Final Report of Summative Learning Project (SLP) presented to the BRAC James P Grant School of Public Health, BRAC University

Resource Allocation and System Efficiency in Dengue Management: A Mixed Methods Study at Savar Upazila Health Complex

Salma Sultana
ID: 24167011, salma.sultana1@g.bracu.ac.bd
Supervisors: Tanvir Hasan, Associate Professor and Co-Director, Centre of Excellence for Urban Equity & Health (CUEH) (thasan@bracu.ac.bd) & Shah Ali Akbar Ashrafi, Division Director (Health), Mymensingh Division, Directorate General of Health Services, Health Services Division, Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh (drshahashrafi@gmail.com)
Mentors: Nigar Sultana Zoha (nigar.szoha@bracu.ac.bd), Sabina Akter Tumpa (tumpa.sabina@bracu.ac.bd), Arifa Bente Mohosin (arifa.mohosin@bracu.ac.bd)

Purpose: In Partial Fulfillment of the Requirements for the Degree of Master of Public Health (MPH)

B. Table of Content

C. Abstract

Introduction: Dengue fever, a mosquito-borne disease, is a significant public health issue in Bangladesh, with outbreaks exacerbated by urban density, inadequate resources, and seasonal patterns. The country reported over 203,000 cases and 989 deaths in 2023, with rising hospitalizations and fatalities in 2024. Challenges include ICU shortages, insufficient diagnostic tools, and economic impacts. Despite national protocols for dengue management, gaps in adherence at primary healthcare facilities hinder effective response, necessitating focused research and interventions.

Method: This study utilized a concurrent mixed-method design at the Savar Upazila Health Complex, combining an observation checklist, supply chain mapping, and qualitative interviews with 12 healthcare providers. The checklist assessed facility resources and dengue management practices, while supply chain mapping identified bottlenecks in resource flow. Interviews explored challenges in protocol adherence, resource limitations, and patient care. Data analysis integrated thematic and quantitative methods, revealing critical deficiencies. Ethical considerations ensured confidentiality, informed consent, and minimal disruption at the UHC.

Findings: The health complex has 50 beds but struggles to accommodate dengue patients during peak seasons, often using floor spaces due to overcrowding. Inadequate isolation facilities increase cross-contamination risks. Staff shortages, particularly nurses and health assistants, compromise care quality, though training on dengue protocols exists. Essential supplies, such as diagnostic kits and PPE, face frequent shortages due to inefficiencies in the government-led supply chain. While IV fluids and medicines are generally available, mosquito repellents and equipment are inconsistent. Proactive measures, like sanitation and mosquito control, are limited by resource constraints. Improved infrastructure, staffing, training, and supply chain management are critical for effective dengue care.

Conclusion: Resource constraints, staffing shortages, and inefficient procurement hinder dengue management at Savar Upazila Health Complex, compromising patient care. Addressing these challenges requires a comprehensive national policy, intersectoral coordination, and increased funding. Integrating dengue management into broader public health frameworks is essential to improve system capacity and ensure sustained preparedness.

D. Introduction:

The dengue virus, or dengue, is a potentially lethal virus that is spread to humans by mosquitoes and is prevalent in over 100 countries (Khan et al., 2024). It is a major health problem worldwide. Approximately 3.9 billion individuals worldwide are presently at risk of contracting dengue fever, per a new research conducted by the World Health Organization (2024). Even though dengue infection is a problem in more than 100 nations, 70% of cases occur in Asia, with South and Southeast Asia accounting for the majority of cases (Ali, 2024). With a variable incidence, dengue has remained endemic in Bangladesh, a South Asian nation, for over 25 years (Khan et al., 2024). In Bangladesh, dengue fever poses a significant risk to public health due to its frequent outbreaks. Since 2019, DENV3 has been the most common serotype; however, DENV2 has surpassed in 2024. As the disease spreads quickly in heavily populated areas, hospitals are finding it difficult to handle the country's fatal dengue fever outbreak (Ali, 2024). Nevertheless, in Bangladesh, dengue has grown to be a major, potentially fatal issue in recent years.

For the first time in three years, there has been a rise in the number of dengue-related hospitalizations and fatalities nationally in 2024. Although several other dengue-endemic nations have recently observed comparable trends, Bangladesh's dengue-related mortality toll is extraordinary. Apart from the direct health effects, dengue is also causing economic losses, stress on healthcare systems, and social unrest in Bangladesh (Khan et al., 2024). A total of 203,406 individuals were infected between January and September of 2023, and 989 of them died, yielding a case fatality rate of 0.49%. Nonetheless, the nation has been putting in great effort to fight the disease and lessen its effects on the population. In Bangladesh, dengue epidemics frequently exhibit seasonal trends, with the monsoon and post-monsoon seasons seeing the highest rates of transmission. Because dengue-carrying mosquitoes have hatching grounds in urban areas, especially highly populated cities, epidemics are more likely to occur there (Sarkar & Ray, 2024).

Bangladesh's hot and humid climate encourages the growth of a wide range of mosquito species; in 2016, there were over 123 species identified (Hasan et al., 2024). The presence or absence of dengue vectors is measured using three key indices: house index (HI: the percentage of houses infested with larvae and/or pupae); Breteau index (BI: the number of positive containers per 100 houses); container index (CI: the percentage of water-holding containers

infested with larvae or pupae). These indices may facilitate understanding of the ecology of vectors in a given control area, but they also serve as useful measures for determining the success of intervention strategies (Cavalcante et al., 2020). Recent research conducted in Dhaka in 2024 revealed a higher Breteau index, which counts the number of positive containers per 100 homes, at 30.8 in 1997, 24.6 in 2000, 55.8 in 2011, 28.7 in 2012, and 22.5 in 2013. The Dhaka South City Corporation area's six wards had the highest Breteau index of >50 in 2022 (Hasan et al., 2024). The Breteau Index, a measure of Aedes mosquito density based on larvae counts, serves as an early warning tool for dengue outbreaks. The index's monthly values are correlated with dengue incidence, revealing specific lag periods that predict outbreaks. Using receiver operating characteristic (ROC) curves, threshold values were set, achieving high sensitivity and specificity for predicting outbreaks (Aryaprema & Xue, 2019). This approach highlights the importance of continuous mosquito surveillance, enabling health officials to respond proactively to potential dengue risks.

Though there is literature that focuses on the spread of dengue, there is a gap in knowledge on how to manage the increasing trends in dengue. October of 2024 alone recorded 108 deaths in the first 23 days of the month. Out of a total of 53,196 cases this year, over 20,000 people were infected in this month alone (The Daily Star, 2024). This escalation has led to public health challenges as hospitals, especially public ones, struggled to provide efficient care with limited ICU facilities, bed shortages, and insufficient diagnostic kits. Government hospitals had to bear the brunt, accommodating most dengue patients, yet resources remain stretched. The financial burden for the people of Bangladesh is considerable; alongside treatment expenses, the high demand for hospital care, facilities already limited in ICU capacity and specialized equipment, worsening patient outcomes and reducing access to necessary care (The Daily Star, 2024).

In Bangladesh, the national dengue management protocol provides standardized guidelines for early diagnosis, treatment, and monitoring of dengue cases to reduce mortality and improve patient care. Following this protocol is essential in primary healthcare facilities to manage outbreaks effectively, especially in densely populated areas. However, little research has examined the challenges healthcare providers face in adhering to these protocols within primary settings like Upazila health complexes. Addressing this gap is vital to improving protocol compliance and patient outcomes in underserved areas to reduce mortality and deliver efficient

care. This research focuses on the dengue management system in primary healthcare and aims to identify the challenges of implementing effective dengue management protocols based on national guidelines prepared for Bangladesh at Upazila Health Complexes.

D.1. Research question:

How do resource and supply chain constraints affect efficient dengue management at Savar Upazila Health Complex?

D.2. Objectives:

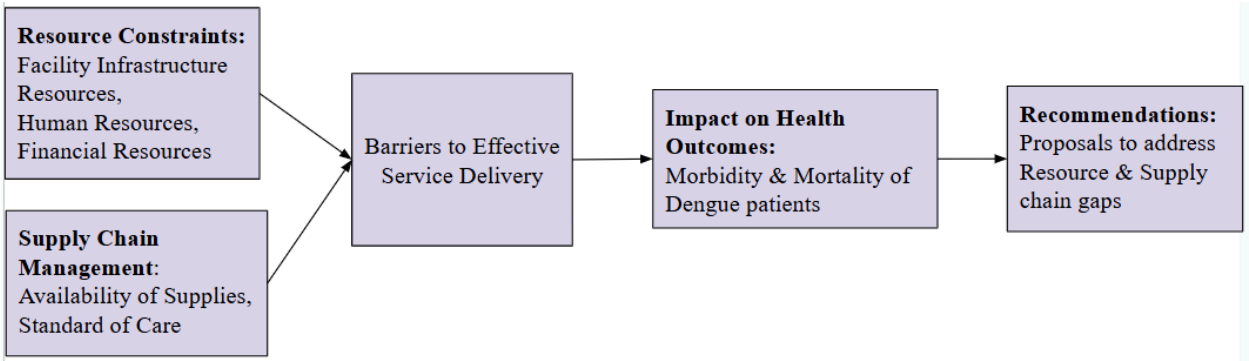
D.2.1. General objective:

To explore how resource and supply chain constraints affect dengue management as per the national guideline for clinical management of dengue at Savar Upazila Health Complex.

D.2.2. Specific objectives:

- To assess if the facility infrastructure resources (such as beds, ambulances and cold chain equipment), human resources (qualified doctors and other health professionals) and financial resources (such as sufficient budget to procure necessary supplies) are adequately available at the Savar Upazila Health Complex to effectively deliver care for dengue patients
- To examine the availability and adequacy of medical supplies (such as intravenous fluids and equipment), medicines (such as paracetamol), diagnostic tools (such as rapid tests for dengue specific IgM/ IgG and dengue NS1 antigen), personal protective equipment (PPE), mosquito nets and sprays for dengue management and prevention within the Savar Upazila Health Complex
- To provide recommendations to the government on how to address the constraints and improve the overall dengue management capacity of Upazila Health Complexes in Bangladesh

D.3. Conceptual framework:



E. Methodology:

E.1. Study design:

This research adopted a concurrent mixed method design which included an observation checklist, a supply chain mapping exercise, and qualitative interviews among healthcare professionals.

The observation checklist was used to assess what resources are available in the facility and systematically observe dengue management practices. Items included in this checklist were dengue standard of care, availability of medical supplies, patient care dimensions and infection control practices. The observation helped identify gaps in resource and supply chain constraints and potential areas of improvement in dengue management.

By visualising and understanding the flow of dengue relevant essential supplies that are required for managing dengue, we mapped supply chains to visualize the connections. It described the journey of resources from suppliers to healthcare facilities and identified factors that contribute to the timely access of these resources including demand variability, logistical challenges, and regulatory burdens. Supply chain mapping revealed the bottlenecks as well as opportunities for the streamlining of the delivery of critical resources in the Savar upazila health complex.

Qualitative interviews (Key Informant Interview, KII) with healthcare providers enabled us to collect in-depth data on the challenges they face in dengue management. These interviews focused on healthcare workers' firsthand experiences with protocol implementation, resource limitations, and patient care obstacles. Interviews revealed underlying issues like workforce shortages, lack of training, and communication barriers. The participants for the qualitative data were healthcare professionals (doctors, nurses, medical officers, support staff), health inspectors,

and upazila health & family planning officers (UHFPO) managing the responsibilities of serving dengue patients.

E.2. Study site: Savar Upazila Health Complex in Dhaka, Bangladesh.

Savar is a peri-urban area close to Dhaka, which experiences both urban and rural characteristics. This made it a suitable location to study the transmission dynamics of dengue, often exacerbated in urbanized settings due to population density and poor waste management. Being near Dhaka, an epicenter for dengue outbreaks, Savar experienced spillover effects of urban dengue transmission (Alam & Mollah, 2021). Savar has reported dengue cases during seasonal outbreaks, providing a relevant setting to study the implementation of national dengue management protocols.

E.3. Study Population: Healthcare providers (doctors, nurses, and administrative staff) involved in dengue management and prevention within the UHC.

E.3.1. Inclusion Criteria of selecting the participants: Healthcare providers involved in the management of dengue cases, healthcare providers willing to participate in the research and provide informed consent.

E.3.2. Exclusion Criteria of selecting the participants: Healthcare providers who are not directly involved in dengue management, providers on leave or unavailable during the data collection period.

E.4. Sample size:

The number of key informants interviewed in the study was 12. The sample included medical officers, nurses, a health inspector, an office assistant and an administrative officer who looked over the registry and management of dengue patients. The medical officers provided detailed perspectives on clinical management and patient care within constrained resources; the nurses elaborated on day-to-day patient care challenges and supply needs; the support staff offered insights on the logistical challenges they face, such as managing medical equipment, bed allocations, and PPE supplies; the health inspector and a senior medical officer who was also facility head helped to understand the facility's resource allocation and prioritization processes, which directly impact the ability to serve dengue patients effectively.

E.5. Sampling technique: Convenience sampling was used for recruiting the key informants'.

E.6. Operational Terms:

Domain	Understanding Domains in Dengue Management	Measurement Method
Resource Constraints	Limitations in the availability of essential resources, including human, financial, and material, that impact the ability to deliver effective healthcare services (Anesi & Kerlin, 2021).	Assessed through interviews with healthcare providers.
Supply Chain Constraints	Challenges in the procurement, storage, and distribution of medical supplies and equipment necessary for dengue management (Maluleke et al., 2021).	Analyzed through supply chain mapping.
Facility Infrastructure	Physical resources and utilities available at the health complex, including buildings, equipment, electricity, and water supply (Kapologwe et al., 2020).	Evaluated using an observation checklist and facility inspection.
Human Resources	The number, qualifications, and skill mix of healthcare staff available to provide dengue management services (Nikookar et al., 2023).	Measured by comparing staffing records to national guidelines.
Healthcare Professionals	Licensed medical personnel, including doctors, nurses, and laboratory technicians, involved in patient care and management (World Health Organization [WHO], 2019).	Identified through staff lists and interviews.
Financial Resource	Budget allocation and funding available for dengue prevention, diagnosis, and treatment at the health complex (Knerer et al., 2021).	Assessed through interviews with administrative staff and facility head.
Medical Supplies	Consumables required for dengue management, including IV fluids, medications, and syringes (Tayal et al., 2022).	Checked against national guideline lists and interviews with the support staff.
Diagnostic Tools	Laboratory and point-of-care devices used for diagnosing dengue, such as rapid diagnostic test kits and blood	Assessed through equipment inventory and laboratory service

	analysis equipment (Kabir et al., 2021).	records.
Personal Protective Equipment (PPE)	Equipment such as gloves, masks, and gowns used by healthcare providers to minimize exposure to infectious agents (Verbeek et al., 2020).	Evaluated through observation and interviews.
Supply Chain Management	The process of planning, implementing, and controlling the flow of medical supplies and equipment from procurement to patient use (Maluleke et al., 2021).	Analyzed through supply chain mapping and stakeholder interviews.

E.7. Tool Development:

E.7.1. Observation Checklist:

The Observation Checklist was developed based on the WHO Service Availability and Readiness Assessment (SARA) tool and the National Dengue Management Guidelines. This was used to collect data on various aspects: facility infrastructure, human and financial resources, medical supplies, diagnostic tools, personal protective equipment (PPE) and supply chain management concerning the study's aims. The checklist was devised based on a detailed review of the literature known, including existing national dengue management protocols and guidelines, and other such studies from resource-constrained health care settings.

E.7.2. Supply Chain Mapping:

The Observation Checklist was used for the supply chain mapping. This was able to grab key elements of the supply chain by looking at the flow of resources, stakeholders, processes and challenges. It helped to understand and write down how the dengue management resources (such as medicines, diagnostic kits and PPE) flow. The mapping was conducted following a broad review of existing literature on National Dengue Management Protocols, guidelines, and the WHO SARA tool.

E.7.3. Key Informant Interview (KII):

The KII tool was developed to explore healthcare providers' perceptions, experiences, and challenges in managing dengue disease. To collect qualitative insights into areas such as resource adequacy, protocol adherence, and recommendations on how to improve dengue

response. Key thematic areas included: challenges in implementing dengue management protocols; availability and adequacy of resources (human, financial, and material); and recommendations for improving facility-level dengue response. The questions were designed to be open-ended to encourage detailed responses and provide rich qualitative data.

E.8. Pre-testing:

The study tools were pre-tested in the Rupgonj Upazila Health Complex. The tools, including observation checklist, interview guides, and supply chain mapping templates, were tested first to identify ambiguities, redundancies or gaps. This pre-testing phase provided feedback that helped refine items for clarity, eliminate redundancies and fill in missing items. The finalised tools were attained after all feedback from the pretesting stage and the supervisor was incorporated. Also, during the pre-testing, questions were pre-phrased to be culturally appropriate and easy to understand for respondents, making them less likely to be misunderstood. The pre-test also enabled estimation of the time needed to collect data as well as logistical adjustments for the main study.

E.9. Data Analysis:

The data collected using the observation checklist was systematically analyzed using Microsoft Excel. Observational notes (notes taken during the observational checklist) underwent thematic analysis to capture recurring issues. Data was presented using tables and charts for clarity. To get a broader understanding of qualitative data, thematic analysis of the common challenges and insights was done triangulating with the quantitative results from the observation checklist using Microsoft Excel. Codes were grouped into broader categories. Themes were developed by identifying patterns and relationships within the data.

E.10. Ethical considerations:

The study obtained ethical approval from BRAC James P Grant School of Public Health, BRAC University (JPGSPH) institutional review board (IRB). Informed consent from all participants was secured. The confidentiality of information by the participants was ensured. Participants were thoroughly informed about the study's nature, purpose, and potential implications before starting the interviews. They were briefed on their role in the research, the type of data to be collected from them, and how it would be utilized. The consent form included information about voluntary participation, the right to withdraw at any time, and how their privacy will be protected. Personal identifying information (such as names or specific roles) was

not disclosed in the final research report or publications. Data was anonymized where possible, and access to data was restricted to the research team only. Any sensitive data, particularly concerning patient care or internal management issues, was handled with the utmost discretion. Care was taken to minimize any potential stress or discomfort for healthcare providers who felt pressured to reveal information about resource constraints or shortcomings in management. The study did not hamper the functioning of the Upazila Health Complex.

F. Findings:

F.1. Brief description of the Site:

The Savar Upazila Health Complex is situated 24 km (15 mi) northwest of Dhaka city. It operates 24 hours and 7 days a week. It is a 50-bed primary healthcare facility which serves a population of 1.386 million. The UHC provides primary healthcare including dengue management and the basic equipment required to care for the dengue patients.

F.2. Qualitative Study, Key Informant Interviews (KII):

12 key personnel were interviewed to gain a comprehensive understanding of the healthcare delivery system and the challenges they face in managing dengue cases. The interviews spanned multiple healthcare professionals (as shown in Table-1), reflecting the diversity of roles involved in the health complex's operations.

Table 1: Socio-demographic characteristics of Key Informant Interviewees

(Healthcare providers- doctors, nurses, administrative staff, Upazila Health & Family Planning Officers, medical officers)

Code	Age	Gender	Designation
KII 1	44	Male	Medical Officer
KII 2	40	Male	Medical Officer
KII 3	30+	Male	Office Assistant
KII 4	57	Male	Administrative Officer
KII 5	27	Female	Senior Staff Nurse (SSN)
KII 6	52	Female	Senior Staff member
KII 7	52	Female	Senior Staff Nurse (SSN)
KII 8	58	Female	Senior Staff Nurse (SSN)

KII 9	43	Male	Senior Medical Officer (Facility Head)
KII 10	57	Male	Health Inspector
KII 11	42	Male	Medical Officer
KII 12	55	Female	Senior Nurse

F.3. Observation Checklist and Supply Chain Mapping:

A 10-12 minute discussion was held with the office assistants, lab technician, and storekeeper to cross-check the observational checklist findings and to address issues related to the supply chain management.

Table-2: Supply Chain Mapping Exercise

Category	Findings
Resource Flow	Critical supplies (medicines, diagnostic kits, PPE) sourced from government-approved suppliers.
	Delivered through a centralized distribution network managed by the DGHS, with frequent delays.
	Limited-capacity stockrooms at the health complex with inadequate storage conditions (e.g., lack of temperature control) is an important challenge.
Key Stakeholders	Central Health Authorities: Responsible for procurement and initial distribution. Detailed information was not provided.
	Healthcare Staff: Reported frequent stockouts and inadequate supplies during peak dengue outbreaks.
Challenges Identified	Stockouts and Delays: Critical items such as diagnostic kits were frequently unavailable during the month of November and were also observed on data collection day.
	Inadequate Storage Facilities: Lack of proper storage conditions was seen, a possibility of potential degradation of supplies.
	Stock Management: Lack of real-time inventory tracking systems was noticeable.
	Emergency Stock Availability: Insufficient funding and no time management for emergency procurement during outbreaks.

Recommendations	Improved Inventory Systems: Implement digital tracking to monitor stock levels and predict shortages.
	Capacity Building: Train staff in efficient supply chain management practices.

F.4. Thematic Analysis:

F.4.1. Facility Infrastructure Resources: During the observation of bed capacity for quantitative data, it was noted that the facility had a sufficient total of 50 beds available for all patients, including those diagnosed with dengue. However, it was observed that adequate beds were not available for dengue patients (Figure-1). As a result, in cases of overcrowding, the area outside the ward was prioritized for patient placement, which highlights a gap in the proper allocation of resources for critical care.

"*Yes, this is a 50-bed hospital, but during the dengue peak season, the number of patients, including non-dengue patients, exceeds capacity. In such situations, patients are either accommodated on the floor or with extra beds due to infrastructural limitations"*

(KII 5, Female, Senior Staff Nurse).

There were no isolation facilities for dengue patients, however separate wards (2) for male and female dengue patients were available but it was not adequate (Figure-1). Additionally, the absence of specialized wards, such as those dedicated to infectious diseases like dengue, exacerbates the problem. Without proper isolation areas, patients were treated alongside those with other health conditions, increasing the risk of cross-contamination.

"*We don't face isolation issues in the ward; patients continue to come in for treatment*"

(KII 7, Female, Senior Staff Nurse).

Observation revealed that a functioning ambulance was available for patient transport; however, it was neither suitable for dengue patients nor sufficient for the facility's needs (Figure-1). While talking with the storekeeper during observation, it was informed that only 1 cold chain equipment (refrigerator) was functioning for the storage of some of the medicines and EPI vaccines (Figure-1).

During observation for sanitation and cleanliness of the facility, there is a person dedicated who comes twice a year to maintain waste disposal and mosquito control measures, but it is not adequate (Figure-1). The facility head of Savar UHC stated,

"*We are unsure of the exact timing of the dengue season, as it is now a year-round concern. During the rainy season, when cases tend to rise, we take responsibility for mosquito control by conducting spraying, ensuring cleanliness, and sending notifications to the municipality, unions, and all relevant areas to encourage sanitation efforts. We also coordinate the cleaning of drains and implement all necessary measures*" (KII 9, Male, Senior Medical Officer).

This quote highlights proactive dengue management efforts in response to its year-round prevalence. Healthcare providers maintain a constant supply of medicines to ensure readiness. During the rainy season, when cases typically increase, they implement preventive measures, including mosquito spraying, drain cleaning, and sanitation drives. Community engagement is emphasized through notifications to municipalities, unions, and local areas, fostering collective responsibility for environmental hygiene. These actions demonstrate a comprehensive approach linking resource preparedness, public health strategies, and environmental management. However, reliance on self-directed efforts, such as conducting spraying themselves, indicates gaps in systemic support, underscoring the need for stronger institutional coordination.

F.4.2. Human Resources: Qualified doctors were observed to be present and actively managing dengue patients. However, the high patient load was evident, with a noticeable shortage of doctors, leading to increased pressure on the available medical staff. This shortage of medical personnel has resulted in challenges in providing timely and comprehensive care to all patients. Healthcare providers echoed the observation that the number of doctors was insufficient to handle the growing demand.

"It would be better with more staff. There are enough for 50 beds, but for extra patients, more staff are needed. It would be better if the system were developed further" (KII 6, Female, Senior Staff member).

The nurse-to-patient ratio was inadequate, with many nurses responsible for managing multiple patients at once, which compromised the quality of care. Nurses were available to look over the dengue patients but there were no health assistants to manage the dengue cases. The lack of male nurses indicates that sufficient nursing staff is a major issue at the health complex. Nurses reported that while they manage the daily tasks, the absence of health assistants and the insufficient number of nursing staff, particularly male nurses, poses a challenge.

"*We have a shortage of nurses. We really need more nurses here as we struggle to manage. We provide as much care as possible within our numbers. The nurses we have are assigned to*

different areas of the hospital, some go to the vaccination center, two nurses are at the vaccination center, two more are assigned to the ICU, and so on. When interns come in from different areas, we do get some help" (KII 8, Female, Senior Staff Nurse).

From qualitative interviews it was seen that training plays a pivotal role in enhancing the capacity of healthcare providers, particularly doctors and nurses, to manage dengue cases effectively. Some of the healthcare professionals reported that they did not have the opportunity to attend training; however, a couple of healthcare providers got the chance to attend Dengue case management training, and they have the protocol available. A doctor mentioned that they had participated in seminar-style training, which functions as a workshop specifically for doctors.

"*I have not received any separate training. We conduct workshops within our team. There is no specific external training. Here at UHC, the experts in respective fields conduct seminars, and when the dengue season starts, we discuss these topics. We have a national guideline, and we follow it. Training means, we read the National Guidelines ourselves, discuss among ourselves, and hold various seminars here. There have been multiple seminars on dengue, where experts in the field share their knowledge with everyone. We essentially train ourselves in this manner. As staff, all the doctors attend the seminars here. And the nurses, who are present at UHC, execute the orders that we give*" (KII 1, Male, Medical Officer).

The response highlights the UHC's reliance on in-house training for dengue management, compensating for the lack of external programs. Staff conduct internal workshops and seminars, discussing topics guided by the National Guidelines. This self-directed approach fosters collaboration and peer learning but may limit access to updated practices and expert-led instruction from outside sources. Doctors actively engage in discussions, while nurses primarily execute orders, indicating a clear role differentiation but minimal participatory opportunities for nursing staff. While this method demonstrates resourcefulness and adherence to national protocols, it underscores the need for structured external training to enhance preparedness and knowledge standardization.

The importance of training was highlighted by all the key informants.

"*If training could be given in phases, group by group, it would make dengue prevention easier*" (KII 3, Male, Office Assistant).

This statement shows the need for phased training for effective dengue prevention. By targeting smaller groups, the process becomes more manageable and ensures better understanding and implementation of preventive measures.

"*Training reactivates our stagnation. I may know something, but if I haven't used it for a long time, I forget it; everyone forgets it. It moves away from memory and even known things become unknown. If there is some training on this, those things come back to mind*" (KII 10, Male, Health Inspector).

During the observation and while taking observational notes, the availability of trained lab technicians for diagnostics was present but the lab manager indicated that there was a need to increase the workforce to meet the diagnostic demands, especially during peak dengue seasons.

F.4.3. Financial Resources: While taking observation notes, it was noticeable that there was always a shortage of supply of dengue kits and medicines (Figure-2). There was evidence of a timely procurement process for dengue supplies, but it was not adequate (Figure-2). A key informant at the UHC mentioned that,

"*The government doesn't provide much financial support here. Only some medicines and saline are provided; other medications have to be purchased by patients from outside*."

According to the facility head (KII 9, Male), "*As I mentioned earlier, if you review the budget, you will see that we are allocated a certain amount for dengue kits, medications, etc. If we analyze the gap, we can better manage our resources. There should be no major challenges. We just need to plan the budget, and the ministry will approve it. If they find the plan acceptable, they will review and justify it. Then, they will approve it. I don't foresee any significant barriers.*"

This statement emphasized the importance of strategic planning and resource gap analysis for effective dengue management. With a well-justified budget plan and necessary adjustments, challenges against dengue management could be reduced.

F.4.4. Medical Supplies, Medicines, and Equipment: While assessing through the observation checklist (Table-3), it was found that there was an adequate amount of IV fluids for dengue treatment and paracetamol (as per treatment protocols) but there was a need for zinc tablets. During the time of data collection, shortages of dengue-specific IgM/IgG rapid tests and NS1 antigen diagnostic kits were noticeable (Table-3). According to a Key Informant,

"*Medicines are generally available, though there can be occasional shortages. However, the main issue lies with diagnostic kits, as dengue tests are currently unavailable*"

(KII 5, Female, Senior Staff Nurse).

This reveals key resource challenges in dengue management. While medicines are generally available, occasional shortages indicate potential gaps in the supply chain that could hinder treatment delivery. The unavailability of diagnostic kits presents a more critical issue, as it directly impacts the facility's ability to confirm dengue cases accurately and promptly. This limitation can lead to delays in treatment, misdiagnoses, and reliance on clinical judgment alone, potentially compromising patient outcomes. The data highlights the need for improved procurement systems and consistent availability of diagnostic tools to enhance the facility's diagnostic capacity and overall dengue response effectiveness.

Another Key Informant reported,

"*Shortage happens when there is a high patient load; otherwise, our supplies are sufficient. When the patient load is high, supplies run out faster*" (KII 7, Female, Senior Staff Nurse).

This reflects the impact of fluctuating patient loads on supply chain management in healthcare facilities. While regular supply levels are sufficient under normal circumstances, high patient loads strain resources, leading to shortages. It highlights the challenge of predicting demand and maintaining an adequate buffer stock during peak periods, such as disease outbreaks. The reliance on reactive management suggests potential gaps in forecasting and procurement planning. Addressing these issues requires improved inventory systems, demand forecasting, and contingency planning to ensure consistent availability of supplies, particularly during high-demand periods, to prevent disruptions in patient care.

The availability of PPE, including gloves, masks, and gowns, was found to be inadequate during observation (Table-3). The availability of mosquito nets in patient wards was notably sufficient (Table-3). Mosquito repellents, such as sprays and creams, were not consistently available in patient care areas (Table-3). The health complex did not have a regular supply of repellents to protect both patients and staff from mosquito bites during treatment and observation periods.

According to a Key Informant,

"*We have PPE. We don't wear them now, but we did during the COVID-19 period. It's not necessary for dengue. Some people use masks*" (KII 8, Female, Senior Staff Nurse).

The statement reflects a perception among healthcare staff that Personal Protective Equipment (PPE) is unnecessary for dengue management, contrasting its essential role during the COVID-19 period. This viewpoint may stem from a limited understanding of dengue

transmission risks or prioritization of PPE use for direct-contact diseases. While acknowledging occasional mask usage, the lack of consistent protective measures could expose staff to other infections and undermine overall safety protocols. The response highlights a potential gap in training or guidelines emphasizing the importance of PPE as part of a broader infection control strategy in managing various communicable diseases, including dengue.

Table-3: Medical Supplies, Medicines, and Equipment

Item	Criteria	Available	Adequate
4.1 Intravenous Fluids	Availability of IV fluids for dengue treatment	Yes	Yes
4.2 Paracetamol	Availability of paracetamol (as per treatment protocols)	Yes	Yes
4.3 Dengue Rapid Test Kits	Availability of dengue-specific IgM/IgG rapid tests	No	No
4.4 NS1 Antigen Test Kits	Availability of dengue NS1 antigen diagnostic kits	No	No
4.5 Personal Protective Equipment (PPE)	Adequate PPE for staff treating dengue patients	No	No
4.6 Mosquito Nets	Availability of mosquito nets for dengue patients	Yes	Yes
4.7 Insect Repellents / Sprays	Availability of repellents or insecticides for dengue prevention	No	No

F.4.5. Supply Chain and Procurement Efficiency: According to the observation checklist, there was evidence of the timely arrival of essential dengue supplies but it was done manually through a registry. There was no stock management or the existence of an inventory system for stock tracking. The emergency stock availability was non-existent and there was no timely reserve stock of supplies for outbreak periods. The presence of efficient communication with suppliers for urgent needs was available but inadequate.

"*When the government has sufficient stock, they send supplies here. We only submit our requirements; if the government doesn't have stock, neither they nor we can do anything. In such cases, the cost of treatment for patients increases, and they have to bear the expenses themselves. In our economically disadvantaged country, this creates difficulties for patients. For dengue, we*

have to perform platelet counts daily, which also involves additional testing costs" (KII 4, Male, Administrative Officer).

The health facility's ability to receive supplies is conditional upon the government's stock availability. If the government does not have sufficient stock, the health facility cannot fulfill its requirements, creating a bottleneck in the supply chain. This dependence highlights a critical weakness: the health complex has limited alternatives or flexibility to secure the necessary resources independently. When the government cannot meet supply demands, the health facility is left without the necessary resources to treat patients. Specifically, the quote above stated platelet counts as a critical diagnostic test for dengue, which involves daily testing. The shortage of diagnostic tools or supplies could delay diagnosis and treatment, negatively impacting patient outcomes.

"*The supply chain is not functioning here because there is a shortage of resources*" (KII 4, Male, Administrative Officer).

The fact that all supplies come from the government implies reliance on public procurement systems and a standardized process for supply distribution. The government manages the procurement, logistics, and allocation of resources, which may ensure a uniform and consistent supply across health facilities in the region. However, it may also indicate bureaucratic delays or rigidity in the system if the government processes are slow or inefficient, which can cause delays in the arrival of critical supplies.

"*Supplies are provided by the Civil Surgeon's Office. Everything comes from the government, through a systematic process. The government sends them to the Civil Surgeon's Office, and then our storekeeper stores them. We collect these supplies from the storekeeper and distribute them to patients. The responsible person, in-charge, brings them. Not everyone is allowed to bring these supplies*" (KII 7, Female, Senior Staff Nurse).

The coordination of patients flowing from the ticket counter to the dengue corner is a key component of the supply chain for patient care. This smooth transition helps avoid delays in diagnosis and treatment. It implies that there is a well-defined pathway for patients suspected of having dengue, which is critical for timely medical interventions.

"*Our supply chain is well-coordinated. Patients are referred from the ticket counter to the dengue corner for tests. If any patient needs emergency admission, they are admitted. Regular*

tests like CBC are done, and any patient whose condition deteriorates is referred. The process runs smoothly" (KII 9, Male, Facility Head).

This qualitative data reflects an organized and systematic approach to dengue management within the facility. The well-coordinated supply chain ensures patients are efficiently referred from registration to the dengue corner for necessary tests like CBC. The inclusion of an emergency admission process indicates preparedness to address severe cases promptly. Smooth operations and patient referrals suggest effective workflow management and communication among staff. However, the narrative focuses on process efficiency and lacks details about potential challenges, such as resource constraints or delays. Future analysis could explore patients' and staff's perspectives to assess the system's responsiveness and identify areas for improvement.

F.4.6. Impact on Patient Care: By rationing medications during shortages, hospital staff ensures that all patients receive some level of care, demonstrating a commitment to equitable treatment. However, this adaptation may compromise the quality of care, as insufficient doses can affect treatment efficacy, particularly for severe dengue cases. The assertion suggests a perception of maintaining service continuity, despite potential challenges. This response highlights resilience but underscores the need for a robust supply chain to ensure consistent access to essential medications, minimizing compromises in patient outcomes.When asked about treatment delay, a key informant replied,

"*There is no gap in care*" (KII 2, Male, Medical Officer).

Due to the unavailability of affordable diagnostic tests, patients with suggestive symptoms often miss out on necessary diagnostics, preventing confirmation of their condition. This lack of access discourages them from seeking further treatment, potentially worsening health outcomes and delaying care. A key informant stated,

"*For instance, regarding test kits: even when a patient shows suggestive symptoms of dengue, since we can't conduct the government-prescribed dengue tests at reasonable fees, patients miss out on this diagnostic service. This also discourages them from seeking further treatment due to the lack of dengue confirmation*" (KII 11, Male, Medical Officer).

As the coordination of the supply chain was not appropriate, there was a delay in the care of dengue patients. Due to constraints, patients showing slight improvements were discharged prematurely, even when extended hospitalization might be beneficial for full recovery. This

practice reflected a compromise between resource availability and patient care, highlighting the strain on healthcare facilities.

"*Yes, this happens. Due to resource limitations, patients who are in a better condition are discharged early. Ideally, they could have stayed for a couple more days, but due to constraints, they are released early, hoping they'll recover at home*" (KII 7, Female, Senior Staff Nurse).

Without diagnostic confirmation, adherence to treatment protocols decreases, leading to gaps in patient care. Patients who remain unaware of their dengue status due to limited testing were more likely to return home and potentially contribute to the disease's spread. This situation exacerbated challenges in both treatment and disease control, underscoring the need for adequate resources to improve diagnostic capacity and containment efforts.

"*Resource limitations, such as the test kit shortage, impact care quality because without confirming the diagnosis through tests, adherence to treatment protocols diminishes. If a patient doesn't know they have dengue due to the lack of testing, they may return home and unintentionally spread the disease to others. Treatment and disease control become much harder under these circumstances*" (KII 11, Male, Medical Officer).

Critical challenges in accommodating dengue patients due to overcrowding in healthcare facilities were revealed. Despite utilizing floor spaces for patient care, there were instances when even this option became insufficient.

"*Yes, exactly. Sometimes there is no space on the floor either, so we have to send the patients to other hospitals*" (KII 1, Male, Medical Officer).

The facility had a policy of ensuring patients were discharged only when fully recovered, reflecting a commitment to patient care and safety. However, it acknowledged instances where patients, due to personal preferences or the hassle of hospitalization, chose to leave before full recovery. In such cases, the facility mitigates liability by documenting the patient's decision. This practice balanced the hospital's duty of care with respect for patients' autonomy, allowing voluntary discharge under clear documentation.

"*Patients are not discharged unless they are fully recovered. Sometimes, due to the hassle, patients want to leave as soon as they feel a bit better. In such cases, they are discharged at their own risk, or a GOR (Going on Record) is written for them. Yes, after follow-up, if someone wants to leave voluntarily, they are allowed to do so*" (KII 8, Female, Senior staff nurse).

F.4.7. Recommendations from Healthcare Providers: The recommendations from healthcare providers of Savar UHC often focused on enhancing patient care, optimizing processes, and ensuring sustainability in resource use.

"*One major improvement would be to provide more training or orientation on the national guidelines for those directly involved in dengue management, such as doctors, nurses, and staff. Additionally, ensuring a consistent supply of IV fluids and dengue test kits would greatly enhance service quality*" (KII 11, Male, Medical Officer).

The key informant underscored the multifaceted and escalating nature of the dengue crisis, emphasizing that it is not limited to hospitals or doctors but involves city corporations and national authorities. Despite its widespread prevalence and consistent detection during testing, many cases remain unreported, undiagnosed, or untreated, reflecting gaps in the healthcare response. Another key informant highlighted a lack of adequate national-level focus and initiatives, despite some media attention, which exacerbates the risk to the entire population. Addressing this crisis required integrated efforts and significant attention to mosquito control strategies to reduce its impact effectively.

"*Changes can be made to the policy. This is an integrated issue, and it's not just about doctors or hospitals alone. The city corporation and the national level are also involved. Many cases are not being reported, many are not being diagnosed, and some are not even coming for treatment*" (KII 1, Male, Medical Officer).

G. Discussion:

Findings indicated that the Savar UHC had enough bed capacity according to government rules, but was overcrowded, especially during the peak dengue season, when patients were accommodated on the floor. Shortages of isolation facilities and diagnostic kits for dengue and medical personnel, mostly nurses and health assistants, were visible. Additionally, inadequate and inconsistent supplies of personal protective equipment (PPE) and mosquito control resources, like sprays and repellents, added to these issues. Fundamentally, the resources to manage dengue were insufficient—relying on the patients themselves to source any necessary medications from the outside. Another issue we noticed was the inefficiency of the supply chain and procurement systems, all subject to dependence on government stocks, and resulting only in delays with essential supplies arriving at the facility.

The evaluation of dengue management at the Savar Upazila Health Complex reveals several critical areas that influence the effectiveness of care delivery. The integration of both observation checklists and key informant interviews has highlighted key strengths, such as the dedication of staff and the availability of essential resources like intravenous fluids and mosquito nets. However, significant challenges persist, particularly in infrastructure, staffing, training, and supply chain management. Overcrowding is often aggravated by limited bed capacity and poor isolation facilities while inadequate isolation facilities, and shortage of medical supplies, especially diagnostic kits, delay care. The facility suffers from staff shortages (particularly nurses), and lacks training on updated clinical guidelines specializing in dengue. And these are compounded by a lack of financial funds and a poor supply chain that makes it hard for the facility to keep up with the rising demand for care during peak times. Improved resource allocation, better training programs and more efficient procurement and supply chain systems could help to address these gaps to increase the UHC's capacity to deal with dengue cases.

The findings of this study align closely with research conducted in other low- and middle-income countries (LMICs), where healthcare systems often face similar challenges in managing dengue outbreaks. A comparison with literature from various countries offers valuable insights into the universal nature of these challenges and how different contexts might influence the implementation of dengue management strategies. The issue of overcrowding and insufficient infrastructure during peak dengue seasons is not unique to Bangladesh. Overcrowding in health facilities during peak dengue seasons is a common problem in dengue-endemic countries. A study in Pakistan found that during the peak of the 2017 dengue outbreak, hospitals in urban areas experienced severe overcrowding, similar to the situation observed at Savar Upazila Health Complex (Awan et al., 2022). Another study noted that overcrowding led to the allocation of inadequate space for patients, affecting care delivery and contributing to the spread of infections within the hospital (Sartini et al., 2022). In the case of Savar, patients were observed being accommodated on the floor, a direct result of limited bed space, which is consistent with the findings. Overcrowded dengue wards during outbreaks resulted in suboptimal patient care and increased the risk of hospital-acquired infections (Ehelepola & Wijesinghe, 2018). These studies highlight that overcrowding exacerbates the strain on healthcare facilities and emphasizes the need for better infrastructure and patient management strategies.

In many LMICs, the shortage of diagnostic tools and medical supplies, such as dengue rapid diagnostic tests (RDTs) and appropriate medications, is a persistent challenge during dengue outbreaks. Similar issues were reported in Nepal, where they found that during the 2017 dengue outbreak, several hospitals lacked sufficient RDTs for early diagnosis of dengue, which delayed treatment and contributed to complications (Dumre et al., 2017). In line with this, the study at Savar found a shortage of diagnostic kits, with reliance on government stocks that were often delayed. Inadequate diagnostic capacity was a common issue in many government-run hospitals, leading to delayed interventions and poor patient outcomes. The lack of timely diagnostic tools also exacerbates the difficulty of monitoring disease progression and makes it challenging to manage the outbreak effectively (Meyer et al., 2021). This issue is particularly critical in rural areas, where access to diagnostic tools is often limited, as seen in the case of Savar.

The shortage of skilled healthcare workers, especially nurses and health assistants, during dengue outbreaks has been documented. In Malaysia, it was found that the healthcare system was overwhelmed due to a shortage of nurses during the 2015 dengue outbreak. The lack of skilled staff directly impacted the quality of care provided, as nurses were unable to manage the increasing patient load, leading to delays in administering treatment and monitoring patients (Chem et al., 2024). Similarly, at Savar, the study found a shortage of nurses and health assistants, contributing to the strain on existing healthcare staff. This shortage is not unique to Bangladesh; a study by Rehan et al., (2022) reported that healthcare workers were overburdened during the dengue peak season, which led to burnout and compromised patient care. These findings underscore the importance of ensuring adequate staffing levels and offering training to healthcare workers to handle seasonal disease outbreaks more effectively.

Inefficient supply chains are a common challenge in many LMICs, particularly during public health emergencies like dengue outbreaks. A study in the Philippines by Interior et al. (2024) noted that the country's dengue response was hampered by delays in the procurement and delivery of essential supplies, including medical equipment and medicines. This delay in the supply chain was also a significant issue at Savar, where supplies were often delayed, and there were shortages in the availability of essential resources like PPE and mosquito control measures. The inefficiency of the procurement system was identified as a major barrier to timely treatment in other countries as well. For example, in Indonesia, a study by Iskandar & Arifin (2023)

showed that logistical challenges in the supply chain caused delays in distributing essential supplies like IV fluids and medications, which are critical during the management of dengue shock syndrome. Both the Philippine and Indonesian cases highlight how a lack of coordination between central and regional authorities and logistical inefficiencies can worsen the impact of an outbreak.

Financial constraints, both at the institutional and patient level, are a major issue in many dengue-endemic countries. The study at Savar found that financial limitations led to patients being required to purchase medicines from external sources, which can delay treatment and impose a significant financial burden on families. This finding is consistent with a study by Zúniga-Gutiérrez et al. (2024) in Honduras, where they reported that inadequate government funding for dengue management resulted in patients paying for medications and treatments, leading to inequities in access to care. Similarly, in a study by Rodriguez et al. (2015) in Colombia, it was found that financial constraints in public hospitals during dengue outbreaks led to a delay in treatment, as patients struggled to afford medications and diagnostic tests. In these contexts, it is clear that government funding must be increased to ensure that essential healthcare services, including medications and diagnostic tools, are accessible to all patients during outbreaks.

The healthcare infrastructure at Savar Upazila Health Complex needs to be improved immediately. This will help to reduce overcrowding and make the environment better for patient care, by expanding ward space, improving bed availability, and being able to provide better patient management systems during the peak dengue seasons. These can further help reduce the risk of developing hospital acquired infections by developing isolation wards for the suspected cases and by strictly ensuring better physical distancing. The design of a more robust, responsive and locally responsive procurement system should evolve, regularly audited and coordinated between the local, regional and central government levels for medical supplies. In terms of policy, the government should increase funding to make sure dengue care is free or affordable at all for their patients, especially in public health facilities. Further research is needed on how well the proposed interventions improve dengue management.

G.1. Limitations:

There are some limitations to this study. The data were collected from a single Upazila Health Complex, and may not be representative of the hurdles experienced by other Upazila

Health Complexes in Bangladesh. Key informant interviews depend heavily on the reliability of the information provided, which may be influenced by personal biases or limited to individual experiences rather than reflecting a comprehensive view of the facility's operations. In addition, patient perspectives, which could provide important information about the obstacles that patients experience in accessing care were not considered either. The study also did not measure the long-term impact of the issues that were identified on patient outcomes, which can be explored in future studies.

H. Conclusion:

Challenges in resource and supply chain management, inadequate infrastructure, staffing shortages and inefficiencies in procurement systems hinder efficient management of dengue at the Savar Upazila Health Complex according to this research. These findings are in line with other studies conducted in LMICs. Overcrowding, lack of medical supplies, lack of diagnostic capacity and cuts in beds and staff all had a direct impact on the quality of patients' care and were compounded by financial constraints which made matters worse for both patients and providers. These findings highlight the need for immediate actions to address these challenges to enhance the capacity of the healthcare system for effective dengue case management.

H.1. Policy Implications:

Improved dengue management in Bangladesh requires policy changes. The results suggest that there is a need for a comprehensive national dengue management policy with clear guidelines on resource allocation, staffing, infrastructural development, and public health interventions. Furthermore, intersectoral coordination between the three sectors, i.e. health, local government and disaster management, must take place to optimally respond to dengue outbreaks. To achieve sustained efforts in times of no outbreak, the funds available for dengue response should increase and dengue management integrated into broader public health preparedness frameworks.

I. References

Alam, H. (2024, October 24). *Dengue outbreak 2024: Oct deadliest month so far.* The Daily Star. https://www.thedailystar.net/news/bangladesh/news/dengue-outbreak-2024-oct-deadliest-month-so-far-3734986

Alam, H & Mollah, S.. (2024, October 11). *Unclean hospital premises escalate risk for patients.* The Daily Star. https://www.thedailystar.net/news/bangladesh/news/unclean-hospital-premises-escalate-risk-patients-3725026

Alam, H & Mollah, S.. (2021, August 28). *Surge in Dengue Cases: Dedicated hospitals still not ready.* The Daily Star. https://www.thedailystar.net/health/disease/news/surge-dengue-cases-dedicated-hospitals-still-not-ready-2162716

Ali, N. (2023). The recent burden of dengue infection in Bangladesh: A serious public health issue. Journal of Infection and Public Health, 17(2), 226–228. https://doi.org/10.1016/j.jiph.2023.12.003

Anesi, G. L., & Kerlin, M. P. (2021). The impact of resource limitations on care delivery and outcomes: routine variation, the coronavirus disease 2019 pandemic, and persistent shortage. Current opinion in critical care, 27(5), 513–519. https://doi.org/10.1097/MCC.0000000000000859

Aryaprema, V. S., & Xue, R. D. (2019). Breteau index as a promising early warning signal for dengue fever outbreaks in the Colombo District, Sri Lanka. Acta tropica, 199, 105155. https://doi.org/10.1016/j.actatropica.2019.105155

Awan, N. J., Chaudhry, A., Hussain, Z., Baig, Z. I., Baig, M. A., Asghar, R. J., Khader, Y., & Ikram, A. (2022). Risk Factors of Dengue Fever in Urban Areas of Rawalpindi District in Pakistan During 2017: A Case Control Study. JMIR public health and surveillance, 8(1), e27270. https://doi.org/10.2196/27270

Cavalcante, A.C.P., de Olinda, R.A., Gomes, A. et al. Spatial modelling of the infestation indices of Aedes aegypti: an innovative strategy for vector control actions in developing countries. Parasites Vectors 13, 197 (2020). https://doi.org/10.1186/s13071-020-04070-w

Castro Rodriguez, R., Galera-Gelvez, K., López Yescas, J. G., & Rueda-Gallardo, J. A. (2015). Costs of dengue to the health system and individuals in Colombia from 2010 to 2012. The American journal of tropical medicine and hygiene, 92(4), 709–714. https://doi.org/10.4269/ajtmh.14-0386

Chem, Y. K., Yenamandra, S. P., Chong, C. K., Mudin, R. N., Wan, M. K., Tajudin, N., Abu Bakar, R. S., Yamin, M. A., Yahya, R., Chang, C. C., Koo, C., Ng, L. C., & Hapuarachchi, H. C. (2024). Molecular epidemiology of dengue in Malaysia: 2015-2021. Frontiers in genetics, 15, 1368843. https://doi.org/10.3389/fgene.2024.1368843

Dumre, S. P., Bhandari, R., Shakya, G., Shrestha, S. K., Cherif, M. S., Ghimire, P., Klungthong, C., Yoon, I. K., Hirayama, K., Na-Bangchang, K., & Fernandez, S. (2017). Dengue Virus Serotypes 1 and 2 Responsible for Major Dengue Outbreaks in Nepal: Clinical, Laboratory, and Epidemiological Features. The American journal of tropical medicine and hygiene, 97(4), 1062–1069. https://doi.org/10.4269/ajtmh.17-0221

Ehelepola, N. D. B., & Wijesinghe, W. M. C. M. (2018). An Analysis of a Dengue Outbreak at a Large Hospital and Epidemiological Evidence for Nosocomial Dengue. Journal of tropical medicine, 2018, 9579086. https://doi.org/10.1155/2018/9579086

Hasan, M. N., Khalil, I., Chowdhury, M. A. B., Rahman, M., Asaduzzaman, M., Billah, M., Banu, L. A., Alam, M. U., Ahsan, A., Traore, T., Uddin, M. J., Galizi, R., Russo, I., Zumla, A., & Haider, N. (2024). Two decades of endemic dengue in Bangladesh (2000-2022): trends, seasonality, and impact of temperature and rainfall patterns on transmission dynamics. Journal of medical entomology, 61(2), 345–353. https://doi.org/10.1093/jme/tjae001

Interior, J. S., Bigay, K. J. J., Iringan, R. A. A., & Tanco, M. B. F. (2024). Resurgence of dengue in the Philippines. World journal of virology, 13(3), 99179. https://doi.org/10.5501/wjv.v13.i3.99179

Iskandar, Tedy & Arifin, Ridwan. (2023). NAVIGATING INDONESIA'S LOGISTICS AND SUPPLY CHAIN CHALLENGES: A DATA-DRIVEN ANALYSIS OF LOGISTICS PERFORMANCE INDEX. Jurnal BPPK: Badan Pendidikan dan Pelatihan Keuangan. 16. 110-123. http://dx.doi.org/10.48108/jurnalbppk.v16i1.820

Kabir, M. A., Zilouchian, H., Younas, M. A., & Asghar, W. (2021). Dengue Detection: Advances in Diagnostic Tools from Conventional Technology to Point of Care. Biosensors, 11(7), 206. https://doi.org/10.3390/bios11070206

Kapologwe, N. A., Meara, J. G., Kengia, J. T., Sonda, Y., Gwajima, D., Alidina, S., & Kalolo, A. (2020). Development and upgrading of public primary healthcare facilities with essential surgical services infrastructure: a strategy towards achieving universal health coverage in Tanzania. BMC health services research, 20(1), 218. https://doi.org/10.1186/s12913-020-5057-2

Khan, S., Akbar, S. M. F., Mahtab, M. A., Yahiro, T., Hashimoto, T., Kimitsuki, K., & Nishizono, A. (2024). Bangladesh records persistently increased number of dengue deaths in recent years: Dissecting the shortcomings and means to resolve. IJID Regions, 12, 100395. https://doi.org/10.1016/j.ijregi.2024.100395

Knerer, G., Currie, C. S. M., & Brailsford, S. C. (2021). Reducing dengue fever cases at the lowest budget: a constrained optimization approach applied to Thailand. BMC public health, 21(1), 807. https://doi.org/10.1186/s12889-021-10747-3

Maluleke, K., Musekiwa, A., Kgarosi, K., Gregor, E. M., Dlangalala, T., Nkambule, S., &

Mashamba-Thompson, T. (2021). A Scoping Review of Supply Chain Management Systems for Point of Care Diagnostic Services: Optimising COVID-19 Testing Capacity in Resource-Limited Settings. Diagnostics (Basel, Switzerland), 11(12), 2299. https://doi.org/10.3390/diagnostics11122299

Meyer, A. N. D., Giardina, T. D., Khawaja, L., & Singh, H. (2021). Patient and clinician experiences of uncertainty in the diagnostic process: Current understanding and future directions. Patient Education and Counseling, 104(11), 2606–2615. https://doi.org/10.1016/j.pec.2021.07.028

Nikookar, S. H., Moosazadeh, M., Fazeli-Dinan, M., Zaim, M., Sedaghat, M. M., & Enayati, A. (2023). Knowledge, attitude, and practice of healthcare workers regarding dengue fever in Mazandaran Province, northern Iran. Frontiers in public health, 11, 1129056. https://doi.org/10.3389/fpubh.2023.1129056

Rehan, S. T., Asghar, M. S., Ullah, I., Mahmood, H., Lee, K. Y., & Tahir, M. J. (2022). Dengue outbreak and fragile healthcare system: Doctors at the verge of mental and physical stress. Brain and behavior, 12(11), e2708. https://doi.org/10.1002/brb3.2708

Sarkar, S. R., & Ray, N. C. (2024). Dengue Fever: A Public Health Threat to Bangladesh. Community Based Medical Journal, 13(2), 282–289. https://doi.org/10.3329/cbmj.v13i2.75323

Sartini, M., Carbone, A., Demartini, A., Giribone, L., Oliva, M., Spagnolo, A. M., Cremonesi, P., Canale, F., & Cristina, M. L. (2022). Overcrowding in Emergency Department: Causes, Consequences, and Solutions-A Narrative Review. Healthcare (Basel, Switzerland), 10(9), 1625. https://doi.org/10.3390/healthcare10091625

Satapathy, Smritirekha. (2023). Observation as a tool for collecting data. https://www.researchgate.net/publication/371475537_Observation_as_a_tool_for_collecting_data

Tayal, A., Kabra, S. K., & Lodha, R. (2023). Management of Dengue: An Updated Review. Indian journal of pediatrics, 90(2), 168–177. https://doi.org/10.1007/s12098-022-04394-8

Verbeek, J. H., Rajamaki, B., Ijaz, S., Sauni, R., Toomey, E., Blackwood, B., Tikka, C., Ruotsalainen, J. H., & Kilinc Balci, F. S. (2020). Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff. The Cochrane database of systematic reviews, 5(5), CD011621. https://doi.org/10.1002/14651858.CD011621.pub5

World Health Organization. (2024). Vector-borne diseases. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases#:~:text=More%20than%203.9%20billion%20people,40%20000%20deaths%20every%20year.&text=Many%20of%20vector%2Dborne%20diseases,protective%20measures%20and%20community%20mobilization.

World Health Organization. (2019). Classifying health workers: Mapping occupations to the international standard classification.

https://cdn.who.int/media/docs/default-source/health-workforce/dek/classifying-health-workers.pdf

Zúniga-Gutiérrez, M., Meléndez, M., Montoya, S. S. R., Escobar, H. A. F., López, J., Paz, S., & Sauceda-Acosta, D. (2024). Dengue Burden and Factors Influencing Severity in Honduras: A Descriptive and Analytical Study. Revista da Sociedade Brasileira de Medicina Tropical, 57, e004072024. https://doi.org/10.1590/0037-8682-0594-2023

J. Annex:

Figure-1: Facility Infrastructure Resources

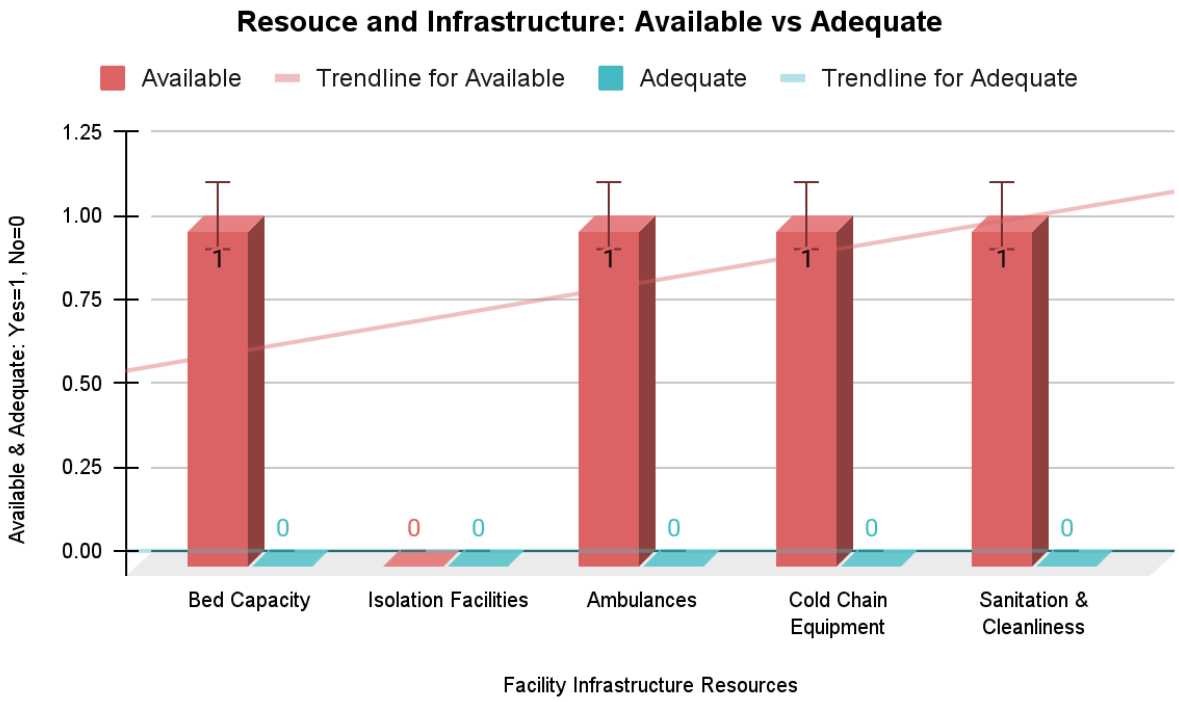


Figure-2: Financial Resources