



# MAPPING DENGUE RESEARCH OUTPUT

A STUDY FROM RAWALPINDI  
MEDICAL UNIVERSITY

## **Authors:**

Prof. Dr. Muhammad Umar  
Dr. Mehwish Iqbal  
D. Shama Zainab



## **Contributors**

<b>Name</b>	<b>Designation</b>
Prof. Jahangir Sarwar Khan	Prof. of Surgery, Rawalpindi Medical University, Rawalpindi
Prof. M. Khurram	Dean, Department of Medicine, Medical Unit II, Holy Family Hospital, Rawalpindi Medical University, Rawalpindi
Dr. M. Mujeeb Khan	In-charge Department of Infectious Diseases, Holy Family Hospital, Rawalpindi, Rawalpindi Medical University
Prof. Nasir Khan	Department of Radiology, Holy Family Hospital, Rawalpindi
Prof. Shehzad Manzoor	Professor of Medicine, Benazir Bhutto Hospital, Rawalpindi
Prof. Arshad Rabbani	Professor of Medicine, Benazir Bhutto Hospital, Rawalpindi
Dr. Saima Ambreen	Department of Emergency Medicine, Holy Family Hospital, Rawalpindi, Rawalpindi Medical University, Rawalpindi
Dr. Arsalan Manzoor Mughal	Associate Editor, JRMC, Rawalpindi Medical University
Dr. Hina Sattar	Department of Pediatrics, Holy Family Hospital, Rawalpindi
Dr. Seemab Haider	Medical Unit I, Holy Family Hospital, Rawalpindi
Dr. Malik Shehryar	Medical Unit I, Holy Family Hospital, Rawalpindi
Dr. Nida Anjum	Medical Unit II, Holy Family Hospital, Rawalpindi
Dr. Abrar Akbar	Intensive Care Unit, Holy Family Hospital, Rawalpindi
Dr. Faran Maqbool	Department of Medicine, District Headquarter Hospital
Ms. Maham Yamin	Manager, ORIC, Rawalpindi Medical University.

# Mapping Dengue Research Output: A Study from Rawalpindi Medical University

Muhammad Umar<sup>1</sup>, Mehwish Iqbal<sup>2</sup>, Shama Zainab<sup>2</sup>

<sup>1</sup> Vice Chancellor Rawalpindi Medical University

<sup>2</sup> Manager, Office of Research, Innovation & Commercialization (ORIC), Rawalpindi Medical University

Dengue fever (DF) is the most prevalent arbovirus-related infection globally, with the majority of cases remaining asymptomatic. The clinical spectrum of dengue ranges from a mild febrile illness to more severe manifestations, such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS), both of which are associated with significantly higher morbidity and mortality. Identifying early predictors of disease severity is essential for timely clinical intervention.

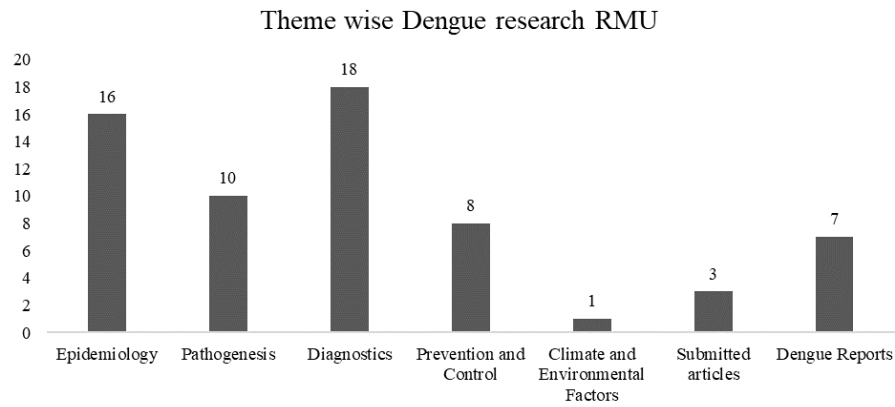
Current report analyses the 53 research articles (total citations 482) published from 2014 to 2025 on Dengue related research. The report is assessing research output and highlighting any groundbreaking research or gaps identified focusing on Dengue-related research (pathogenesis, epidemiology, diagnostic, prevention, etc.). The 53 research articles were selected from RMU repository, PubMed, Google Scholar, Research gate etc.

## 1. Categorization and Thematic Analysis

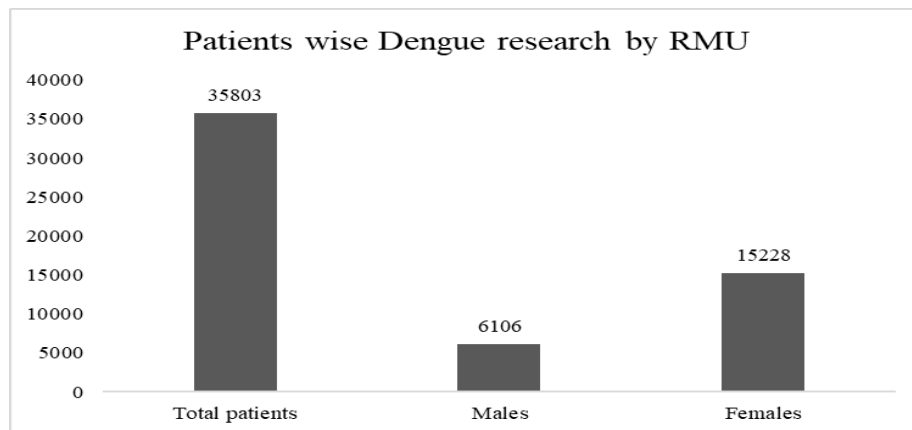
53 research articles were organized into key themes or research areas. (Table 1) (Figure 1)

**Table 1:** Research Themes in Dengue Publications (53) by RMU

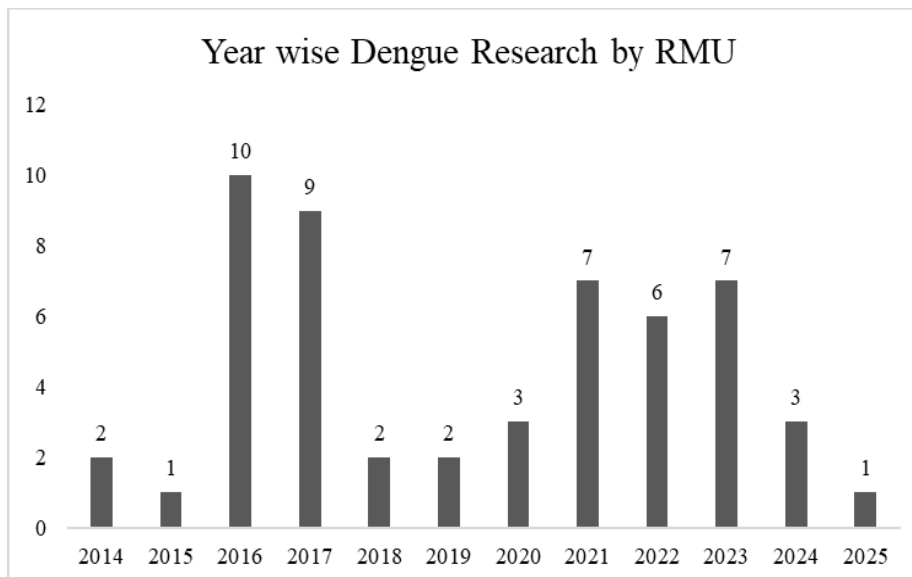
Sr. No.	Research area	No. of articles	Key findings
1	Epidemiology	16	Trends in Dengue spread, risk factors, regional patterns
2	Pathogenesis	10	Virus strains, immune response, molecular mechanisms
3	Diagnostics	18	New detection methods, rapid tests, accuracy studies
4	Prevention and Control	08	Vector control, public health strategies, community awareness
5	Climate and Environmental Factors	01	Impact of climate change on Dengue transmission
6	Submitted Research Articles	03	Trends in Dengue spread, detection accuracy studies
7	Departmental Reports	07	Trends in Dengue spread



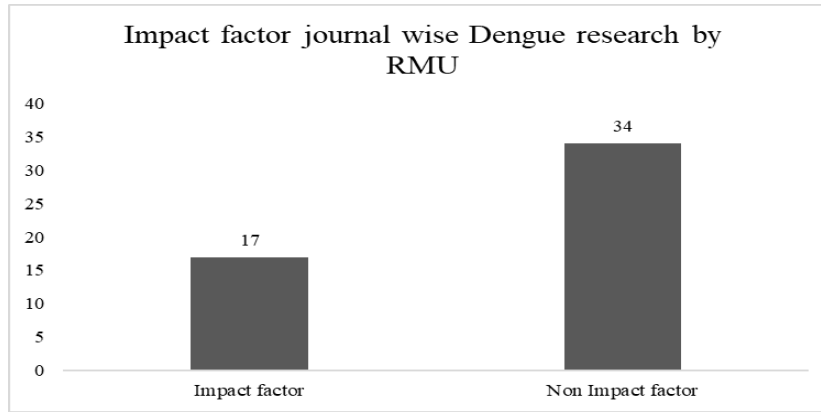
**Figure 1:** Graph of no. of articles in each research area/theme wise distribution.



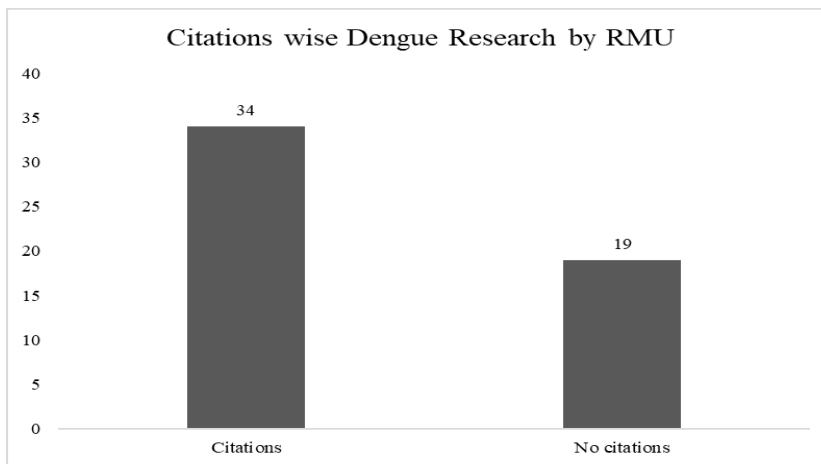
**Figure 2:** Graph of total patients, male and female patients



**Figure 3:** Publication trends over time (year wise no. of publication)



**Figure 4:** Graph of articles published in impact factor and non-impact factor journals



**Figure 5:** Graph of articles with and without citations

## 2. Key Area Analysis (theme/area)

### 2.1. Epidemiology

Most studies on dengue in Pakistan have primarily focused on urban outbreaks, accounting for approximately 70% of the available data, while research from rural areas remains limited. In one study involving 234 patients diagnosed with Dengue Hemorrhagic Fever (DHF), the frequency of primary and secondary dengue infections was assessed, and the two groups were compared based on demographic characteristics, laboratory parameters, disease severity, and clinical outcomes. Among these patients, 66.2% were male and 33.8% were female, with a mean age of  $28.8 \pm 12.4$  years. This analysis aimed to enhance understanding of how the nature of dengue infection—primary or secondary—impacts clinical presentation and prognosis in DHF patients [1].

Another observational study was conducted to assess the clinical characteristics, management, and outcomes of patients with Dengue Shock Syndrome (DSS) during the Rawalpindi dengue epidemic of 2014. Data were collected on patient demographics, clinical presentation, laboratory parameters, diagnostic basis, treatment interventions, and outcomes. A total of 25 patients with DSS were enrolled, of whom 52% were male. The mean age of the patients was  $26.8 \pm 11.52$  years. The mean duration of illness prior to hospitalization was  $5.4 \pm 1.5$  days. Commonly reported symptoms included vomiting, body aches, and headache. DSS developed on average by the  $5.7 \pm 2.04$  day of illness. Comorbid

conditions were noted in 24% of the patients. Secondary dengue infection was present in 56% of the cases, while 84% of the patients tested positive for dengue virus serotype DEN-3 by PCR. In summary, young adults infected with DEN-3 were predominantly affected by DSS during the 2014 Rawalpindi dengue epidemic. While secondary dengue infection was observed in more than half the cases, primary infection was also frequently noted. Despite the severity of the condition, the mortality rate remained relatively low at 4%, indicating effective clinical management [2].

Another study focused on evaluating the clinical manifestations, disease severity, and outcomes among patients diagnosed with dengue fever (DF), confirmed through serological testing. The objective was to provide a comprehensive analysis of the demographic and clinical features associated with DF, as well as to assess the overall patient outcomes during hospitalization. The study highlighted a clear male predominance among confirmed DF cases, reflecting gender-related vulnerability or exposure patterns during outbreaks. Fever was reported as the most frequent and consistent presenting symptom, aligning with the typical clinical profile of dengue fever. Other associated symptoms varied in frequency but were generally mild, contributing to a low rate of complications in this patient group. The duration of hospitalization was notably short, with patients experiencing a brief mean stay and a limited critical phase. These findings point toward mild to moderate disease severity in the majority of cases. Most patients showed rapid clinical improvement, which was further supported by the high discharge rate observed. The overall outcomes were positive, indicating effective disease management and low morbidity in serologically confirmed cases of DF [3].

## 2.2. Pathogenesis

Many articles found the pathophysiology and underlying immunity related mechanism of Dengue patients. One such report presented the first documented case of a young male patient who developed fatal Hemophagocytic lymphohistiocytosis (HLH) complicating a concurrent infection with DHF and *Plasmodium vivax*. This case underscores the importance of considering HLH in the differential diagnosis of patients presenting with severe systemic inflammatory responses in the context of dengue or malaria, particularly when clinical deterioration occurs despite appropriate treatment for the primary infections. Early recognition and prompt intervention are crucial to improving outcomes in such rare but fatal complications [4].

Among various laboratory markers, elevated serum alanine aminotransferase (ALT) levels have been proposed as a potential indicator of severe dengue infection. A cross-sectional study was conducted to investigate the relationship between ALT levels at presentation and the progression to severe dengue. Over a six-month period, 65 patients with confirmed dengue infection were enrolled. Serum ALT levels were measured at the time of presentation, and all patients received standardized management according to clinical guidelines. Their clinical course was subsequently monitored for the development of DHF or DSS. Based on these findings, the study concluded that elevated ALT levels at the time of presentation are significantly associated with the development of severe forms of dengue infection. Higher ALT levels may serve as an early warning marker for disease progression, underscoring the importance of closer monitoring and more aggressive management in such patients. These results support the incorporation of liver enzyme evaluation into the routine assessment of dengue patients to aid in risk stratification and improve clinical outcomes [5].

A cross-sectional study was conducted to investigate the correlation between polymorphism in the C-reactive protein (CRP) gene and variations in serum CRP levels among dengue patients. The analysis revealed that increased CRP levels were associated with suppressed platelet counts among dengue patients, reflecting the inflammatory response characteristic of the infection. However, the SNP rs199953854 in the CRP gene showed no polymorphism in the sampled population, suggesting that this specific genetic variation does not contribute to the variability in CRP levels among dengue patients in this cohort. The findings highlight the potential of CRP as a biomarker of disease severity but do not support a genetic basis for CRP level variation through the rs199953854 polymorphism in this study population [6].

A multi-center study was conducted between 2016 and 2018 to investigate the circulating serotypes of dengue virus (DENV) and the prevalence of Chikungunya virus (CHIKV) co-infection in three major Pakistani cities: Lahore, Rawalpindi, and Peshawar. The study employed both hospital-based cross-sectional surveillance in Lahore and Rawalpindi, and a community-based approach in Peshawar during 2017. The primary objective was to assess the distribution of DENV serotypes and detect co-infections with CHIKV, offering insight into the evolving epidemiology of arboviral diseases in the region. The concurrent circulation of several DENV serotypes alongside CHIKV co-infection represents a significant public health concern. These findings underscore the urgent need for enhanced vector surveillance, diagnostic capacity, and integrated disease management strategies to mitigate the risk of future outbreaks in Pakistan [7].

### **2.3. Diagnostics**

In an effort to explore the utility of Raman spectroscopy as a non-invasive optical diagnostic tool, a study was conducted to analyze the Raman spectra of human serum samples infected with dengue virus (DENV). Raman spectra were recorded from 32 DENV-infected and 28 healthy serum samples in the near-infrared spectral range (540 to 1700  $\text{cm}^{-1}$ ) using a 785 nm laser as the excitation source. Distinct differences were observed between the spectra of DENV-infected and healthy samples, indicating potential biomolecular alterations associated with dengue infection. The study identified 12 unique Raman spectral bands that differentiated DENV-infected sera from healthy samples. Notably, these bands had not been previously reported in the context of dengue diagnosis. These findings highlight the strong diagnostic potential of the identified Raman bands as biomarkers for dengue virus infection. The study provides a valuable foundation for future research in the field of optical diagnostics and suggests Raman spectroscopy as a promising tool for early and accurate detection of DENV infections [8].

An observational retrospective study was conducted at Holy Family Hospital, Rawalpindi, to assess ultrasonographic findings used in diagnosing plasma leakage among patients with dengue haemorrhagic fever (DHF). All included patients underwent ultrasonography to detect signs of plasma leakage, such as ascites, gallbladder wall thickening, and pleural and/or pericardial effusion. These findings were documented in terms of their presence, quantification, and anatomical localization. The most frequently observed ultrasonographic pattern of plasma leakage was a combination of mild ascites and mild right pleural effusion. These results highlight the importance of ultrasonography as a non-invasive, readily available diagnostic tool for identifying plasma leakage in patients with dengue haemorrhagic fever [9].

A study aimed to evaluate the effectiveness of Raman spectroscopy as a rapid diagnostic tool for detecting dengue fever in human blood sera, comparing its performance with commonly used serological tests. These findings suggest that Raman spectroscopy shows moderate diagnostic potential, particularly in comparison to IgM antibody testing, and could serve as a rapid screening method for dengue infection. However, its relatively lower sensitivity and accuracy compared to established serological assays indicate that further refinement and validation are necessary before it can be adopted as a standalone diagnostic tool [10].

A quantitative analysis for the screening of immunoglobulin-G (IgG) positive human sera samples is presented for the dengue virus infection. The regression model was developed using 79 samples while 20 samples were used to test the performance of the model. The *R*-square ( $r^2$ ) value of 0.91 was found through a leave-one-sample-out cross validation method, which shows the validity of this model. This model incorporates the molecular changes associated with IgG. Molecular analysis based on regression coefficients revealed that myristic acid, coenzyme-A, alanine, arabinose, arginine, vitamin C, carotene, fumarate, galactosamine, glutamate, lactic acid, stearic acid, tryptophan and vaccenic acid are positively correlated with IgG; while amide III, collagen, proteins, fatty acids, phospholipids and fucose are negatively correlated. For blindly tested samples, an excellent agreement has been found between the model predicted, and the clinical values of IgG. The parameters, which include sensitivity, specificity, accuracy and the area under the receiver operator characteristic curve, are found to be 100%, 83.3%, 95% and 0.99, respectively, which confirms the high quality of the model [11].

Another study presents the use of Raman spectroscopy combined with support vector machine (SVM) for the classification of dengue suspected human blood sera. Raman spectra for 84 clinically dengue suspected patients acquired from Holy Family Hospital, Rawalpindi, Pakistan, have been used in this study. The spectral differences between dengue positive and normal sera have been exploited by using effective machine learning techniques. In this regard, SVM models built on the basis of three different kernel functions including Gaussian radial basis function (RBF), polynomial function and linear function have been employed to classify the human blood sera based on features obtained from Raman Spectra. The classification model have been evaluated with the 10- fold cross validation method. In the present study, the best performance has been achieved for the polynomial kernel of order 1. A diagnostic accuracy of about 85% with the precision of 90%, sensitivity of 73% and specificity of 93% has been achieved under these conditions [12].

Raman spectroscopy based investigations of the molecular changes associated with an early stage of dengue virus infection (DENV) using a partial least squares (PLS) regression model is presented. This study is based on non-structural protein 1 (NS1) which appears after three days of DENV infection. In total, 39 blood sera samples were collected and divided into two groups. The control group contained samples which were the negative for NS1 and antibodies and the positive group contained those samples in which NS1 is positive and antibodies were negative. Out of 39 samples, 29 Raman spectra were used for the model development while the remaining 10 were kept hidden for blind testing of the model. PLS regression yielded a vector of regression coefficients as a function of Raman shift, which were analyzed. Cytokines in the region  $775\text{--}875\text{ cm}^{-1}$ , lectins at 1003, 1238, 1340, 1449 and  $1672\text{ cm}^{-1}$ , DNA in the region  $1040\text{--}1140\text{ cm}^{-1}$  and alpha and beta structures of proteins in the region  $933\text{--}967\text{ cm}^{-1}$  have been identified in the regression vector for their role in an early stage of DENV infection. Validity of the model was established by its *R*-square value of 0.891. Sensitivity, specificity



and accuracy were 100% each and the area under the receiver operator characteristic curve was found to be 1 [13].

Another study explored the potential of using Raman spectroscopy to screen for dengue virus (DENV) infection in human blood sera by analyzing lactate concentration as a biochemical marker. A total of 70 serum samples were examined, including 50 from confirmed DENV-infected patients and 20 from healthy volunteers. Raman spectra were recorded over the spectral range of  $600\text{ cm}^{-1}$  to  $1800\text{ cm}^{-1}$  using a 532 nm laser as the excitation source. The spectral data were analyzed to identify biochemical changes associated with dengue infection. Distinctive Raman peaks were observed in the sera of DENV-infected patients at 750, 830, and  $1450\text{ cm}^{-1}$ . These peaks are believed to correspond to elevated lactate levels, which are indicative of impaired organ function commonly seen in dengue infection. To validate this observation, controlled additions of lactic acid solution were made to healthy serum samples. The results of this study suggest that lactate levels, as detected by Raman spectroscopy, may serve as a potential biomarker for the diagnosis of DENV infection. This approach offers promising avenues for rapid, non-invasive screening and warrants further investigation for clinical application in dengue diagnostics [14].

This work presents the evaluation of Raman spectroscopy using random forest (RF) for the analysis of dengue fever in the infected human sera. A total of 100 dengue suspected blood samples, collected from Holy Family Hospital, Rawalpindi, Pakistan, have been used in this study. Out of these samples, 45 were dengue-positive based on immunoglobulin M (IgM) capture enzyme-linked immunosorbent assay (ELISA) tests. For highlighting the spectral differences between normal and infected samples, an effective machine learning system is developed that automatically learns the pattern of the shift in spectrum for the dengue compared to normal cases and thus is able to predict the unknown class based on the known example. In this connection, dimensionality reduction has been performed with the principal component analysis (PCA), while RF is used for automatic classification of dengue samples. For the determination of diagnostic capabilities of Raman spectroscopy based on RF, sensitivity, specificity, and accuracy have been calculated in comparison to normally performed IgM capture ELISA. According to the experiment, accuracy of 91%, sensitivity of 91%, and specificity of 91% were achieved for the proposed RF-based model [15].

A study was conducted during dengue fever outbreak to observe gastrointestinal manifestations in patients admitted with dengue infection. One hundred patients, aged 13-72 years were included in the study. Information regarding gastrointestinal symptoms and atypical GI manifestations were collected. Test of significance was applied to document correlation between severity of dengue infection and atypical gastrointestinal findings. A p value of  $<0.05$  was considered as statistical significance. Among 100 patients, 58 were male and 42 were female. GI manifestations were present in all patients. The most frequent finding was nausea in 89%, followed by abdominal pain in 59% and vomiting in 55% of patients. The atypical GI manifestations like acalculus cholecystitis in 22%, ascities in 44%, hepatomegaly in 14%, GI bleed in 9%, acute pancreatitis in 2% and severe acute liver injury in 5% patients were noted. GI manifestations like abdominal pain, ascites, hepatomegaly, severe acute liver injury, acalculous cholecystitis, and acute pancreatitis were correlated with severity of dengue infection. Gastrointestinal manifestations are common in patients with dengue infection. Patients of acute febrile syndrome with abdominal pain and atypical GI findings in endemic areas should be considered for dengue infection [16].

A retrospective study aimed to identify various factors associated with dengue hemorrhagic fever (DHF) and to compare the clinical and laboratory features of DHF with those of dengue fever (DF). The objective was to improve patient evaluation and management at admission. The study was conducted over six years (2013–2018) in two tertiary care hospitals in Pakistan. Data were collected using a pre-structured form and statistically analyzed to determine clinical and laboratory characteristics of dengue virus infection (DVI) and risk factors for the development of DHF. The study demonstrated clear distinctions between the clinical and laboratory profiles of DF and DHF. Significant predictors of DHF included advanced age, diabetes mellitus, ascites, pleural effusion, gallbladder wall thickening, and delayed hospitalization. Early identification of these factors can help clinicians recognize high-risk patients promptly, enabling timely intervention to reduce dengue-related morbidity and mortality [17].

## **2.4. Prevention and Control**

The articles published by RMU related to prevention and control focused on effectiveness of vitamin D in prevention of dengue haemorrhagic fever and dengue shock syndrome [18], comparison of vitamin D levels in patients with dengue haemorrhagic fever and dengue fever [19], awareness of Dengue Fever in Non-Medical University Students in Punjab [20], seroprevalence of Dengue Among Healthcare Workers: Assessing Infection Risk and Preventive Strategies in a Tertiary Care Hospital [21], electrolyte disturbances in patients with dengue fever [22], knowledge About Dengue Fever Prevention Among People Visiting Benazir Bhutto Hospital [23], awareness of Dengue Fever in Non-Medical University Students in Punjab [24] etc.

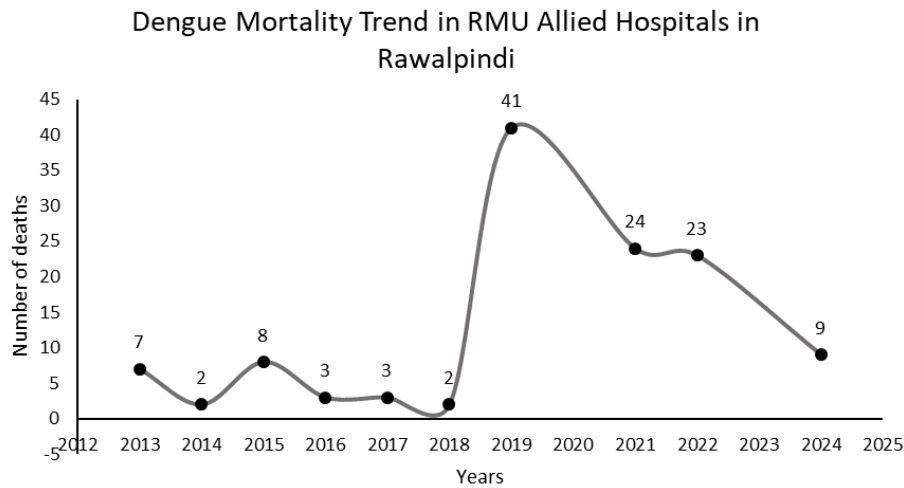
## **2.5 Climate and Environmental Factors**

Only one study on Dengue and Climate and Environmental Factors i.e. Decoding Dengue: A Comprehensive Analysis of Cases at Holy Family Hospital (2019–2023) and Anticipating Pakistan's Future Dengue Dynamics under Climate Change [25].

## **2.6. Mortality analysis**

Dengue typically has a low mortality rate, with simple dengue fever presenting a mortality of less than 1%, dengue hemorrhagic fever ranging from 2-5%, and dengue shock syndrome carrying a significantly higher mortality of nearly 50%. Rawalpindi Medical University (RMU) affiliated hospitals have achieved an exceptional mortality rate of less than 0.1%, with all recorded fatalities attributed to cases of dengue shock syndrome. Each death underwent thorough review in mortality meetings held at the respective hospitals. Clinical mortality audits were submitted to the Dengue Expert Advisory Group (DEAG) and the Punjab Health Department using the prescribed mortality forms.

In 2019 Dengue Epidemic, highest number of deaths (41) occurred. The reasons were found to be decompensated severe shock at the time of admission, co-morbidities, late arrival to teaching hospitals, pre-hospital treatment from government/private hospitals, resulting in a delay or mismanagement, changing nature of disease due to immunological factors, severe hepatitis which lead to liver failure, multi-organ failure, metabolic acidosis, lactic acidosis and secondary infections [26]. Mortality rates were notably higher among patients with DHF and DSS compared to those with DF ( $p=0.002$ ), emphasizing the severity of complications associated with these advanced forms of dengue [27].



**Figure 6:** Twelve years (2013-2024) comparative mortality trends from RMU-affiliated hospitals  
Source: <https://rmur.edu.pk/wp-content/uploads/2024/12/denguerreport21122024.pdf>

According to the [report published in 2024](#) by Rawalpindi Medical University, the mortality was 09 and morbidity was 6528. By 2024, despite a significant increase in case numbers, the mortality rate declined to 0.22%, reflecting advancements in clinical management and treatment strategies.

## 2.7 RMU Dengue Reports analysis

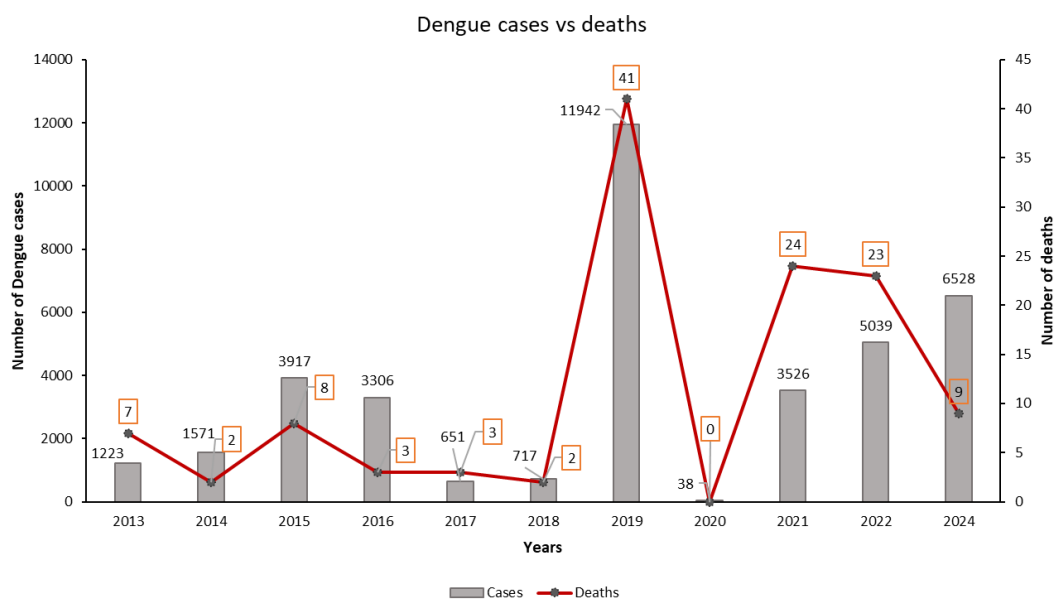
This collection of reports on Dengue has been compiled by the faculty of Rawalpindi Medical University, Rawalpindi as part of an ongoing effort to advance understanding, diagnosis, treatment, and prevention of one of the world's most rapidly spreading mosquito-borne viral diseases. Drawing upon both clinical research and fieldwork, these reports provide valuable insights into the epidemiology, pathophysiology, and public health challenges associated with Dengue. The aim is to contribute to the global body of knowledge while supporting the development of effective medical and community-based responses to this pressing health threat. Since 2015, faculty members has written seven reports on Dengue.

The **Dengue Report (2015)** by the Divisional Dengue Expert Advisory Group (DDEAG), RMU documents the third consecutive dengue epidemic in the region, highlighting a significant increase in cases compared to previous years. The outbreak spanned from August 1 to December 30, with over 44,000 outpatient visits and 6,139 hospital admissions, resulting in 3,917 confirmed cases and 8 deaths. The predominant virus genotype was DEN-2 (61%). DDEAG played a key role in patient management, verification of deaths, and capacity building, training over 1,100 healthcare workers during the season. Despite having no dedicated funding or office, the group contributed to research, published articles, and maintained strong coordination with local health institutions. The report underscores the urgent need for improved preventive measures and highlights the future potential of vaccination efforts in Pakistan [28].

The report **Dengue Patient Care and Training Model (2016)** developed by Rawalpindi Medical College and Allied Hospitals outlines a comprehensive, multidisciplinary approach to managing dengue outbreaks, focusing on clinical care, healthcare worker training, and standardized protocols. In 2016, Rawalpindi experienced its fourth consecutive dengue epidemic, with 20,449 outpatient visits,

5,258 admissions, and 3,306 confirmed cases, primarily affected by DEN-2 and DEN-3 genotypes. Despite the widespread impact, the mortality rate was impressively low at 0.09%, attributed to improved prevention, early diagnosis, and structured patient care. The document details the operational framework, including triage systems, HDU/ICU protocols, training programs (over 870 professionals trained that year), and collaboration with Dengue Expert Advisory Group (DEAG) Punjab. The model emphasizes rapid diagnostics, hands-on training, strict monitoring of patients by severity, and real-time data sharing through smart technology, serving as a replicable framework for dengue outbreak preparedness and response [29].

The document **Dengue Epidemic (2019)** details the **clinical and operational management** of the 2019 Dengue Epidemic in Rawalpindi and Islamabad, Pakistan, which was identified as the worst year for the epidemic with over 10,000 confirmed cases in Allied Hospitals. The Rawalpindi Medical University and its Allied Hospitals, including Holy Family Hospital, Benazir Bhutto Hospital, and District Headquarters Hospital, along with the newly acquired Red Crescent Hospital, dedicated significant resources such as 1100 beds, a team of over 1300 doctors, nurses, and paramedics, and essential equipment like hematology analyzers and ultrasound machines, to manage the influx of patients. The increased burden was attributed to delayed preventive measures, a new circulating serotype, and low public awareness. The Department of Infectious Diseases played a central role, coordinating with the Punjab Information Technology Board for real-time monitoring and conducting regular training sessions for healthcare worker. The document also highlights the crucial support and coordination from the Government of Punjab, including visits from high-ranking officials and emergency procurement of supplies, and emphasizes that all patient treatment and services were provided free of cost [26].



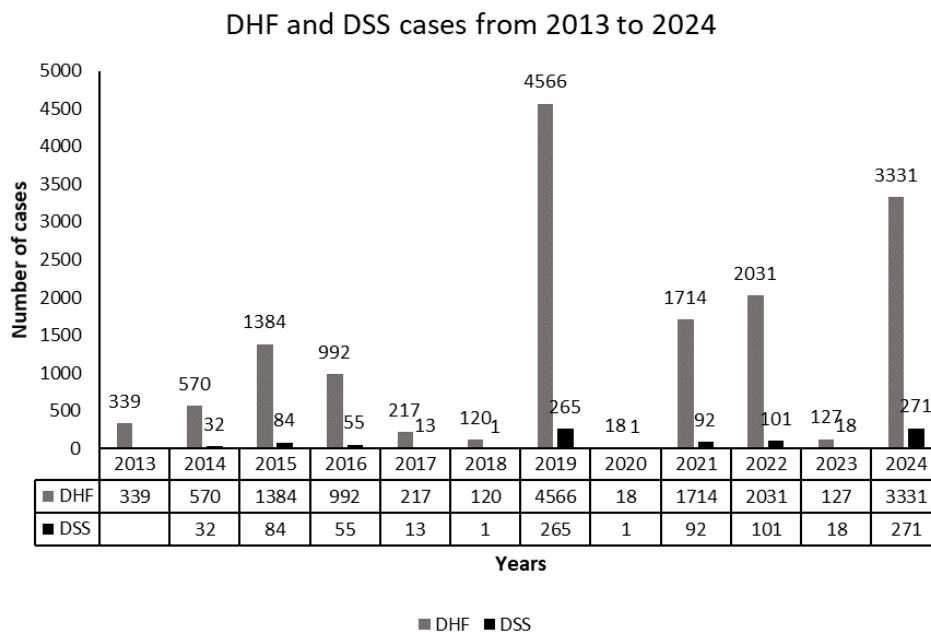
**Figure 7:** Twelve years (2013-2024) comparative Dengue cases vs death trends from RMU-affiliated hospitals

The report **Dengue Epidemic Clinical Management (2020)** details the extensive efforts of Rawalpindi Medical University (RMU) and its Allied Hospitals in managing the 2019 dengue epidemic, which saw 11,941 confirmed cases at RMU Allied Hospitals, making it the worst outbreak since 2015. The report outlines the clinical management strategies, including the phased increase of bed capacity across RMU hospitals and other government/semi-government facilities, the deployment

of additional medical and ancillary staff, and the procurement of necessary medical supplies and equipment. It also highlights the adaptation of Dengue Expert Advisory Group (DEAG) guidelines to include modified treatment protocols for Dengue Shock Syndrome (DSS) patients who did not respond to standard management, which significantly improved patient outcomes. Furthermore, the document emphasizes the importance of prevention over management, detailing efforts in data maintenance, inter-departmental liaison for disease prevention, and continuous training of healthcare workers to enhance capacity for future outbreaks [30].

The **Dengue Epidemic Report (2022)** from Rawalpindi Medical University (RMU) provides a comprehensive overview of the clinical and operational management of dengue fever by the Department of Infectious Diseases at Holy Family Hospital. The 2022 Dengue epidemic in Rawalpindi saw a resurgence close to pre-pandemic levels, striking early in August, with nearly 60,000 symptomatic individuals visiting the OPDs of Rawalpindi Medical University's teaching hospitals. The screening algorithm proved effective, resulting in a low admission rate but a high positivity rate among admitted patients. Approximately 5,039 cases were confirmed, with 23 fatalities, yielding a mortality rate of 0.4%. The epidemic caused significant fiscal and economic losses, though these were not quantified. Data from hospitals (HFH, BBH, DHQ) showed 59,223 OPD visits, 7,059 admissions, 5,039 confirmed cases, 2,031 cases of Dengue Hemorrhagic Fever (DHF), 101 cases of Dengue Shock Syndrome (DSS), and 23 deaths. The report covers the history of dengue epidemics in Pakistan and specifically in Rawalpindi, detailing the 2019 outbreak and the subsequent preparedness and response efforts. It highlights RMU's commitment to managing infectious diseases, including dengue, through a structured approach that encompasses patient care, staff training, and resource allocation, aiming to effectively combat current and future epidemics [31].

The **RMU Model of Data Bank of Dengue, Diabetes and Hepatitis (2023)** outlines the establishment and Standard Operating Procedures (SOPs) for a centralized data bank at Rawalpindi Medical University, aimed at collecting, storing, retrieving, and utilizing patient data for Dengue Fever, Diabetes Mellitus, and Hepatitis. This platform serves healthcare professionals and researchers by providing access to valuable data, guidelines, and best practices to prevent, diagnose, and treat these prevalent diseases. The data bank seeks to enhance understanding, facilitate research, and promote preventive strategies, ultimately addressing the increasing burden of these illnesses. It details procedures for data collection, including patient demographics and clinical parameters, ensures data security and confidentiality through measures like encryption and access controls, and outlines mechanisms for data retrieval and reporting for research and public health initiatives. The document emphasizes the importance of continuous improvement, staff training, and compliance with data protection regulations and ethical guidelines to ensure the data bank's success in improving patient care and public health outcomes [32].



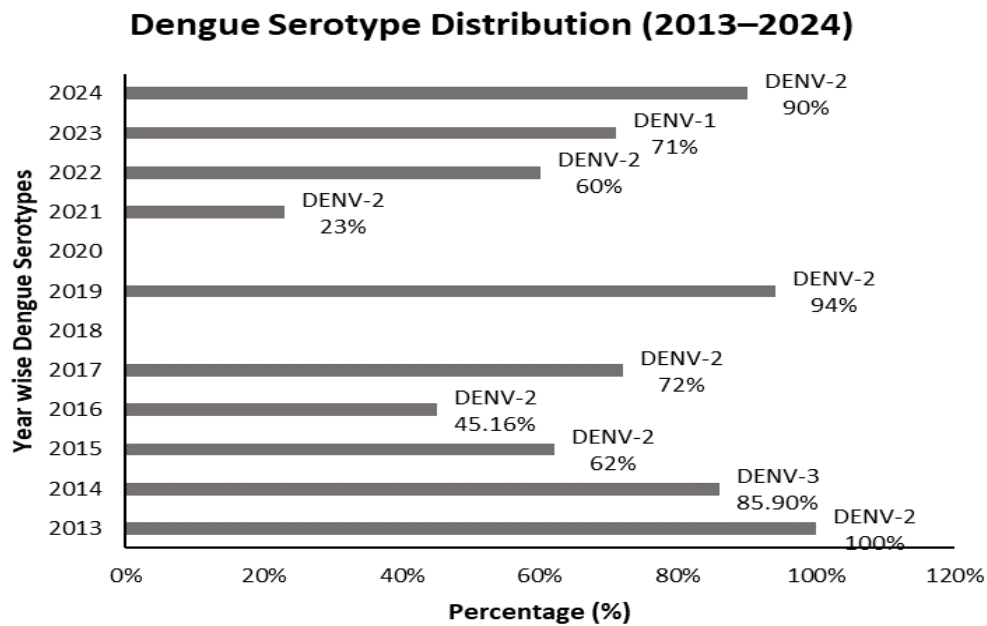
**Figure 8:** Twelve years (2013-2024) comparative DHF and DSS trends from RMU-affiliated hospitals

The **Dengue Epidemic Report (2024)- Patient Care and Operational Optimization** by Rawalpindi Medical University (RMU) provides a comprehensive overview of the dengue fever situation in Rawalpindi, Pakistan, highlighting the significant increase in cases during 2024, which approached pre-pandemic levels. The report details the historical context of dengue epidemics globally and in Pakistan, emphasizing Rawalpindi as a particularly affected region due to factors like urbanization and inadequate sanitation. RMU and its Department of Infectious Diseases have been at the forefront of combating the crisis through surveillance, early diagnosis, treatment, and community awareness campaigns, dedicating 1,000 beds across its allied hospitals for dengue patients and providing training to healthcare professionals. The document also presents comparative data on dengue cases, admissions, and mortality rates from 2013 to 2024, showing fluctuations and the impact of various serotypes and interventions [27].

## 2.8 Twelve-Year Dengue Serotype Trends (2013–2024) at RMU and Allied Hospitals

Over the 12-year period, DENV-2 consistently emerged as the predominant serotype, showing peak prevalence in several years—including 100% in 2013 and 94% in 2021. DENV-3 appeared significantly in 2015, accounting for 85.9% of cases, but has since declined. Interestingly, DENV-1 was detected in 2024 for the first time in this dataset, constituting 90% of reported cases that year.

The data indicates cyclical or evolving trends in serotype dominance, which may correlate with changes in herd immunity, environmental factors, and vector control measures. This comprehensive surveillance is critical for anticipating outbreaks, developing vaccine strategies, and enhancing clinical preparedness based on serotype-specific risks.



**Figure 9:** Twelve years (2013-2024) comparative Dengue serotype distribution (2013-2024) from RMU-affiliated hospitals

## 2.9 Analysis of submitted research articles

### 1- Evolving Trends in Dengue Severity and Serotype Dominance: A Decade-Long Analysis in Rawalpindi, Pakistan

Rawalpindi, Pakistan, has experienced recurrent dengue outbreaks over the past decade, with fluctuating intensity, severity, and mortality. Demographic, clinical, and epidemiological trends of dengue cases presented at Rawalpindi Medical University (RMU) and its allied hospitals from 2013 to 2024 were examined, highlighting epidemiological patterns, disease shifts in severity, mortality, and serotype prevalence. This retrospective, descriptive study analyzed 58,625 laboratory-confirmed dengue cases treated at RMU and affiliated hospitals. Data included outpatient visits, admissions, severity patterns (Dengue Fever [DF], Dengue Hemorrhagic Fever [DHF], and Dengue Shock Syndrome [DSS]), mortality rates, and serotype prevalence. Descriptive statistics and comparative analysis (Chi-square, t-tests) were employed to identify trends and statistical associations. The clinical severity of dengue cases escalated over the study period. Dengue hemorrhagic fever (DHF) cases rose from 27.71% in 2013 to 50.01% in 2024 ( $p=0.003$ ). Similarly, dengue shock syndrome (DSS) cases increased from 2.03% in 2013 to 4.10% in 2024, with epidemic years like 2019 showing notable spikes in severe cases. Comparisons among dengue fever (DF), DHF, and DSS incidences revealed statistically significant trends ( $p<0.05$ ), underscoring a consistent increase in disease severity over time. Despite higher admissions in 2024, the case fatality rate (CFR) decreased from 0.34% (2019) to 0.22%. The overall CFR across the study period was 0.26%, with higher mortality observed in DHF and DSS cases compared to DF ( $p=0.002$ ). Predominantly, DENV-2 was the dominant serotype across most years, correlating with increased severity. Shifts in serotype predominance appeared to correlate with increased DHF and DSS severity, though statistical significance was not observed ( $p=0.08$ ). This study demonstrates an upward trend in dengue severity, with DENV-2 dominance correlating with severe disease outcomes. The findings emphasize the need for enhanced vector control, diagnostic

strategies, and molecular surveillance to mitigate outbreaks, guide vaccine development, and improve public health preparedness in endemic regions [33].

## **2- Evaluation of Outcome Predictors in Dengue Shock Syndrome: A Comparative Study of Survivors and Non-Survivors during the Epidemic 2024 in Rawalpindi**

A prospective cohort study investigates clinical outcomes and identifies key predictors of survival in Dengue Shock Syndrome (DSS) patients at three hospitals in Rawalpindi during the 2024 epidemic. The mortality rate was 26.98% in patients with DSS. Higher WBC count in CBC tests, higher levels of urea and bilirubin in renal function and liver function tests, co-morbidities, admission to MICU, pleural effusion were determined to be the key predictors of DSS outcome and were associated with higher mortality rate whereas factors like ascites showed significant association with improved survival outcome ( $p < 0.05$ ). For rest of the variables no significant correlation was found ( $P > 0.05$ ). Serological markers, including NS1, IgM, and IgG, also could not significantly predict the outcomes. The identification of seven key predictors of DSS survival underscores the need for targeted management to improve outcomes. Given the limited prognostic value of serological markers, future research should focus on early triage systems and larger multicenter studies to refine treatment protocols in resource-limited settings [34].

## **3- Dengue Dynamics: Unraveling Serotype Trends over a Decade at Rawalpindi Medical University**

Dengue fever poses a persistent health challenge in Pakistan, marked by cyclic epidemics driven by serotype shifts. A cross-sectional observational study was conducted at Rawalpindi Medical University (RMU) to identify annual predominant Dengue Virus (DENV) serotypes from 2013 to 2024 and shifts in serotype distribution were compared across the study period. From 2013 to 2024, the dengue serotype landscape at RMU was predominantly shaped by DENV-2, which began as the sole serotype in 2013 and maintained its dominance, peaking at 72% in 2017. Notable shifts occurred with DENV-3 taking precedence in 2014 and a co-dominance of DENV-1 and DENV-2 in 2019. By 2023, DENV-1 surged to become the dominant serotype at 71%, only for DENV-2 to reclaim supremacy in 2024 with a striking 90%. While data gaps for certain years limit a comprehensive analysis, the study underscores significant trends: the persistent prevalence of DENV-2, the emergence of DENV-1, and the episodic presence of DENV-3. These findings align with regional dengue patterns, underscoring the interconnected nature of its transmission. The dominance of DENV-2 highlights critical implications for disease severity and targeted public health responses. The RMU data indicates dynamic serotype shifts in dengue virus prevalence over the past decade, emphasizing the need for adaptive surveillance systems. Continuous monitoring and resource allocation adjustments are essential to mitigate potential severe outbreaks linked to serotype changes [35].

## **Future Horizons**

Future research on dengue should focus on a multi-pronged approach to improve early diagnosis, treatment, prevention, outbreak control, diagnosis of emerging Dengue strains and cost-effective diagnostics for low-resource settings. There is a pressing need to identify reliable biomarkers—such as those detected through Raman spectroscopy or genetic profiling—that can differentiate between mild and severe dengue early in the course of illness. Studies on the host immune response, including the role of cytokines and genetic polymorphisms (e.g., in CRP or TNF genes), may uncover critical insights into disease progression and potential therapeutic targets. Additionally, vector surveillance and control strategies should be enhanced through integration of geospatial technologies and artificial



intelligence to predict high-risk areas and outbreaks. The emergence of co-infections with other arboviruses like chikungunya and Zika also necessitates research into differential diagnostics and clinical management. Evaluating the long-term effectiveness and safety of dengue vaccines, especially in different serotype environments, remains crucial. Moreover, community-based awareness and behavioral studies can inform public health interventions to reduce transmission. A collaborative, interdisciplinary approach incorporating clinical, molecular, environmental, and social sciences will be vital in tackling the growing burden of dengue.

## Recommendations:

To strengthen dengue research at RMU, it is recommended that the institution establish a research collaboration between Department of Infectious diseases and Department of Public Health. This should focus on multidisciplinary collaboration, including entomology, virology, epidemiology, and clinical medicine. Emphasis should be placed on conducting longitudinal and community-based studies to track disease patterns, mosquito breeding behaviors, and patient outcomes. The university should also seek national and international research grants, forge partnerships with public health organizations, and invest in modern diagnostic tools and data analytics platforms. Encouraging student-led research and integrating dengue-focused modules into the curriculum will further promote sustained academic interest and innovation in tackling this public health challenge.

## References:

- [1] *Dengue hemorrhagic fever: comparison of patients with primary and secondary infections.* Khurram M, Qayyum W, ul Hassan SJ, Mumtaz S, Bushra HT, Umar M. *Journal of infection and public health.* 2014 Nov 1;7(6):489-95.
- [2] *Characteristics of dengue shock syndrome during 2014 dengue epidemic in Rawalpindi, Pakistan.* Khurram M, Qayyum W, Faheem M, Umar M, Bushra HT, Khan MU, Khan N. *Rawal Medical Journal.* 1970 Jan 1;41(2):142.
- [3] *Syed F, Arif MA, Mansoor VB, Usman M, Arif SA. Evolving Spectrum of Dengue: A Two-Year Experience From a Tertiary Care Hospital in Pakistan.* *Cureus.* 2024 Feb;16(2).
- [4] *Khurram M, Faheem M, Umar M, Yasin A, Qayyum W, Ashraf A, Zahid Khan J, Hasnain Yasir A, Ansari Y, Asad M, Khan I. Hemophagocytic lymphohistiocytosis complicating dengue and Plasmodium vivax coinfection.* *Case Reports in Medicine.* 2015;2015(1):696842.
- [5] *Ayaz F, Furrukh M. Assessment of severity of dengue fever by deranged alanine aminotransferase levels.* *Cureus.* 2020 Sep;12(9).
- [6] *Shamshad S, Khan S, Raja GK, Ahmad MS, Asad MJ, Zainab T. Correlation of C-reactive protein levels, gene polymorphism and platelets count in Dengue infection.* *JPM. The Journal of the Pakistan Medical Association.* 2021 Feb 1;71(2 (A)):429-33.
- [7] *Raza FA, Javed H, Khan MM, Ullah O, Fatima A, Zaheer M, Mohsin S, Hasnain S, Khalid R, Salam AA. Dengue and Chikungunya virus co-infection in major metropolitan cities of provinces of Punjab and Khyber Pakhtunkhwa: A multi-center study.* *PLoS Neglected Tropical Diseases.* 2021 Sep 23;15(9):e0009802.

- [8] Amin A, Ghouri N, Ali S, Ahmed M, Saleem M, Qazi J. Identification of new spectral signatures associated with dengue virus infected sera. *Journal of Raman Spectroscopy*. 2017 May;48(5):705-10.
- [9] Khurram M, Qayyum W, Umar M, Jawad M, Mumtaz S, Khaar HT. Ultrasonographic pattern of plasma leak in dengue haemorrhagic fever. *J Pak Med Assoc*. 2016 Mar 1;66(3):260-4.
- [10] Khan S, Ullah R, Khurram M, Ali H, Mahmood A, Khan A, Ahmed M. Evaluation of Raman spectroscopy in comparison to commonly performed dengue diagnostic tests. *Journal of Biomedical Optics*. 2016 Sep 1;21(9):095005-.
- [11] Bilal M, Saleem M, Bilal M, Ijaz T, Khan S, Ullah R, Raza A, Khurram M, Akram W, Ahmed M. Raman spectroscopy-based screening of IgM positive and negative sera for dengue virus infection. *Laser Physics*. 2016 Oct 21;26(11):115602.
- [12] Khan S, Ullah R, Khan A, Wahab N, Bilal M, Ahmed M. Analysis of dengue infection based on Raman spectroscopy and support vector machine (SVM). *Biomedical optics express*. 2016 Jun 1;7(6):2249-56.
- [13] Bilal M, Bilal M, Saleem M, Khurram M, Khan S, Ullah R, Ali H, Ahmed M, Shahzada S, Khan EU. Raman spectroscopy based investigation of molecular changes associated with an early stage of dengue virus infection. *Laser Physics*. 2017 Feb 17;27(4):045601.
- [14] Bilal M, Ullah R, Khan S, Ali H, Saleem M, Ahmed M. Lactate based optical screening of dengue virus infection in human sera using Raman spectroscopy. *Biomedical optics express*. 2017 Feb 1;8(2):1250-6.
- [15] Khan S, Ullah R, Khan A, Sohail A, Wahab N, Bilal M, Ahmed M. Random forest-based evaluation of Raman spectroscopy for dengue fever analysis. *Applied spectroscopy*. 2017 Sep;71(9):2111-7.
- [16] Hassan M, Ali S, Saleem M, Sanaullah M, Fahad LG, Kim JY, Alquhayz H, Tahir SF. Diagnosis of dengue virus infection using spectroscopic images and deep learning. *PeerJ Computer Science*. 2022 Jun 1;8:e985
- [17] Riaz M, Harun SN, Mallhi TH, Khan YH, Butt MH, Husain A, Khan MM, Khan AH. Evaluation of clinical and laboratory characteristics of dengue viral infection and risk factors of dengue hemorrhagic fever: a multi-center retrospective analysis. *BMC Infectious Diseases*. 2024 May 17;24(1):500.
- [18] Zaman S, Mahmud MR, Khalid MA, Zahid A, Khalid S, Kabir I, Manzoor S, Zaman HZ, Mahmud MR, Khalid MA, Zahid A. Effectiveness of vitamin D in prevention of dengue haemorrhagic fever and dengue shock syndrome. *Journal of Rawalpindi Medical College*. 2017 Sep 30;21(3).
- [19] Mahmud MR, Zaman S, Naseem N, Iqbal N, Tanveer N, Khalid MA, Mahmud HZ, Zaman S, Naseem N, Iqbal N, Tanveer N. Comparison of vitamin D levels in patients with dengue haemorrhagic fever and dengue fever. *Journal of Rawalpindi Medical College*. 2018 Jun 30;22(2).
- [20] Ahmed M, Mehmood M, Tahir MJ, Javed H, Ahmed S. Awareness of Dengue Fever in Non-Medical University Students in Punjab. *Pakistan Armed Forces Medical Journal*. 2022 Apr 30;72(2):440-3.
- [21] Seroprevalence of Dengue Among Healthcare Workers: Assessing Infection Risk and Preventive Strategies in a Tertiary Care Hospital. Seemab Abid, Muhammad Umar, Saima Ambreen, Mujeeb Khan, Mehwish Iqbal, Kekhshan Jabeen & Misbah Nadeem. *International Journal of Endorsing Health Science Research*
- [22] Sarfraz M, Rabbani A, Manzoor MS, Sarfraz HZ, Rabbani A, Manzoor MS, Zahid H. Electrolyte disturbances in patients with dengue fever. *Journal of Rawalpindi Medical College*. 2018 Jun 30;22(2).
- [23] Fayyaz T, Yasin M, Tariq A, Mughal A, Bukhari MH, Ms K. Knowledge About Dengue Fever Prevention Among People Visiting Benazir Bhutto Hospital. *Journal of Rawalpindi Medical College*. 2020 Dec 12;24(1):23-6.

- [24] Ahmed M, Mehmood M, Tahir MJ, Javed H, Ahmed S. Awareness of Dengue Fever in Non-Medical University Students in Punjab. *Pakistan Armed Forces Medical Journal*. 2022 Apr 30;72(2):440-3.
- [25] Karimi S, Akhtar N, Katiana O, Haider S, Ahmed B, Khan M, Umer M. Decoding Dengue: A Comprehensive Analysis of Cases at Holy Family Hospital (2019–2023) and Anticipating Pakistan's Future Dengue Dynamics under Climate Change. *Journal of Islamabad Medical & Dental College*. 2024 Jul 20;13(2):345-54.
- [26] Dengue Epidemic 2019, Clinical and Operational Management ([https://rmur.edu.pk/wp-content/uploads/2025/02/denfue\\_book.pdf](https://rmur.edu.pk/wp-content/uploads/2025/02/denfue_book.pdf))
- [27] Dengue report 2024 (<https://rmur.edu.pk/wp-content/uploads/2024/11/denguesheet30112024.pdf>)
- [28] Divisional Dengue Expert Advisory Group (DDEAG) Rawalpindi: 2015 Report. [https://www.researchgate.net/publication/290192109\\_Divisional\\_Dengue\\_Expert\\_Advisory\\_Group\\_DDEAG\\_Rawalpindi\\_2015\\_Report](https://www.researchgate.net/publication/290192109_Divisional_Dengue_Expert_Advisory_Group_DDEAG_Rawalpindi_2015_Report)
- [29] Dengue Patient Care and Training Model (2016) (<https://rmur.edu.pk/?s=dengue#research>)
- [30] Dengue Epidemic Clinical Management 2020 ([https://www.researchgate.net/profile/Muhammad-Khurram-7/publication/338501002\\_Dengue\\_Epedemic\\_Clinical\\_Management/links/5e180d9c92851c8364c0238b/Dengue-Epedemic-Clinical-Management.pdf](https://www.researchgate.net/profile/Muhammad-Khurram-7/publication/338501002_Dengue_Epedemic_Clinical_Management/links/5e180d9c92851c8364c0238b/Dengue-Epedemic-Clinical-Management.pdf))
- [31] Dengue Epidemic report 2022 (<https://rmur.edu.pk/?s=dengue#research>)
- [32] RMU Model of Data Bank 2023 ([https://rmur.edu.pk/wp-content/uploads/2025/03/Data-Bank-Log-Bank\\_VC\\_SK.pdf](https://rmur.edu.pk/wp-content/uploads/2025/03/Data-Bank-Log-Bank_VC_SK.pdf))
- [33] Evolving Trends in Dengue Severity and Serotype Dominance: A Decade-Long Analysis in Rawalpindi, Pakistan. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen
- [34] Evaluation of Outcome Predictors in Dengue Shock Syndrome: A Comparative Study of Survivors and Non-Survivors during the Epidemic 2024 in Rawalpindi. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, Khuzeema Tanveer, Saima Ambreen, M Mujeeb Khan, Malik Shehr yar, Hamza bin Rahat, Somal Sehar, Zainab Ahsan
- [35] Dengue Dynamics: Unraveling Serotype Trends over a Decade at Rawalpindi Medical University. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen

## Appendices

**Table 1:** List of Dengue research articles (Title, authors, year, journal, impact factor).

Sr. No.	Research Article	Year	Journal and IF
1	Khurram M, Qayyum W, ul Hassan SJ, Mumtaz S, Bushra HT, Umar M. Dengue hemorrhagic fever: comparison of patients with primary and secondary infections. Journal of infection and public health. 2014 Nov 1;7(6):489-95.	2014	Journal of Infection and Public Health (4.7)
2	Khurram M, Qayyum W, Faheem M, Umar M, Bushra HT, Khan MU, Khan N. Characteristics of dengue shock syndrome during 2014 dengue epidemic in Rawalpindi, Pakistan. Rawal Medical Journal. 1970 Jan 1;41(2):142-.	2014	Rawal Medical Journal (0.4)
3	Khurram M, Faheem M, Umar M, Yasin A, Qayyum W, Ashraf A, Zahid Khan J, Hasnain Yasir A, Ansari Y, Asad M, Khan I. Hemophagocytic lymphohistiocytosis complicating dengue and Plasmodium vivax coinfection. Case Reports in Medicine. 2015; 2015(1):696842.	2015	Case Reports in Medicine (0.8)
4	Khurram M, Qayyum W, Umar M, Jawad M, Mumtaz S, Khaar HT. Ultrasonographic pattern of plasma leak in dengue haemorrhagic fever. J Pak Med Assoc. 2016 Mar 1;66(3):260-4.	2016	Journal of the Pakistan Medical Association (0.8)
5	Khan S, Ullah R, Khurram M, Ali H, Mahmood A, Khan A, Ahmed M. Evaluation of Raman spectroscopy in comparison to commonly performed dengue diagnostic tests. Journal of Biomedical Optics. 2016 Sep 1;21(9):095005-.	2016	Journal of Biomedical Optics. (3.0)
6	Bilal M, Saleem M, Bilal M, Ijaz T, Khan S, Ullah R, Raza A, Khurram M, Akram W, Ahmed M. Raman spectroscopy-based screening of IgM positive and negative sera for dengue virus infection. Laser Physics. 2016 Oct 21;26(11):115602.	2016	Laser Physics (1.2)
7	Khan S, Ullah R, Khan A, Wahab N, Bilal M, Ahmed M. Analysis of dengue infection based on Raman spectroscopy and support vector machine (SVM). Biomedical optics express. 2016 Jun 1;7(6):2249-56.	2016	Biomedical optics express (2.9)
8	Amin A, Ghouri N, Ali S, Ahmed M, Saleem M, Qazi J. Identification of new spectral signatures associated with dengue virus infected sera. Journal of Raman Spectroscopy. 2017 May;48(5):705-10.	2017	Journal of Raman Spectroscopy (2.4)
9	Bilal M, Bilal M, Saleem M, Khurram M, Khan S, Ullah R, Ali H, Ahmed M, Shahzada S, Khan EU. Raman spectroscopy based investigation of molecular changes associated with an early stage of dengue virus infection. Laser Physics. 2017 Feb 17;27(4):045601.	2017	Laser Physics (1.2)
10	Bilal M, Ullah R, Khan S, Ali H, Saleem M, Ahmed M. Lactate based optical screening of dengue virus infection in human sera using Raman spectroscopy. Biomedical optics express. 2017 Feb 1;8(2):1250-6.	2017	Biomedical optics express (2.9)

11	Khan S, Ullah R, Khan A, Sohail A, Wahab N, Bilal M, Ahmed M. Random forest-based evaluation of Raman spectroscopy for dengue fever analysis. <i>Applied spectroscopy</i> . 2017 Sep;71(9):2111-7.	2017	Applied spectroscopy (2.2)
12	Ayaz F, Furrukh M. Assessment of severity of dengue fever by deranged alanine aminotransferase levels. <i>Cureus</i> . 2020 Sep;12(9).	2021	Cureus Journal of Medical Science (1.0)
13	Shamshad S, Khan S, Raja GK, Ahmad MS, Asad MJ, Zainab T. Correlation of C-reactive protein levels, gene polymorphism and platelets count in Dengue infection. <i>JPMA. The Journal of the Pakistan Medical Association</i> . 2021 Feb 1;71(2 (A)):429-33.	2021	The Journal of the Pakistan Medical Association (0.8)
14	Raza FA, Javed H, Khan MM, Ullah O, Fatima A, Zaheer M, Mohsin S, Hasnain S, Khalid R, Salam AA. Dengue and Chikungunya virus co-infection in major metropolitan cities of provinces of Punjab and Khyber Pakhtunkhwa: A multi-center study. <i>PLoS Neglected Tropical Diseases</i> . 2021 Sep 23;15(9):e0009802.	2021	PLoS Neglected Tropical Diseases (3.4)
15	Hassan M, Ali S, Saleem M, Sanaullah M, Fahad LG, Kim JY, Alquhayz H, Tahir SF. Diagnosis of dengue virus infection using spectroscopic images and deep learning. <i>PeerJ Computer Science</i> . 2022 Jun 1;8:e985.	2022	PeerJ Computer Science (3.5)
16	Syed F, Arif MA, Mansoor VB, Usman M, Arif SA. Evolving Spectrum of Dengue: A Two-Year Experience From a Tertiary Care Hospital in Pakistan. <i>Cureus</i> . 2024 Feb;16(2).	2024	Cureus Journal of Medical Science (1.0)
17	Riaz M, Harun SN, Mallhi TH, Khan YH, Butt MH, Husain A, Khan MM, Khan AH. Evaluation of clinical and laboratory characteristics of dengue viral infection and risk factors of dengue hemorrhagic fever: a multi-center retrospective analysis. <i>BMC Infectious Diseases</i> . 2024 May 17;24(1):500.	2024	BMC Infectious Diseases (3.4)

**Table 2:** Table of Dengue research articles with citations

Sr. No.	Research Article	Year	Citations
1	Khurram M, Qayyum W, ul Hassan SJ, Mumtaz S, Bushra HT, Umar M. Dengue hemorrhagic fever: comparison of patients with primary and secondary infections. <i>Journal of infection and public health</i> . 2014 Nov 1;7(6):489-95.	2014	58
2	Khurram M, Qayyum W, Faheem M, Umar M, Bushra HT, Khan MU, Khan N. Characteristics of dengue shock syndrome during 2014 dengue epidemic in Rawalpindi, Pakistan. <i>Rawal Medical Journal</i> . 1970 Jan 1;41(2):142-.	2014	02
3	Khurram M, Faheem M, Umar M, Yasin A, Qayyum W, Ashraf A, Zahid Khan J, Hasnain Yasir A, Ansari Y, Asad M, Khan I. Hemophagocytic lymphohistiocytosis complicating dengue and Plasmodium vivax coinfection. <i>Case Reports in Medicine</i> . 2015; 2015(1):696842.	2015	21
4	Shams N, Amjad S, Yousaf N, Ahmed W, Seetlani NK, Qaisar N. Predictors of Severity of Dengue Fever in Tertiary Care Hospitals. <i>Journal of Liaquat University of Medical &amp; Health Sciences</i> . 2016 Oct 1;15(4).	2016	06
5	Nadeem M, Shafiq MM, Manzoor MS, Ahmed SI.	2016	08

	Serum ferritin: an indicator of disease severity in patients with dengue infection. JRMCM. 2016;20:165-7.		
6	Faheem M, Osama M, Khurram M, Khan MM, Ur H, Rehman SA, Anjum N, Hamid S, Umar M. Dengue Fever Induced Fulminant Hepatic Failure. Journal of Rawalpindi Medical College (JRMCM). 2016;20(4):331-2.	2016	02
7	Khurram M, Faheem M, Masood F, Manzoor S, Khan MM, Masood N, Umar M. Management of adult dengue shock syndrome patients not improving with DEAG guidelines based therapy. Journal of Rawalpindi Medical College. 2016 Mar 30;20(1).	2016	02
8	Khurram M, Qayyum W, Umar M, Jawad M, Mumtaz S, Khaar HT. Ultrasonographic pattern of plasma leak in dengue haemorrhagic fever. J Pak Med Assoc. 2016 Mar 1;66(3):260-4.	2016	22
9	Khan S, Ullah R, Khurram M, Ali H, Mahmood A, Khan A, Ahmed M. Evaluation of Raman spectroscopy in comparison to commonly performed dengue diagnostic tests. Journal of Biomedical Optics. 2016 Sep 1;21(9):095005-.	2016	19
10	Bilal M, Saleem M, Bilal M, Ijaz T, Khan S, Ullah R, Raza A, Khurram M, Akram W, Ahmed M. Raman spectroscopy-based screening of IgM positive and negative sera for dengue virus infection. Laser Physics. 2016 Oct 21;26(11):115602.	2016	11
11	Khan S, Ullah R, Khan A, Wahab N, Bilal M, Ahmed M. Analysis of dengue infection based on Raman spectroscopy and support vector machine (SVM). Biomedical optics express. 2016 Jun 1;7(6):2249-56.	2016	133
12	Ashfaq MW, Nadeem M, Khalid MA, Shafiq MM, Ahmad SI. Liver biochemistry: difference between dengue fever and non dengue febrile illnesses. JIMDC. 2016;5:10-3.	2016	02
13	Zaman S, Mahmud MR, Khalid MA, Zahid A, Khalid S, Kabir I, Manzoor S, Zaman HZ, Mahmud MR, Khalid MA, Zahid A. Effectiveness of vitamin D in prevention of dengue haemorrhagic fever and dengue shock syndrome. Journal of Rawalpindi Medical College. 2017 Sep 30;21(3).	2017	12
14	Amin A, Ghouri N, Ali S, Ahmed M, Saleem M, Qazi J. Identification of new spectral signatures associated with dengue virus infected sera. Journal of Raman Spectroscopy. 2017 May;48(5):705-10.	2017	33
15	Bilal M, Bilal M, Saleem M, Khurram M, Khan S, Ullah R, Ali H, Ahmed M, Shahzada S, Khan EU. Raman spectroscopy based investigation of molecular changes associated with an early stage of dengue virus infection. Laser Physics. 2017 Feb 17;27(4):045601.	2017	03
16	Bilal M, Ullah R, Khan S, Ali H, Saleem M, Ahmed M. Lactate based optical screening of dengue virus infection in human sera using Raman spectroscopy. Biomedical optics express. 2017 Feb 1;8(2):1250-6.	2017	20
17	Khan S, Ullah R, Khan A, Sohail A, Wahab N, Bilal M, Ahmed M. Random forest-based evaluation of Raman spectroscopy for dengue fever analysis. Applied spectroscopy. 2017 Sep;71(9):2111-7.	2017	57
18	Mahmud MR, Zaman S, Naseem N, Iqbal N, Tanveer N, Khalid MA, Mahmud HZ, Zaman S, Naseem N, Iqbal N, Tanveer N. Comparison of vitamin D levels in patients with dengue haemorrhagic fever and dengue fever. Journal of Rawalpindi Medical College. 2018 Jun 30;22(2).	2018	03
19	Sarfraz M, Rabbani A, Manzoor MS, Sarfraz HZ, Rabbani A, Manzoor MS, Zahid H. Electrolyte disturbances in patients with dengue fever. Journal of Rawalpindi Medical College. 2018 Jun 30;22(2).	2018	03
20	Fayyaz T, Yasin M, Tariq A, Mughal A, Bukhari MH, Ms K. Knowledge About Dengue Fever Prevention Among People Visiting Benazir Bhutto Hospital. Journal of Rawalpindi Medical College. 2020 Dec 12;24(1):23-6.	2020	01

21	Ayaz F, Furrukh M. Assessment of severity of dengue fever by deranged alanine aminotransferase levels. <i>Cureus</i> . 2020 Sep;12(9).	2021	02
22	Asghar RM, Ashraf RR, Saheel K, Hussain A. An Evaluation of Haematological Changes in Paediatric Dengue Fever Patients at a Tertiary Care Hospital Rawalpindi during 2019 Outbreak. <i>Journal of Rawalpindi Medical College</i> . 2021 Jun 30;25(2).	2021	07
23	Shamshad S, Khan S, Raja GK, Ahmad MS, Asad MJ, Zainab T. Correlation of C-reactive protein levels, gene polymorphism and platelets count in Dengue infection. <i>JPMA. The Journal of the Pakistan Medical Association</i> . 2021 Feb 1;71(2 (A)):429-33.	2021	01
24	Raza FA, Javed H, Khan MM, Ullah O, Fatima A, Zaheer M, Mohsin S, Hasnain S, Khalid R, Salam AA. Dengue and Chikungunya virus co-infection in major metropolitan cities of provinces of Punjab and Khyber Pakhtunkhwa: A multi-center study. <i>PLoS Neglected Tropical Diseases</i> . 2021 Sep 23;15(9):e0009802.	2021	18
25	Malik J, Batool M, Yasmeen T, Manzoor S, Bhatti HW, Mumtaz S. Correlation of serological markers and thrombocytopenia in Dengue infection-a cross sectional study from 2019 epidemic in Rawalpindi, Pakistan. <i>The Professional Medical Journal</i> . 2022 May 31;29(06):764-9.	2022	02
26	Ahmed M, Mehmood M, Tahir MJ, Javed H, Ahmed S. Awareness of Dengue Fever in Non-Medical University Students in Punjab. <i>Pakistan Armed Forces Medical Journal</i> . 2022 Apr 30;72(2):440-3.	2022	02
27	Hussain T, Baloch SK, Adil B, Shaukat M, Rauf F, Khalid MA. Gastrointestinal Manifestations in Adult Patients Presenting with Dengue Infection, A Local Study from Tertiary Care Hospital. <i>Biomedical Journal of Scientific &amp; Technical Research</i> . 2022;42(3):33587-91.	2022	02
28	Hassan M, Ali S, Saleem M, Sanaullah M, Fahad LG, Kim JY, Alquhayz H, Tahir SF. Diagnosis of dengue virus infection using spectroscopic images and deep learning. <i>PeerJ Computer Science</i> . 2022 Jun 1;8:e985.	2022	11
29	Gul N, Gul S, Anwar GM, Ali M, Gul M, Ahmad E. Epidemiological parameters of dengue infections in Pakistan. <i>Pakistan Journal of Medical &amp; Health Sciences</i> . 2023 Mar 25;17(02):296-.	2023	01
30	Malik J, Waheed N, Manzoor S, Mumtaz S, Bhatti HW, Yasmeen T. Association of pattern of thrombocytopenia and serology with timings of plasma leakage in patients of dengue hemorrhagic fever during dengue epidemic 2019—an experience from Rawalpindi Medical University: A cross sectional study. <i>The Professional Medical Journal</i> . 2023 Mar 31;30(04):461-6.	2023	02
31	Karimi S, Akhtar N, Katiana O, Haider S, Ahmed B, Khan M, Umer M. Decoding Dengue: A Comprehensive Analysis of Cases at Holy Family Hospital (2019–2023) and Anticipating Pakistan's Future Dengue Dynamics under Climate Change. <i>Journal of Islamabad Medical &amp; Dental College</i> . 2024 Jul 20;13(2):345-54.	2024	02
32	Syed F, Arif MA, Mansoor VB, Usman M, Arif SA. Evolving Spectrum of Dengue: A Two-Year Experience From a Tertiary Care Hospital in Pakistan. <i>Cureus</i> . 2024 Feb;16(2).	2024	02
33	Riaz M, Harun SN, Mallhi TH, Khan YH, Butt MH, Husain A, Khan MM, Khan AH. Evaluation of clinical and laboratory characteristics of dengue viral infection and risk factors of dengue hemorrhagic fever: a multi-center retrospective analysis. <i>BMC Infectious Diseases</i> . 2024 May 17;24(1):500.	2024	11
34	Ultrasound As An Aid To Diagnosis In Dengue. Fatimah Kashif Rasool, Ahmed Kashif Rasool, Lubna Meraj, Farhat Bashir. <i>Journal of Rawalpindi Medical College (JRMCI)</i> ; 2023; 27(1): 208-215. <a href="https://doi.org/10.37939/jrmc.v27i1.2148">https://doi.org/10.37939/jrmc.v27i1.2148</a>	2023	1
	Total citations	482	

## Research articles/reports unpublished, RMU

Sr. No.	Research Articles	Year
1	Evolving Trends in Dengue Severity and Serotype Dominance: A Decade-Long Analysis in Rawalpindi, Pakistan. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen	2025
2	Evaluation of Outcome Predictors in Dengue Shock Syndrome: A Comparative Study of Survivors and Non-Survivors during the Epidemic 2024 in Rawalpindi. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, Khuzeema Tanveer, Saima Ambreen, M Mujeeb Khan, Malik Shehr yar, Hamza bin Rahat, Somal Sehar, Zainab Ahsan	2025
3	Dengue Dynamics: Unraveling Serotype Trends over a Decade at Rawalpindi Medical University. Muhammad Khurram, Muhammad Umar, Kehkshan Jabeen, M Mujeeb Khan, Arshad Rabbani, Shahzad Manzoor, Saima Ambreen	2025
Sr. No.	Reports	Year
1	Divisional Dengue Expert Advisory Group (DDEAG) Rawalpindi: 2015 Report. <a href="https://www.researchgate.net/publication/290192109_Divisional_Dengue_Expert_Advisory_Group_DDEAG_Rawalpindi_2015_Report">https://www.researchgate.net/publication/290192109_Divisional_Dengue_Expert_Advisory_Group_DDEAG_Rawalpindi_2015_Report</a>	2015
2	Dengue Patient Care and Training Model ( <a href="https://rmur.edu.pk/?s=dengue#research">https://rmur.edu.pk/?s=dengue#research</a> )	2016
3	Dengue Epidemic 2019, Clinical and Operational Management ( <a href="https://rmur.edu.pk/wp-content/uploads/2025/02/denfue_book.pdf">https://rmur.edu.pk/wp-content/uploads/2025/02/denfue_book.pdf</a> )	2019
4	Dengue Epidemic Clinical Management 2020 ( <a href="https://www.researchgate.net/profile/Muhammad-Khurram-7/publication/338501002_Dengue_Epedemic_Clinical_Management/links/5e180d9c92851c8364c0238b/Dengue-Epedemic-Clinical-Management.pdf">https://www.researchgate.net/profile/Muhammad-Khurram-7/publication/338501002_Dengue_Epedemic_Clinical_Management/links/5e180d9c92851c8364c0238b/Dengue-Epedemic-Clinical-Management.pdf</a> )	2020
5	Dengue Epidemic report 2022 ( <a href="https://rmur.edu.pk/?s=dengue#research">https://rmur.edu.pk/?s=dengue#research</a> )	2022
6	RMU Model of Data Bank 2023 ( <a href="https://rmur.edu.pk/wp-content/uploads/2025/03/Data-Bank-Log-Bank_VC_SK.pdf">https://rmur.edu.pk/wp-content/uploads/2025/03/Data-Bank-Log-Bank_VC_SK.pdf</a> )	2023
7	Dengue report 2024 ( <a href="https://rmur.edu.pk/wp-content/uploads/2024/11/denguesheet30112024.pdf">https://rmur.edu.pk/wp-content/uploads/2024/11/denguesheet30112024.pdf</a> )	2024