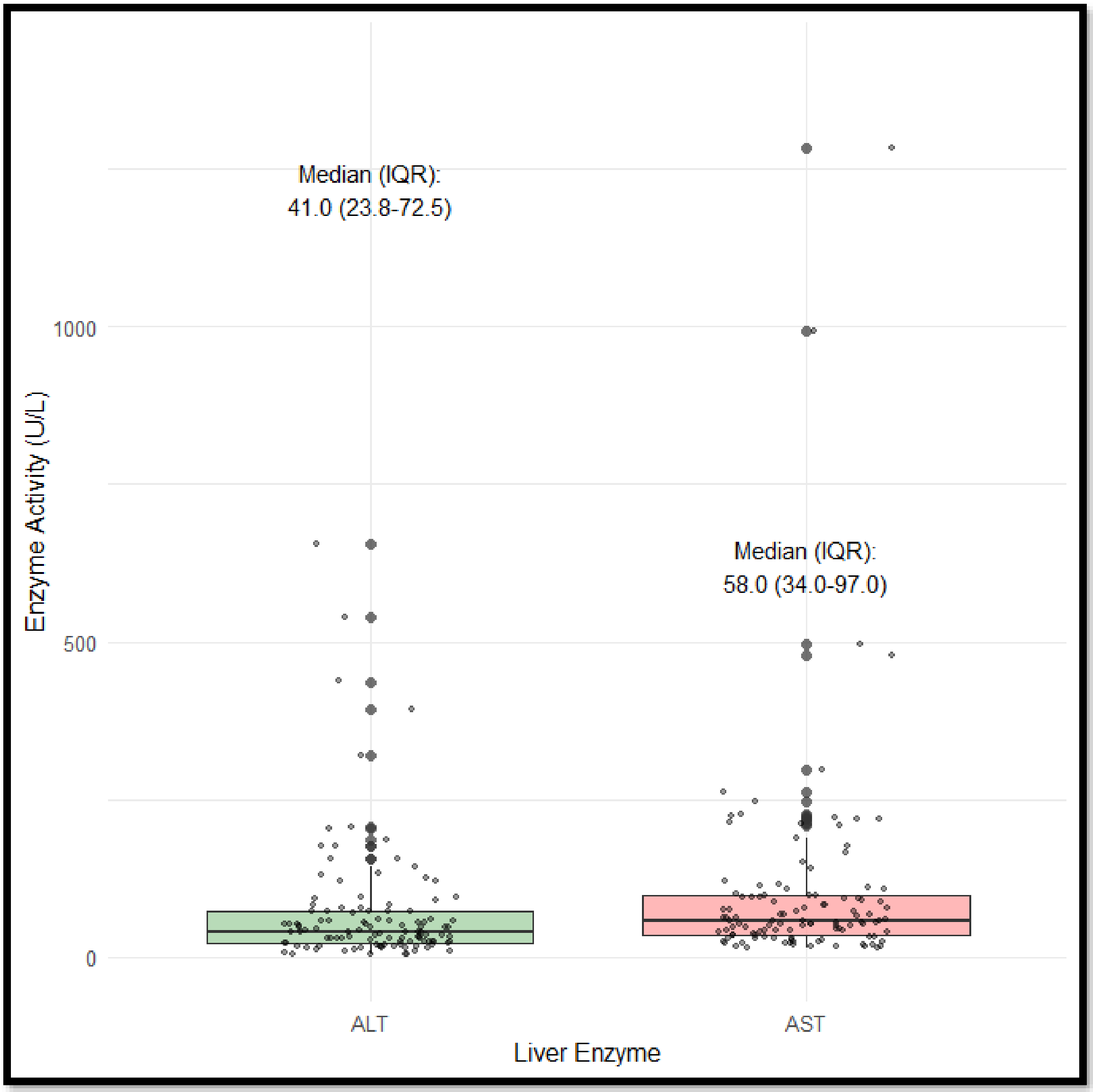

Figure 3: Serum Transaminase Levels in the Cohort