SOCIAL TECH SUMMIT 2025

toward zeros

INNOVATING **HEALTHCARE,**
EMPOWERING **HUMANITY**

OCT
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2025

HIROSHIMA UNIVERSITY
HIROSHIMA, JAPAN (HYBRID)

Conference Tracks

Digital Health Platforms and Infrastructure:

- Cloud Computing in Healthcare
- Big Data Analytics for Health
- Interoperability and Standards
- Cybersecurity in Digital Health

Artificial Intelligence in Healthcare:

- Machine Learning for Disease Diagnosis
- Natural Language Processing in Healthcare
- Robotics and Automation in Medicine
- AI for Personalized Medicine

Wearable Technologies and Sensors:

- Remote Patient Monitoring
- Smart Wearable in Healthcare
- IoT Application in Health
- Sensor Technologies for Healthcare

Telemedicine and Virtual Healthcare:

- Telehealth Services and Solutions
- Virtual Reality in Medical Training
- Telemedicine Ethics and Regulations
- Remote Consultation and Diagnosis

Health Informatics and Data Management:

- Electronic Health Records (EHR)
- Data Privacy and Ethics
- Health Information Exchange
- Data-driven Decision Making in Healthcare

Sustainable Approach for Healthcare Service Delivery:

- SDG Progress and Challenges in Healthcare
- Social Business and Digital Health Entrepreneurship
- Healthcare Workforce Resilience
- Public Health, Policy, & Community Engagement

Oral Health:

- Oral Epidemiology
- Oral Health Promotion and Education
- Geriatric Dentistry
- Tele-dentistry and Dental Data Management

Overview	The **7th SocialTech Summit and International Conference on Healthcare, SDGs, and Social Business** will bring together professionals, academics, practitioners, and policymakers across multiple sectors to explore current innovations, issues, and prospects in social technology, healthcare, sustainable development goals (SDGs), and social business. This conference will act as a forum for presenting creative approaches, effective practices, and academic contributions within these areas, aiming to encourage social impact and meaningful transformation. Through keynote lectures, expert panels, workshops, and networking sessions, participants will gain exposure to new perspectives, methods, and tools that can contribute to solving urgent social and environmental challenges facing our world today, while also fostering collaboration, knowledge exchange, and collective action toward building a more sustainable and inclusive future.
Date	October 2-4 (Thursday, Friday, Saturday)
Time & Venue	8:30 to 18:30 JST Hiroshima University, Medical Campus (Koujin Kaikan, 1-2-3 Kasumi, Minami Ward, Hiroshima, 734-8551, Japan)
Types of Participants	Academicians, Researchers, Healthcare Professionals, Dental Professionals, Digital Health Entrepreneurs and Executives, Healthcare Policy Makers, Healthcare Activists, Social Entrepreneurs, Social Development Activists, Students, Youth Leaders, etc.
Sessions	This summit offers a wide variety of sessions centered on creative strategies in healthcare, sustainable growth, and the fusion of technology with social enterprise. The program features introductory remarks, specialist panel discussions, poster and paper presentations, and themed sessions examining issues like sustainable healthcare systems, the role of HealthTech in everyday lives, and digital health innovation. Attendees will also have chances to participate in hospital tours and connect with colleagues, while the concluding day highlights a plenary session, award presentations, and closing speeches. The event combines onsite and virtual participation, enabling broad sharing of perspectives and experiences among international experts, academics, and professionals committed to advancing knowledge and practice in these interconnected fields

Preface

It is my great pleasure to welcome you all to the proceedings of our conference on Disruptive Healthcare Technology to Achieve Sustainable Development Goal 3. As chair of this conference, I would like to extend my sincere gratitude to the organizers, participants, speakers, sponsors, committee members, and student volunteers from both Hiroshima and Kyushu University, whose contributions have made this event a success.

Over the past few days, we have had the privilege of exchanging ideas, presenting research findings, and learning from one another about the latest innovations and breakthroughs in healthcare technology. Together, we explored how disruptive technologies can address the challenges faced by healthcare systems worldwide and how these innovations can be harnessed to achieve SDG 3—ensuring good health and well-being for all.

This 6th edition of our conference has shown steady and meaningful growth, with participation increasing year by year. We look forward to welcoming an even larger audience in the future and trust that we will continue to have your support as we work together in the areas of healthcare, SDGs, and social business.

These proceedings include all the papers and posters presented at the conference. A total of 38 submissions were received. On average, each paper submitted for oral presentation was reviewed by more than three reviewers. Based on these evaluations, the committee accepted 6 papers for oral presentations and 32 for poster presentations.

I would like to sincerely thank the program committee members and reviewers for their careful evaluation of the submissions and for selecting the best papers and posters. Congratulations to all the recipients of the Best Paper and Best Poster awards. I hope this conference has provided valuable opportunities for the exchange of ideas, knowledge, and expertise. We look forward to welcoming you again next year.

Dr. Moshiur Rahman
General Chair

October 2, 2025
Hiroshima, Japan

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List of Presentations

1 Accepted for Paper Presentation

2 Accepted for Poster Presentation

Accepted Paper Presentations

Empowering Healthcare with Dynamic Control: A Strategic Framework for Personal Health Record Management

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***Abstract*—The management of personal health records (PHRs) has emerged as a critical issue amid increasing private sector involvement and government efforts to improve healthcare equity and efficiency. Current systems are constrained by limited consumer control and rigid, coarse-grained access policies. This paper introduces a novel system for PHR usage management, enabling fine-grained control, dynamic data mining, and user-driven data dissemination. By bundling health data with customizable, traceable usage policies, this framework addresses diverse stakeholder needs, from research institutions to healthcare providers, while ensuring user autonomy. Key scenarios, including data negotiation and aggregation for research purposes, demonstrate the system's potential to revolutionize health data accessibility and usage. Through robust architecture, dynamic policy evaluation, and secure management principles, this framework paves the way for advanced, user-centric healthcare solutions.**

I. Introduction

An unprecedented influx of public and private investments aimed at improving healthcare technology and delivery efficiency has resulted from recent healthcare legislation. One crucial area of focus within this domain is Personal Health Records (PHRs). Progress in this area has begun with existing platforms like Microsoft HealthVault and Google Health, both of which are no longer in operation. However, these systems impose significant limitations, including rudimentary control over personal medical data, restricted user authority over their information, and substantial barriers to data portability due to proprietary system dependencies [1]. In this study, A novel framework is presented to foster an open, user-centric methodology for managing health information. The system is built upon adaptable and granular usage management policies, along with an implemented prototype. Empowering individuals with control over personal health data is essential, and well-designed systems that fulfill this requirement are likely to experience widespread adoption [2]. To address this issue, a method is proposed for encapsulating medical records or their subsets with traceable, aggregated usage policies governed by users. These policies enable the selective sharing of health data with various entities, including research institutions conducting retrospective analyses and healthcare providers requiring specific diagnostic information.

The health data of multiple users can be dynamically aggregated using this system, adhering to the policies of each user. The system is able to diagnose the competing policies and offer suggestions for resolving them if there is a conflict in the usability of the combined dataset. The **primary research contribution** of this work lies in the *application* of usage management principles to the medical domain and the *demonstration* of their practical feasibility in a unified system architecture. Granular usage management for PHRs is emphasized, its advantages are shown, its design methodology is explained, and its practical application is evaluated in this paper. A system is proposed that enables precise control over the dissemination of information by allowing policies to be enforced at the data-element level rather than across the entire record. Two usage scenarios illustrate the capabilities of this system. The first scenario involves negotiations between entities over controlled access to health record components, where access is granted if mutually agreed terms are met. The second scenario integrates multiple health records into a dataset for research purposes, ensuring compliance with data licensing agreements. Additionally, the challenges of incorporating such aggregated datasets into a broader market are examined. This system enhances targeted healthcare delivery, ensures that providers can access necessary information, and improves data utilization for analytical purposes by facilitating user-controlled data access with flexible dissemination and reuse options. By applying established architectural principles from Internet-scale networks (cite:Al:04,BlCl:01,ClWrSoBr:02), the design balances logical data domain standardization with operational semantic standardization while minimizing interference with data-sharing policies.

A. Previous Work

Despite the evolving nature of automated PHR usage management, extensive literature exists in the domains of usage control, Digital Rights Management (DRM), and access regulation. To navigate the particular difficulties of PHR management, the framework incorporates insights from these fields. The DRM industry is the source of much of the pertinent research on combining multiple records into a single dataset. These approaches generally employ formal languages rooted in mathematical logic, enabling rule-based reasoning [3], [4], [5], [6], [7]. While effective in controlled settings, these methodologies falter in dynamic and open environments, necessitating interoperability solutions [8], [9], [10]. Unfortunately, most policy translation mechanisms are either impractical or infeasible [11], [12]. OMADRM,ODRL-req,Wa:04, and XrML-spec are alternative models that call

for the widespread adoption of expressive policy languages. However, such a strategy naturally restricts creativity and adaptability (cite HeJa:05,JaHe:04,JaHe:08,JaHeMa:06). Utilization management, on the other hand, outperforms traditional access control methods in this area because access control alone is not sufficient for comprehensive asset governance (cite PaSa:04, BL:73, BL:76). Recent studies applying DRM methodologies to healthcare records, particularly those emphasizing encryption-based data protection and controlled segmentation, complement the research and reinforce the framework's foundational principles [13].

II. Emerging Models

For years, engineers and futurists have speculated about the impact of Personal Health Records (PHRs) [14], [15]. citeEmr:doi:10.1056/NEJMc081118 Others have investigated the institutional applications of PHRs in today's regulated medical environment. When under personal control, health records are not governed by the Health Insurance Portability and Accountability Act (HIPAA); however, companies managing them on behalf of users are largely regulated under the Electronic Communications Privacy Act. These factors introduce certain requirements for robust health record systems, making usage models and data control increasingly complex. Without strong usage management, the full benefits and risks of PHRs cannot be realized. A dependable usage management framework opens new service horizons for interested adopters. Section Assurance of Reliability Healthcare providers must actively engage with PHRs in order for them to be effective. Medical professionals may disregard systems with inadequate auditing mechanisms or editability constraints. Ideally, PHRs should mirror the essential information found in patient charts, as healthcare providers are legally obligated to maintain accurate treatment records. However, patients lose credibility if they can alter these records at will. Employer-sponsored wellness programs may also incentivize employees to alter their medical records to meet predefined health targets. Programs like Virgin HealthMiles market their services to employers for monitoring employee health [16]. Some companies track employee exercise and offer health savings account contributions as incentives. Personal health management could soon be influenced by similar models, which would force employees to report artificially improved metrics like lower blood pressure or weight loss. If these pressures lead to falsification, healthcare providers will no longer trust PHRs as valid sources of medical data. Any system managing health records must, therefore, incorporate mechanisms to certify the integrity of stored information. While perfect accuracy cannot always be guaranteed, systems should at least verify the authenticity of data. Without having to look into edit histories, healthcare providers must be able to trust the information. This necessitates a role-based distinction between those with permission to control access to records and those with permission to modify records. Remote Access to Medical Data (subsection) A common requirement is remote access to medical records. Students are required to show proof that they have been immunized, and visitors from other countries frequently purchase travel insurance in case of an emergency. While internet access remains sporadic in some regions, its availability is expanding through global cellular networks, making digital record retrieval increasingly feasible. Open access to healthcare information can simplify these processes for users, provided strong usage management mechanisms are in place. Different stakeholders require selective access to specific portions of a PHR. For instance, school administrators need access to vaccination records but not psychiatric history. Similarly, visa officials may require immunization data but not genetic test results. By contrast, healthcare providers need comprehensive medical records to provide accurate treatment. Furthermore, access speed varies by situation; a school administrator can wait for verification, whereas an emergency physician requires immediate access. Permissions for access need not be set in stone. Administrators and foreign doctors could be granted temporary, role-based access that could be revoked when no longer required. Implementing this level of granularity in data control would save users time and stress while preserving privacy. Health Monitoring, Section Some employers have implemented preventative health programs to control healthcare costs. These initiatives aim to reduce medical expenses by encouraging screenings, exercise programs, and regular health monitoring. Employers typically focus on indicators like cholesterol levels, blood glucose, and blood pressure. Employee participation is often voluntary but incentivized through financial rewards, such as contributions to health savings accounts. Privacy concerns, on the other hand, arise from employees' perspectives. While they may wish to participate in these programs for financial benefits, they may also prefer to withhold certain medical details, such as mental health treatments or addiction recovery. Users are able to divide up access to their health records thanks to a robust usage management framework. Employees can selectively share relevant data with employers while safeguarding sensitive information. Also, historical health data could be compiled over time to show a pattern of responsible health management, which could make people more appealing to potential employers. Access controls that are safe and controlled by the user can keep personal information private and let people participate in programs that are good for their health.

A. Personalized Treatment

Thanks to centralized medical information, companies can create highly individualized treatments based on users' medical histories, drug reactions, and prescription status. Patients could immediately report adverse reactions to medications rather than waiting for an in-person consultation. This capability would enable pharmaceutical companies to offer tailored medication solutions, improving treatment efficacy and patient comfort. For example, Niacin is a common treatment for high cholesterol but frequently causes facial flushing [17]. This side effect can be reduced by taking aspirin 20 to 30 minutes before taking Niacin (cite Emr:Web: Niacin). If

pharmaceutical providers have access to this information, a patient experiencing this reaction could have their medication formulation adjusted accordingly. Strategies for individualized treatment have the potential to both improve outcomes and reduce healthcare costs. For pharmaceutical providers, a usage management system that controls who has access to data could provide individualized treatment options while safeguarding user privacy.

The system includes a Health Data marketplace where users and data brokers can monetize health data under mutually agreed-upon terms. The following sections describe the approach. Usage policies accompany filtered data for static or dynamic evaluation, ensuring compliance with user-defined conditions. These policies allow flexibility in defining how specific health data can be utilized, fostering a balance between accessibility and privacy control.

III. System Architecture

In order to guarantee accessibility, security, and usability, the system must incorporate particular architectural features. Effective usage management is an essential feature of this architecture, and it is a fundamental requirement. Section Key Characteristics and Requirements In order to guarantee functionality, effectiveness, and user acceptance, the outlined system must include a set of essential characteristics. These features support the system, but they do not guarantee its widespread adoption on their own. The primary requirements include:

- **Editability:** Specific fields in a health record should be editable only by authorized users. Record owners can change personal information, while medical professionals can update clinical data. Certain predefined roles may access fields that the owner cannot edit. For instance, a physician can append or alter medical data, while the owner can only modify contact details.
- **Role-Based Access:** The system should define verifiable roles that manage ownership of health record sections. Role verification can be done through credential uploads, professional registries, or direct provider validation. For example, only certified healthcare professionals should have access to modify sensitive medical records. Item Textbf Auditability: The system must keep a thorough audit log that records contributors, timestamps, and changes. Such a trail enhances trustworthiness and enables version control of records. Security: To safeguard sensitive data, modern security protocols must be utilized. Security breaches could reveal a person's medical history, which could lead to misuse or privacy violations.
- **Accessibility:** The system should support diverse platforms, including mobile, tablets, desktops, and programmatic access. Additionally, it must accommodate both human-readable and data-centric interfaces.
- **Performance:** The system must be responsive, ensuring smooth data entry and retrieval. Delays in accessing records, particularly in emergency scenarios, could reduce the system's usability.

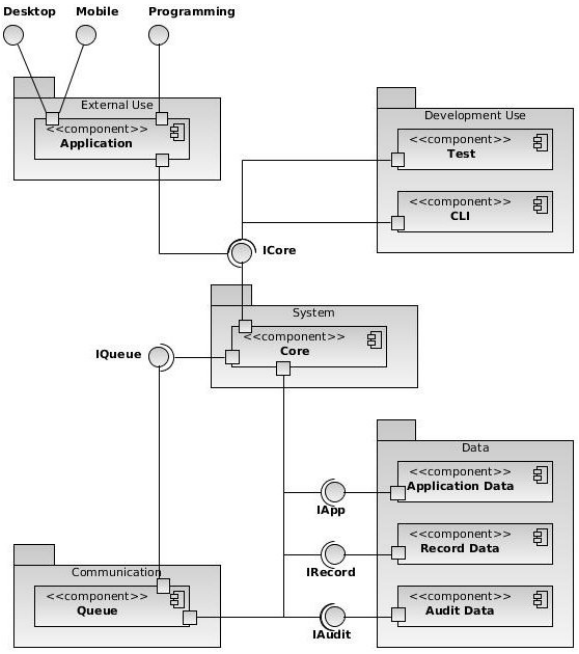

Fig. 1. System Architecture Runtime Component View

- **Flexibility:** The system must integrate with external platforms through standardized protocols such as REST APIs or SOAP-based communication. Extensibility: To ensure long-term viability, programmatic interfaces must permit seamless integration with unidentified future systems.

The system architecture must facilitate Personal Health Record (PHR) management, including secure storage, record creation, and updates. Although notifications and social media integrations may enhance user experience, they should be implemented through extensibility mechanisms rather than core functionalities.

A. Proposed System Architecture

A possible architecture that meets the requirements above is shown in Figure reffig:RuntimeView. Other technological frameworks can be used in place of the Ruby-based implementation that is used in the current system. The following parts make up the architecture:

- **External Interface:** This module includes mobile, desktop, and API-based access for end-users.
- **Development Tools:** Consists of backend access for system administrators, including command-line interfaces and automated testing frameworks.
- **Core System:** Contains business logic, policy management, and access control mechanisms.
- **Communication Layer:** Provides asynchronous data transmission, potentially leveraging message queues for efficient inter-module communication.
- **Data Storage:** Employs multiple databases to enhance security and storage flexibility.

Different parts can be made with different technologies. Ruby on Rails can be used to build the core system with

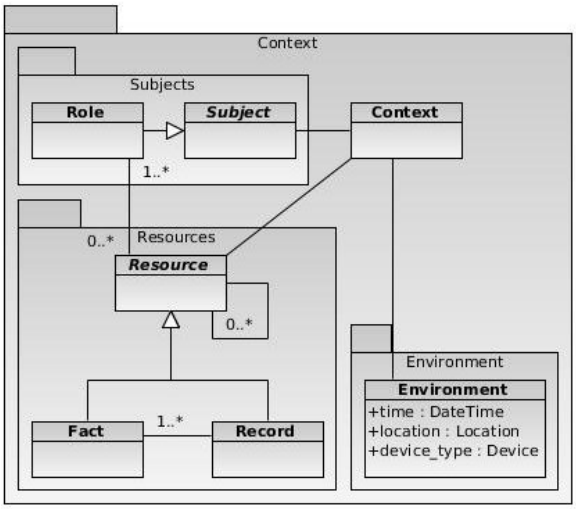

Fig. 2. System Usage Management Ontology

a PostgreSQL database, and Amazon SQS or Kafka can be used for queueing mechanisms. Through distributed data partitioning, the system guarantees high security.

B. Usage Management and Ontology

The system manages health records using a logical data model. The static entity relationships that govern record management are depicted in Figure ref:fig:Ontology. The model consists of:

- **Records:** Each health record consists of multiple data points known as facts.
- **Roles:** Defines access control, determining which users can interact with specific data fields.
- **Context:** Encompasses environmental parameters like device type, location, and timestamps, influencing data access policies.

A hospital policy, for instance, may restrict record updates to authorized devices only during work hours within a medical facility. Such fine-grained access control enhances data security and compliance with regulations. These policies can be defined using a variety of rule expression languages (XrML-spec,PaSa:04,JaHeLa:10). These rules must be able to adapt to different environments and remain in place throughout the PHR lifecycle. PHRs often undergo transformations when integrated into research studies or shared across institutions. The system must support data aggregation while individual record-level security policies must be maintained. Additionally, dynamic rule interpretation is necessary to handle evolving requirements, including data mashups [18].

C. System Compliance with Requirements

The proposed architecture meets the outlined system requirements:

- **Editability:** Enforced through fact-role associations.
- **Role-Based Access:** Explicitly defined roles regulate data access.

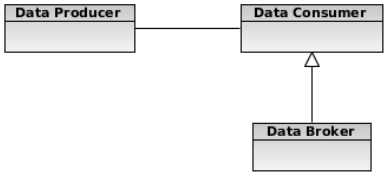

Fig. 3. Medical Data Exchange System Roles

- **Auditability:** Implemented via queueing mechanisms and audit logs.
- **Security:** Ensured through data partitioning and encryption protocols.
- **Accessibility:** Supported via diverse user interfaces and data APIs.
- **Performance:** Optimized through asynchronous processing and indexing.
- **Flexibility and Extensibility:** Achieved through modular design and standardized interfaces.

This architecture ensures security, usability, and interoperability across various platforms while providing a robust framework for managing personal health records.

IV. Prototype System - Medical Data Exchange

A medical data exchange platform allows individuals to monetize their health records while maintaining control over data access and usage. A data marketplace model is introduced to promote the adoption of Personal Health Records (PHR) as a proof of concept for the proposed system architecture. The system comprises three key roles:

- *Data Providers*: Individuals who generate and offer electronic health data. Typically, these are patients or individuals seeking healthcare services.
- *Data Clients*: Entities that utilize medical information, including physicians, researchers, and healthcare organizations.
- *Data Mediators*: Intermediaries that acquire, process, and repackage medical data for value-added services, making them available to data clients.

Data providers have the autonomy to determine how their data is utilized within the marketplace. During negotiations, they can specify usage terms before finalizing an agreement with a *data client*. The negotiation process typically follows these steps:

1) A *data client* searches for medical data matching specified criteria via a search interface or manual process.
2) A list of *data providers* with relevant records is returned.
3) The *data client* initiates a transaction by proposing access terms.
    a) The *data client* submits an initial proposal.
    b) The *data provider* may accept, reject, or counter the proposal.
    c) The *data client* can then respond with acceptance, rejection, or another counteroffer.

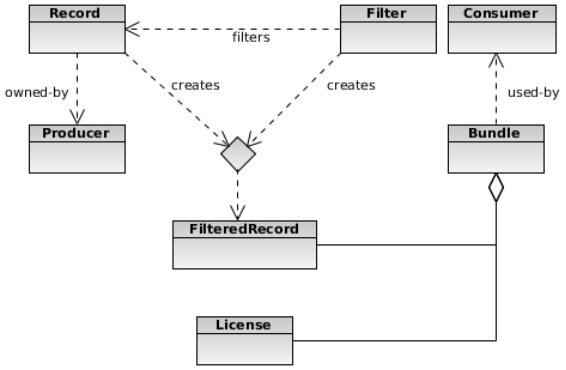

Fig. 4. Refined System Data Ontology

4) Negotiations conclude either with a mutually agreed-upon contract or a termination of discussions.

The finalized contract outlines access conditions, permissible usage, duration, location constraints, and compensation models, which can vary based on factors like time, frequency, or geographic scope.

A. System Implementation

Cucumber test cases are used to implement the system in the Ruby ecosystem (cite Emr:Web:Cucumber). The following are the maps of the architecture:

- *User Interfaces*: Implemented using JavaScript Object Notation (JSON) and RESTful APIs over HTTP [19], [20].
- *Application Framework*: Developed on Ruby on Rails, with ongoing migration efforts toward Sinatra [21], [22].
- *Testing*: Conducted using Cucumber and RSpec [23].
- *Command Line Interface*: Facilitated through Interactive Ruby Shell (IRB).
- *Core System Components*: Hosted on an application server and distributed as Ruby Gems [24].
- *Data Management*: Implemented in SQLite [25].

B. System Data Model

The system is structured around a common data ontology, which is essential for developers. Figure 4 illustrates the core entities:

- *Provider*: A data provider who owns a medical record compiled from healthcare interactions.
- *Client*: A data client who utilizes health records for various applications.
- *Record*: A health record containing medical facts.
- *Transformation*: A function applied to a record, producing a filtered version: $r' = T(r)$, where $r' \subseteq r$.
- *Filtered Record*: A transformed record derived from an original data source.
- *License*: Defines permitted data usage and enforces compliance with agreed-upon terms.
- *Package*: A filtered record bundled with an associated license for distribution.

C. Policy Evaluation: Dynamic vs. Static

Policies governing data usage can be evaluated in two ways:

- **Dynamic Evaluation**: Policies are enforced at the request time, ensuring up-to-date compliance with contextual variables like time and location.
- **Static Evaluation**: Policies are determined when a bundle is created, requiring no runtime infrastructure but limiting adaptability.

This system takes a mix of approaches. Post-negotiation static evaluation reduces runtime complexity. Dynamic evaluation allows flexibility for evolving usage scenarios, particularly for policies dependent on time-sensitive conditions. Offline functionality is made possible while robust access control is maintained.

V. Conclusion

Personal health records (PHRs) are expected to gain widespread acceptance as a result of the government's growing involvement in healthcare delivery. Future developments will likely introduce systems that are capable of effectively managing this priceless health data despite the fact that many existing PHR initiatives remain restrictive, proprietary, and devoid of user-centric approaches. In this paper, Access control and editing challenges associated with PHRs were examined, along with the potential for innovative business models enabled by effective data usage management. These models support remote health monitoring, allowing medical records to be accessed and managed across multiple devices, including mobile phones. Additionally, the benefits of continuous health monitoring were explored, demonstrating improvements in long-term outcomes for both healthcare providers and patients. A PHR system with usage management capabilities enhances the delivery of highly personalized and effective medical care, which would not be feasible without robust usage controls.

Furthermore, the architecture of a system designed to manage the usage of health records was elaborated upon, including details of the proof-of-concept implementation and the technologies utilized. The proposed system provides a foundational framework for addressing these concerns. A data marketplace, serving as a key design element of the implemented system, was introduced. This marketplace incorporates secure agent-based negotiation mechanisms for data access while defining distinct roles for data providers and consumers. Future research in this domain could focus on expanding the system's applicability to additional use cases, as outlined in this study while enhancing scalability, security, and interoperability with existing healthcare infrastructure.

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Toward Non-Invasive Monitoring of Blood Parameters: A Proposed Model for Platelet Count Estimation

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***Abstract*—Advancements in medical sensor technology and the widespread adoption of non-invasive techniques have made it possible to measure various blood parameters without requiring a blood sample. However, research on non-invasive platelet count measurement remains limited, with existing methods facing challenges related to accuracy, portability, and cost. In tropical and developing countries like Bangladesh, a significant number of dengue patients are unable to monitor their platelet levels due to the limited availability of clinical diagnostic centers. This research aims to address these challenges by focusing on three key objectives: examining the current advancements and limitations in non-invasive blood parameters measurement techniques, suggesting artificial intelligence together with near infrared spectroscopy approach, and experimental design of the whole research for future. Non-invasive platelet count would be particularly valuable in resource-limited settings, helping improve dengue patient management and ensuring timely medical intervention.**

***Index Terms*—Platelet count, Photoplethysmography, Hyperspectral imaging, Dengue fever, Thrombocytopenia, Near infrared spectroscopy**

I. Introduction

In developing countries, access to healthcare is often constrained by inadequate infrastructure, limited resources, and a shortage of trained medical professionals. To address this challenge, the Portable Health Clinic (PHC) has been introduced as a solution, designed to be easily transportable to remote and underserved regions [1]. The portable health clinic box is equipped with five essential medical sensors, including a pulse oximeter, glucometer, thermometer, urine test strips for protein and sugar detection, and a blood pressure measuring device. Additionally, it contains body measurement tools such as a measuring tape and a weight scale.

Dengue fever has become increasingly severe in developing and tropical countries, particularly in Bangladesh. According to the Directorate General of Health Services (DGHS), as of December 31, 2023, Bangladesh recorded 1,705 dengue-related deaths and 321,179 hospitalizations within a single epidemic year [2]. In 2024, Bangladesh saw another fatal dengue outbreak, with over 100,000 illnesses and 575 fatalities. According to official data released here on Tuesday by the Directorate General of Health Services (DGHS), 9,745 instances were registered in December, compared to 29,652 in November 2024 [3]. And over the globe around 48 nations and territories have reported 159 dengue-related deaths and 640,349 dengue cases since the start of 2025. There have been reports of dengue circulation in South-East Asia, Africa, America, and the Western Pacific region as of February 25, 2025 [4].

One of the key diagnostic indicators of dengue severity is platelet count, which exhibits an inverse relationship with disease progression. As platelet levels decline, the severity of the disease increases, potentially leading to Dengue Shock Syndrome, plasma leakage, organ failure, and fatal internal bleeding [5]. Continuous platelet monitoring is therefore crucial for early intervention, timely platelet transfusion, and hospitalization decisions.

Integrating a non-invasive platelet count measurement device into the portable health clinic system would significantly enhance its capability to manage dengue fever. This addition would provide real-time monitoring of platelet levels, facilitating early diagnosis and intervention, and ultimately adding substantial value to the Portable Health Clinic (PHC) system in regions affected by frequent dengue outbreaks.

The structure of this paper is as follows: Section II presents a modeling framework for non-invasive blood parameter estimation. Section III discusses current limitations in non-invasive platelet count methods. Section IV introduces the proposed approach. Section V details the experimental design and validation. Section VI concludes with future directions for improving sensor integration and model robustness.

II. Non-invasive Model to Estimate Blood Parameters

This section describes the non-invasive measurement principles of six blood parameters: SpO_2, blood glucose, red blood cells (RBC), white blood cells (WBC), hemoglobin, and platelets. All these principles are explained using a unified model shown in Fig. 1.

A. SpO_2

To illustrate the non-invasive measurement principle of blood oxygen saturation (SpO_2), Chan et al. [6] used a dual-

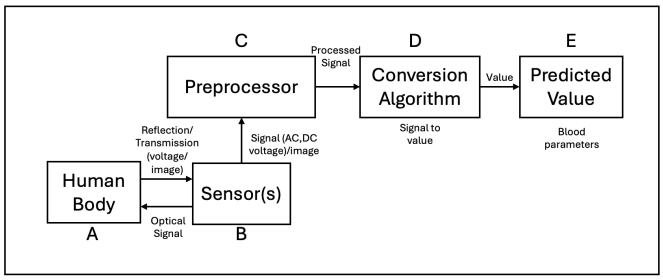

Fig. 1. Steps of Typical Non-invasive Measurement

wavelength photoplethysmography (PPG) method based on red and infrared light absorption, as shown in the unified model Fig. 1.

A. Human Body: Pulse oximetry is commonly performed on capillary-rich and accessible sites such as the fingertip, earlobe, forehead, or nose, which allow detection of arterial blood flow through light-based sensors.
B. Sensor(s): The system uses red (660 nm) and near-infrared (940 nm) LEDs, with a photodetector on the opposite side to measure transmitted light. Sensor formats include reusable clips or adhesive patches.
C. Preprocessor: To ensure clean readings, the device filters out noise from movement and cancels interference from surrounding light. Only the pulsating (arterial) part of the signal is kept, and invalid pulses are rejected.
D. Conversion Algorithm: Light absorption differences between oxygenated and deoxygenated hemoglobin are analyzed. The device calculates a ratio ("R") of pulsatile to steady signals and uses a calibration curve to estimate oxygen saturation.
E. Predicted Value: The system outputs SpO_2, a non-invasive estimate of arterial oxygen saturation. While generally accurate, it may be affected under specific conditions like anemia or CO poisoning.

B. Blood Glucose

To demonstrate non-invasive blood glucose monitoring, Shaikh et al. [7] employed a photoacoustic spectroscopy approach using near-infrared (NIR) light to measure glucose-induced acoustic signals from tissue, as illustrated in Fig. 1.

A. Human Body: Though conducted in-vitro, the study models a future wearable glucose monitor intended for use on the wrist or fingertip, leveraging skin as the optical interaction site.
B. Sensor(s): A 980 nm NIR laser diode (10 mW) generates thermal expansion-induced acoustic waves, captured by a photoacoustic transducer. A lock-in amplifier enhances signal clarity, with components like a 1 MHz timer and polydimethylsiloxane (PDMS) layer supporting signal transfer.
C. Preprocessor: Signals were filtered using phase-sensitive detection at 1 MHz. Key features (e.g., amplitude, RMS) were averaged over 15 trials to ensure consistency before modeling.
D. Conversion Algorithm: Ordinary least squares (OLS) regression, showing high correlation for amplitude, was the primary model. Support vector regression (SVR), k-nearest neighbors (KNN), LASSO, and Bayesian Ridge were also tested using an 80/20 split in scikit-learn.
E. Predicted Value: The system estimated glucose in the 0–300 mg/dL range, with amplitude as the strongest predictor. The approach shows promise for future non-invasive glucose monitoring.

C. RBC

To estimate red blood cell (RBC) count non-invasively, J. He et al. [8] utilized optical coherence tomography (OCT) to capture high-resolution images of the lip mucosa, enabling cell-level detection based on grayscale thresholding, as depicted in Fig. 1.

A. Human Body: The measurement site was the labial mucosa (inner lip), chosen for its rich capillary structure, ease of access, and compatibility with Optical Coherence Tomography (OCT). This area allows detailed imaging of superficial blood vessels.
B. Sensor(s): The system employed OCT, offering a resolution of 5–20 μm and a depth penetration of 1–3 mm, sufficient to visualize sub-epidermal vasculature. An advanced imaging enhancement technique, Deconvolved Random Phase Mask Modulation (Deconv-RPM), was applied to reduce speckle noise and enhance the visibility of individual blood cells.
C. Preprocessor: Image preprocessing involved several steps:
   - *Motion Artifact Removal:* Images were aligned to a reference frame, and misaligned ones were discarded.
   - *Projection Artifact Removal:* Shadows beneath blood vessels were identified using depth variance and removed.
   - *Vessel Segmentation:* Blood vessels were segmented using averaged B-scans to define regions of interest.
   - *Focus Region Selection:* Only regions within the optical focus were included for analysis.
   - *Noise Reduction:* Gaussian filtering was used to smooth the image.
   - *Morphological Opening:* This technique was applied to emphasize the edges of cell-like bright spots for better identification.
D. Convsersion Algorithm: A scanning window of 6×6 pixels (approximately 7–8 μm) was used to detect red blood cells (RBCs). Each window's maximum grayscale value was recorded, and a histogram-based threshold—typically the first quartile—was used to filter out background noise. To avoid duplicate counts, nearby bright spots within the size of a typical RBC were grouped as a single cell.

E. Predicted Value: RBC concentration was estimated using the formula:

$$V = v \cdot X, \quad C = \frac{\eta \cdot t}{V}$$

where v is the pixel volume, X is the number of pixels in the segmented vessel region, t is the total RBC count, and η is a correction factor. This allowed calculation of the RBC concentration in cells per liter.

D. Hemoglobin and WBC

A. Human Body: Measurement is performed on capillary-rich sites like the fingertip, toe, wrist, earlobe, or forehead to ensure strong optical signals. Support attachments help maintain proper sensor alignment.
B. Sensor(s): LEDs of 465 nm (blue), 515 nm (green), 660 nm (red), and 940 nm (infrared) are used, depending on the parameter (e.g., hemoglobin or WBC). Silicon photodiodes capture transmitted or reflected light while shielding against ambient interference.
C. Preprocessor: Signals are filtered to remove noise, averaged over cardiac cycles, and checked for pulsatile features to ensure quality before analysis.
D. Conversion Algorithm: Light amplitudes are transformed into factors (e.g., Hgb Factor) using mathematical equations, and regression models trained on clinical data convert these into concentrations.
E. Predicted Value: Parameters like hemoglobin are predicted in real-time, e.g.,

$$\text{Hemoglobin (g/dL)} = 5.389 \times e^{1.026 \times \text{Hgb Factor}}$$

Results are displayed or transmitted for monitoring, with support for personalized calibration.

E. Platelet

To enable non-invasive platelet counting, Mahmuda et al. [10] proposed a smartphone-based system that extracts PPG signals from fingertip videos and uses deep neural networks to predict platelet count from waveform features, as visualized in Fig. 1.

A. Human Body: The right index fingertip was used for measurement due to its strong capillary network. Participants placed their finger over the smartphone's camera and flash to capture reflected PPG signals.
B. Sensor(s): A Samsung Galaxy Note 10 Lite was used, with its RGB camera recording at 30 fps and 1080×2400 resolution. The smartphone flash illuminated the fingertip while the camera captured light variations to generate raw PPG signals.
C. Preprocessor: Signals were processed using:
- Butterworth bandpass filter (60–220 BPM) for noise reduction
- airPLS for baseline correction
- Normalization (0–1 scaling)
- Automatic pulse cycle selection
- Extraction of 46 time/frequency features + demographic info

D. Conversion Algorithm: A Deep Neural Network (DNN) with ReLU activations and dropout (0.3) was trained over 50 epochs (batch size 32) using extracted features to predict platelet count.
E. Predicted Value: The model predicted platelet count (cells/mm^3) with an R^2 of 0.882 and MAE of 27.858 ± 1.548, validated against Ves-Matic 80 ESR Analyzer results using regression and Bland-Altman plots.

III. Limitations for Platelet Count

So far, only two methods have been proposed for non-invasive platelet count estimation: one using hyperspectral imaging with a partial least squares regression (PLSR) model, and another leveraging photoplethysmography (PPG) signals from a smartphone camera combined with a deep neural network (DNN) model [10], [11]. As shown in Table I, Mahmuda et al. achieved approximately 88% accuracy using a DNN model validated against the Ves-Matic 80 ESR analyzer. Their dataset included patients with both thrombocytopenia and thrombocytosis, covering a wide clinical range. Meanwhile, Li et al. developed a multi-parameter non-invasive device that measured hemoglobin, platelets, and bilirubin, reporting 87.5% accuracy for platelet count. Their study included 148 participants aged 13–65, with a near-equal gender distribution.

Both methods have notable limitations. In the case of the PPG-based smartphone method, the challenges include:

- The accuracy level for platelet count measurement is approximately 88%, which requires further improvement.
- The experiment was conducted using only a Samsung Galaxy Note 10 Lite smartphone, relying on its 12-megapixel wide-angle, ultra-wide, and telephoto cameras with a white flash light spectrum (400–700 nm). Since different smartphones have varying camera and light specifications, accuracy may vary significantly across different devices.
- Using a specific smartphone model as a standard tool for non-invasive platelet count measurement is not cost-effective, particularly in developing countries, where the device cost ($400) may be barrier for widespread adoption.

The hyperspectral imaging method also has several drawbacks:

- The observed accuracy level for platelet count measurement is 87.5%, which is lower than the accuracy achieved for other blood parameters such as hemoglobin (94.3%) and bilirubin (89.4%).
- The experimental setup is bulky and expensive, requiring a computer, hyperspectral camera, halogen light source, and a regulated switching power supply.
- The light spectral range is limited to 650–960 nm, restricting its capability in broader spectral analysis.

TABLE I
EXISTING RESEARCH

Authors	**M. Mahmuda et al. (2024) [10]**	**Li et al. (2023) [11]**
Method	Photoplethysmography (PPG) using a smartphone	Hyperspectral Imaging (HSI)
Measurement	Platelet count	Hemoglobin, Platelets, and Total Bilirubin
Algorithm	Deep Neural Network (DNN)	Partial Least Squares Regression (PLSR)
Spectral channels	3 channels (Red, Green, Blue)	24 channels
Performance	$\sim$88% accuracy for platelet estimation	- 94.3% accuracy (Hemoglobin) - 87.5% accuracy (Platelet) – lower than hemoglobin and bilirubin but acceptable - 89.4% accuracy (Total bilirubin)
Number of subjects	170 participants, aged 1–70 years	148 participants, aged 13–65 years (71 males, 77 females)
Gold standard for comparison	Ves-Matic 80 ESR Analyzer (clinical CBC test at Ibn Sina Diagnostic Center, Bangladesh)	Biochemical Analyzer (Model: Cobas C501, Automatic Biochemical Detector, Roche, Germany)
Platelet count data	80×10^9/L to 458×10^9/L	106×10^9/L to 369×10^9/L

- The sample size in experiments was limited, as platelet levels below 106,000 Cmm and above 369,000 Cmm were not considered.

IV. OUR CONCEPT

A non-invasive glucose monitoring system was previously developed, integrating SpO_2 and heart rate tracking, and demonstrated an accuracy of 97.46% for glucose estimation [12]. The device utilized the RPR-220 sensor (940 nm LED and photodiode), the MAX30100 sensor, and an ESP32 microcontroller. Measurements were displayed on an LCD, and the circuit was constructed on a dot-type veroboard.

Building on this approach, a prototype for non-invasive platelet count estimation was designed [13]. The system similarly employed the RPR-220 sensor and ESP32 microcontroller, with circuit components mounted on a veroboard. Measurement data were transmitted via Bluetooth to a mobile application developed using MIT App Inventor. An accuracy of 94.143% was achieved in estimating platelet counts non-invasively.

In both systems, linear regression models were applied. However, model performance was limited by a small dataset comprising only 10 samples. The datasets lacked representation from individuals with platelet abnormalities, such as thrombocytopenia (Platelet count $<$ 150,000 Cmm and thrombocytosis (platelet count $>$ 450,000 Cmm) . Additionally, variables such as skin tone, tissue thickness, and environmental conditions (e.g., ambient light, temperature) were not accounted for, potentially affecting measurement accuracy.

To improve model generalization and device accuracy, future datasets should include diverse patient profiles based on age, gender, platelet range, and skin characteristics. Environmental conditions should also be controlled or factored into the modeling process. These improvements are necessary for developing a robust and clinically reliable system. An overview is presented in Fig. 2.

A. Human Body : Capillary-rich sites such as the fingertip, toe, wrist, forehead, earlobe, chest, and nostril are suitable for non-invasive platelet measurement. These regions enable strong light-tissue interaction and support consistent sensor placement via wearable holders.

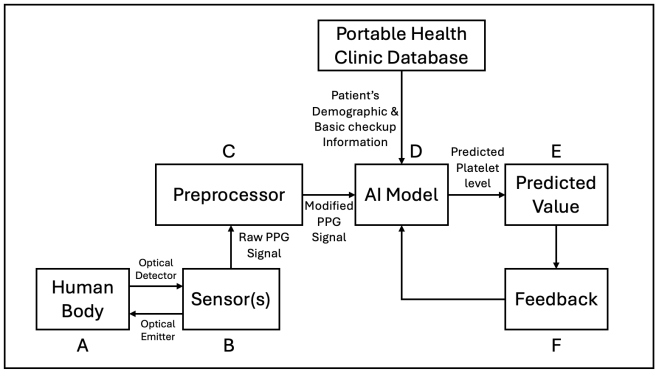

Fig. 2. Our concept of Non-invasive Platelet Count Estimation

B. Sensor(s): The system uses Near-Infrared Spectroscopy (800–1000 nm) in reflectance mode with modulated NIR LEDs and photodetectors. It captures backscattered light to detect subtle scattering changes associated with platelet concentration.

C. Preprocessor: Signals are cleaned using motion correction, smoothing, and pulse alignment. AC/DC components and features like slope, harmonics, and wavelength attenuation are extracted to characterize platelet-related scattering patterns.

D. AI Model: Features are input to regression models (e.g., SVR, Random Forest) trained on datasets linking spectral data to CBC-based platelet counts. The dataset will also contain patients' demographics and basic checkup informatioin from portable health clinic database. Models are refined through cross-validation and tuning.

E. Value Prediction: The system predicts platelet count ($\times 10^3/\mu L$) in real-time. It is intended for both clinical use and continuous monitoring, particularly for conditions like dengue.

F. Feedback: Adaptive updates are planned using patient history, recalibration, and context factors (e.g., skin tone, hydration) to improve model accuracy and robustness over time.

V. Experiment Design

As shown in Table II, this study will be conducted in Bangladesh during the dengue season (May to September), when the occurrence of thrombocytopenia is most prevalent. Before data collection begins, ethical approval will be obtained from the relevant institutional review boards to ensure compliance with local and international research standards.

TABLE II
Experimental Design for Non-Invasive Platelet Count Estimation

Items	Details
Target Population	100 dengue patients and 100 healthy control participants
Sensor Technology	NIR spectroscopy (700–2500 nm wavelength range)
Supporting Data	Demographic and basic check-up data from PHC system
Timeline	May–September (Dengue season)
Ethical Approval	IRB approval and clearance from Kyushu University

A diverse cohort of 200 participants will be recruited, comprising 100 dengue patients and 100 healthy individuals. Measurements will be performed using a custom-designed Near-Infrared (NIR) spectroscopy device positioned on capillary-rich body sites, such as the fingertip. Reference platelet counts will be determined via laboratory-based Complete Blood Count (CBC) tests. Simultaneously, NIR spectral data will be collected under controlled environmental conditions.

To enhance predictive modeling, additional patient data—including demographic information and basic health check-up parameters such as age, gender, temperature, and blood pressure etc—will be integrated from the PHC database. Preprocessing of the spectral signals will include denoising, pulse alignment, and feature extraction from AC and DC signal components.

Machine learning models such as Partial Least Squares Regression (PLSR) or Support Vector Regression (SVR) will be trained using this dataset. Feature selection techniques will be used to isolate key wavelength bands most relevant to platelet variation. Model performance will be evaluated using RMSE, R^2, MAE, and Bland-Altman analysis.

Subsequent validation phases will apply the trained models to a separate test cohort to evaluate generalizability. Additional experiments will be conducted to assess the influence of confounding variables such as skin tone, hydration level, and ambient temperature. Based on these findings, the model will be refined and tested for robustness. Finally, the study will explore clinical feasibility and contribute to the design of a compact, non-invasive, point-of-care platelet monitoring device for broader deployment.

VI. Conclusion and Future Work

Non-invasive blood parameter monitoring holds transformative potential for digital healthcare, particularly in enhancing disease diagnosis and management. In tropical and subtropical regions, the rising incidence of dengue fever has created an urgent need for accessible platelet count measurement. While only two non-invasive approaches currently exist, both face limitations in cost, size, and accuracy. Integrating artificial intelligence with near-infrared spectroscopy offers a promising solution—improving precision, reducing costs, and enabling practical use in low-resource settings. This emerging strategy addresses existing gaps and paves the way for broader application in modern diagnostics.

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The effect of health care zone for managing Diabetic Complications Among the Elderly in Southern Thailand (A Spatial Mapping Study)

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***Abstract*—This study explores the clinical profiles and geographic patterns of elderly patients (aged 60 and over) with type 2 diabetes in Cha-uat District, southern Thailand. We used patient records from 2018 to 2024 to examine the number of cases with major complications, especially cardiovascular disease and stroke, across five health service zones.**

A key part of the study was using household-level pin-mapping to show where high-risk patients live. By combining clinical data with location information, we were able to spot areas with more severe cases and use that insight to support better health service planning.

We analyzed the data using Chi-square and Kruskal–Wallis tests, along with geospatial tools like Google My Maps. Additionally, household geocoding was performed using patient addresses from the HosXP system, and spatial clustering methods were applied to identify high-risk areas. The results showed significant differences between zones in systolic blood pressure (p=0.0046), total cholesterol (p=0.0001), and LDL cholesterol (p=0.0006). These findings show how map-based tools can help identify priority areas and improve diabetes care at the local level.

***Index Terms*—**type 2 diabetes, elderly, mapping, complications, health care

I. INTRODUCTION

Cha-uat District in Nakhon Si Thammarat Province is predominantly a rural community with complex road networks and geographical characteristics comprising foothills and lowlands. These features make it difficult for patients to travel to healthcare facilities. In some areas, the lack of a mobile phone signal further complicates direct communication with patients. Most diabetic patients with complications are geographically dispersed and live far from the community hospital, limiting their access to healthcare services.

The Cha-uat District Health Network has divided the health service area into five zones: one community hospital located in the urban area of the district and four primary care units situated in rural communities. Each zone is managed by a multidisciplinary healthcare team, with support from village health volunteers participating in patient care.

This study utilized data from the HosXP database of Cha-uat Hospital, covering a retrospective period of seven years (2018–2024). The objective was to examine the geographic distribution of diabetic patients and geocode their household locations, including those with cardiovascular complications and stroke, to visualize patient locations and travel routes. This information facilitates coordination, field visits, and patient care, as well as the analysis of patients' clinical characteristics to monitor diabetic complications.

Laboratory results were used to monitor risk factors associated with the development of further complications. The approaches described above represent techniques for efficiently monitoring and caring for all diabetic patients—both with and without complications—to ensure that they receive appropriate services. Importantly, consistent follow-up and care for these patients can reduce the risk of further complications, lower mortality rates, and enhance the quality of life of diabetic patients within the Cha-uat District Health Network [7],[8],[9].

II. METHODS

This Retrospective study utilized patient data from the HosXP electronic medical records system at Cha-uat Hospital, covering the period between 2018 and 2024. The target population included individuals aged 60 years and older diagnosed with type 2 diabetes. Patients were stratified into three groups based on complication status: those with diabetes only, those with both diabetes and cardiovascular disease, and those with both diabetes and stroke.

Clinical indicators evaluated in this study included systolic and diastolic blood pressure, HbA1c, total cholesterol, triglycerides, LDL, HDL, BUN, creatinine, and estimated glomerular filtration rate (eGFR). Descriptive statistics were calculated using medians and percentiles. Group comparisons across the five health service zones were performed using the Chi-square test and Kruskal–Wallis test, depending on data type and distribution.

In addition to statistical analysis, geospatial visualization techniques were employed to identify and

interpret spatial distribution patterns. The residential locations of patients were geocoded utilizing address records from the HosXP system, verified with Google Earth, and validated by local health personnel to assure precision. Addresses that were missing or unclear have been adjusted via field validation. Patient residences were subsequently mapped on an interactive digital platform utilizing Google My Maps. Clustering algorithms and density mapping were employed to evaluate spatial distribution and identify regions with elevated concentrations of complications. The areas were divided into zones as follows:

Zone 0 represents Cha-uat Hospital.

Zone 1 comprises primary healthcare units including Ban Khuan Ching Health Promoting Hospital, Hua Thanon Health Promoting Hospital (Khreng Subdistrict), and Ban Rai Noen Health Promoting Hospital (Tha Samet Subdistrict), as well as Ban Sam Yaek Health Promoting Hospital (Cha-uat Subdistrict).

Zone 2 includes Ban Nang Long Health Promoting Hospital, Ban Phru Bua Health Promoting Hospital (Nang Long Subdistrict), Ban Trok Khae Health Promoting Hospital, and Ban Khod Hat Health Promoting Hospital (Khod Hat Subdistrict).

Zone 3 consists of primary care units including Ban Khao Lampa Subdistrict Health Promoting Hospital (Tha Pracha Subdistrict), Khuan Nong Hong Subdistrict Health Promoting Hospital (Khuan Nong Hong Subdistrict), Ban Khao Prathong Subdistrict Health Promoting Hospital, Ban Huai Yaeng Subdistrict Health Promoting Hospital (Khao Prathong Subdistrict), and Ban Khuan Ngoen Subdistrict Health Promoting Hospital (Ban Tul Subdistrict).

Zone 4 consists of primary care units including Ban Mai Siap Subdistrict Health Promoting Hospital (Ko Khan Subdistrict), Ban Na Khuan Rang Subdistrict Health Promoting Hospital (Wang Ang Subdistrict), and Ban Khuan Sombun Subdistrict Health Promoting Hospital (Tha Pracha Subdistrict).

Within each zone, diabetic patients without complications are indicated by green pins. Diabetic patients with cardiovascular complications are represented with orange pins, and those with cerebrovascular complications are marked with blue pins.

This mapping strategy facilitates easier identification of patient clusters and supports the development of location-specific public health responses.

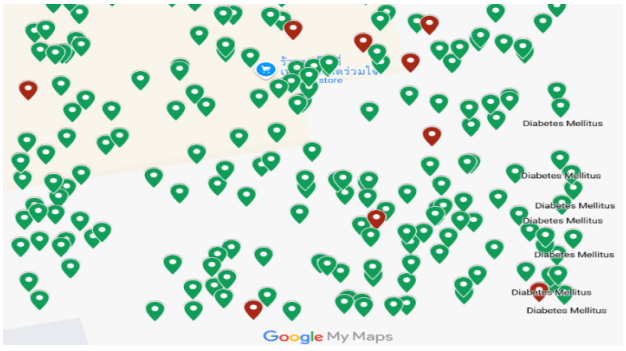

Fig. 1. Distribution of diabetic patients with and without complications in Zone 0

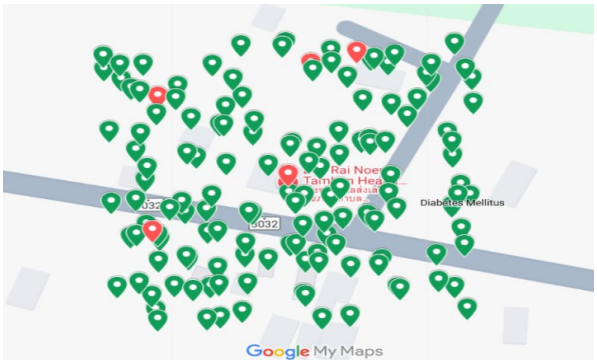

Fig. 2. Distribution of diabetic patients with and without complications in Zone 1

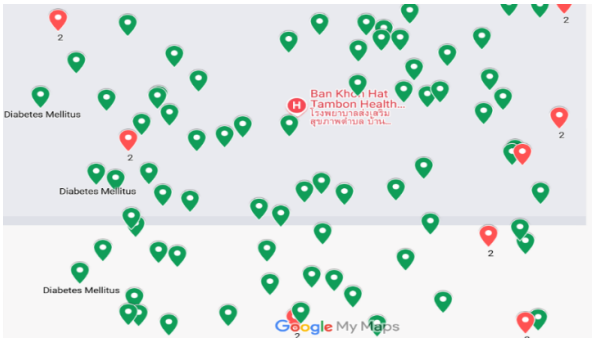

Fig. 3. Distribution of diabetic patients with and without complications in Zone 2

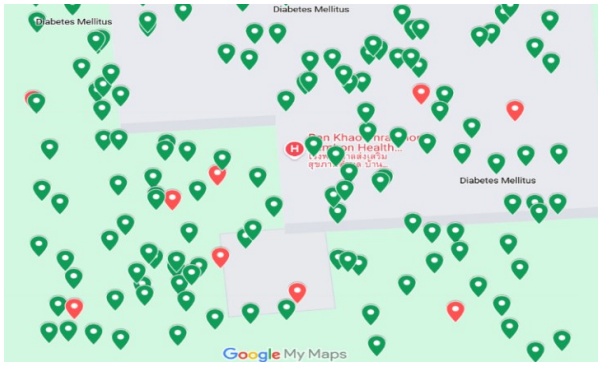

Fig. 4. Distribution of diabetic patients with and without complications in Zone 3

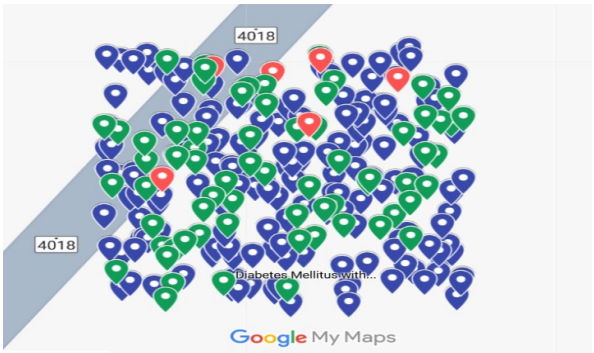

Fig. 5. Distribution of diabetic patients with and without complications in Zone 4

III. RESULTS

The bar charts illustrate the number of elderly patients with diabetes mellitus, categorized into those with and without complications. The complications include cardiovascular disease and stroke. The data, collected between 2018 and 2024, were analyzed across five service zones (Zone 0–Zone 4). In 2018, all zones reported a high number of diabetic patients, with Zone 1 and Zone 3 exceeding 250 cases. Zone 0, which serves as the central healthcare facility, also showed a notably high number of patients (n=119). However, from 2019 onwards, the number of DM patients in all zones demonstrated a declining trend, particularly in Zone 0 and Zone 4, where the reduction was most pronounced. In contrast, the trend of diabetic patients with complications showed heterogeneous patterns across the service zones.

For patients with cardiovascular disease, Zone 0 reported only a small number of cases throughout the study period, with no sustained increase after 2018 (highest at 5 cases in 2018). Zone 1 and Zone 3, however, exhibited a gradual rise, particularly in 2021 (Zone 1: 4 cases; Zone 3: 4 cases) and in 2023 (Zone 3: 4 cases), suggesting a higher cardiovascular burden in these areas. Zone 2 demonstrated sporadic occurrences with overall low numbers (mostly ≤3 cases per year), while Zone 4 showed fluctuations, peaking in 2020 (4 cases) and 2022 (4 cases) before declining in subsequent years.

For stroke complications, the distribution also varied across zones. Zone 0 recorded very few cases (≤3 per year), while Zone 1 and Zone 3 consistently showed higher counts compared to other areas. Zone 3, in particular, experienced repeated peaks in 2019 (8 cases), 2021 (8 cases), and 2023 (8 cases), reflecting a recurring burden of stroke among its diabetic population. Zone 2 maintained moderate but persistent levels (approximately 1–3 cases annually), whereas Zone 4 displayed irregular increases, with notable peaks in 2018 (6 cases), 2021 (5 cases), and 2022 (4 cases).

Overall, diabetic patients with complications such as cardiovascular disease and stroke were consistently found in all zones each year. Notably, Zone 1 and Zone 3 showed a tendency to have a higher number of patients with such complications compared to other areas. These findings reflect an overall improvement in diabetes control across the district, yet underscore the continued need for attention to the prevention of chronic complications in all zones within the Cha-uat District Health Service Network.

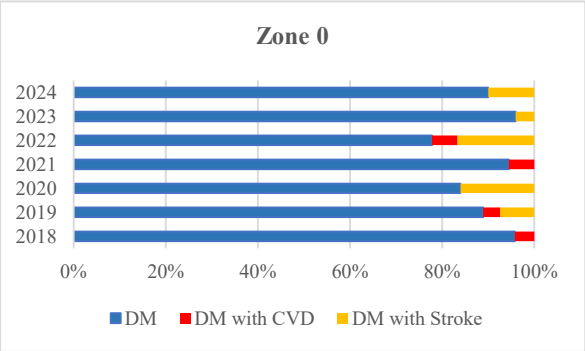

Fig. 6. The annual number of diabetic patients at Cha Uat Hospital (Zone 0)

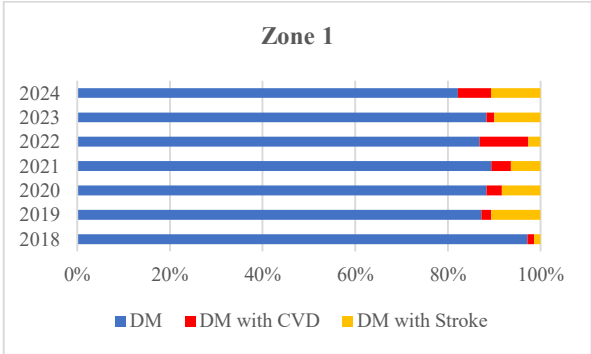

Fig. 7. The annual number of diabetic patients in Zone 1, a primary care unit under the Subdistrict Health Promoting Hospital network.

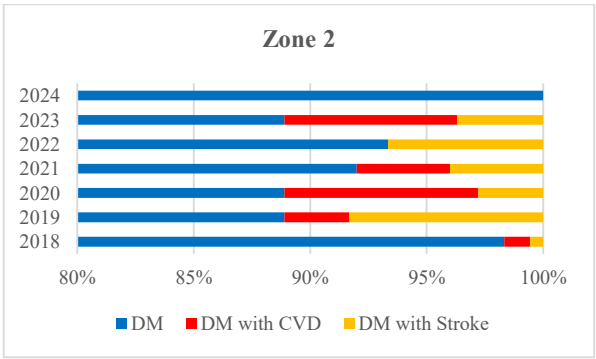

Fig. 8. The annual number of diabetic patients in Zone 2, a primary care unit under the Subdistrict Health Promoting Hospital network.

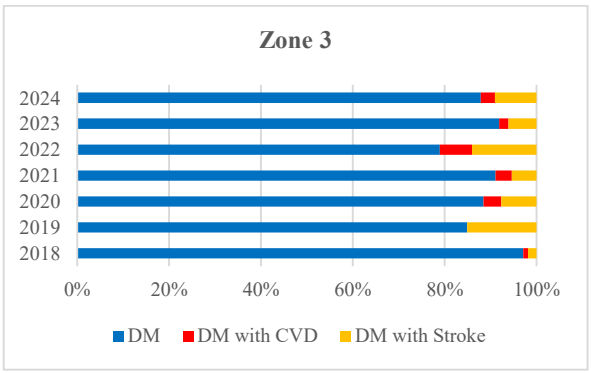

Fig. 9. The annual number of diabetic patients in Zone 3, a primary care unit under the Subdistrict Health Promoting Hospital network

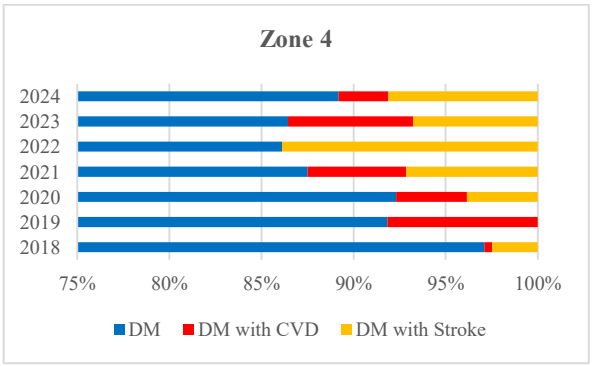

Fig. 10. The annual number of diabetic patients in Zone 4, a primary care unit under the Subdistrict Health Promoting Hospital network.

From Table 1 and based on the results of the analysis, clinical data from elderly patients with diabetes across five service zones (Zone 0 to Zone 4) showed that there were clear differences in some health indicators between the zones. Specifically, systolic blood pressure (p=0.0046), total cholesterol (p=0.0001) , and LDL cholesterol levels (p=0.0006) were significantly different. Patients in Zone 1 and Zone 0 tended to have higher values for these measures, while Zone 2 generally had the lowest. For example, Zone 1 had the highest median SBP at 136 mmHg, and Zone 0 showed the highest levels of total cholesterol and LDL. On the other hand, other indicators such as diastolic blood pressure, HbA1c, triglycerides, HDL, kidney function (eGFR), BUN, and creatinine did not show meaningful differences between zones.

These results suggest that, although blood sugar and kidney function were similarly managed across areas, some zones may still need extra support in controlling blood pressure and cholesterol to help prevent long-term cardiovascular complications.

TABLE I.
Comparison of Median (25th–75th Percentile) Laboratory Results Across Health Zones

Laboratory	Zone 0 (Median, P25–P75)	Zone 1 (Median, P25–P75)	Zone 2 (Median, P25–P75)	Zone 3 (Median, P25–P75)	Zone 4 (Median, P25–P75)	Kruskal–Wallis test (df)	p-value
SBP	134.5(130-146)	136(128.5-144)	135(130-146)	133(125-139)	135(130-146)	15.03(4)	0.0046*
DBP	73(69-78)	73(68-80)	73(66-78)	73(68-78)	72(68-78)	1.96(4)	0.7409
HbA1c	7.1(6.5-8.6)	7.1(6.4-8.5)	7.1(6.4-8.4)	7.3(6.4-8.5)	7.2(6.4-8.4)	0.71(4)	0.9501
Chol	177.5(151.5-208)	175(148-203)	162(139-192)	169(143-195)	175(151-208)	22.76(4)	0.0001*
Tri	128.5(96-174.5)	119(89-161.5)	115(87-164)	122(91-165)	125(90-171)	3.73(4)	0.4434
eGFR	72.08(54.66-87.82)	65.84(49.65-87.18)	70.23(51.2-86.9)	71.52(52.76-88.34)	67.97(49.35-83.84)	4.56(4)	0.3351
LDL	97.5(75.5-123)	95.5(72-121.5)	84(67-111)	90(69-114)	95(76-123)	19.45(4)	0.0006*
HDL	50(42-60)	51.5(42-61)	49(42-57)	51(43-61)	50(43-60)	3.45(4)	0.4851
BUN	14.75(11.1-18.45)	14.6(11.2-18.35)	13.5(10.6-17.9)	14.2(11.3-18.6)	14.8(11.8-18.5)	5.43(4)	0.2456
Cr	0.88(0.70-1.14)	0.92(0.73-1.17)	0.88(0.7-1.16)	0.89(0.71-1.12)	0.92(0.76-1.17)	6.14(4)	0.1883

IV. DISCUSSION

The use of color-coded household-level pin-mapping served as a valuable addition to traditional statistical analysis. By showing where patients with and without complications were located, the maps provided clear, location-based insights to support local healthcare planning and intervention efforts [10], [11].

The simple use of yellow, orange, and red pins helped quickly identify high-risk households and made it easier for healthcare teams and policymakers to communicate and prioritize actions. In particular, the clustering of red and orange pins in Zones 1 and 3 highlighted the need for targeted outreach, These findings underline the importance of integrating spatial epidemiology tools into routine health surveillance. By combining GIS-based household mapping with clinical indicators, healthcare planners can design zone-specific strategies, such as mobile health units for Zone 3 or enhanced cardiovascular risk screening in Zone 1." regular follow-up, and preventive strategies in those areas [12].

This study shows that geospatial mapping is more than just a tool for visualization—it can support precision public health efforts. By turning complex health data into easy-to-understand, place-based formats, it helps bridge the gap between data analysis and real-world action [13], [14]. In rural or resource-limited settings, this approach may be essential for ensuring that care reaches the people who need it most.

V. CONCLUSION

This study underscores the critical role of household-level pin-mapping in visualizing the geographic burden of diabetes and its major complications. By using a color-coded map, yellow for diabetes only, orange for diabetes with cardiovascular disease, and red for diabetes with stroke, this approach provided a clear and actionable representation of clinical risk across communities.

The ability to identify high-risk clusters based on household location empowers local healthcare providers to prioritize care, allocate resources more efficiently, and implement geographically targeted interventions. Far from being a supplementary feature, the mapping component of this study proved essential for translating epidemiological data into public health action. As healthcare systems move toward more personalized and localized strategies, pin-mapping should be recognized as a key element in community-based chronic disease management.

ACKNOWLEDGMENT

We thank Cha-uat Hospital and subdistrict health staff for data access and support.

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Comparative Analysis of Prompting Strategies for ASR Correction in Low-Resource Languages Using Large Language Models

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***Abstract*—In this article, we explore a prompt-based Large Language Model correction approach to improve ASR transcription quality for low-resource languages (LRLs) in clinical settings. ASR outputs from real-world doctor-patient conversations in an LRL were used as input, with the goal of reducing the manual effort required to generate ground truth transcriptions (GTTs). We evaluate seven prompting strategies—Few-Shot, Chain-of-Thought, Instruction, Self-Consistency, Role-Based (with 2 different roles), and a Combined method—across two state-of-the-art LLMs: GPT-4o and Gemini 2.5 Pro. Word Error Rate (WER) is used as the primary evaluation metric. Results show that Gemini 2.5 Pro outperforms GPT-4o in six out of seven prompting strategies, achieving its best performance with Few-Shot prompting (WER = 0.3696). In contrast, GPT-4o performs best with Chain-of-Thought prompting (WER = 0.3742) but shows degraded performance under Few-Shot prompting (WER = 0.6873). The Combined prompt yields stable performance across both models. These findings highlight the critical role of prompt-model alignment and demonstrate the potential of LLMs to support scalable and automated ASR correction pipelines for voice-based healthcare tools in LRL environments.**

***Index Terms*—Medical Transcript, Automatic Speech Recognition (ASR), Word Error Rate, Ground Truth Text, Large Language Model (LLM), Prompt Engineering**

I. Introduction

Building reliable ASR systems for LRLs is challenging due to the lack of large, labeled speech datasets and supporting language tools [1]. These languages often have complex phonetics, morphology, and dialectal variation, reducing ASR accuracy—especially in sensitive domains like healthcare, where specialized terms and spontaneous doctor-patient speech pose additional hurdles [2]. ASR performance is typically measured using Word Error Rate (WER) [3], which compares ASR output to a manually created GTT. However, generating GTTs for unscripted clinical conversations is slow and labor-intensive, delaying ASR evaluation and hindering voice-based health tool development for LRL-speaking communities.

The recent rise of LLMs offers a promising solution to ASR challenges. Trained on vast multilingual data, LLMs excel at understanding and generating human-like text [4]. This has led to growing interest in using LLMs for Generative Error Correction (GEC), where they improve ASR outputs by leveraging their linguistic and world knowledge [5]. This approach may reduce the manual effort needed to create GTT. However, LLM effectiveness depends heavily on prompt engineering—the design of clear, purposeful instructions to guide model behavior [6]. Techniques such as Few-Shot Prompting, Chain-of-Thought, and Role Prompting can significantly impact performance, enhancing the model's reasoning and correction capabilities. Careful study of these methods is essential to maximize LLM utility for ASR correction [7].

Building on prior work showing that LLMs can generate GTT for medical ASR in LRLs [8], this study compares prompt engineering methods to identify the most effective for correcting ASR transcripts of doctor-patient conversations. While LLMs show promise for Generative Error Correction (GEC), few studies directly compare prompting strategies in this context. This work evaluates: (1) seven prompting methods; (2) Bangla ASR outputs from Wit.ai [9]; (3) performance of GPT-4o vs. Gemini 2.5 Pro; and (4) WER scores against human-made GTTs. It offers the first detailed comparison of prompts for ASR correction in LRL healthcare, while also testing how well leading LLMs handle complex, real-world medical tasks.

The structure of the remaining parts of the article is as follows. Section II reviews prior research efforts and findings that share similar objectives. Section III provides a detailed overview of the experimental setup, including the evaluation metric, speech dataset, LLM models, prompting strategies, and the ASR system. The outcomes of the experiment, along with key observations, are presented in Section IV. Furthermore, Section V explores the future directions and potential impact of this conceptual framework.

II. Related Research

Over the years, numerous strategies have been proposed to estimate and reduce WER without relying on gold-standard references. Huang et al. demonstrated a 38.6% improvement in correct-reject rate using ASR confidence classifiers based on distinct confidence metrics [10]. Fang et al. (2025) proposed a three-stage Reliable LLM Correction Framework (RLLM-CF) leveraging Chain-of-Thought prompting with GPT-4, achieving 9–21% relative reductions in WER/CER via iterative correction and reasoning-based verification [11]. Ma et al. (2024) showed that few-shot prompting using N-best hypotheses and structured examples reduced WER by 15–30%, even

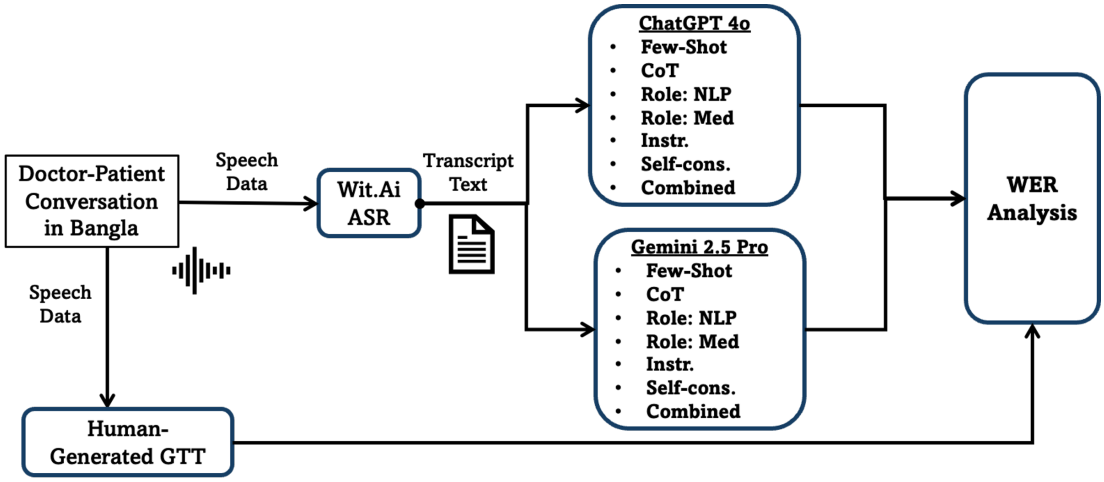

Fig. 1. Overview of the evaluation pipeline: ASR transcripts from Wit.AI are corrected using ChatGPT 4o and Gemini 2.5 Pro with seven prompt types. Outputs are compared to human-generated ground truth to compute WER for performance analysis.

outperforming baseline ASR models in zero-shot setups [6]. Similarly, Matasyoh et al. (2024) used surgical-domain few-shot prompts to reduce WER by 64.3% on Whisper transcripts (from 11.93% to 4.26%) and by 37.8% on another ASR system, with GPT-4 consistently outperforming GPT-3.5 [12]. Zeng et al. (2024) found LLMs prone to over-correction in advanced learner texts, showing high recall (0.585) but low precision (0.497); few-shot prompts with proficiency-matched examples reduced recall (0.543), improved precision (0.606), and led to more balanced and conservative edits, achieving state-of-the-art GEC with GPT-4 [13]. He et al. (2023) introduced PivotFEC, improving SARI by 11.3 points over distantly supervised methods and by 7.9 points over direct few-shot LLM FEC, by using factual error injection as a pivot task [14]. GPT-4o also demonstrated strong potential in surgical oncology applications [15]. In the clinical domain, Savage et al. (2024) showed that GPT-4, when guided with Chain-of-Thought and role-based prompts, reached 91.3% diagnostic accuracy while offering interpretable reasoning [16]. Sonoda et al. (2025) demonstrated that a two-step prompt—first summarizing findings, then reasoning to a diagnosis—boosted radiology accuracy from 56.5% to 60.6%, with prompt framing (e.g., journal quiz style) enhancing performance, while misleading cues degraded it [17]. For Indic languages, Ghosal et al. (2024) introduced PromptRefine, selecting diverse few-shot examples from related high-resource languages, improving translation and QA performance across tasks without fine-tuning [18]. Lastly, Cahyawijaya et al. (2024) showed that cross-lingual query alignment outperformed label translation in 25 low-resource languages, boosting accuracy by up to 5–8% and reinforcing the importance of semantically aligned prompts in LLM-driven low-resource NLP [19].

III. Experimental Environment

This section explains the fundamentals of the evaluation metric WER, a brief explanation of the speech data in use, the LLM models used, the ASR system, the types of prompt engineering attempted and the experimental approach to generate the ground truth texts.

A. Experimental Setup

The experimental setup (Fig. 1) used Meta's ASR tool Wit.Ai, Google Colab, and GPT-4o and Gemini 2.5 Pro for transcript correction. Seven prompt strategies were designed based on prior studies to align with human-generated GTTs and reduce hallucinations—irrelevant or off-topic content [20]. Both models were tested on the same 10 ASR transcripts using identical prompts to ensure fair WER comparison.

B. Speech Dataset

Speech data was collected from 10 doctor-patient consultations conducted via the Portable Health Clinic (PHC) system [21] at a school in Dhaka, Bangladesh. The conversations, held over Zoom with audio and video, were mainly in Bangla with some English medical terms. Sessions covered greetings, health history, symptoms, diagnosis, and recommendations, lasting between 44 seconds and 7 minutes 30 seconds. Doctors used personal smartphones, while patients were recorded from a school setup, resulting in clearer doctor audio and noisier patient audio.

C. Word Error Rate

Word Error Rate is a standard metric for evaluating ASR accuracy, calculated by comparing the ASR output to a reference transcription. It measures the ratio of total errors to the number of words in the reference, with errors classified as Substitutions (S), Insertions (I), and Deletions (D). A lower WER indicates higher transcription accuracy. Equation 1 shows the WER formula.

$$\text{WER} = \left(\frac{S + D + I}{N}\right) \tag{1}$$

TABLE I
WER SCORES ACROSS 10 TRANSCRIPTS FOR CHATGPT 4O AND GEMINI 2.5 PRO USING SEVEN PROMPT TYPES

File	ChatGPT 4o							Gemini 2.5 Pro						
	Few-Shot	CoT	Role:NLP	Role:Med	Instr.	Self-cons.	Combined	Few-Shot	CoT	Role:NLP	Role:Med	Instr.	Self-cons.	Combined
1.wav	0.4927	0.3317	0.3122	0.5024	0.3024	0.4244	0.2829	0.3268	0.4439	0.3317	0.3171	0.3415	0.3366	0.3073
2.wav	0.4793	0.3223	0.4050	0.4463	0.3140	0.3636	0.3884	0.3554	0.3554	0.3967	0.3802	0.4463	0.3884	0.3471
3.wav	0.6547	0.4388	0.5036	0.5540	0.4892	0.5540	0.4532	0.4676	0.4748	0.4748	0.5324	0.5036	0.5036	0.4748
4.wav	0.4219	0.2969	0.3125	0.3125	0.3125	0.3281	0.3125	0.2500	0.3015	0.2813	0.2813	0.2656	0.2969	0.2656
5.wav	0.8276	0.2192	0.2266	0.6552	0.3892	0.4458	0.2734	0.3966	0.3695	0.4015	0.4557	0.3842	0.4212	0.4015
6.wav	0.8203	0.3464	0.3516	0.6563	0.4401	0.6354	0.4531	0.3958	0.3880	0.3880	0.4427	0.3906	0.4036	0.4010
7.wav	0.8499	0.4974	0.7718	0.8911	0.6691	0.9003	0.8263	0.3438	0.3930	0.4450	0.5005	0.4502	0.4553	0.4306
8.wav	0.7474	0.4246	0.3544	0.7053	0.4000	0.6982	0.6386	0.3404	0.3544	0.3404	0.3719	0.3474	0.3509	0.3404
9.wav	0.8464	0.4115	0.3385	0.7995	0.5208	0.8906	0.7656	0.3594	0.3724	0.3776	0.4167	0.3724	0.4010	0.3828
10.wav	0.7325	0.4529	0.4498	0.7356	0.5502	0.8055	0.7295	0.3647	0.3830	0.3647	0.4529	0.3739	0.3921	0.3982
Average	**0.6873**	**0.3742**	**0.4026**	**0.6336**	**0.4388**	**0.6046**	**0.5124**	**0.3696**	**0.3889**	**0.3802**	**0.4151**	**0.3876**	**0.3950**	**0.3749**

D. LLM Model

ChatGPT-4o, based on the GPT-4 Turbo (Omni) architecture, is a fast, multimodal LLM supporting advanced prompting and multilingual understanding, including low-resource languages like Bangla [22]. Gemini 2.5 Pro, built on the Gemini 1.5 architecture, offers strong long-context reasoning and multimodal support, with prompt-based adaptability for LRLs like Bangla [23].

E. Prompt Engineering Methods

This section provides a brief introduction and the designated addressing terms in the experiment of the 7 prompt engineering methods.

- **Few-Shot Prompting (Few-Shot):** This approach provides the model with a few input-output examples of ASR corrections, enabling it to learn the correction pattern through demonstration before applying it to new transcripts.
- **Chain-of-Thought Prompting (CoT):** This method guides the model to reason step-by-step, encouraging it to identify and fix errors logically by breaking down the transcript analysis into smaller, interpretable steps.
- **Role Prompting as a Natural Language Processing Engineer (Role:NLP):** The model is instructed to assume the role of an NLP expert with knowledge of ASR and transcription, prompting it to focus on language structure, error types, and correction rules.
- **Role Prompting as a Medical Professional and Transcription Specialist (Role:Med):** Here, the model is asked to take on the role of a domain expert familiar with medical terminology and conversational patterns in clinical settings, allowing for contextually accurate corrections.
- **Instruction Prompting (Instr.):** A directive style prompt that provides clear, rule-based instructions for correcting transcripts, such as preserving English terms, maintaining word count, and avoiding contextual changes.
- **Self-Consistency Prompting (Self-cons.):** This technique prompts the model to generate multiple correction candidates and converge on a final output by identifying the most consistent and plausible solution among them.
- **Combination Prompt (Combined):** A hybrid strategy that integrates elements from few-shot, role-based, and chain-of-thought prompting to combine example-based learning, contextual awareness, and structured reasoning for optimal correction performance.

F. ASR System

Wit.Ai, developed by Meta, is one of the few ASR tools supporting the low-resource language Bangla. Experimental results show it outperforms similar tools in Bangla medical conversations. It is open-source, available on GitHub, and integrates via API.

IV. RESULT AND DISCUSSION

This section elaborates on the findings of the experiment and conducts a comparative analysis based on prompt methods and LLM models. For reference, the average WER observed without any prompt-based optimization was **0.4169**.

A. Overall Performance Comparison Between Models

A detailed analysis of WER values presented in Table I and visualized in Figure 2 reveals a clear performance distinction between ChatGPT 4o and Gemini 2.5 Pro in correcting ASR-generated transcripts. Gemini outperforms ChatGPT across 6 of the 7 prompt types, achieving a lower overall mean WER of **0.3876** compared to ChatGPT's **0.4388**. This suggests that Gemini is not only more accurate on average but also more robust across different prompting conditions. The only exception is the Chain-of-Thought prompt, where ChatGPT marginally surpasses Gemini with a mean WER of **0.3742** versus **0.3889**.

B. Prompt Effectiveness: Few-Shot for Gemini, CoT for ChatGPT

The most effective prompting strategy differs significantly between the two models. For Gemini, the best performance is achieved using **Few-Shot Prompting**, with the lowest

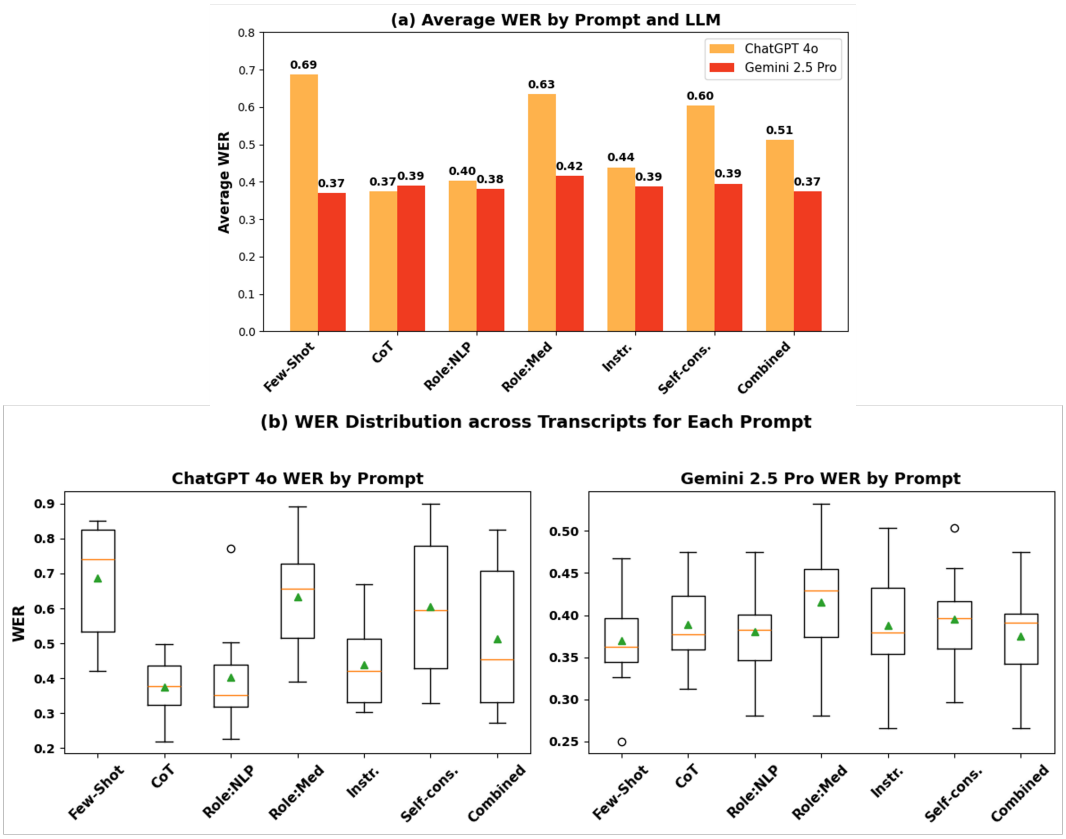

Fig. 2. (a) Bar chart showing average WER across seven prompts for ChatGPT 4o and Gemini 2.5 Pro, (b) Boxplots showing WER distribution across 10 transcripts for each prompt and model

WER of **0.3696**. In contrast, ChatGPT performs worst under the same Few-Shot configuration, recording a WER of **0.6873**, its highest across all prompt types. However, when guided through a **Chain-of-Thought (CoT)** prompt, ChatGPT demonstrates its best performance with a WER of **0.3742**. This divergence highlights how Gemini benefits most from example-based instruction, whereas ChatGPT requires logical scaffolding to achieve optimal results. The stark contrast under Few-Shot prompting—**0.6873** for ChatGPT vs. **0.3696** for Gemini—emphasizes the importance of aligning prompt design with model behavior.

C. Combined Prompt Performance and Role-Based Observations

The **Combined Prompt**, which integrates Few-Shot, Role, and Chain-of-Thought elements, yields strong performance in both models. Gemini achieves a WER of **0.3749**, its second-best score, while ChatGPT records **0.5124**, ranking this prompt as mid-level in performance. Role-based prompts produced mixed results. For ChatGPT, the **Role:NLP** prompt results in a WER of **0.4026**, whereas the **Role:Med** prompt leads to a much higher WER of **0.6336**. Similarly, Gemini achieves **0.3802** under Role:NLP and **0.4151** under Role:Med. These outcomes suggest that while role framing can help, it must be carefully crafted—especially in medical contexts where loosely defined roles may introduce ambiguity rather than clarity.

D. Visual Insights from Figure 2: WER Distribution and Variability

Figure 2 supports the trends shown in Table I. The bar chart (left) shows ChatGPT's higher WERs across most prompts, especially Few-Shot (**0.69**), while Gemini achieves lower values for Few-Shot and Combined prompts (both **0.37**). The boxplots (right) highlight consistency differences: ChatGPT shows wide variability and high medians—up to **0.75** in Role:Med and Self-Consistency—while Gemini maintains tight distributions and lower medians across all prompts. The close alignment of Gemini's mean and median WERs further reflects its stability.

V. Observation and Future Prospect

A. Key Insights from Experimental Findings

The results show clear differences in LLM responses to prompts. **Gemini 2.5 Pro outperformed ChatGPT 4o** in 6 of 7 strategies, with its best WER at **0.3696** using Few-Shot prompting. ChatGPT performed worst under the same prompt (**0.6873**) but best with Chain-of-Thought (**0.3742**), showing its reliance on structured reasoning. The Combined prompt was effective for both, especially Gemini (**0.3749**). Figure 2 and

Table I support Gemini's consistently lower and more stable WER.

B. Limitations and Contributing Factors

While promising, this study has limitations. It used only **10 doctor-patient consultations**, limiting diversity in age, dialects, and conditions. Recordings via Zoom led to **noisy patient-side audio**, affecting ASR quality. The ASR system (Wit.Ai) was used without tuning, possibly introducing baseline errors. Evaluation was based solely on **WER**, which overlooks semantic and clinical accuracy. Future work should use broader datasets and more comprehensive metrics.

C. Future Directions for Healthcare Applications

The results suggest strong potential for using prompt-based LLM correction in **automated transcription pipelines for telemedicine**, particularly in low-resource languages like Bangla. This method could be embedded in **EHR systems** to support structured documentation with minimal human intervention. Future developments could include **domain-adaptive prompting** (e.g., for pediatrics or cardiology), **multilingual support** for code-switching contexts, and integration with ASR confidence scores or clinician feedback for real-time correction and validation. With proper tuning, this approach can support scalable, accurate, and trustworthy speech-based data entry in global healthcare systems.

VI. Conclusion

This study explores using Large Language Models (LLMs) to generate Ground Truth Transcriptions (GTTs) for Bangla ASR outputs in healthcare. Seven prompt strategies—Few-Shot, Chain-of-Thought, Self-Consistency, Instruction, Role-based, and Combined—were tested on GPT-4o and Gemini 2.5 Pro. Ten doctor-patient transcripts from the Wit.Ai ASR system were evaluated using Word Error Rate (WER). Gemini performed best with Few-Shot prompting (**0.3696**), while GPT-4o's lowest WER came from Chain-of-Thought prompting (**0.3742**). The Combined prompt yielded balanced performance for both. These findings demonstrate that prompt-tuned LLMs can reduce manual transcription workload and support scalable ASR correction for low-resource healthcare applications.

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Expanding Access to Rural Eyecare Through Telemedicine using Portable Health Clinic: A Case Study from Bangladesh

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Abstract
This paper presents a case study on the implementation of a teleophthalmology module within the Portable Health Clinic (PHC) system to address the eyecare gap in rural Bangladesh. Developed by Grameen Communications and Grameen Healthcare Services, in technical collaboration with Kyushu University, Japan, the Tele-eyecare Module empowers community health workers to conduct standardized vision screening, refraction, and preliminary examinations, while enabling remote consultation and follow-up with ophthalmologists. The service is delivered through 15 community-based vision centers operated under four partner eyecare hospitals, covering 12 underserved districts. The system integrates electronic health records (EHRs) with eyecare diagnostic data, ensuring continuity of care and effective referral pathways. Between 2021 and 2024, the program reached more than 159,000 patients, providing affordable and timely eyecare services in rural areas. Findings indicate significant improvements in access, early diagnosis, and cost-effectiveness. This case study demonstrates how localized, ICT-enabled service delivery models can strengthen healthcare systems and reduce inequities in low-resource settings.

Index Terms
Telemedicine, Teleophthalmology, Rural Healthcare, Portable Health Clinic, Bangladesh, Vision Screening, Digital Health, Electronic Health Records

I. Introduction

Preventable visual impairment remains a pressing public health issue in Bangladesh, particularly in rural regions where access to ophthalmologists and specialized eyecare services is severely limited. Despite global advances in digital health, eyecare in underserved areas has lagged due to infrastructure, resource, and mobility challenges.

To address these barriers, Grameen Communications and Grameen Healthcare Services, with support from Kyushu University, developed a Tele-eyecare Module integrated into the existing Portable Health Clinic (PHC) system. This initiative aims to bridge the healthcare divide through digital infrastructure, trained frontline health workers, and remote medical expertise. This paper explores the design, deployment, and outcomes of this model as implemented in 12 rural districts of Bangladesh from 2021 to 2024, offering insights into its scalability, impact, and future direction.

II. Background and Related Work

Teleophthalmology—the use of telemedicine for delivering eyecare—has shown promise in regions with high patient demand but limited specialist availability. Previous studies across India, Sub-Saharan Africa, and Southeast Asia have shown improved diagnosis rates and cost efficiency. However, few implementations have addressed the full spectrum of rural challenges in LMICs, including connectivity, patient recordkeeping, and service integration.

The PHC model, originally developed as a modular health delivery system, was adapted to include eyecare in this initiative. Unlike generic telemedicine platforms, this system ensures:

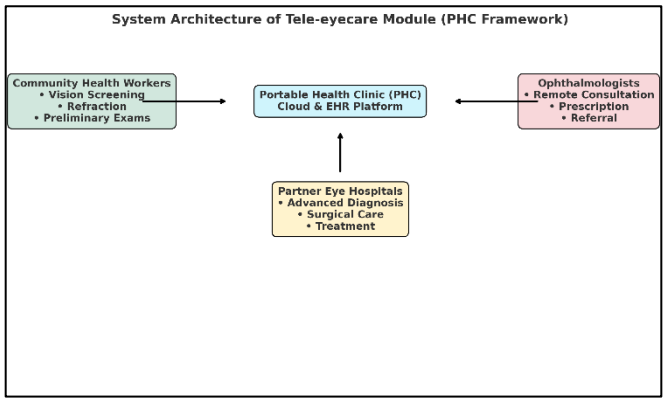
• Integration with EHRs for continuity of care,

• Offline data syncing for low-connectivity areas,
• Protocol-based screening and consultation processes,
• Localized training of non-specialist staff for early-stage triage.

III. Methodology

A. System Architecture

The Tele-eyecare Module is a cloud-supported, portable diagnostic system embedded within the PHC framework. Community health workers collect vision data using standardized digital tools, including:
• Visual acuity tests,
• Refraction analysis (automated or manual),
• Preliminary ophthalmic evaluations,
• Integration with fundus cameras where available.
Patient records, test results, and glass prescriptions are digitized and synchronized with the PHC central EHR platform. Remote ophthalmologists then review the case, conduct virtual consultations (via mobile or desktop interfaces), and issue prescriptions or referrals.



B. Implementation Regions

From 2021 to 2024, the system was deployed across 12 rural districts:
Panchagarh, Thakurgaon, Nilphamari, Joypurhat, Bogura, Jhalkathi, Barishal, Pirojpur, Satkhira, Jessore, Khulna, Sirajganj.

IV. Results

Table 1. Annual patient coverage of the Tele-eyecare Module

Year	Patients Served
2021	379
2022	36,180
2023	52,463
2024	70,271 (as of June)
Total	159,293

A. Key Outcomes

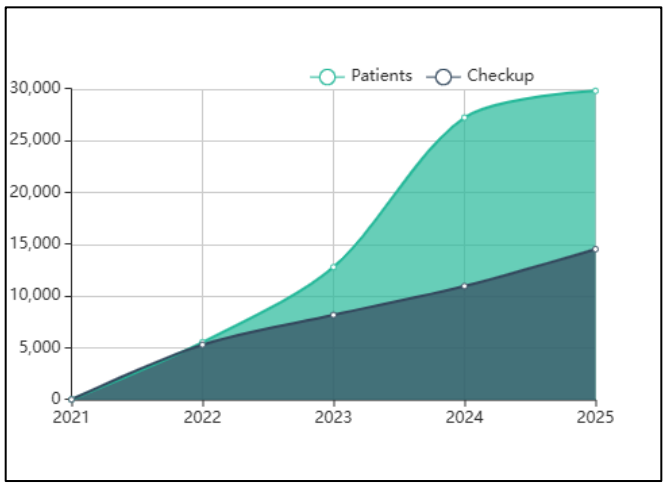
• Coverage: 12 districts reached through mobile PHC units.
• Efficiency: Reduced average waiting time for specialist consultations from weeks to 24–48 hours.
• Accuracy: Improved diagnostic precision through standardized protocols and specialist review.
• Satisfaction: High user satisfaction reported, particularly among elderly patients and low-income households (formal survey pending).

V. Discussion

The Tele-eyecare Module within the PHC framework has demonstrated significant potential to transform rural eyecare delivery in Bangladesh. The integration of portable diagnostic tools with a centralized EHR system has enabled frontline health workers to perform accurate preliminary screenings, thereby addressing the shortage of ophthalmologists in remote areas. The rapid increase in patients served—from under 400 in 2021 to over 70,000 by mid-2024—highlights the scalability and growing acceptance of teleophthalmology services. The reduction in consultation wait times to 24–48 hours also suggests improved efficiency in managing patient flow and specialist workload. Moreover, the user satisfaction among elderly and low-income populations underscores the system's accessibility and affordability. Challenges remain, such as ensuring consistent internet connectivity in extremely remote regions, training sustainability for health workers, and integration with broader healthcare policies. Future improvements may include AI-assisted diagnostics and expanding eyecare services to include more advanced treatments remotely.

VI. Conclusion & Future Work

This case study illustrates how ICT-enabled, context-aware telemedicine solutions can effectively bridge healthcare gaps in low-resource settings. The success of the Tele-eyecare Module under the Portable Health Clinic model in Bangladesh demonstrates that combining technology with local capacity building can enhance access, affordability, and quality of eyecare. Future work will focus on expanding geographic coverage, refining diagnostic capabilities through AI integration, and conducting comprehensive patient outcome studies. Additionally, efforts will be made to strengthen collaborations with government health agencies to embed teleophthalmology more fully into national health systems.



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Sustainability of Digital Health Entrepreneurship in Bangladesh: A Review of Current Evidence

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***Abstract*—Approximately 98 out of 100 HealthTech startups fail, despite the sector's strong market potential. While digital health offers significant opportunities to transform healthcare delivery in resource-limited settings—particularly in developing countries—the sustainability of these ventures remains uncertain. Digital health can bridge critical healthcare gaps through innovative solutions, and many young entrepreneurs are entering the space with enthusiasm. However, important questions arise: Are these entrepreneurs aware of the long-term sustainability challenges? How will these businesses survive in the long run? Are current policies, government support, and other ecosystem components conducive to sustaining digital health enterprises? Sustaining such ventures remains a major challenge due to policy fragmentation, limited funding opportunities, infrastructure deficits, and workforce constraints. This review assesses the current landscape of digital health entrepreneurship in Bangladesh, using the WHO-ITU National eHealth Strategy Toolkit to evaluate sustainability across key domains: governance, investment, service delivery, interoperability, infrastructure, and human resources. The SPIDER tool was used to guide evidence selection aligned with the study's objectives. Key findings highlight both systemic barriers and emerging enablers, such as hybrid care models, increasing investor interest, and agent-based delivery innovations. This study provides actionable insights for entrepreneurs, policymakers, and investors aiming to build a resilient and scalable digital health ecosystem in Bangladesh and other LMICs.**

***Index Terms*—Digital Health, Health Entrepreneurship, Sustainability, Developing Country, eHealth, LMICs, HealthTech Startup**

I. Introduction

Although the global digital health market is expanding rapidly, sustainability remains a significant challenge for startups. Globally, 98 out of 100 health tech startups fail to survive in the long run. Approximately 60% of them fail within the first five years, and even among those that receive venture capital funding, nearly 75% do not achieve long-term sustainability [1], [2]. This high failure rate is not only a global phenomenon but is also prevalent in developing countries like Bangladesh. Approximately 90% of tech startups in Bangladesh fail within 2 to 5 years, including many in the health-tech sector [3].

In resource-constrained settings, digital health has the potential to play a transformative role. Developing countries often face critical challenges such as limited healthcare infrastructure, shortages in the healthcare workforce, high out-of-pocket health expenditures, and persistent health inequities. In such contexts, the advancement of mobile technologies, cloud computing, artificial intelligence (AI), and big data analytics presents new opportunities to strengthen healthcare delivery systems and expand access to care [4].

Bangladesh, with a population exceeding 170 million and rapidly increasing smartphone penetration, offers fertile ground for digital health innovation [5]. Over the past decade, the country has witnessed the rise of numerous health tech startups, telemedicine platforms, and mobile health (mHealth) initiatives. These ventures aim to bridge healthcare gaps by offering remote consultations, diagnostic support, health education, preventive health screening, and data-driven care coordination [6].

Despite these promising developments, sustaining digital health initiatives beyond pilot phases remains a pressing concern. Many of these ventures face challenges such as limited access to long-term funding, weak regulatory frameworks, low digital literacy among users, and scalability issues. While several studies have examined the implementation and impact of digital health interventions in Bangladesh, few have systematically addressed the sustainability of entrepreneurial ventures in this domain.

In this context, sustainability refers to financial viability, technological scalability, user adoption, and alignment with national health system priorities [7]. A focused review of existing evidence is needed to better understand the challenges faced by digital health startups in Bangladesh and to identify the key enablers of long-term sustainability.

The objective of this paper is to review the current literature on digital health entrepreneurship in Bangladesh, assess the factors influencing sustainability, and provide actionable insights for entrepreneurs, policymakers, and investors aiming to support resilient health innovation ecosystems in low- and middle-income settings.

II. Literature Review

Digital health entrepreneurship has grown sustainability worldwide, driven by the integration of mobile apps, telemedicine, artificial intelligence (AI), and Internet of Things

(IoT) technologies into health systems [8]. In low-and middle-income countries (LMICs), this growth is often seen as a pathway to overcome longstanding barriers to healthcare access, such as workforce shortages, high costs, and geographic isolation [9]. Startups in digital health typically offer services such as remote consultations, Ai-based diagnostics, and digital patient management platforms. Despite the innovation, startup survival remains a global concern. A report by CB insights found that 70% of health startups fail due to business model issues, lack of market need, or regulatory hurdles [10]. In LMICs, challenges are amplified by infrastructural limitations, digital illiteracy, and low institutional support [11].

Bangladesh has witnessed a growing number of health tech startups in recent years. These include platforms like Praava Health, Maya, Arogga, MedEasy, DoctorKoi, Shukhee, Pulse, Zaynax Health, CMED Health, Portable Health Clinic (PHC) etc., which provide a range of digital services such as virtual consultations, electronic prescriptions, and health education through mobile apps and call centers [12], [13]. The COVID-19 pandemic further accelerated the adoption of digital health tools across the country. During lockdown periods, the use of telemedicine services increased, and new players entered the market to meet the growing demand [14]. Government-led platforms such as the Health Information System (HIS) and DHIS2 have also contributed to improving digital health data management, though still at a limited scale [15].

Despite these advancements, many initiatives have struggled to transition from pilot projects to sustainable and scalable businesses. Several startups have disappeared from the market—some without gaining public recognition—while others have pivoted through mergers, collaborations, or strategic shifts. Sustainability is essential for remaining in the market and achieving both economic viability and social impact.

Sustainability in digital health entrepreneurship refers to a startup's ability to maintain operations, scale solutions, meet user needs, and remain financially viable [16]. Key factors influencing sustainability include financial viability, technological infrastructure, policy and regulation, human resource capacity, and trust and cultural acceptance [17].

Although various studies have documented the rise of digital health in Bangladesh, few have systematically analyzed the sustainability of these entrepreneurial ventures. Most of the existing literature focuses either on the technical deployment of digital tools or the short-term outcomes of specific projects, without assessing long-term business viability or scalability. Moreover, there is limited empirical evidence on how different funding models, regulatory environments, and user behaviors affect the survival and growth of health startups in the Bangladeshi context.

This study seeks to bridge this gap by synthesizing existing evidence on digital health entrepreneurship in Bangladesh through the lens of sustainability. It focuses on financial, technological, organizational, and systemic dimensions. By identifying key barriers and enablers, this review aims to guide stakeholders—including entrepreneurs, policymakers, and investors—toward supporting a more durable and impactful innovation ecosystem in the country.

III. Methodology

This study adopted a qualitative, narrative review approach to synthesize existing evidence on the sustainability of digital health entrepreneurship in Bangladesh. The goal was to identify key challenges, success factors, and contextual enablers by systematically analyzing scholarly literature, policy documents, and grey literature. Guidelines from established qualitative review methodologies, including the SPIDER tool (Sample, Phenomenon of Interest, Design, Evaluation, Research type), were followed, as it is commonly used for qualitative evidence synthesis in health and social sciences [18]. This approach allowed for a broad yet structured inclusion of studies relevant to the phenomenon of interest, sustainable digital health entrepreneurship in the Bangladeshi context.

Literature was retrieved from academic databases such as PubMed, IEEE Xplore, Scopus, ScienceDirect, and Google Scholar, using search terms including: "digital health entrepreneurship", "digital health initiatives in developing countries", "health tech startups", "Bangladesh", "Sustainability", and "e-health". Reports and case studies from organizations like WHO, BRAC, a2i, and the Ministry of Health and Family Welfare (MoHFW) were also included. Studies were included if they: Focused on digital health initiatives or startups in Bangladesh; Discussed aspects of sustainability (financial, technological, policy-related, or organizational); Were published between 2015 and 2025; Were in English. A total of 42 documents met the inclusion criteria and were reviewed.

To guide the analysis, we used the WHO-ITU National eHealth Strategy Toolkit as a conceptual framework [19]. This framework assesses sustainability across dimensions such as leadership and governance, strategy and investment, services and applications, infrastructure, standards and interoperability, and human capacity. Themes from the reviewed literature were mapped onto this framework to identify recurring patterns, gaps, and strategic opportunities. This approach enabled a structure interpretation of diverse sources and supported the development of actionable insights for stakeholders involved in digital health innovation in Bangladesh.

IV. Results

Digital health entrepreneurship presents a promising market in Bangladesh, projected to reach a volume of USD 849.26 million by 2029 [20]. The Bangladeshi healthtech ecosystem is segmented into four main categories: Well-being (55%), Diagnostic services (23%), Pharmacy (14%), and Doctor's consultancy (9%), as shown in Figure 1. The COVID-19 pandemic significantly accelerated digital health adoption, with consumers increasingly trusting telemedicine, e-pharmacies, and online consultation platforms. Healthtech now ranks as the third most preferred sector among investors, with 67% of venture capital firms favoring it. The increasing availability of AI, cloud-based health records, and health analytics is expected to transform preventive healthcare delivery [21]. Startups such as Praava Health, CMED, Maya, and Arogga have

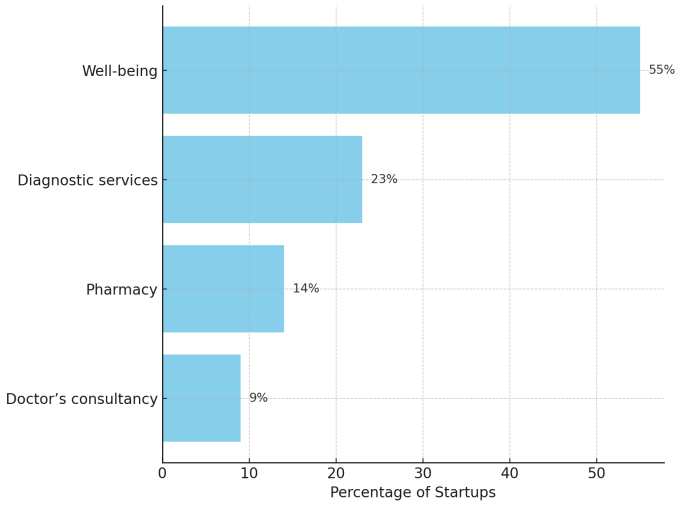

Fig. 1. Segmentation of HealthTech startups in Bangladesh

gained traction using hybrid models that combine virtual care with doorstep services. Additionally, agent-based models (e.g., Info-lady, AmarLab) are emerging as innovative approaches to bridge the digital divide in rural areas. The sector is projected to become a mature industry within the next few years, with telemedicine, insurance integration, and AI applications poised to play critical roles in shaping its future trajectory.

The findings are structured around themes that emerged from a qualitative synthesis of selected literature, using the SPIDER Tool to give evidence selection and the WHO-ITU National eHealth Strategy Toolkit to frame the analysis. The toolkit's six core building blocks-Leadership and Governance, Strategy and Investment, Services and Applications, Standards and Interoperability, Infrastructure, and Health Workforce provided a lens for mapping challenges and enablers related to sustainability of digital health entrepreneurship in Bangladesh. A summary of these challenges is presented in Table I.

A. Leadership and Governance

There is an increasing policy focus on digital health in Bangladesh, but fragmented governance across ministers and absence of startup-oriented digital health regulations are major barriers. For instance, entrepreneurs struggle with licensing, approval delays, and unclear accountability structures [22], [10]. This regulatory ambiguity leads to high-risk perceptions among investors and hinders public-private collaboration. *"Coordinated governance and dedicated policy frameworks are essential to reduce operational fiction and increase investor confidence in digital health ventures."*

B. Strategy and Investment

Some health-tech startups established by donor fund, research grant or CSR funds and their long term sustainability remains uncertain [23], [24]. While government initiatives like Startup Bangladesh have helped inject capital into the ecosystem, most funding is short-term, grant-based, and lacks continuity. *"Financial sustainability demands venture pathways beyond grants such as impact investment models, hybrid revenue streams, and long-term capital instruments tailored to health innovation."*

C. Services and Applications

Bangladesh startups offer a broad array of services: virtual consultations (Praava, MedEasy), Ai-Driven triage (Maya, PHC), e-pharmacy delivery (Arogga), and preventive health programs (PHC, CMED) etc. However, low digital literacy, limited trust, and urban bias restrict adoption and repeat usage, particularly in rural communities [22], [25]. *"Entrepreneurs must co-design culturally relevant, language-accessible services, while policymakers should support digital health literacy programs to expand user engagement."*

D. Standards and Interoperability

Most private startups operate in data silos, with minimal integration into public health infrastructure like DHIS2 or the Health Information System (HIS). This limits potential for scale, public-private collaboration, and population health monitoring [22]. *"Standards for interoperability and health data exchange must be mandated and incentivized to improve collaboration and facilitate ecosystem-wide scale-up."*

E. Infrastructure

Despite strong mobile and internet penetration in urban Bangladesh, infrastructure bottlenecks-including patchy rural networks and low smartphone ownership, impede service access and scalability [22], [26]. Many startups are unable to maintain up-time and reliability in resource-poor areas, leading to poor user retention. *"Infrastructure equity (connectivity, device affordability) should be a joint invetment focus for government, telcos, and impact investors to ensure inclsuive digital health delivery."*

F. Health Workforce

Digital health startups often face a skills mismatch, tech entrepreneurs lack health system knowledge, while health workers resist adopting unfamiliar tools. There is also limited training in areas like health informatics, UX for health platforms, and digital ethics [27], [22]. *"Capacity-building programs should target both startup teams and health professionals to align workforce capabilities with digital transformation goals."*

V. Discussion

This review highlights that while digital health entrepreneurship in Bangladesh is expanding, its sustainability remains fragile due to systemic challenges—particularly in governance, financing, and infrastructure. These findings align with existing literature from other LMICs, where startups face similar issues [11], [28]. From a systems perspective, the absence of national mHealth policies and limited involvement of public health authorities hinder scalability and long-term sustainability. Aamir et al. (2018) found that digital health efforts are often treated as non-priority initiatives in resource-constrained

TABLE I
SUSTAINABILITY CHALLENGES MAPPED TO WHO-ITU FRAMEWORK

WHO-ITU Domain	Key Sustainability Challenges in Bangladesh
Leadership & Governance	Fragmented digital health policies; lack of startup-specific regulatory pathways; inter-ministerial overlap
Strategy & Investment	Dependency on donor funding; limited venture capital access; lack of scalable, sustainable business models
Services & Applications	Poor user trust; low digital literacy; urban-centric design; lack of service localization
Standards & Interoperability	Data silos; minimal API or system integration with national health infrastructure (e.g., DHIS2)
Infrastructure	Urban–rural digital divide; weak internet access in rural areas; affordability of smartphones and data
Health Workforce	Limited digital skills among providers; resistance to change; lack of capacity-building for digital innovation

settings, lacking alignment with national strategies and proper infrastructure support [29]. Additionally, limited digital skills among frontline health workers, poor internet connectivity, and lack of design flexibility further inhibit adoption and scale-up. Nonetheless, Bangladesh shows potential through increasing mobile penetration and early experimentation with digital health startups. As the Wellcome Open Research study notes, targeted digital tools can strengthen healthcare delivery and data collection when appropriately integrated into national systems and tailored to local user needs. The lack of comprehensive digital health regulations, as also observed in other countries, continues to constrain scale-up efforts and investor confidence [30]. Yet, the findings also point to enabling conditions unique to Bangladesh, such as growing mobile penetration, early government interest, and grassroots experimentation. However, as in other LMIC contexts, success will depend on whether stakeholders can transition from project-based innovations to integrated, policy-supported systems that align with national health goals. Importantly, this study addresses a gap in existing literature by applying a structured framework to assess sustainability across multiple dimensions—financial, technological, organizational, and policy-related. While earlier research has focused on implementation and outcomes of digital tools, few have examined startup viability through a systems-level lens.

VI. CONCLUSION

This study assessed the current state of digital health entrepreneurship in Bangladesh, focusing on sustainability through the lens of the WHO-ITU National eHealth Strategy Toolkit. While digital innovation in the country shows promise—driven by increasing mobile penetration and growing startup activity—challenges in governance, financing, infrastructure, and workforce capacity continue to limit long-term viability. Key findings emphasize the need for coordinated policy frameworks, more resilient funding models, and improved system integration to support the scale and sustainability of health tech ventures in low-resource settings. This study has certain limitations. It followed a narrative review methodology; future studies could employ systematic reviews or meta-analyses for more robust evidence synthesis. Additionally, longitudinal research could track startup journeys over time to better understand enablers, inflection points, and failure dynamics within the digital health ecosystem. By identifying key gaps and opportunities, this study offers actionable insights for entrepreneurs, policymakers, and investors seeking to strengthen digital health entrepreneurship in Bangladesh and other LMICs.

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Accepted Poster Presentations

School Zone Object Detection Using Deep Learning For Child Safety

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1. Background of the Research: Children are more likely to have accidents during school hours because they are slower and less alert than adults. In particular, careless accidents are more likely to happen on the way to school. Therefore, more specific information should be proposed for safety management in front of schools.

2. Research Objectives: Stop lines, traffic signals, speed bumps, traffic signs, speed cameras, yellow carpets, and pedestrian crossings are used to reduce school zone crashes. However, they can't completely prevent school zone accidents. Since there is no system that can inform drivers about school zones in advance, an AI-based accident prevention system that can recognize traffic conditions in school zones is needed. In other words, AI-based technology that can prevent traffic accidents by informing drivers about pedestrians in advance is needed[1].

3. Research Problem/ Research Questions: In the traditional rule-based method, the user models a filter that removes noise from the image to effectively detect objects. However, the disadvantage of this rule-based method is that new filter modeling is required depending on the focal length of the image, the effects of the shooting environment, the shooting quality, the resolution, and so on. In addition, the cameras developed to compensate for this are capable of capturing high resolution images, but are very expensive and therefore not economically viable. To improve the overall performance of these interpretative object detection methods, it is very important to know the statistical characteristics of the target image in advance in order to estimate the relevant parameters appropriately, which usually requires a rather complex implementation to identify additional features of the objects and incorporate them into the design of the algorithm. These analytical approaches have the disadvantage of being inelastic compared to deep learning based methods, which are less robust and can continuously improve their accuracy with additional data, especially when the characteristics of the target images vary due to climatic characteristics[2].

4. Approach: To compensate for the limitations of traditional techniques, the need for analysis techniques using machine learning such as SVM and KNN[3,4] has become prominent. The SVM is a classification algorithm that classifies two or more pieces of data and is expected to have high generalization performance. The KNN algorithm is a popular method for classification purposes because of its low training effort. Deep learning[3] has become more prominent in recent years, and related research has been actively conducted. In particular, there have been recent studies on how to inspect and analyze the appearance of large-scale infrastructure using deep learning-based image processing techniques [5].

5. Experiment/Methodology: We have tested many different popular deep learning models such as YOLO and Detectron. YOLO [2], one of the deep learning models that perform object recognition based on CNN. YOLO is a model that focuses on object detection, dividing the image into a grid and simultaneously predicting the bounding box and class probability of the object within each grid cell, and is particularly effective for real-time object detection, providing high accuracy and fast processing speed. In this study, we developed a deep learning method and image processing method that can effectively and quickly detect objects and analyze the characteristics of objects in school zones, and verified the performance of the developed method for practical application.

6. Results: The dataset used in this experiment is an object dataset consisting of 1213 camera images taken in 2024 and published on Roboflow, which is aimed at object detection. It is a dataset of RGB images annotated in Coco format and resized to 640 x 640. It is also pre-processed with 50% horizontal flip and 50% vertical flip. Out of the

total images, 87% images were used as training dataset for training, 8% images were used as validation dataset for hyperparameter tuning, and 5% images were used as test dataset for final performance evaluation of the model. The dataset is classified into nine types of objects: child, green light, parking sign, red light, school zone, slow sign, traffic light, and background. Figure 2 is an example image of the data set.

Fig. 2. Example images

We trained Yolo, which is often used for image processing via CNN, on the imported dataset. The Yolo model consists of 285 layers, including convolutional, block, and connection layers, and 2.7 million parameters tuned through training. After training the model, the learning progress graphs of Yolo v10 are shown in Figure 2. The training time required to achieve similar performance generally varied with hyperparameters such as batch size, epoch, and optimize. The model has approximately 5.5ms inference time after 0.3ms preprocessing.

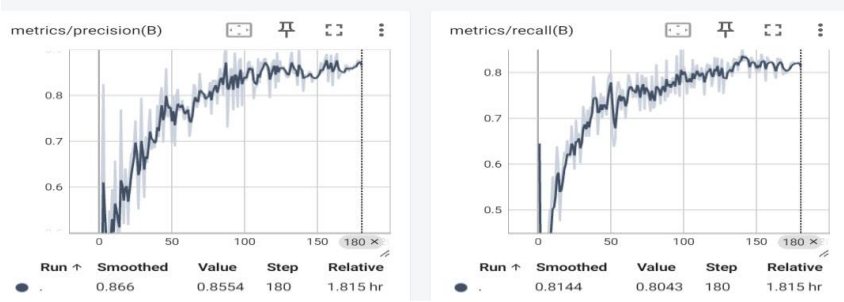

Fig. 2. Example of Training Results

7. Conclusion and Future Work: A YOLOv10-based detection model was proposed, and its effectiveness was verified using real-world big data. The experimental results showed a performance with precision of 0.86, mAP50 of 0.85, and processing time of 5.8ms with only 2.7 million parameters. This is probably feasible in real time with low-cost portable devices. This model will help to make child safety systems more widespread and feasible. As future work, we would like to prepare a high quality training dataset with more diverse objects and use data augmentation techniques, and investigate lightweighting the model so that it can perform well on lower-end hardware.

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Text-Derived Knowledge Graphs for Decision Support in Medication Recommendation: A Conceptual Framework

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1. Background of the Research: Selecting appropriate medications requires integrating vast biomedical knowledge scattered across texts and databases. Knowledge graphs (KGs) provide a framework to unify entities (e.g. drugs, diseases, symptoms) via semantically meaningful edges. In healthcare, KGs can combine structured textual drug information to enhance decision support. For instance, Sang et al. extracted relations from PubMed abstracts to build "SemKG", a biomedical KG used to discover new drug-disease links[1]. Drug-centric databases (e.g. DrugBank) offer partially structured drug information in textual format that can be leveraged to populate such graphs. Thus, text-derived KGs enable linking of drug attributes to potential therapies in a single network, motivating their use in decision support.

2. Research Objectives: The aim of this survey is to consolidate existing literature on constructing knowledge graphs from textual data for medication selection and to propose a conceptual framework that retrieves drug information by identifying links between patient symptoms using knowledge graphs built purely from textual content. We summarize methods that map textual data into KG and assess how such KGs can support automated drug recommendation. Ultimately, we seek to outline a generic KG-based framework for translating text data into decision support.

3. Research Problem/ Research Questions: Clinicians face an ever-growing volume of unstructured drug and disease information, making it challenging to retrieve relevant treatment knowledge. Key problems include:

1. Knowledge integration: How can we automatically extract and integrate drug-symptom-disease relations from text?
2. Decision support: How can a KG leverage these relations to suggest safe and effective medications for given patient symptoms?
3. Reliability: How accurate and complete are the extracted relations from textual data?

Addressing these questions is essential for building a system that consolidates textual knowledge to assist medication choice.

4. Approach: We propose a conceptual workflow to create KG derived from textual medical content for drug recommendation:

- Text Data Sources: Use biomedical corpora such as DrugBank, and symptom-to-drug collected from Kaggle datasets can be used as input[3, 5].
- KG Triples Extraction: Leveraging Large Language Model (LLM) to plugged to extract structured knowledge graph triples as demonstrated in KGGen[2].
- Knowledge Graph Construction: Integrate extracted entities using standard vocabularies (UMLS) and form a KG where nodes are medical concepts and edges denote relations (e.g. treats, causes)[1].

This approach generalizes across domains, making the KG generation strategy adapt to the available drug and symptoms data.

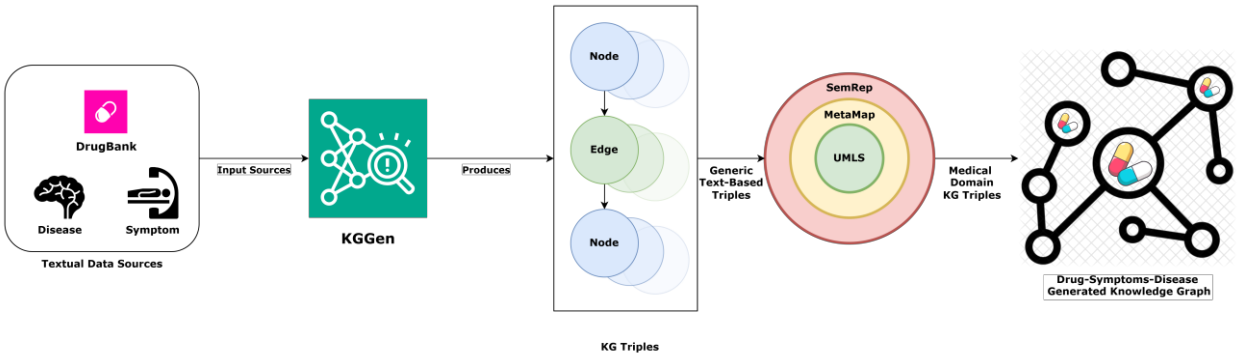

Fig. 1. Proposed Conceptual Framework for Constructing Medical Knowledge Graphs from Textual Data

5. Experiment/Methodology: Since this is a literature-based study, methodology focuses on survey and conceptual validation. We performed a systematic search of relevant work on KGs and clinical decision support (keywords: "knowledge graph", "medication recommendation", etc.), primary focus was to make use of textual data to for decision support. Key papers on KG construction and medication recommendation (e.g. SemKG, KGGen) were collected and analyzed. Based on the surveyed methods, we outline a pipeline for building a drug-symptom knowledge graph from textual data. This includes identifying relevant data sources that can be leveraged to construct an informed and comprehensive knowledge graph. Additionally, we specify tools for extracting entities and relations from text, and describe how this information can be processed and structured using UMLS standards to enrich the knowledge graph specifically for the medical domain.

6. Results: Our literature consolidation yields the following insights:

- Knowledge Graph Generation: KGGen provides state-of-the-art approach in constructing a Knowledge Graph from generic textual data, which can be utilized across medication textual descriptions.
- Medication Relevant Knowledge Graph Mining: Graph-based mining methods can uncover novel drug therapies by extracting structured information from unstructured text. Sang et al.'s SemKG approach, identified new drug–disease associations by mining PubMed abstracts. Their methodology incorporates MetaMap and SemRep, which utilize the UMLS framework to extract standardized triples from biomedical text[4]. This ensures that the identified entities and relations are medically meaningful and aligned with domain-specific ontologies, enhancing their utility for medication-related applications.

7. Conclusion and Future Work: This survey highlights the potential of knowledge graphs constructed from biomedical text for supporting medication selection. By linking symptoms, diseases, and drugs, such graphs enable more accurate and explainable recommendations. Future work should focus on integrating longitudinal patient data to personalize and enhance decision support outcomes.

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Gestational Diabetes in Bangladesh: A Multi-Stakeholder Perspective on Self-Management and Challenges

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1. Background of the Research: The aberrant increase in the prevalence of diabetes in pregnancy in recent decades has imposed an alarming public health burden in Bangladesh [1-3]. Women with GDM are taken care of by different healthcare professionals (HCPs), including diabetologists, endocrinologists, and gynecologists. Exercising a standard care guideline is not commonly followed by practicing doctors in the country. Additionally, only 52.8% of the physicians had good knowledge about GDM. However, service providers usually face unique challenges when they interact with GDM women due to their lack of knowledge regarding the disease, its consequences, and management. Furthermore, the elimination of challenges and barriers to self-management of GDM can be achieved through a comprehensive intervention targeting the health system, patients, and caregivers [4].

2. Research Objectives: The present study aimed to identify the self-management status of GDM women, including the factors associated with non-adherence to the self-management of GDM among pregnant women, caregivers, and health care providers.

3. Research Problems: The aberrant increase in the prevalence of diabetes in pregnancy in recent decades has imposed an alarming public health burden in Bangladesh. It is crucial to establish a widely accepted and practical national guideline for the effective management of Gestational Diabetes Mellitus (GDM) in Bangladesh, aiming to mitigate the consequences and subsequent burdens of GDM. In addition, the elimination of challenges and barriers to self-management of GDM can be achieved through a comprehensive intervention in the health system and among patients.

4. Approach: To have effective management, patients should care for themselves and need to be adherent to the advice provided to help in controlling GDM. To ensure that mothers receive diabetes education tailored to their specific needs and are provided with ongoing support to actively engage in self-management, healthcare providers need to have a thorough understanding of their knowledge and self-management experiences related to the condition. As a consequence, challenges and barriers towards adherence to the self-management strategies might be reduced among pregnant women with GDM. In addition, these challenges are more pronounced when individuals require social and familial support to adhere correctly to the components of self-management for GDM [5-6]. Very few published articles were found to assess the factors associated with non-adherence to self-management of GDM among pregnant women and the related roles of caregivers and healthcare providers in promoting self-management of GDM in Bangladesh. So, this study aimed to identify these issues.

5. Methodology: This study was conducted with a cross-sectional design in a mixed-method approach. A total of 251 samples of GDM patients, including 251 caregivers, were selected conveniently for the quantitative approach and to yield a quantitative outcome. For the qualitative approach, 04 physicians, 04 nurses & 04 nutritionists were chosen from four respective hospitals. Quantitative data were collected using a pre-tested and semi-structured questionnaire administered through face-to-face interviews, and qualitative data were collected using a key informant interview (KII) topic guide tailored to the objectives and variables. Data were collected on different characteristics i.e. demographic, hospital access, disease, anthropometry, pregnancy, knowledge on GDM management and diabetes self-management using Diabetes Self-Management Questionnaire (DSMQ). Quantitative data was cleaned, edited, verified and coded to exclude any error or inconsistency. Moreover, qualitative data was recorded and then transcribed into the English language. Analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version

21, and results with p-values < 0.05 were considered statistically significant. Univariate and multivariate logistic regression analyses were performed to identify associations. Thematic analysis was done for the qualitative data.

6. Results: In this study, the quantitative part reflected that the mean age of respondents was 28.31 ± 5.24 years. The majority of women with GDM (65.7%) had not completed higher secondary education and were housewives. Most GDM participants came from families with four or fewer members (70.1%), had a monthly household income of ≤40,000 BDT (75.7%), had a positive family history of diabetes (58.6%), reported no comorbidities (68.9%), and had poor knowledge of GDM (53.8%). The majority of caregivers of GDM patients were over 38 years of age (50.2%), had completed education beyond the higher secondary level (46.6%), but demonstrated poor knowledge of GDM (53.0%), and the support services available for GDM management were also inadequate (62.5%). This unique study revealed that the majority of women with GDM exhibited suboptimal self-care in diabetes management (68.5%), including glucose control (82.5%), dietary controls (75.7%), physical activity (73.3%), and healthcare use (43.8%). Significant characteristics associated with suboptimal self-care included nuclear (OR: 4.70, 95% Cl: 2.23-9.70) & combined family (OR: 3.88, 95% Cl: 1.59-7.59), positive family history of diabetes (OR: 1.73, 95% Cl: 1.01-2.96), presence of comorbidities (OR: 2.46, 95% Cl: 1.29-4.68), and caregiver's higher level of education (OR: 2.34, 95% Cl: 1.15-4.76). Qualitative information reflected the health care provider's opinion. Educated and multiparous women are more likely to follow recommended care, while rural and low-income patients show poor adherence due to limited understanding. Fear and misconceptions often lead many to avoid insulin, and diet and exercise guidelines are not always strictly followed. Misinformation from social media further influences patient behavior. Caregiver support varies widely—educated caregivers offer better care, but many lack awareness of blood sugar control. Immediate family gives limited help, extended family often remains indifferent, and some even discourage physical activity. The challenges faced by the provider reveal that patients usually resist insulin out of fear of lifelong dependency. At the same time, financial constraints hinder adherence to medication and diet plans, especially among lower-income groups. Rural and illiterate patients struggle to understand medical advice, and misconceptions—such as avoiding rice—add to dietary challenges. Caregivers of illiterate patients often struggle to support treatment adherence, and poor knowledge leads to inadequate care. Social stigma discourages GDM patients from disclosing their condition, while nuclear family settings further limit caregiver support.

7. Conclusions and Future Work: The majority of women with GDM in this study exhibited suboptimal self-care practices, particularly in glucose control, diet, physical activity, and healthcare use. Socio-demographic and clinical factors such as income, family size, comorbidities, and caregiver education were significantly associated with self-care behavior. Targeted diabetes education and support programs should be developed to address key socioeconomic and clinical factors, improving self-care among GDM patients.

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A Proposed Social Business Model Linking University Food Sales to Rural School Nutrition

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1. Background of the Research: Food insecurity is a persistent issue among children in rural Bangladesh [1]. Simultaneously, students in developed nations increasingly seek meaningful ways to contribute to global development. This research stems from a personal connection with a rural school in Cumilla, operated by a family member, and explores how Japanese university students can address global nutrition inequality through local entrepreneurial efforts. By selling food on the Kyushu University campus and using the profit to fund rural school meals in Bangladesh, this initiative proposes a practical, scalable model of cross-border social business that promotes awareness, engagement, and impact.

2. Research Objectives: To design and validate a social business model that converts halal, vegan, and vegetarian food sales at Kyushu University into sustainable meal support for poor students in Cumilla, Bangladesh.

3. Research Problem/ Research Questions: How can students in Japan directly impact food security abroad through social entrepreneurship? What structure allows for ethical profit-making, transparent fund flow, and measurable impact while remaining feasible for student-led operations? The research investigates the design of a low-barrier, self-sustaining business model where both buyer and beneficiary are empowered by a single transaction.

4. Approach: We propose a cross-border social business model operating under the unified brand “Ocha No Mizu”, a restaurant originally founded in Cumilla, Bangladesh. Social business models focus on reinvestment of profits to solve social problems rather than generating financial returns [2]. The business will sell halal, vegan, and vegetarian breakfast meals at Kyushu University’s Ito Campus, with all food prepared and served locally in Japan by two paid volunteers—one for cooking and another for service. Halal, vegan, and vegetarian food options also align with growing ethical consumption trends among youth [3].

What makes this model unique is its "One Meal Shared, Two Lives Nourished" philosophy: The same meals sold on the Kyushu University campus will also be distributed for free to underprivileged children at the One Drop Elementary School in Cumilla. This creates a tangible emotional and nutritional connection between the buyer and the beneficiary.

The initial capital will come from donors who previously supported the school through charity, now reallocated as non-dividend seed investment. Investors will receive back only the original amount, with no profit distribution, in alignment with Social Business principles.

Profits from food sales in Japan will be reinvested in two ways:

- One portion will fund the free meal distribution at the One Drop School, using the same recipes and nutritional standards.
- The other portion will support the growth of the Ocha No Mizu brand, enabling the expansion of social impact through increased production and student engagement.

This initiative is structured using the Social Business Model Canvas (SBMC) to prioritize impact, sustainability, and reinvestment.

5. Methodology:

As shown in Figure 1 the social business model canvas includes the following components:

<table>
<tr><td colspan="5">(I) Social Problem/Objective
Nutrition/Food problem in One Drop Elementary School in Cumilla.</td></tr>
<tr><td rowspan="2">(II) Segment
2-1: Beneficiary
One Drop School Students
2-2: Customer
Kyushu University Students</td><td>(III) Type of Intervention
-Nutritional support</td><td rowspan="2">(IV) Value Proposition
-Nutritious meals for students in need
-A Socially conscious dining option for customers
-Real-time Cross-border social impact</td><td rowspan="2">(V) Key Activities
- Preparing and Selling breakfast meals
- Managing daily food operations
- Coordinating free meal distribution to One Drop School</td><td>(VI) Key Resources
-Restuarant Staff
-Halal/Vegan Ingredients
-Meal Recipes
-Cooking Equipment</td></tr>
<tr><td>(VII) Partners + Key Stake holders
One Drop Elementary School
Investors/Seed Capital Providers</td><td>(VIII) Channel
Food Sales at Kyushu University</td></tr>
<tr><td colspan="2">(IX) Cost Structure
-Food Production Costs
-Staff Wages
-Equipment and utilities</td><td colspan="3">(X) Revenue
Meal Sales</td></tr>
<tr><td colspan="5">(XI) Surplus
-Funding for Free Meals
-Business Expansion</td></tr>
</table>

Figure 1: Proposed Social Business Model Canvas

(I) Social Problem: Food and Nutrition problem of the students of One Drop elementary school.
(II) Segments: Customers are Kyushu University students; beneficiaries are underprivileged students in Cumilla.
(III) Type of Intervention: Nutritional support through the sale and distribution of culturally appropriate, affordable meals
(IV) Value Proposition: value propositions are nutritious meals, socially of religiously conscious dining options for customers, and real-time cross-border social impact.
(V) Key Activities: Daily food preparation, meal sales, operations management, and coordination with the school for free meal delivery.
(VI) Key Resources: Restaurant staff, halal/vegan ingredients, cooking equipment, and culturally sensitive recipes.
(VII) Partners & Key Stakeholders: Collaboration with One Drop Elementary School, Kyushu-based suppliers, and initial seed funders ensures community involvement and accountability.
(VIII) Channel: The channel will be the food sales at the Kyushu University campus.
(IX) Cost Structure: Covers food production, staff wages, equipment, and utility costs.
(X) Revenue Model: Sustained through meal sales; no external profit required.
(XI) Profit Utilization: One portion of profits is for free school lunches in Cumilla and the remaining is reinvested into expanding the business.
This model enables a real-time, cross-border impact where a meal purchased by a student in Japan directly supports a child in need in Bangladesh—making the consumption experience socially conscious and deeply meaningful. Transparent impact tracking improves donor confidence and operational accountability [4].

6. Conclusion and Future Work: This research validates the feasibility of a student-led, cross-border social business model addressing child malnutrition. Future work will include formal legal registration, expansion to multiple campus events, digital marketing, and AI-powered impact tracking. Long-term, the model aims to replicate in other universities and partner with global NGOs for scale.

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Knowledge Towards Prevention of Sexually Transmitted Infections Among College Students in Bangladesh

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1. **Background of the Research**: Sexually Transmitted Infections (STIs) are a major global health problem, caused by more than 30 microbes. STIs can lead to both acute and chronic health issues, such as infertility, ectopic pregnancy, and psychological problems. While some STIs are curable and others are not, all are preventable. In Bangladesh, accurate epidemiological data on the prevalence of STIs are limited. However, the country remains highly susceptible, despite having a relatively low prevalence of HIV. Nonetheless, new infections are rising, posing a growing threat to public health.

2. Research Objectives: The study aims to examine the relationship between socio-demographic characteristics and knowledge towards the prevention of STIs among college students in Bangladesh.

General Objective

To examine the relationship between socio-demographic characteristics and knowledge towards prevention of sexually transmitted infections among college students in Bangladesh.

Specific Objectives

1. To describe the socio-demographic characteristics of the participants.
2. To assess the level of knowledge towards prevention of sexually transmitted infections among college students in Bangladesh.
3. To examine the relationship between socio-demographic characteristics and knowledge towards prevention of sexually transmitted infections among college students in Bangladesh.

3. Research Problem/ Research Questions: What is the level of knowledge towards prevention of sexually transmitted infections among college students in Bangladesh.

4. Approach: There is an urgent need to review the existing sex education curriculum and teaching strategies used in educational institutions. To promote health and prevent STIs, the government should consider implementing CSE programs, giving priority to parental involvement, expanding healthcare facilities, launching awareness campaigns, and offering e-health education.

5. Experiment/Methodology: A descriptive correlational study was conducted among 148 students from Hamdard Public College. The data were collected using convenient sampling techniques, and a self-structured questionnaire was used to collect data. The questionnaire was divided into two sections. Firstly, socio-demographic characteristics (independent variable) and included nine items. The second part assessed knowledge towards prevention of STIs (dependent variable) and consisted of 27 dichotomous items, each scored as either correct (1) or incorrect (0). Based on Bloom's cut-off points, total knowledge scores were categorized into low, moderate, or high levels of knowledge. The data were analyzed using descriptive statistics such as mean, SD, frequency, and percentage, and inferential statistics, including t-test, ANOVA, and Pearson correlation, were used to describe the relationship between variables. After collecting data, the Cronbach's alpha coefficient of this scale found knowledge was.70 as an acceptable value.

6. Results: The mean age of participants was 17.76 (SD =.69). The result found a statistically significant negative correlation between age and knowledge ($r = -0.204$, $p = 0.013$). Study also revealed that some socio-demographic factors such as field of study ($t = 3.21$, $p = .002$), awareness of healthcare amenities ($t = 2.17$, $p = .032$), sources of sexual health information ($F = 2.908$, $p = .037$), and participating in STI programs ($t = 2.42$, $p = .033$) were also statistically significant associated with knowledge.

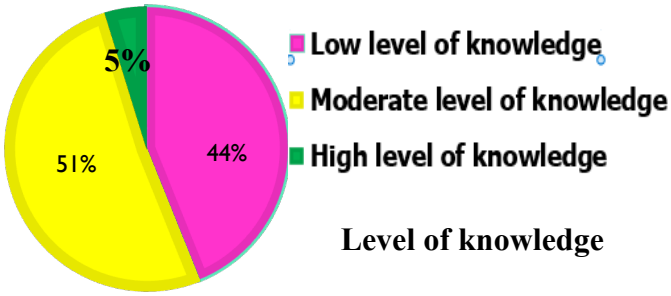

Table. Distribution of Socio-Demographic Characteristic and STI Knowledge toward STI prevention of the Participants and the Relationships among variables (N=148)

Variables	Categories	*f* (%)	STI Knowledge		
			M±SD	r /t/ F	*p* value
Age in years [Min= 16; Max= 19; M=17.76; SD= .69]				**-.204**	**.013**
Field of study	Science	124(83.8)	16.21±3.77	**3.21**	**.002**
	Commerce	24(16.2)	13.42±4.51		
Knew the Health Care places where STIs prevention services are available	Yes	54(36.5)	16.65±3.53	**2.17**	**.032**
	No	94(63.5)	15.24±4.20		
Sources of sexual health education	Parent/Guardian	57(38.5)	16.72 ±3.61	**2.908**	**.037**
	High School	33(22.3)	15.61±2.95		
	College	25(16.9)	15.84±4.11		
	None	33(22.3)	14.18±5.07		
Participated in STI knowledge and prevention programs	Yes	10 (6.8)	17.90±2.8	**2.42**	**.033**
	No	138 (93.2)	15.60±4.05		

7. Conclusion and future work: The study findings represent that below 5 % participants had a high level of knowledge about STI prevention, which usually occurs due to a lack of knowledge, which may trigger inadequate sexual education, social stigma, and a matter of hesitation, and so on. To increase the generalizability of the results, this study recommends replicating the research across diverse settings with larger sample sizes and conducting an interventional study among college students in Bangladesh.

Acknowledgement: Firstly, I am grateful to the Almighty for granting me the opportunity to complete this thesis successfully. I also sincerely thank my research guides for their practical guidance. Finally, I want to express my special thanks and appreciation to my mother and family members for their invaluable support in doing this work.

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An Assessment of the Knowledge and Practices Concerning Routine Medical Checkups Among Adults' People at Kushtia Housing Community Area

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1. Background of the Research: Routine medical checkups serve as a cornerstone of preventive healthcare, facilitating early diagnosis and timely management of chronic and acute conditions [1]. However, the utilization of such services remains inconsistent, influenced by sociocultural and economic factors [2]. Understanding the community's knowledge and practices regarding routine medical screenings is crucial to designing targeted interventions. This study is motivated by the need to evaluate these factors within a specific population, thereby contributing to enhanced health promotion strategies and reduced disease burden [3].

2. Research Objectives: This study aims to assess the knowledge and practices concerning routine medical checkups among adults. It further seeks to explore the associations between sociodemographic variables and health-seeking behaviors, identifying barriers to regular checkups.

3. Research Problem/ Research Questions: Despite widespread advocacy for regular health screenings, many adults fail to engage consistently in routine medical checkups [4]. This study addresses critical questions:

- What is the level of awareness and frequency of practice regarding routine medical checkups among adults?
- How do factors such as age, gender, education, and occupation influence these knowledge and practice levels?
- What impedes consistent participation in routine health screenings within this community?

4. Approach: A descriptive cross-sectional design was utilized to capture a snapshot of adult respondents' knowledge and practices related to routine medical checkups. Data collection was executed via a validated, structured questionnaire adapted from prior studies [5]; [1], encompassing demographic characteristics, awareness levels, and health screening behaviors. Statistical analyses, including chi-square tests, explored correlations between sociodemographic factors and outcomes. This approach facilitates the identification of high-risk groups, allowing tailored public health interventions and resource allocation.

5. Experiment/Methodology: A total of 203 adults were surveyed using convenience sampling from a defined community. Participants completed a structured questionnaire that collected sociodemographic information and assessed routine health practices, including self-reported measurements of blood pressure, body mass index (BMI), and blood glucose levels. The questionnaire underwent pre-testing to ensure reliability and validity of the instrument. Data analysis was conducted using descriptive statistics to summarize participant characteristics and response patterns. Chi-square tests were applied to evaluate associations between demographic variables and levels of knowledge and practice, with statistical significance set at $p<0.05$. Results were presented in tables and figures to clearly depict participant profiles and the distribution of responses, facilitating transparent interpretation and reproducibility of findings.

6. Results: The results demonstrated that 60.5% of participants possessed a moderate level of knowledge regarding routine checkups (Figure 1), while 67.8% reported engaging in average preventive practices (Figure 1). Statistically significant associations were observed between knowledge levels and variables such as age ($p<0.001$), religion ($p<0.001$), and marital status ($p<0.045$). Practice levels were significantly associated with age ($p<0.001$), religion ($p<0.018$), education ($p<0.012$), occupation ($p=0.001$), and income ($p<0.029$) In contrast, gender, education, and income did not exhibit significant correlations with knowledge level, and gender was not significantly associated with practice level. Although awareness of the benefits of routine screenings was high among respondents, actual adherence to recommended practices varied. Screenings for hypertension and diabetes mellitus were the most frequently reported. These findings are consistent with trends identified in comparable contexts [2], underscoring ongoing discrepancies between knowledge and implementation of preventive health behaviors.

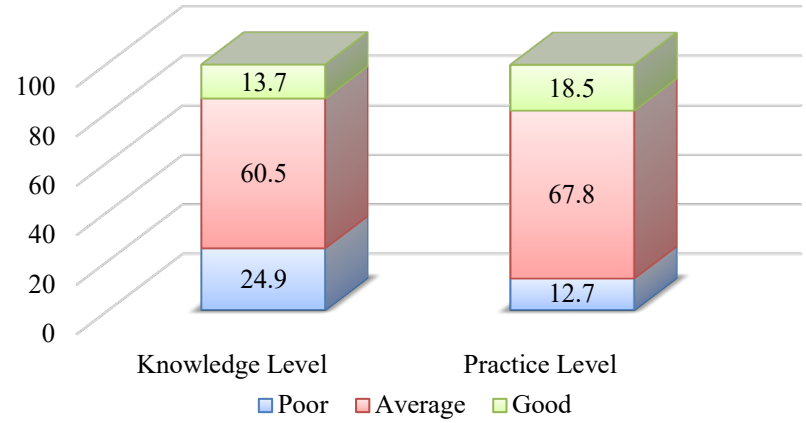

Figure 1: Overall level of Knowledge and Practice of Respondents (n= 203)

7. Conclusion and Future Work: This study underscores moderate knowledge and practice levels regarding routine medical checkups, primarily influenced by age and occupation. Interventions focusing on tailored health education and addressing occupation-specific barriers could improve screening uptake. Future research should expand to diverse populations using longitudinal designs to capture behavior changes over time and explore cultural determinants influencing preventive health behaviors [1].

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AI-based Detection Model for IoT Water-related Facility Management

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1. Background of the Research: Recently, Internet of Things (IoT) technology has been applied to the construction of smart cities. The IoT consists of a network of devices that can collect and control data from the physical world [1]. Despite these revolutionary advancements in smart city engineering and IoT management technologies, significant pollution incidents still occur every day due to the sudden leakage of gas, air, oil, fuel, water, etc. due to incomplete inspections and equipment failures (Fig. 1).

Fig.1 Examples of leak accident

2. Research Objectives: Water is an important resource that is indispensable in cities where many people live. There is a vast network of water pipes throughout the city and country, responsible for maintaining the quality of the water and transporting it. Leak detection technology is the starting point for the efficient management of these pipes. Despite this, around one third of the world's water systems lose around 40% of their water through leakage. [1].

3. Research Problem/ Research Questions: In general, various liquids, including water, are transported or stored in pipes or storage tanks. If they leak, the consequences can be enormous, paralysing the entire system of a building or factory, so leak detection is an essential safety prevention technology to prevent this [2]. From this perspective, this paper analyses the characteristics of several models that can be used in critical leak detection systems, and compares the performance and accuracy of each model after conducting experiments based on public big data to validate the effectiveness of the models.

4. Approach: Traditional machine learning(ML) schemes for leak detection typically include classification models, predictive classification models, and statistical models, each of which has advantages and limitations[3,4,5]. Classification models use supervised learning models and require large data sets under both normal and leak conditions. Machine learning algorithms have been developed and evaluated using simulation data and have achieved reasonable accuracy. The accuracy of statistical ML models depends on the degree of uncertainty. In this study, we test the effectiveness of the deep learning model using public big data to detect water leaks.

5. Experiment/Methodology: To verify the performance of the proposed MLP model which used TensorFlow and Keras, this experiment used two machine learning models and AI-hub waterleak dataset[5]. SVM(Support Vector Machine)[6] and KNN(k-nearest neighbors)[4] were used for performance comparison with Deep Learning Model[3]. This experiment was conducted using normal noise, indoor leakage, and mechanical and electrical noise classes among water pipe leak detection, and the description of the classes is shown in Table 1.

Table 1: Class and evaluation criteria

Class	Evaluation Criteria
normal noise	Normal data that do not indicate leaks
leaky noise	Data where a leak investigator determined a leak occurred indoors
mechanical or electrical noise	Data where a leak investigator determined that there is no evidence of a leak and that certain sounds, such as mechanical or electrical sounds, have been generated.

6. Results: The water pipe leakage data was based on the results of acquiring water pipe leakage vibration data and checking the acquired data in the field through water leakage exploration, and going through the classification process by class. For a brief performance comparison with existing models, the accuracy of SVM and KNN were measured. As a result, Table 2 shows that the proposed deep learning model is superior.

Table 2: Comparison of Methods

Methods	Accuracy
SVM	80.06 %
KNN	91.86 %
Deep Learning	**93.84 %**

The detailed performance of the model was checked by plotting a training and validation graph to see if overfitting occurs in a particular epoch, or from which range the accuracy does not increase. In this experiment, two graphs were plotted using the subplot API of matplotlib (Fig. 2).

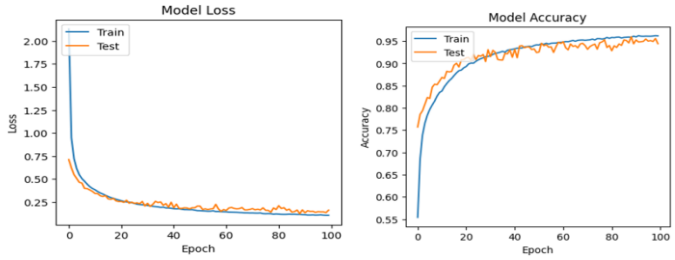

Fig. 2. Model Loss and Accuracy

7. Conclusion and Future Work: As the number of ageing pipelines continues to increase significantly, it has become very difficult to deal with water leaks using traditional methods. This paper discussed the use of an AI-based detection model for IoT water-related facility management. The paper presented a deep learning model that uses public water leakage data and achieves an accuracy rate of 94%. The test results of the deep learning model showed that it outperformed the traditional models, such as SVM and KNN, in terms of accuracy. The results indicate that AI-based systems can effectively replace human-based leak detection and analysis activities, resulting in reduced response time and minimized waste of water resources and economic losses.

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Determinants of Healthcare Supply Chain Efficiency: Evidence from Chinese Provincial Panel Data (2011-2024)

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1. Background of the Research: The healthcare supply chain is a complex and critical system that plays a vital role in ensuring the efficient delivery of medical products, equipment, and services. However, the COVID-19 pandemic has highlighted significant vulnerabilities within these systems, particularly in the healthcare sector. As factors such as an aging population and the rise of chronic diseases drive continued growth in healthcare demand, an efficient healthcare supply chain is more critical than ever.

The healthcare supply chain encompasses a vast network of systems and processes that collectively ensure the procurement, manufacturing, and distribution of medical products [1]. Stakeholders involved include pharmaceutical companies, hospitals, medical device manufacturers, and insurance providers, among others [2].

Recent studies have highlighted the role of digital technologies in addressing these inefficiencies. Digital tools such as artificial intelligence (AI), the Internet of Things (IoT), and blockchain have been shown to optimize supply chain operations by enhancing data visibility and coordination [3]. These technologies help overcome challenges such as poor inventory management, manual data processing, and limited real-time tracking capabilities.

2. Research Objectives: This paper focuses on healthcare supply chain efficiency, exploring key factors influencing performance. By analyzing the challenges faced by healthcare systems and proposing evidence-based solutions, this study aims to contribute to the development of more resilient, patient-centered healthcare service models.

3. Research Problem/ Research Questions: The supply chain is critical to the smooth operation of healthcare systems, but many healthcare institutions face numerous challenges in this area, which hinder the timely and cost-effective delivery of services. These challenges typically stem from poor coordination, insufficient data integration, and a lack of transparency in supply chain operations.

The healthcare supply chain is driven by diverse product types, stringent regulatory requirements, and high service level expectations, making these systems particularly vulnerable to external disruptions such as pandemics or geopolitical crises. The COVID-19 pandemic has particularly exposed these weaknesses, highlighting the urgency for healthcare organizations to enhance emergency preparedness, flexibility, and digital infrastructure.

Despite growing awareness, many healthcare providers lack a systematic understanding of the factors influencing supply chain efficiency. Without this knowledge, efforts to improve supply chain performance remain fragmented and ineffective. This study aims to address these gaps by analyzing the potential factors influencing healthcare supply chain efficiency. By identifying key challenges and exploring potential solutions, this study seeks to support more resilient, cost-effective, and patient-centered healthcare supply chain strategies.

4. Approach:

A. Theoretical Framework

Supply Chain Operations Reference (SCOR) Model

The SCOR model introduced by Steward (1997) is widely used to evaluate and improve supply chain performance. In healthcare, the SCOR model can be applied to understand and inprove the efficiency of operations such as inventory management and procurement [4]. The SCOR model has evolved to the SCOR Digital Standard (SCOR DT), a fully digitalized dynamic development model that encompasses sustainability standards and supply chain coordination enablers with digital technology. Its functions include: plan, order, transform, return, source, and fulfill. This

transforms the entire supply chain into a more synchronized and coordinated network for more efficient supply chain [5].

Dynamic Capabilities Theory

Dynamic Capabilities Theory (DCT) explores an organization's ability to adapt to changing environments. In healthcare, DCT helps explain how organizations can improve supply chain efficiency and resilience by adjusting their capabilities in response to external challenges, such as health emergencies or demand fluctuations. Studies [6] emphasize the importance of adaptability and agility in healthcare supply chains. And with better coordination and digital transformation tools like blockchain and AI demand forecasting, the healthcare distribution networks can work more adaptable so as to achieve high efficiency of supply chain [7]. Both SCOR and DCT can complement each other to identify inefficiencies that a firm's dynamic capabilities must address, and dynamic capabilities enable a firm to effectively implement the process improvements.

B. Hypotheses between dependent and independent variables

Level of Coordination Capability

Coordination among healthcare supply chain stakeholders is crucial for efficiency [8]. Effective coordination mechanisms can enhance the responsiveness of the supply chain, improve inventory management, and reduce operational costs [9]. Future research should extend beyond dyadic relations and incorporate more holistic approaches of supply chain coordination, which highlights the needs of collaborative approaches between firms (supplier-manufacturer-retailer) [10]. Thus, it hypothesizes:

H1: Operational coordination is positively related to healthcare supply chain efficiency.

Demand Forecasting Capability

Accurate demand forecasting is critical for managing inventory and ensuring timely availability of healthcare supplies. Demand sharing and forecasting are helpful for supply chain managers since it provides great source of information using artificial intelligence and big data analytics for planning and decision-making [11] [12]. Therefore, it hypothesizes:

H2: Demand forecasting capability is positively related to the healthcare supply chain efficiency.

Healthcare Institution Scale and Healthcare Supply Chain Efficiency

The scale of healthcare institutions, measured through factors such as hospital bed count, has been linked to improved operational efficiency. Research [13] [14] suggests that larger healthcare institutions benefit from economies of scale, leading to better resource utilization and cost efficiency. Thus, it hypothesizes:

H3: Healthcare institution scale is positively related to the healthcare supply chain efficiency.

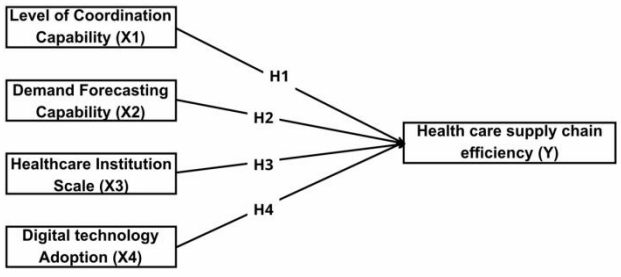
Digital Technology Adoption and Healthcare Supply Chain Efficiency

Digital technologies, which include AI, IoT, and blockchain, are increasingly integrated into healthcare supply chains to enhance efficiency. Studies [15] show that these technologies improve real-time monitoring, data transparency, and decision-making in supply chain management. Therefore, it hypothesizes:

H4: Digital technology is positively related to the healthcare supply chain efficiency.

5. Experiment/Methodology: The framework illustrated in Figure 1 below proposes that healthcare supply chain efficiency (Y) is directly influenced by four key independent variables: Level of Coordination Capability (X1), Demand Forecasting Capability (X2), Healthcare Institution Scale (X3), and Digital Technology Adoption (X4), shall be further explained in section Measurement of Variables.

Figure 1 Conceptual Framework



In addition to empirical analysis, the study utilizes a systematic literature review to further develop the research framework. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework was employed to systematically identify, screen, and select relevant literature on healthcare supply chain efficiency. A search of the Web of Science Core Collection database for articles published from 2021 to 2025 resulted in the review of 5,089 relevant papers.

Research Design

This study adopts a quantitative research design using secondary panel data from 31 provinces in Mainland China, spanning from 2011 to 2024. Given the structure of the data, panel data regression analysis is employed, with the fixed-effects model chosen as the primary estimation technique to control for unobserved time-invariant heterogeneity across provinces. The appropriateness of the fixed-effects model is tested using the Hausman test. Additionally, diagnostic tests for multicollinearity, heteroskedasticity, and autocorrelation are performed to ensure the robustness and validity of the model. If issues arise, robustness tests are employed to evaluate the model's sensitivity to these problems.

To further understand research trends, VOSviewer is used for bibliometric analysis, conducting keyword co-occurrence and cluster analysis based on the selected literature. This helps identify frequently used terms, major research clusters, and potential research gaps, which guide the development of the conceptual framework and hypotheses.

Measurement of Variables

The dependent variable, healthcare supply chain efficiency (EFF), is measured using a composite index based on indicators derived from the China Health Statistics Yearbook (NBS) and National Health and Family Planning Commission (NHSC) reports [16].

Level of Coordination Capability (LOC) is represented by indicators such as the degree of hospital and regional group integration, and public-private partnerships. Data are sourced from regional synergy guidelines and healthcare indices across provinces, rated on a 1-5 scale.

Demand Forecasting Capability (DFC) is measured using regional healthcare demand-supply variance and emergency preparedness indicators, reflected in the annual GDP growth rate of each province [17].

Healthcare Institution Scale (HIS) is quantified by the number of hospital beds across provinces, serving as a measure of capacity and infrastructure scale in the healthcare system.

Digital Technology Adoption (DT) is measured using a composite index representing the level of digital economic development across provinces. This index is constructed using the entropy weighting method, considering digital infrastructure, industry development, and digital-inclusive finance indicators [18].

Model Specification

This study adopts a fixed-effects panel regression model employed is specified as follows:

$EFF_{it}=\beta_0+\beta_1 LOC_{it}+\beta_2 DFC_{it}+\beta_3 HIS_{it}+\beta_4 DT_{it}+\alpha_{it}+\varepsilon_{it}$

Techniques of Data Analysis

This study employs panel data regression analysis using software such as EViews and Stata. Before estimation, descriptive statistics and correlation analyses are performed. Model selection is determined using F-tests and Hausman tests to decide between fixed-effects and random-effects models. The robustness of the results is tested using multicollinearity, heteroskedasticity, and autocorrelation tests. Robust standard errors are used when necessary to address any issues detected in these tests.

6. Results: This study empirically examines the determinants of healthcare supply chain efficiency (EFF) across 31 Chinese provinces from 2011 to 2024. It focuses on four critical factors: level of collaborative capability (LOC), demand forecasting capability (DFC), healthcare institution scale (HIS), and digital technology adoption (DT). The fixed-effects panel regression model yields a high explanatory power, with an R^2 of 0.941 and a statistically significant F-statistic of 1541.446 ($p < 0.001$).

The key findings are synthesized as follows:

Level of Collaborative Capability (LOC) exhibits a statistically significant positive impact on EFF (= 0.031, $p < 0.01$). A 1-unit increase in LOC improves healthcare supply chain efficiency by approximately 11.36%, highlighting that enhanced coordination among stakeholders is a critical driver of operational effectiveness.

Demand Forecasting Capability (DFC) shows a negative coefficient (= -0.085) but fails to achieve statistical significance ($p > 0.1$). This suggests a potential inverse trend between DFC and EFF, but the lack of statistical significance implies that the relationship is not empirically supported.

Healthcare Institution Scale (HIS) demonstrates a significant positive effect (= 0.004, $p < 0.05$). Larger-scale institutions correlate with higher supply chain responsiveness, likely due to economies of scale and resource advantages.

Digital Technology Adoption (DT) shows a strongly significant positive influence (= 0.785, $p < 0.01$). DT is the most powerful driver of EFF, where a 1-unit increase in digitalization elevates efficiency by 0.785 units, highlighting technology's transformative role in optimizing healthcare supply chains. Furthermore, research has found that larger hospitals or more centralized healthcare systems have a higher adoption rate of data technology than smaller healthcare facilities [19]. Digital technology facilitates end-to-end visibility [20], improves procurement and replenishment matching, promotes process automation and standardization and integrates information, thereby enhancing the resilience of the supply chain [21].

The Hausman test confirmed the appropriateness of the fixed-effects model. The mean VIF indicates no multicollinearity concerns.

Tests for heteroskedasticity and autocorrelation revealed the presence of both issues. To address these violations, robust standard errors were employed in the estimation. This correction ensures that coefficient estimates remain unbiased and that statistical inferences are valid despite the presence of these problems.

7. Conclusion and Future Work: The analysis reveals that LOC, HIS, and DT all exert a statistically significant positive influence on EFF, with DT emerging as the most influential driver. This underscores the transformative role of digital technologies in enhancing coordination, responsiveness, and overall performance in healthcare supply chains.

In contrast, DFC exerts a negative but statistically insignificant effect on healthcare supply chain efficiency. Because unlike multi-echelon supply chains where forecast errors can be absorbed across tiers, the provincial-level structure in China represents largely single-echelon systems [22]. Second, substantial heterogeneity exists across provinces. These macro-level disparities reduce the transferability of forecasting models and hinder their ability to translate predictions into efficiency gains. Another possible explanation lies in the measurement of DFC. In this study, provincial GDP growth was employed as a proxy indicator. However, forecasting capability in healthcare supply chains is inherently multi-dimensional, encompassing not only macroeconomic trends but also hospital-level practices

such as inventory planning, staffing capacity (e.g., number of doctors and nurses), and patient flow prediction. The omission of these micro-level dimensions may have constrained the validity of the DFC variable, leading to measurement bias and potentially obscuring its true relationship with supply chain efficiency.

Grounded in the dynamic capabilities and SCOR model, the findings extend technology enablement theory by highlighting the outsized marginal gains of digitalization in healthcare and challenge the universal applicability of forecasting accuracy theories. Practically, they call for sustained investment in healthcare IT infrastructure, the development of cross-agency coordination mechanisms, and the strategic use of scale-based resource sharing, while adopting cautious and context-specific approaches to demand forecasting.

Limitations include reliance on provincial-level panel data and omission of some variables (e.g. number of doctors and nurses) to measure independent variables like DFC. Future research should incorporate hospital-level or cross-country data and expand performance dimensions to balance efficiency with resilience and equity.

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Development of a continuity of care model integrating Thai traditional medicine for stroke patients in rural community southern Thailand

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1. Background of the Research: Stroke is a leading cause of death and disability worldwide including Thailand. Post-stroke stage in particular tends to face complication and reduce self-care ability and premature death. Although Thai traditional medicine (TTM) has been promoted as combination method for stroke rehabilitation to improve patient outcomes, the accessibility remains relatively low in rural areas. Many patients do not receive early-stage rehabilitation service. This can result in poor recovery and develop higher risk of complications.

2. Research Objectives: This study aimed to develop a home-based continuity of care model that integrates TTM for stroke survivors in southern Thailand

3. Research Problem/ Research Questions: The current home-based continuity of care for stroke patients in rural area faces multiple challenges. Key issues include a shortage of TTM practitioners at primary care units, patients' fail to follow-up appointments, unclear roles of TTM practitioners and lack of effective coordination and information-sharing among healthcare professionals. These gaps bring about inconsistent patient follow-up schedule. They can delay to receive the effective community-based stroke care. These challenges contribute to increase morbidity and mortality rates in the area. Thus, developing a structured and integrated home-based stroke care model that combines TTM and multidisciplinary collaboration is crucial for enhancing patient outcomes and quality of life.

4. Approach: To address the challenges in home-based continuity of care for stroke patients in rural health setting, we developed care model that incorporates with TTM. This approach aims to improve patients' health, prevent complications and support them a better health outcome. We also designed an integrated care model that enhances the access to TTM treatments and rehabilitation through collaborative efforts among healthcare professionals across different levels of health service. Key elements include providing patient education, sharing decision-making with multidisciplinary team, setting up community-driven support networks. The latter element of the model can empower family caregivers the necessary skills, so that they are able to provide effective home care and facilitate continuous follow-up through coordinated teamwork linking hospitals, primary care units and community resources. It is hoped that this model can ensure continuing care that helps reduce disability and enhances better quality of life of stroke survivors in rural area.

5. Experiment/Methodology:

Study Design

A descriptive qualitative study was conducted to explore the current status of stroke care, identify system gaps of health service and guide the development of a home-based continuity of care model integrating TTM. The ECCM served as the guiding conceptual framework, ensuring alignment between health service delivery and community-based resources.

Participants and Sampling

A total of 36 participants were purposively invited into focus group discussions. The participants participated in this study included: (1) 10 health professionals working in community hospital; All were members of the stroke rehabilitation subcommittee with at least one year of experience; (2) 8 TTM practitioners from primary care units who were responsible for implementing stroke-related care; (3) health care providers who practice TTM and had a minimum of six months of experience in caring for stroke patients and (4) 8 primary caregivers of stroke patients who provided long-term care and were able to offer in-depth insights into the care process. Participants were excluded if they withdrew from the study, relocated their job or were unable to attend the group discussion during the study period.

Data Collection Procedures

We conducted four focus group discussions using semi-structured interviews. The focus groups were organized at the place and time that were convenient for those participants: hospital meeting room and community hall. Before starting the group conversation, the first author informed them about study back ground, objectives and related issues. Then they were asked to participate in the study and signed consent form. To start the group discussion, the researcher started with talking about general topics and moved to more specific issues to obtain deep information about study objectives. Each session lasted between 1.5 and 2 hours. Local dialect was used to ensure natural communication and gain richer information. Digital voice recorder was used to record the group discussion.

Data Analysis

Thematic analysis method was used to analyze the data. The process included familiarization with the data through repeated reading, inductive coding and development of sub-themes and themes. Member checking was concerned to ensure validity. Final themes were refined and aligned with the research objectives. The study ensured rigor by following Lincoln and Guba's criteria: credibility through triangulation, transcript verification, member checking and expert consultation; transferability via detailed context and participant descriptions; dependability through systematic documentation; and confirmability by reflexive analysis and use of participants' verbatim quotes to reduce bias.

Ethical Considerations

This study was approved by Thaksin University's Ethics Committee, Thailand (COA No. TSU 20242_162). Participants were provided informed consent and were informed of their rights, including withdrawal without impact on care. Data were anonymized, securely stored and destroyed after study completion.

6. Results: Three key themes emerged: (1) Limited integration of multidisciplinary teams, (2) Barriers to support continuity of care and (3) Insufficient skills of formal and informal caregivers. The major challenges found in this study indicated fragmented care systems provision, limited access to health care in rural areas, insufficient caregiver training and weak community involvement. To reduce these issues, all stakeholders emphasized the integration of TTM, enhanced community networks and caregiver empowerment to strengthen health service system for the patients. This lead to the development of model: "KANUN–TTM Stroke Care Model" consist of five core components: Knowledge-based practice, Appropriate integration, Navigation system, Up-skill caregiver and Network-driven system (Figure. 1).

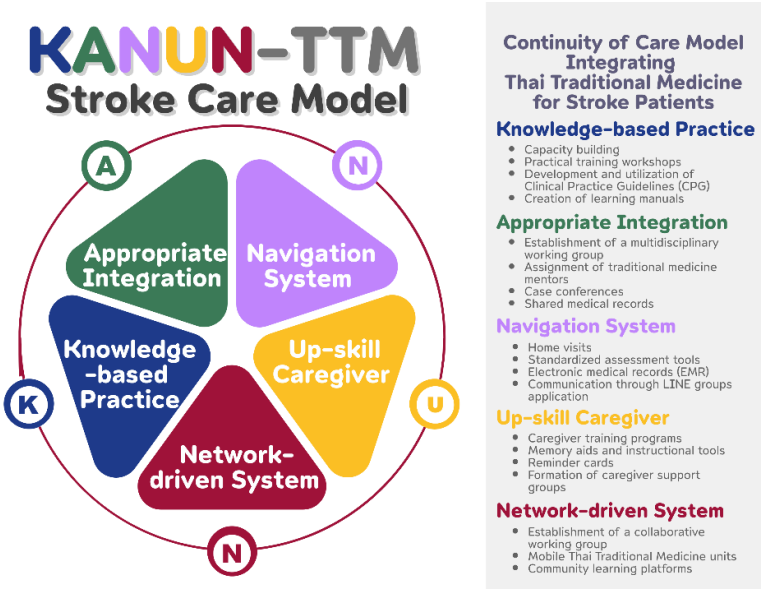

Figure 1: KANUN–TTM Stroke Care Model

7. Conclusion and Future Work: This study designed an effective home-based continuity of care model for stroke patients in rural communities by incorporating TTM. The model is built around core elements: enhancing knowledge, facilitating coordinated care, following up with patients, strengthening caregiver roles, and engaging community support systems. This holds promise in reducing complications, enhancing patients' quality of life, and fostering a sustainable holistic healthcare system. Future research should prioritize pilot testing this model in similar contexts and promote policy initiatives to formally integrate TTM into community-based healthcare frameworks.

Acknowledgement: The researcher would like to express sincere gratitude to all participants, healthcare personnel, primary caregivers and healthcare service units in the study area for their participation which made this research completed.

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Status of Elderly People Attending at Old Age Home in Bogura: A Cross-Sectional Study

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1. Background of the Research: Bangladesh is recognized as one of the twenty countries with the largest elderly populations, and by 2025, alongside four other Asian nations, it is projected to account for 44% of the world's total elderly population (Kabir, 2001). This rapid demographic transition highlights the elderly as an increasingly important group in the country's social and health policy agenda. The sustained growth of this population has brought forward critical challenges concerning their social status, familial roles, living arrangements, healthcare access, social support networks, and overall quality of life (Kabir R., 2013).

The traditional joint family system, which historically provided a strong foundation of care and support for older adults, is gradually eroding under the influence of urbanization and modernization. As a result, elderly care has emerged as a pressing societal issue. Many older individuals struggle to maintain a sense of purpose and identity following retirement, often experiencing loneliness, diminished self-worth, and a loss of social standing. These difficulties are further compounded when aging parents face economic dependency on their children, which can exacerbate feelings of vulnerability and marginalization (Iaspoint, 2016).

2. Research Objectives: To assess the status of elderly people attending at old-age home in Bogura.

3. Research Problem/ Research Questions: Bangladesh is experiencing a rapid rise in its elderly population amidst significant changes in family structure, economic participation, and societal norms. As traditional joint families break down and women increasingly join the workforce, many elderly individuals are being displaced from their homes and placed in old age care facilities. This growing social shift has led to alienation, loneliness, and inadequate care for the elderly. The study aims to assess the status and livelihood patterns of elderly residents at TMSS-Masuda Probin Nibas in Bogura to understand their challenges and unmet needs.

4. Approach: The proposed solution for elderly care in Bangladesh is a culturally sensitive, integrated model that combines traditional family support with modern institutional care. It includes creating small, community-based elderly care centers that respect Bengali culture and religious practices while offering professional services. Families are engaged through caregiver training and financial incentives for home care, supported by locally trained caregivers in culturally appropriate practices. The model links elderly care facilities with community health systems, blending traditional and modern healthcare. Recreational and social activities rooted in Bengali culture will reduce isolation. This approach aims to build a sustainable system that honors tradition while adapting to nuclear family structures, ensuring dignified care for older adults.

5. Experiment/Methodology: This study utilized cross-sectional descriptive study conducted at TMSS-Masuda Probin Nibas, Thengamara, Bogura, from July to December 2023, involving 50 elderly participants selected through purposive sampling. Although Cochran's formula suggested a sample size of 384, 50 samples were taken due to short academic syllabus, time, and resource constraints. A structured questionnaire developed by the researcher was used, consisting of two parts: socio-demographic data (8 items) and the status of elderly people (70 items), measured on a dichotomous scale (Yes/No). The instrument was validated through literature review, expert opinion, and pilot testing. Data were collected directly by the researcher with informed consent and analyzed using descriptive statistics. Ethical clearance was obtained from TMSS Nursing College's Ethical Committee, ensuring participant privacy, confidentiality, and voluntary participation.

6. Results: This study evaluated the physical, emotional, and social well-being of elderly residents at TMSS-Masuda Probin Nibas, Thengamara, Bogura, through a structured questionnaire covering socio-demographic characteristics and multiple quality-of-life domains. A total of 50 elderly individuals participated, of whom 78% were female and the majority identified as Muslim. Most respondents (82%) were married, had no formal education, and previously worked in informal sectors.

Regarding living arrangements, 96% had resided in the old age home for more than two years, and 86% shared rooms. Regular medical care was accessible to 94%, but only 40% could independently perform daily activities. Chronic health issues limiting mobility were reported by 32% of participants.

Emotional well-being indicators showed that 68% frequently experienced loneliness, while 54% reported a loss of purpose post-retirement. Satisfaction with safety and emotional security was moderate, with 48% feeling confident in their living environment.

Social engagement was limited, as 60% reported never receiving family visits, though 70% participated in recreational or group activities within the facility. Financial independence was low, with 46% relying solely on institutional support. The mean total quality-of-life score was 19.9 out of 70 (SD = 4.2), placing most respondents in the 'poor' status category.

Domain	Indicator	n (%) / Mean ± SD
Socio-demographics	Female	39 (78%)
	Married	41 (82%)
	No formal education	36 (72%)
	Previously worked in informal sectors	33 (66%)
Living arrangements	Residing > 2 years in old age home	48 (96%)
	Shared rooms	43 (86%)
Physical well-being	Regular medical care access	47 (94%)
	Independent in daily activities	20 (40%)
	Chronic mobility-limiting conditions	16 (32%)
Emotional well-being	Frequent loneliness	34 (68%)
	Loss of purpose post-retirement	27 (54%)
	Satisfied with safety/security	24 (48%)
Social well-being	No family visits	30 (60%)
	Participation in recreational activities	35 (70%)
Economic support	Reliant solely on institutional support	23 (46%)
Overall quality of life	Mean total score (out of 70)	19.9 ± 4.2
	Quality of life category	**Poor**

7. Conclusion and Future Work: This study assessed the physical, emotional, and social well-being of elderly residents at TMSS-Masuda Probin Nibas, revealing poor overall quality of life despite access to basic medical care. Findings highlight challenges related to limited independence, emotional distress, financial insecurity, and weak family support. Addressing these issues requires culturally sensitive, community-based elderly care models and stronger family engagement. Future research should explore scalable interventions, including caregiver training, policy-driven financial support, and integration of traditional and modern healthcare approaches to improve dignity and well-being for Bangladesh's aging population.

Acknowledgement: The authors express sincere gratitude to TMSS Health Research Foundation, TMSS Grand Health Sector for providing institutional support and facilitating access to research participants at TMSS-Masuda Probin Nibas, Bogura, which made this study possible. Special appreciation is extended to TMSS Nursing College for their collaborative partnership and technical expertise in conducting this comprehensive assessment of elderly care and livelihood patterns.

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Explainable AI for Personalized Triage: Health Screening Data

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1. Background: Machine learning has significantly enhanced clinical decision-making. However, most AI-driven models lack transparency, operating as black boxes. Explainable AI (XAI) methods such as LIME [1], [3] and SHAP [5] offer interpretability, aiding clinicians in understanding model-driven recommendations. The Portable Health Clinic (PHC) system currently uses static WHO-based logic for triaging, but such generalizations fail to capture individual health variability. Developing a personalized triage system using XAI could greatly enhance healthcare outcomes by tailoring clinical decisions to individual patient characteristics.

2. Research Objectives: This study aims to investigate the feasibility of developing a personalized triage system by employing Explainable AI techniques to interpret predictive machine learning models. The specific objective is to identify individualized health status thresholds based on patient health data.

3. Research Problem:
The core research problem stems from the clinical and practical inadequacies of the static, one-size-fits all triage logic currently embedded within the PHC system. While the B-Logic provides a scalable and standardized method for initial risk assessment, its fails to address for the variations among different population segments except for gender-specific criteria. This can lead to systematic misclassification of risk, potentially offering false reassurance to some individuals while causing undue alarm for others.

4. Proposed Approach:
This conceptual pipeline is designed to transform raw health data into actionable, personalized clinical logic through a sequence of well-defined stages:

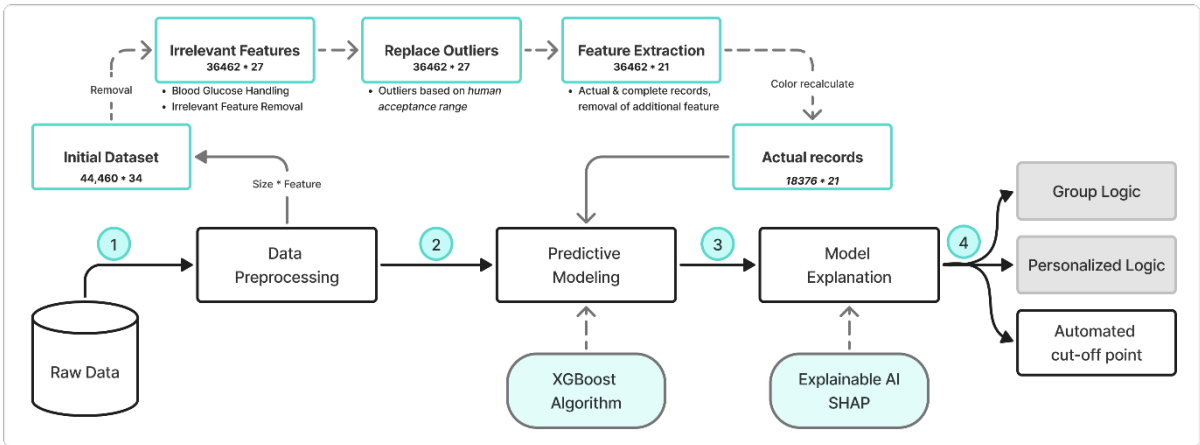

Figure 1. Process flow of personal and group logic

- **Data Preprocessing**: The dataset of 44,460 health screening records from the PHC. Post data preprocessing, addressing missing values, outliers and rearranging based on human acceptance range, feature extraction, color recalculation approach to acute the dataset of 18,376 reliable records was finalized.
- **Predictive Modelling:** The study selected XGBoost (eXtreme Gradient Boosting) [4], a highly efficient and scalable implementation of gradient-boosted decision trees. XGBoost is renowned for its state-of-the-art performance on tabular data, making it an ideal choice for modeling the structured health records. Its ability

to handle complex interactions and non-linear relationships within the data is essential for learning the subtle patterns required for personalized risk prediction.

- **Model Explanation (SHAP):** For model interpretation, we implemented SHAP (SHapley Additive exPlanations) [5]. Unlike simpler feature importance methods like 'gain' (which can be inconsistent), SHAP is grounded in cooperative theory approach. It is model agnostic, offers mathematically sound guarantees of consistency and local accuracy, and can explain not just the global behavior of a model but also the specific reasons for each individual/local prediction. This local explanatory power is crucial for understanding why the model makes a certain decision for a specific patient or demographic group.
- **Algorithmic thresholding:** A systematic algorithm was developed to automatically calculate these personalized cut-off points, ensuring efficiency and reproducibility. A backward scan pinpoints the SHAP sign-change, producing demographic specific cut-offs i.e. BMI, blood pressure, etc.).

5. Experimental Methodology and Data Validation: The PHC dataset underwent rigorous preprocessing, including the recalibration of color-coded health status. XGBoost predicted patient health statuses categorized as *Healthy* or *Unhealthy*, validated using *10-fold cross-validation*, achieving a high accuracy of 99.96%. SHAP values provided interpretative explanations, presenting a ranked summary of clinical parameters by their impact on health status. We analyzed these parameters across different demographic groups, using SHAP dependence plots to visualize and determine precise cut-off points algorithmically.

6. Results: XGBoost predicted health statuses with exceptional accuracy (99.96%). SHAP analysis identified blood pressure as the most influential factor for health predictions, differing from standard XGBoost feature rankings. Notably, cut-off points varied significantly between demographic groups. For example, the optimal BMI threshold for males aged 25 was 27.78, compared to 26.43 for females of the same age group. Such insights demonstrate substantial variability from the static WHO guidelines currently in use, underscoring the necessity for personalized triage logic in healthcare practice.

Clinical Indicator	Population	20 – 29 yrs	30 – 39 yrs	40 – 49 yrs	≥ 50 yrs	B-Logic Threshold*
BMI (kg/m²)	Male	**28.29**	**28.99**	**28.63**	**27.73**	30
	Female	**28.38**	**29.07**	**29.32**	**29.00**	30
Temperature (°F)	Male	**98.80**	**98.80**	**98.47**	**98.85**	99.5
	Female	**99.21**	**99.26**	**99.01**	**98.84**	99.5
Systolic BP (mm Hg)	Male	**138.0**	**138.0**	**137.5**	**139.0**	140
	Female	**130.0**	**134.5**	**136.5**	**136.0**	140
Diastolic BP (mm Hg)	Male	**88.0**	**89.5**	**89.5**	**89.0**	90
	Female	**88.5**	**89.5**	**89.0**	**89.5**	90
Blood Glucose (PBS) (mg dL⁻¹)	Male	**142.5**	**164.0**	**154.0**	**162.0**	200.18
	Female	**129.0**	**152.5**	**139.0**	**144.5**	200.18

Demographic Variations in Health Thresholds: Personalized Triage with XGBoost vs. Static WHO Guidelines

7. Conclusion and Future Work: Our findings confirm that personalized triage thresholds derived through XAI are feasible and provide meaningful clinical insights. However, challenges remain, notably for parameters with non-linear relationships and categorical data. Future research will include refining clustering methods to improve demographic groupings, developing categorical data thresholds, and validating thresholds through clinical expert verification.

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Epidemiology and contributing factors of antenatal depression among mothers living in Tanzania

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Background: Antenatal depression (AND) represents one of the most prevalent complications associated during pregnancy among women worldwide. The global prevalence of antenatal depression varies between 15 to 65% [1]. However, this common condition among new mothers may remain undetected and unaddressed if not adequately evaluated during the antenatal period and might lead to postpartum depression also. The pooled prevalence of antenatal depression is higher in low-income countries, which stands at 34% in comparison with middle-income countries 22.7% [2]. Africa significantly contributes to the global and developing countries AND rates, with a pooled prevalence of approximately 26.3%in sub-Saharan Africa [3]. The etiology of AND is multifaceted, involving neuroendocrine, hormonal, and psychosocial factors, and it exerts a wide range of adverse effects on both maternal health as well as in child growth and well-being.

Research Objectives: This study aimed to assess the prevalence of antenatal depression along with its associated factors among pregnant women living in the Pwani region of Tanzania.

Research problems: Tanzania, a low- and middle-income country located in eastern Africa, faces challenges such as limited access to mental health resources and a scarcity of trained healthcare professionals to address mental health issues. Annually, a substantial number of pregnant women in Tanzania suffer from depression during their antenatal period in silence due to inadequate information, lack of facilities, and fear of addressing psychological problems, rendering it a public health concern. In Tanzania, few studies have focused on the epidemiology of antenatal depression and its causative factors, resulting in a lack of comprehensive information on this issue.

Approach: The integration of mental health services into existing maternal care facilities can play a crucial role in reducing both antenatal and postpartum depression. Implementing routine mental health checkups during the antenatal period, providing free counselling and health education sessions to pregnant women, and identifying vulnerable groups during antenatal visits for close monitoring and psychotherapy sessions throughout pregnancy and after delivery can have a positive impact on maternal and newborn health. Increasing awareness and knowledge among women, their male partners, and family members may also help reduce the incidence of AND.

Method: We conducted a cross-sectional study among 806 pregnant mothers attending antenatal care in four health centers in the Pwani region of Tanzania. The 10-item Edinburgh Postnatal Depression Scale was used to measure depressive symptoms, with a cutoff value of ≥10 used to determine antenatal depression. Data analysis was conducted using Stata version 18.5 software. Univariate and multivariate logistic regression analyses were performed to identify associations, with a p-value <0.05 considered statistically significant.

Results: Among 806 participants, the prevalence of AND was 20.72%. The mean age of the participants was 27.49 years, with nearly half of them, 47.89%, belonging to the 25-34 age group. Two-thirds of the participants, 71.22%, were married. Approximately 92.81% of the participants were educated, and more than half were involved in income-generating activities. One third of them had a monthly income <5000 Tshs. In univariate unplanned pregnancy (OR: 1.76, 95% Cl: 1.24-2.50) and divorced or cohabiting mothers (OR: 1.82, 95% Cl: 1.18-2.80) were associated with AND, after adjusting the covariates the multivariate logistic regression analysis revealed divorced or cohabiting mothers (aOR:1.64, 95% Cl: 1.03-2.61) was significantly associated with AND.

Conclusion: The percentage of antenatal depression among pregnant women was high in Tanzania. Being a divorced or widowed mother has a significant role in developing AND. Providing special attention and counselling sessions during pregnancy, along with the establishment of societal aid for this group, might help in reducing antenatal depression. This research could be a potential resource for the policymakers, researchers and hospital administration of Tanzania to understand the real picture of antenatal depression and take appropriate measures or invent a practical way through future research work to minimize the incidence of antenatal depression.

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Predictive Digital Twin for Early NCD Prevention: A Personalized Predictive Avatar Framework Using EHR Data

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1. Background of the Research: Non-communicable diseases (NCDs) like type 2 diabetes, hypertension, and obesity are emerging as major health risks among adolescents worldwide. Globally, adolescent obesity rates have risen dramatically over the past few decades, with one in five U.S. teens now classified as obese (and facing elevated risks of diabetes and hypertension) [1]. Similar upward trends are observed in regions like South Asia and even in Japan, where lifestyle shifts are contributing to higher NCD susceptibility in youth. However, current early prevention efforts are often hindered by limited data and engagement. Many adolescents do not accurately perceive their health risks, relying on social comparison rather than objective measures [1]. Digital Twin (DT) technology offers a promising solution: DTs are dynamic virtual replicas of individuals that integrate medical and physiological data, enabling simulation of disease progression and personalized intervention testing [2]. By leveraging even minimal health data (basic anthropometrics and vital signs), a predictive digital twin can forecast user health trajectory and provide real time triage [3]. To resonate with tech-savvy youth, we propose coupling this twin with a 3D avatar – a personalized visual representation of the teen's current and projected health status. Visually rich, relatable avatars can make abstract health data tangible, having a greater impact on adolescent behavior than numbers on a scale [1]. This research is motivated by the need to harness minimal data in an innovative, adolescent-centric way to prevent NCDs, aligning with global precision health trends and initiatives.

2. Research Objectives: The research objectives are to accurately predict individual adolescent NCD risk using minimal health data and visualizing future health trajectories through a personalized 3D avatar to make abstract risks tangible and motivate positive behavior change, empowering adolescents to simulate lifestyle modifications and see their long-term impact.

3. Research Problem/ Research Questions:
1. How are existing models and approaches being used to create Digital Twins (DTs) for healthcare data?
2. How can a new model be developed to create a more efficient and accurate Digital Twin for healthcare applications, integrating minimal health data to predict and visualize patient health trajectories?
3. What new attributes can be added to a Digital Twin to enhance patient awareness, and how do these attributes influence the patient's understanding of their health risks and motivation to adopt healthier behaviors?

4. Approach: Our research adopts a hybrid approach, combining data-driven modeling with personalized simulation. We will utilize data from Portable Health Clinics, along with behavioral and clinical information. This data will be preprocessed and fed into our AI models, which will then generate a 3D digital twin representing both current and future health states. We will also leverage large language models (LLMs) to provide personalized health recommendations and triage guidance based on simulated outcomes. System effectiveness will be continuously evaluated through user feedback, digital health literacy assessments, and behavioral outcome metrics, ensuring both clinical relevance and user engagement. Figure 1 shows the workflow of the proposed approach.

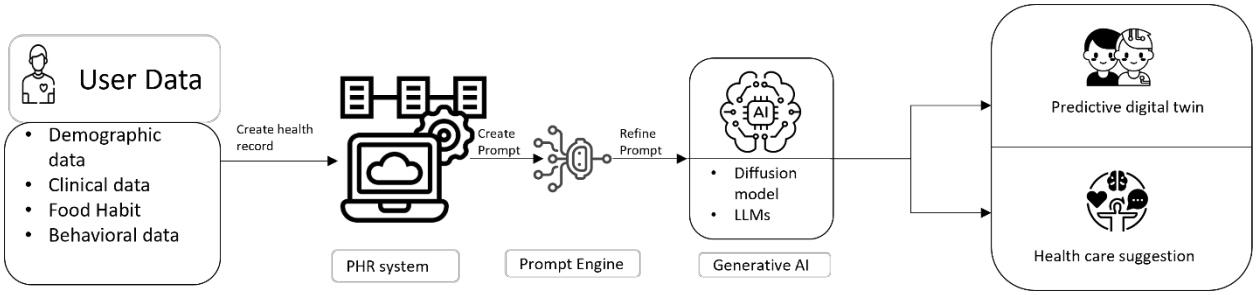

Figure 1: Conceptual Approach of The System

5. Proposed Methodology:

The framework comprises four components:

1. **Data Collection:** We collect behavioral, lifestyle, and clinical data (e.g., BMI, blood pressure, glucose) along with a frontal facial image. These minimal inputs ensure accessibility in low-resource settings.
2. **Silhouette Generation:** An AI model generates a personalized 3D body silhouette from anthropometric data, visualizing current and projected physical health.
3. **Face Reconstruction:** A neural model reconstructs the user's face from a single image and merges it with the body model to create a full 3D avatar.
4. **Healthcare Suggestions:** Based on risk predictions, the system provides personalized lifestyle and clinical recommendations, visualized through the avatar to enhance awareness and motivation.

6. Results: We expect the following outcomes from the predictive digital twin framework:

- **Predictive Accuracy**: The model will predict NCD risks with accuracy and sensitivity comparable to traditional models but using minimal health data.
- **User Engagement**: The 3D avatar will enhance user engagement with health data, leading to better understanding and motivation for lifestyle changes, as assessed by surveys.
- **Health Impact**: Interactive simulations will raise awareness of lifestyle consequences, with at least 70% of users likely to adopt positive behavior changes.
- **Personalized Recommendations**: The avatar's health suggestions will have a tangible impact on users' perceived health, with real-time visualizations of the effects of lifestyle modifications.

7. Conclusion and Future Work: This research focuses on developing a predictive digital twin framework to enhance user health by utilizing minimal health data for risk prediction of non-communicable diseases (NCDs) like diabetes and hypertension. The framework incorporates a personalized 3D avatar to improve user engagement, awareness, and motivation for healthier lifestyle changes. Future directions include building the AI models, integrating more data sources, and refining the avatar's interactive capabilities to provide more tailored health recommendations.

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Medical Reports Classification Using Vision Models: Development and Validation

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1. Background: Despite global advances in digital health, approximately 80% of medical data remains unstructured, particularly in developing countries [1]. Much of this data exists in paper-based formats, making it inaccessible, error-prone, and easily lost. Consequently, patients often rely on memory or fragmented documents to communicate their medical histories, while physicians face challenges in retrieving critical clinical information needed for accurate diagnosis and treatment. To address this, automated classification of medical reports serves as a foundational step toward digitization. In this study, we explore the use of vision-based deep learning models for medical report classification, leveraging their ability to replicate human-like perception when interpreting complex visual data [2]. Accurate classification facilitates downstream tasks such as data structuring, retrieval, and storage, accelerating the transformation toward interoperable digital health systems[3].

2. Research Objectives: To develop a vision-based deep learning model that classifies medical reports into different classes, enabling easier data structuring, storage, and retrieval to support healthcare workflows.

3. Research Questions: (i) What type and quality of medical report data are required to effectively train a vision-based classification model? (ii) Which model architecture—Convolutional Neural Networks (CNNs) or Vision Transformers (ViTs)—yields better performance for this task? (iii) What validation strategies are appropriate to ensure the model's reliability and generalizability across diverse document types?

4. Approach: To address the outlined research questions, this study adopts a structured experimental pipeline. First, a diverse dataset of medical reports in image format—including scanned and photographed documents—is collected, ensuring variability in layout, language, and content quality. The dataset is then preprocessed to enhance image consistency and minimize noise. Subsequently, multiple state-of-the-art vision-based models, including Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs), are trained on this dataset. The performance of these models is rigorously evaluated using key classification metrics: Precision, Recall, and F1-score, along with the Receiver Operating Characteristic (ROC) curve and Confusion Matrix. These evaluation tools facilitate a comparative analysis of the models' accuracy and generalizability. Based on the results, the best-performing model is selected for further integration into downstream health information systems.

5. Methodology: To systematically assess the effectiveness of the proposed classification framework, the methodology was structured into the following key components:

1) **Data Collection and Preprocessing:** A total of 502 medical report images were compiled, donated by laboratory members and sourced online. The dataset spans reports from Bangladesh, India, Pakistan, and Iran. Initially containing 51 imbalanced classes, classes with fewer than 10 samples were reassigned to a "Not Relevant" category. For multi-label cases, only the less frequent label was retained to support a single-label classification task. Due to high confusion among similar categories (haematology, biochemistry, CBC and blood biochemistry), these were merged into a unified "Clinical Pathology" class. To address class imbalance, synthetic data augmentation was applied to minority classes using random flipping, rotation (±20°), brightness/contrast adjustments, affine transformations, and perspective distortion. The final dataset used for training and validation is presented in Table 1.
2) **Vision models:** This study used two vision-based models: EfficientNet-B4, a CNN known for its efficiency and accuracy in image classification, and Swin Transformer-Large, a ViT model effective at capturing long-range dependencies and complex layouts. EfficientNet-B4 was chosen for its performance with fewer parameters, while Swin-Large was selected for its strong representation capabilities in structured documents. Both models were evaluated on the curated dataset to compare classification performance.

6. Results: After data preprocessing and augmentation, the two selected models—Swin-Large and EfficientNet-B4—were trained and evaluated on the curated dataset. Table II presents a detailed comparison of their performance across eight medical report classes using Precision, Recall, and F1-score metrics. EfficientNet-B4 consistently outperformed Swin-Large in most categories, achieving perfect scores (1.00) on several classes such as Urine, Immunology, Microbiology, and Haemogram. Swin-Large also performed competitively, especially in high-recall and balanced-F1 categories like Serology and Hormone, but showed relatively lower F1-scores in Clinical Pathology and Not Relevant. Overall, EfficientNet-B4 demonstrated higher macro and weighted averages, suggesting it is more robust across both majority and minority classes. This makes it a more suitable candidate for deployment in real-world digitization pipelines. To further assess EfficientNet-B4, Figure 1 shows its confusion matrix. Most classes were correctly classified with minimal misclassification. Notably, Clinical Pathology showed a few confusions with Not Relevant and Hormone, while other classes like Urine, Immunology, and Microbiology achieved perfect separation.

Figure 2 displays the multiclass ROC curve, where all classes achieved AUC scores close to or equal to 1.00, indicating excellent separability and overall classification reliability.

These results confirm EfficientNet-B4 as the more suitable model for reliable and accurate medical report classification within the proposed framework.

TABLE I
DATASET SIZE BEFORE AND AFTER DATA AUGMENTATION

Class	Sample Size (Raw Data)	Sample Size (After Augmentation)
Clinical Pathology	255	255
Not Relevant	82	255
Urine	42	255
Hormone	35	255
Microbiology	18	255
Serology	37	255
Immunology	20	255
Haemogram	13	255
Total	**502**	**2040**

TABLE II
COMPARISON OF SWIN-LARGE AND EFFICIENTNET-B4

Metric / Class	Precision (Swin)	Recall (Swin)	F1-score (Swin)	Precision (Eff-B4)	Recall (Eff-B4)	F1-score (Eff-B4)
Clinical Pathology	0.80	0.85	0.82	0.95	0.91	0.93
Urine	**1.0**	0.95	0.97	**1.0**	**1.0**	**1.0**
Not Relevant	0.84	0.94	0.89	0.96	**1.0**	0.98
Serology	0.93	0.93	0.93	**1.0**	0.95	0.97
Hormone	0.91	0.91	0.91	0.95	0.98	0.96
Immunology	**1.0**	**0.98**	**0.99**	**1.0**	**1.0**	**1.0**
Microbiology	**1.0**	0.97	0.98	**1.0**	**1.0**	**1.0**
Haemogram	**1.0**	0.93	0.96	**1.0**	**1.0**	**1.0**

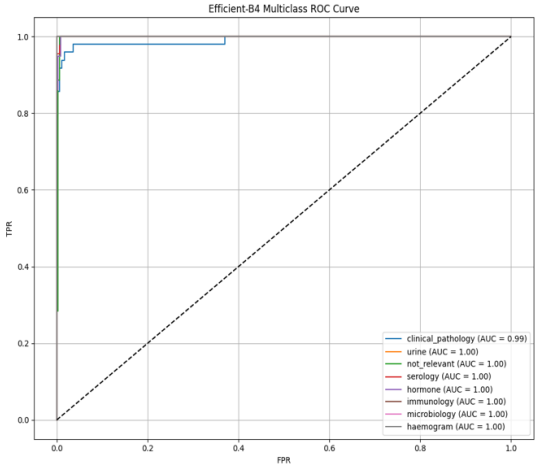

Figure 1: EfficientNet-B4 ROC curve

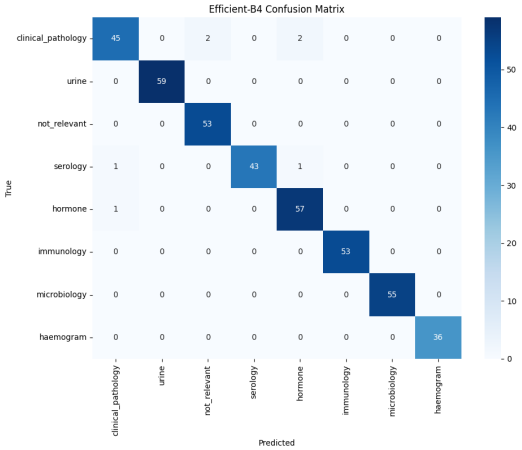

Figure 2: EfficientNet-B4 confusion matrix

7. Conclusion and Future Work: This study demonstrated the effectiveness of vision-based deep learning models for classifying medical reports. Among the tested models, EfficientNet-B4 achieved the highest performance, with strong precision, recall, and F1-scores across all classes. Its near-perfect AUC values and low misclassification rates confirm its suitability for supporting medical data digitization efforts in low-resource settings. In future work, we plan to (1) extend the dataset to include more diverse document types, (2) explore multi-label classification to better reflect real-world scenarios, and (3) integrate the model into a broader EHR-compatible system to enable automated data extraction and storage in structured formats.

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Title: Exploring the causes of suicide attempts in Mongolia: Surveillance-based analysis

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1. Background of the Research: Suicide remains a major public health concern in Mongolia, with high rates, especially among youth and rural populations. In 2021, Mongolia reported a suicide rate of 18 per 100,000 population, double the global average of 9. Despite the urgency of the problem, national-level surveillance and evidence-based intervention strategies remain limited. The motivation for this study comes from the urgent need to provide evidence-based insights to inform policy and prevention strategies. By analyzing nationwide surveillance data from 2016 to 2023, this research aims to identify key risk factors and trends, ultimately supporting more targeted mental health interventions.

2. Research Objectives: This study aimed to identify the causes of suicide attempts in Mongolia from 2016 to 2023, focusing on geographic location, demographic characteristics, and socio-economic factors.

3. Research Problem/ Research Questions: Although suicide attempt rates in Mongolia remain alarmingly high, few studies have explored the underlying causes across age, gender, regional, and socio-economic dimensions. Existing prevention efforts tend to rely on generalized approaches rather than data-driven strategies tailored to population needs. This research seeks to fill that gap by examining national surveillance data from 2016 to 2023. The study aims to identify the primary causes of suicide attempts, evaluate how trends vary across demographic and geographic groups, and determine which populations are most vulnerable. Specifically, it asks: What are the leading contributors to suicide attempts in recent years? How do trends differ by region, age group, and gender? And which high-risk groups require urgent and targeted public health interventions?

4. Approach: This study employs a surveillance-based quantitative design to analyze trends in suicide attempts and risk factors in Mongolia from 2016 to 2023. Data are sourced from the National Injury Surveillance System (NISS), which compiles nationwide records from health facilities and forensic agencies using ICD-10 codes (X60–X84) to classify intentional self-harm. After data cleaning to remove duplicates and incomplete entries, variables such as age, gender, cause, and geographic location will be standardized.

Descriptive statistics will be used to calculate annual suicide attempt rates by key subgroups. Joinpoint regression analysis will be conducted to evaluate temporal trends and identify significant changes over time, with the Average Annual Percent Change (AAPC) estimated. These trends will be stratified by gender, age groups, and causes of suicide attempts.

To assess risk factors, multivariable Poisson regression will be used to estimate Incidence Rate Ratios (IRRs), identifying populations with increased risk. Geographic disparities will be examined through spatial mapping using QGIS to visualize regional hot spots and high-burden provinces.

This multi-dimensional approach, which combines statistical trend analysis, risk modeling, and spatial mapping, aims to produce actionable evidence to guide mental health policies and targeted suicide prevention efforts in Mongolia.

5. Experiment/Methodology: We analyzed surveillance data on suicide attempts collected by the National Trauma and Orthopedic Research Center of Mongolia from 2016 to 2023. Average Annual Percentage Change (AAPC) in suicide attempt rates by cause was examined using Joinpoint regression analysis. Incidence Rate Ratios (IRRs) were calculated to compare rates by sex, age group, and location. Count rates were used to compare suicide attempts by education level and occupation.

6. Results: A total of 4,896 suicide attempts were analyzed, with psychological distress accounting for 71%, physical illness 15%, and family conflict 14%. A significant upward trend in suicide attempts due to psychological distress was observed, especially among males in provinces between 2016 and 2020 (AAPC = 30.76, $p < 0.05$) and individuals aged 20–24 (AAPC = 16.85, $p < 0.05$). Suicide attempts due to physical illness showed an overall but statistically insignificant decline. Family conflict-related attempts fluctuated throughout the study period. No significant sex differences were observed across causes. The 20–24 age group had the highest attempt rates across all causes compared to those under 19. Ulaanbaatar had consistently higher suicide attempt rates for all three causes compared to provincial areas. Individuals with lower education levels and who dropped out of school had the highest number of suicide attempts.

Table 1. Suicide attempts attributed to psychological, physical, and family-conflict related causes and their demographic and socio-economic characteristics in Mongolia, 2016–2023.

	Psychological distress			Physical illness			Family conflict		
	N	Rate	%[1]	N	Rate	%[1]	N	Rate	%[1]
Gender									
Male	1854	14.5	53%	481	3.8	64%	371	2.9	54%
Female	1613	12.3	47%	266	2.0	36%	311	2.4	46%
Age									
<19	364	3.6	10%	61	0.6	8%	71	0.7	10%
20-24	632	34.5	18%	152	8.3	20%	103	5.6	15%
25-44	2072	25.5	60%	478	5.9	64%	449	5.5	66%
45-64	371	7.7	11%	50	1.0	7%	53	1.1	8%
65+	28	2.4	1%	6	0.5	1%	6	0.5	1%
Geographic area									
Ulaanbaatar	2679	22.4	77%	592	4.9	79%	417	3.5	61%
Provinces	788	5.6	23%	155	1.1	21%	265	1.9	39%
Year									
2016	346	11.3	10%	127	4.1	17%	124	4.0	18%
2017	354	11.3	10%	142	4.5	19%	136	4.3	20%
2018	287	9.0	8%	138	4.3	18%	92	2.9	13%
2019	476	14.7	14%	104	3.2	14%	55	1.7	8%
2020	398	12.2	11%	96	3.0	13%	53	1.6	8%
2021	566	17.1	16%	63	1.9	8%	40	1.2	6%
2022	555	16.5	16%	48	1.4	6%	77	2.3	11%
2023	485	14.3	14%	29	0.9	4%	105	3.1	15%
Education									
No former education	101		3%	36		5%	27		4%
Primary, middle	1650	NA	52%	468	NA	64%	341	NA	56%
High school	1415		45%	225		31%	242		40%
Diploma education	301		10%	18		2%	72		12%
Occupation									
Unemployed	1538		44%	419		56%	270		40%
School drop out	29		1%	9		1%	5		1%
School student	83		2%	4		1%	12		2%
University student	365	NA	11%	64	NA	9%	58	NA	9%
Employed	1274		37%	229		31%	275		40%
Herdsmen and agriculter	103		3%	11		1%	52		8%
Retired	75		2%	11		1%	10		1%
Total (N=4,896)	**3467**	**13.4**	**71%[2]**	**747**	**2.88**	**15%[2]**	**682**	**2.63**	**14%[2]**

N: Number of suicide attempts
[1]: Column percentage ; [2] Row percentage
NA: Not applicable, as data specific to education and occupation is not available.

Table 2 Association Between Sociodemographic Characteristics and Suicide Attempts by Psychological Distress, Physical Illness, and Family Conflict

	Psychological distress				Physical illness				Family conflict			
	IRR	95% CI		P value	IRR	95%CI		P value	IRR	95%CI		P value
Gender												
Male	0.98	0.70	1.35	0.91	1.48	0.98	2.23	0.062	0.92	0.66	1.29	0.65
Female	Reference											
Age												
<19	Reference											
20-24	12.87	8.01	20.60	<0.001	13.7	7.43	25.18	<0.001	7.52	4.59	12.40	<0.001
25-44	6.12	3.96	9.44	<0.001	6.16	3.47	10.93	<0.001	5.89	3.74	9.27	<0.001
45-64	2.45	1.51	3.98	<0.001	2.26	1.26	5.44	0.009	1.84	1.06	3.19	0.028
65+	2.75	1.15	6.55	<0.001	6.6	1.57	27.70	<0.001	4.01	1.26	12.70	0.018
Geographic area												
Ulaanbaatar	3.97	2.88	5.48	<0.001	3.22	2.11	4.92	<0.001	2.17	1.55	3.03	<0.001
Province	Reference											
Education[2]												
No former educatin	0.599	0.34	1.05	0.074	1.62	0.65	4.01	0.29	0.63	2.87	1.40	2.26
Primary,middle school	5.630	3.62	8.74	<0.001	7.30	3.49	15.20	0.000	2.72	1.58	4.69	<0.001
High school	3.730	2.51	5.54	<0.001	4.42	2.11	9.26	0.000	1.81	1.08	3.03	0.023
Diploma	Reference											
Occupation[2]												
Unemployed	12.30	6.44	23.50	<0.001	19.77	7.41	52.71	<0.001	7.10	2.41	20.80	<0.001
School drop out	35.80	9.75	131.9	<0.001	30.6	5.81	161.50	<0.001	10.60	1.39	81.40	0.023
School student	5.92	2.10	16.60	<0.001	4.50	0.66	31.60	0.123	2.60	0.52	12.80	0.239
Student	14.81	6.36	34.40	<0.001	16.03	4.79	53.55	<0.001	4.58	1.24	16.80	0.022
Employed	14.87	7.63	28.98	<0.001	12.93	4.79	34.89	<0.001	7.16	2.38	21.50	<0.001
Herdsmen and agriculture	3.56	1.68	7.52	<0.001	2.44	0.69	8.57	0.161	6.16	1.85	20.40	0.003
Retired	Reference											

IRR - Incidence Rate Ratio
[2]: Count Ratio
CI - Confidence Interval

7. Conclusion and Future Work: Suicide attempts driven by psychological distress are rising, especially among urban youth aged 20–24. Our findings highlight the importance of targeted suicide prevention efforts by integrating mental health into primary care, enhancing urban psychosocial support, and implementing school-based programs and real-time surveillance systems to protect vulnerable youth and communities.

Acknowledgement: This research was supported by the Ritsumeikan Asia Pacific University Subsidy for the Preparation of International Collaborative Research.

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Role of Smartphone Application-Based Telehealth Technology in Diabetes Management: Evidence from a Randomized Trial in Bangladesh

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1. Background of the Research: Telehealth technology includes mobile health (m-Health) or electronic health (e-Health) initiatives using mobile phones to improve health have recently spread the world [1]. The m-Health approach appears to work well in cities and among educated young individuals [2-3] including rural regions [4]. Mobile phone use could be a low-cost way to give patients more control over their diabetes care. Numerous smartphone apps based on self-management strategies for DM have been developed globally but not concerning the seven self-management components [5-7]. In Bangladesh, a middle-income country, there are many various cultures and religions, as well as vast differences in socioeconomic status and access to medical care depending on where you live. At the same time, the number of diabetics in Bangladesh is rising. Very few studies that show how well smartphone applications help to control their diabetes The improvement in the diabetes patient's knowledge and behavior, together with the behavioral change method, demonstrated the effectiveness of the smartphone application "Diabetes-Self Care."

2. Research Objectives: This study was designed to explore the effectiveness of this smartphone application (including seven diabetes self-management components) in managing patients' daily in diabetic condition and thereby empowering diabetic population in Bangladesh.

3. Research Problems: Bangladesh is the country with the 10th-highest prevalence of adult diabetes worldwide. Its prevalence in Bangladesh is also increasing (5.52% in 2013 and 7.4% in 2015) and rising costs for complications (41 USD in 2013 and 51 USD in 2015) can be avoided with early diagnosis and adequate management [3, 8]. Diabetes has no cure; thus, self-management is essential throughout one's lifetime. Self-management covers things like foot care, food, medication, physical activity, follow-up appointments, blood glucose tests, and avoiding risky behaviors [9]. By doing these things, one can lessen problems, enhance glycemic control, and enhance one's quality of life.

4. Approach: The smart phone application concept is widely recognized as a tool to support patients' adherence. Using different types of reminder-based materials combined with traditional health education has demonstrated its effectiveness in enhancing knowledge and fostering adherence to diabetes management.

5. Methodology: A randomized controlled trial was conducted in Dhaka district of Bangladesh. A total of 388 diabetic patients were selected in this study for the intervention and control group with a number of 194 in each group. Smartphone Application 'Diabetes Self-Care' installed in the smart phone of each patient of the intervention group and instructed them to use. No intervention was done for the control group. Data were collected by face-to-face interview using a semi-structured questionnaire at baseline and endline. Knowledge and adherence to the seven self-management components was measured and compared in the different groups before and after the intervention using t-test, McNemar's test and logistic regression technique.

6. Results: Endline status of intervention group showed significant ($p<0.01$) improvement in knowledge and adherence to self-management compared to the baseline status. Independent t-test between groups showed that knowledge (regarding seven self-management components, basic and technical knowledge of diabetes) improved significantly ($p<0.01$) more in the intervention group than the control group. Similarly, adherence to self-management components improved significantly ($p<0.01$) more in the intervention group than control group.

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Table 2: Changes in adherence and differences between groups

Adherence to different components of diabetes management	Intervention Group (n=194)			Control Group (n=194)			After the intervention
	Baseline	Endline	p	Baseline	Endline	p	Odd ratio (95% CI)/p
	n (%)	n (%)		n (%)	n (%)		
1. Drug	83 (42.8)	163 (84.0)	0.01*	87 (44.8)	102 (52.6)	0.01*	4.74 (2.94-7.63)/ 0.01*
2. Diet	86 (44.3)	164 (84.5)	0.01*	89 (45.9)	92 (47.4)	0.54	6.06 (3.74-9.80) 0.01*
3.Physical exercise	50 (25.8)	139 (71.6)	0.01*	58 (29.9)	63 (32.5)	0.23	5.25 (3.40-8.10) 0.01*
4. Follow-up visit	49 (25.3)	127 (65.5)	0.01*	54 (27.8)	58 (29.9)	0.21	4.44 (2.90-6.81) 0.01*
5. Blood glucose test	71 (36.6)	138 (71.1)	0.01*	78 (40.2)	84 (43.3)	0.10	3.22 (2.11-4.91) 0.01*
6. Tobacco use	150 (77.3)	167 (86.1)	0.01*	138(71.1)	138(71.1)	1.00	2.51 (1.50-4.18)/ 0.01*
7. Foot care	72 (37.1)	146 (75.3)	0.01*	81 (41.8)	86 (44.3)	0.06	3.82 (2.48-5.88) 0.01*
8.Total adherence	88 (45.4)	172 (88.7)	0.01*	86 (44.3)	96 (49.5)	0.01*	7.98 (4.71-13.49) 0.01*

Data are presented as proportion; n (percentage%). McNemar test was used within-group comparisons and LogisticRegression was used between-group comparisons after one-year intervention with a significance level of p* <0.05. The adherence level of each parameter was indicated. The Control Group was the reference category for calculating the Odds ratio. Adjusted for gender, number of children, family size, family history, used therapy, distance to go to hospital, cost to go to hospital, accompanying person needed, blood pressure (diastolic), and blood glucose (fasting).

7. Conclusions and Future Work: The study showed a significant improvement and positive impact of the m-Health intervention by using smart phone application on patients´ knowledge and adherence on seven self-management components of diabetes. These types of interventions could be replicated for the self-management of diabetes and other non-communicable diseases.

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Knowledge and practice regarding infection control measures among Bangladeshi dental professionals: A cross-sectional study

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Background: Infection is one of the most crucial problems in healthcare services worldwide. It constitutes one of the most important causes of morbidity and mortality associated with clinical, diagnostic, and therapeutic procedures [1]. Healthcare workers are at a high risk of needle stick injuries and bloodborne pathogens as they perform their clinical activities in hospitals. During dental procedures, the transmission of infections could occur either through direct contact with blood, saliva, or contaminated treatment water from dental units, injury with an anesthetic needle or splash exposure of the mucous membranes, droplets, and aerosols, or indirect contact with contaminated instruments and surfaces. By using safety precautions at work and implementing infection control guidelines, accidental exposure to infections in dental settings can be avoided [2]. Studies from developing countries have shown that adherence rates to infection control measures in dental practice were much lower than in developed countries. For resource-constrained settings like Bangladesh, significant deficits in IPC (infection, prevention, and control) lie in the limited availability of essential resources, insufficiently trained personnel, and lack of infection control policies [3].

Research Objectives: This study aimed to determine the knowledge and behavior of Bangladeshi dental professionals on the infection control system during clinical case management.

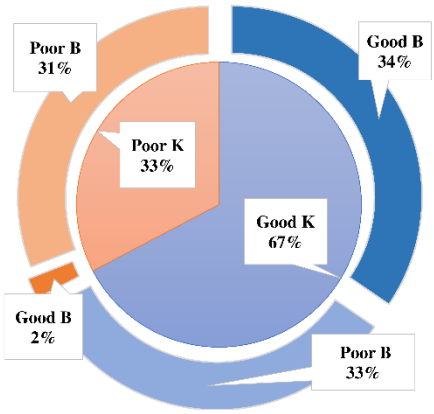
Research Problem: There are several IPC (infection, prevention, and control) guidelines and tools developed by the WHO for assessing IPC practices. Quality Improvement Secretariat (QIS), an initiative under the Directorate General of Health Services (DGHS), Bangladesh, tailored those guidelines and tools for hospital infection control in Bangladesh [4]. However, very few IPC programs have been implemented due to a lack of familiarity with IPC and inconsistent monitoring of compliance with this directive. Most studies of Dentists' infection control practices have investigated compliance with specific procedures, such as the use of gloves and masks, eye protection, hepatitis B virus (HBV) vaccination, and heat sterilization of dental hand pieces [5]. Exposure to blood through percutaneous injury, contact with mucous membranes of the eyes, nose, or mouth, or by contact with non-intact skin is the primary method in this practice.

Approach: There is a scarcity of knowledge and behavior about infection control measures of Bangladeshi dental professionals and their support systems for the dental chamber, including the patients. So, this study aimed to address these issues, which would be helpful to fill in some of the gaps that are not addressed by other articles. More studies on this topic are required to update and standardize the universal infection control protocol, which is safe for dental surgeons and professionals. In addition, national and local regulations or guidance should be clearly documented and followed where appropriate.

Methods: This study followed a descriptive cross-sectional design with a quantitative approach and conducted during March to June 2022. Data were collected from a total of 110 dental professionals in the Khulna district of Bangladesh, using pre-tested and modified, semi-structured questionnaires administered through face-to-face interviews. Validation of the questionnaire was obtained prior data collection. Analysis was conducted using univariate and multivariate techniques, followed by regression modelling. Participants were selected through multi-stage random sampling, and inclusion required a BDS (Bachelor of Dental Surgery) degree registered under the BMDC (Bangladesh

Medical & Dental Council). The data collection focused on their knowledge and behavior regarding infection control measures. Analysis was performed using SPSS, with descriptive statistics and binary logistic regression modeling to identify predictors of poor knowledge and behavior. Ethical approval was obtained from Northern University Bangladesh.

Results: About 67% of dental surgeons showed good knowledge of infection prevention measures, whereas only 33% had poor knowledge. But instead of having good knowledge of infection control measures, a percentage of 33% of dental surgeons were found to have poor behavior in their dental setting, and the remaining 34% followed all the preventive measures to control infection (Figure 1). Binary regression analysis of this study revealed significant predictors associated with poor knowledge and behavior on infection control measures. Dental service provision with <2 assistants per day (AOR= 4.59) and lack of support from authorities concerning infection control (AOR= 3.43) were identified as significant predictors of poor knowledge. Furthermore, the dentists who executed their daily practice with the support of <2 assistants (AOR= 9.49) and who were only graduates (AOR= 4.45) were identified as significant predictors for poor behavior regarding infection prevention.



K= Knowledge; B= Behavior; OR/p= 17.94/0.01; 95%CI= (4.02- 80.19); Reference category= good knowledge

Conclusion: This study revealed a depressive scenario regarding knowledge and behavior on infection control measures among dental professionals. A large-scale study is required to generalize the information and to improve the situation. Moreover, this study will provide future researchers of this field with a concrete base for further study and will be of great assistance to the policymakers of the pertinent arena.

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Knowledge and Practices of Bangladeshi Patients in Seeking Safe Dental Care: A cross-sectional quantitative approach

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Background: Oral health is an essential component of individuals' general health and overall well-being, which is related to individuals' oral health knowledge and healthy oral hygiene habits [1]. Safe dental service-seeking knowledge and behavior is essential for the sustainable management and prevention of dental problems among the general population, which might help to avail exact treatment management facilities regarding dental issues. Health-seeking behavior is any activity undertaken by individuals who perceive themselves as having health issues for the purpose of defining their stage of health until discovering and undertaking an appropriate remedy [2]. Patients' attitude in making decisions regarding their oral health is now changing from passive recipients to recipients who play an active role in taking measures to control their health and taking self-care initiatives. Good oral hygiene is an important part of the general well-being of an individual in society and also contributes to the healthy life of a human being. Before choosing/visiting any dental facility for their treatment, patients consider several factors. These factors may be related to the patient or service provider [3].

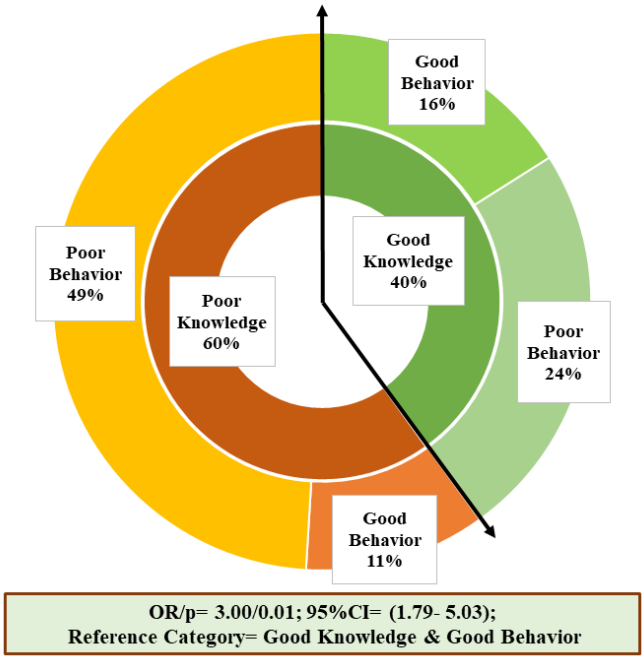
Research Objectives: This study was carried out to evaluate the knowledge about safe dental service seeking of dental patient of Khulna city, who is going to different dental chamber and hospital for their dental treatment.

Research Problem: The overall safety dentistry is not available in every chamber. Due to the nature of dental treatment, procedures typically produce aerosols and splatters, which can contain large amounts of saliva or blood from patients and thus carry the risk of large-scale transmission of the virus [4]. Patient associated factors such as age, gender, and family background appear to be particularly significant components in the advancement of oral diseases while in rural population risk seems to increase due to their geographical location, food habits, and oral hygiene practices. The most important determinant of oral disease is Socio Economic Status (SES) [5]. The lack of studies on patient's health seeking behavior in our region has directed the attention of the study authors to analyze the patient's health seeking behavior. By understanding patient's health seeking behavior, their attitude towards the oral health can be judged which would help to reduce the amount of damage caused by the lesion and prevent its further progression. The prevalence of oral diseases continues to increase in most of the low- and middle-income countries with increasing urbanization and changes in living conditions.

Approach: This study helps to fill in some of the gaps that are not addressed by the articles. As shown later on in the paper, there was a lack of knowledge about safe dental service seeking among the dental patients. More studies on this topic are required to improve public awareness regarding cross infection within dental chamber that can be associated with dental treatment. In addition, national and local regulations or guidance should be clearly documented and followed where appropriate. We want to assess the level of knowledge and behavior on safe dental service-seeking practice among the dental patients of Khulna City. In the future, this study will help policymakers to make further strategies for the improvement of knowledge on safe dental service-seeking practices improves awareness among the community which is good for dental health and how we should practice properly.

Methods: This was a descriptive cross-sectional study conducted from March to June 2022 among 312 dental patients at two major hospitals in Khulna, Bangladesh. Participants were selected using multi-stage random sampling and met inclusion criteria based on their dental visit and consent. Data were collected through face-to-face interviews using a pre-tested, semi-structured questionnaire in Bengali. The survey included questions on dental service-seeking knowledge, behavior, demographics, lifestyle, and oral hygiene practices. Analysis was performed using SPSS software. A scoring system was used to classify knowledge and behavior as "good" or "poor." Multinomial logistic regression was applied to identify significant predictors influencing knowledge and behavior levels. Ethical approval was obtained from the Ethical Review Committee of Northern University Bangladesh**.**

Results: The average age was found as 34 years with higher (61.2%) female respondents. Most of the study subjects had graduated and above education (69.6%) belonged to a nuclear family (24.7%) and resided in urban areas (71%). The majority of the respondents had poor service-seeking knowledge (60%) and behavior (73%) regarding safe dental care. Poor knowledge was significantly associated with the poor practice [OR/p= 3.00/0.01; 95%CI: 1.79- 5.03]. Some determinants under socio-demographic and clinical information were identified as significantly ($p<0.05$) associated with poor knowledge (less education [up to secondary education: AOR= 2.29; 95% CI: 1.14- 4.63], having deleterious habit [AOR= 2.05; 95% CI: 1.15-3.66] and poor seeking practice (urban habitation [COR= 0.54; 95% CI: 0.27 – 1.04], low monthly income of <482.14 USD [AOR= 3.31; 95% CI: 1.55 – 7.09] and having deleterious habits [AOR= 1.82; 95% CI: 0.99 – 3.30].



Conclusion: This study reveals a depressive scenario regarding knowledge and behavior on safe dental service-seeking practice. A large-scale study is required to generalize the information and to improve the situation. Hence, this study will provide future researchers of this field with a concrete base for further study and will come into great assistance for the policymakers the pertinent arena.

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Exploring tobacco expenditure corresponds to pivotal attributes of Bangladeshi rickshaw pullers: Insights from a cross-sectional study

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Background: Bangladesh is one of the most populated countries in the world, having 35.2% of its rural residents dwelling below the poverty line [1]. Tobacco use is nevertheless rather common despite its negative effects, especially among low-income and marginalized populations like rickshaw pullers [2]. They are a vulnerable group who face hard lives, long work hours, and limited access to healthcare and education. Additionally, very low income and job stress are closely linked to high tobacco use [3, 4]. In Dhaka discovered that over 76% of rickshaw pullers were active tobacco smokers, showing a prevalence well above the national average [2].

Research Objective: This study, therefore, aimed to explore how tobacco expenditure corresponds with pivotal attributes among Bangladeshi rickshaw-pullers, shedding light on a critical yet understudied aspect of urban poverty and public health in Bangladesh.

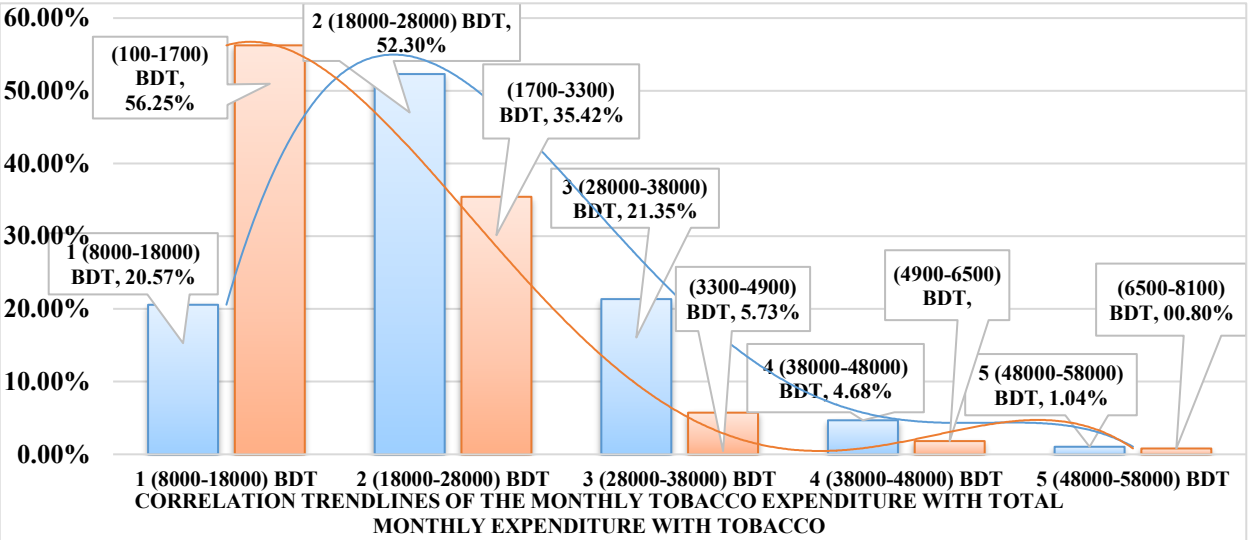
Research Problem: Tobacco consumption, particularly bidis, contributes to medical issues that disproportionately affect the poor, including malnutrition and chronic diseases [5]. Moreover, tobacco consumption poses a major financial burden for rickshaw pullers in Bangladesh [6]. More than half of their income is spent on necessities, leaving little for savings or health care [7]. The typical daily income is between BDT 300 and 400, with very few people earning more than BDT 500 [8]. Rickshaw pullers may spend up to 20% of their income on tobacco—more than on food or housing—causing malnutrition, health issues, and worsening poverty [7]. Reducing tobacco spending could allow rickshaw pullers to spend more on food, leading to better nutrition and health for themselves and their families [9].

Approach: This strategy can help create community programs that teach them about the harms of tobacco and give other ways to earn money. A comprehensive strategy can reduce use of tobacco and improve their health and income. It should also include access to healthcare to deal with their financial problems. This study highlights an urgent necessity to implement tailored health interventions to overcome the specific socioeconomic barriers rickshaw pullers in Bangladesh especially tobacco use and tobacco-related health challenges. Such interventions must consider the fiscal costs of tobacco use among rickshaw drivers, which overburdens their limited household budgets and leaves them with less money for food and health care.

Method: It was a cross-sectional analytical study conducted among randomly selected 384 adult Rickshaw-pullers of Dhaka city of Bangladesh. Data was collected by using a pre-tested and semi-structured questionnaire through the face-to-face interview administered method. Multivariate methods and logistic regression modelling were used for the analysis.

Result: The study shows that greater proportion of the rickshaw pullers (62.5%) spend less than BDT 1900 per month on tobacco, while 37.5% spend BDT 1900 or more. The study found a generally proportionate relationship between total and tobacco expenses, except for those spending between BDT 8,000–18,000 monthly. Among the lowest

spenders (20.57%), most (56.25%) spent BDT 100–1700 on tobacco. Interestingly, this group had the highest proportion of tobacco expenditure relative to their income. In contrast, the highest spenders (BDT 48,000–58,000) included a small group (0.80%) who spent as much as BDT 6,500–8,100 on tobacco. Study identified the important factors linked to the monthly high tobacco expenditure among rickshaw puller. Binary regression analysis showed that pulling rickshaws for >12 years (AOR/p=1.79/0.04, 95% CI= 1.02-3.14), frequency of tobacco consumption was (>9 times/day: AOR/p=3.11/0.01, 95% CI: 1.76-5.50), and had a high proportion of individual tobacco expenditure rate (AOR/p=18.87/0.01, 95% CI: 10.63-33.50) showed higher odds of monthly tobacco expenditure among rickshaw puller.



Conclusion: Expenditure on tobacco cause a major burden for impoverished Rickshaw pullers. This study revealed that the rickshaw pullers who had been pulling rickshaw for >12 years, frequency of tobacco consumption and had a high proportion of individual tobacco expenditure rate showed higher odds of monthly tobacco expenditure among them. These findings have important implications for policy makers and initiatives aiming at improving quality of life and addressing health and economic concern among rickshaw pullers.

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Prevalence of falls among community-dwelling older adults and associated factors: A cross-sectional study in Arankamwaree southern Thailand

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1. Background of the Research: Falls are leading cause of injury, disability, and death among older adults, contributing to reduce quality of life and increase health system cost [1]. Globally, 28-35% of people aged 65 and over fall each year, increasing to over 40% among those aged over 70 [5]. The consequences of fall include fractures, fear of falling and loss of independence [2]. The evidence shows that falls associated with biological, behavioral, and environmental factors [3-4]. Thailand is undergoing rapid population ageing, and falls among older adults are growing concern. However, there is a limited number of community-based studies in southern Thailand that has quantified the prevalence of falls and investigated associated factors.

2. Research Objectives: This study aimed to estimate the prevalence of falls and associated factors among community-dwelling older adults in Arankamwaree subdistrict, southern Thailand.

3. Research Problem/ Research Questions: Falls are major public health problems among older adults, associated with morbidity, mortality, and high costs. They often lead to severe injuries such as fractures or head trauma, significantly reducing quality of life. Falls may also result in long-term disability, loss of independence in daily activities, and increased caregiving burdens for families. This situation can create substantial pressure on healthcare systems and economic resources within communities. Moreover, frequent falls can trigger fear of falling, reduced mobility, and social isolation among older. Therefore, fall prevention is a crucial strategy to reduce health risks and promote a better quality of life for older adults.

4. Approach: To address the burden of falls among older adults in Arankamwaree subdistrict, this study proposes a community-based fall prevention approach guided by the socio-ecological model (SEM). At the individual level, older adults will be encouraged to participate in balance and strength training programs, accompanied by regular health and medication reviews. Families will be engaged to provide supportive care and to adapt home environments to reduce hazards. At the community level, health volunteers and peer support networks will be mobilized to raise awareness and promote active participation. Health service providers, particularly sub-district health-promoting hospitals This multi-level, collaborative approach aims to reduce fall risk, promote healthy aging, and create safer environments tailored to the needs of community-dwelling older adults.

5. Experiment/Methodology: We conducted a cross-sectional study of 464 randomly selected community-dwelling adults aged ≥60 years in Arankamwaree, southern Thailand. Data on socio-demographics, comorbidities, and fall history were obtained via structured questionnaires. Descriptive statistics assessed prevalence, while chi-square/Fisher's exact tests and multivariable logistic regression identified associated factors. Model validity showed good fit (Hosmer–Lemeshow χ^2=3.25, p=0.777) and strong discrimination (AUC=0.80). Ethical approval was obtained from the Human Research Ethics Committee of Thaksin University (COA No. TSU 2024_294).

6. Results: The mean age of participants was 69.9 years (SD=8.3), and 54.7% were female. Overall, 22.2% reported at least one fall in the past six months. Falls prevalence increased with age: 10.9% (60–69 years), 29.4% (70–79 years), and 51.6% (80+ years); p<0.001. Females had slightly higher prevalence than males (24.8% vs. 19.0%, p=0.138). Falls were more common among those with low income (<5,000 Baht: 30.6%) and comorbidities, especially diabetes (48.3%) and hypertension (47.0%); p<0.001. (Table 1). Multivariable analysis showed that age 70–79 (AOR=3.26,

95% CI: 1.83–5.78) and 80+ (AOR=4.37, 95% CI: 2.08–9.19), as well as comorbidities (diabetes AOR=5.77; hypertension AOR=5.24) were independent predictors of falls. Agricultural occupation was revealed as protective factor (AOR=0.47, 95% CI: 0.25–0.88). (Table 2).

Table 1: Characteristics of study participants

Characteristics	Fall n(%)	Non-Fall n(%)	Total n(%)
Sex			
Female	63(13.58)	191(41.16)	254(54.74)
Male	40(8.62)	170(36.64)	210(45.26)
Age (Years)			
60-69	28(6.03)	229(49.36)	257(55.39)
70-79	42(9.05)	101(21.77)	143(30.82)
80+	33(7.11)	31(6.68)	64(13.79)
x̄(SD): 69.88(8.29)			
Income (Baht)			
>20,000	1(0.22)	24(5.17)	25(5.39)
15,001-20,000	5(1.08)	20(4.31)	25(5.39)
10,001-15,000	7(1.51)	47(10.12)	54(11.63)
5,001-10,000	27(5.82)	127(27.37)	154(33.19)
≤5,000	63(13.58)	143(30.82)	206(44.40)
x̄(SD): 9,803.88(24,487.06)			
Occupation			
Unemployed	43(9.27)	57(12.28)	100(21.55)
Casual worker	7(1.50)	40(8.62)	47(10.13)
Merchant	3(0.65)	11(2.37)	14(3.02)
Agriculture	50(10.78)	252(54.31)	302(65.08)
Government officer	0	1(0.22)	1(0.22)
Comorbidity			
None	42(9.05)	293(63.15)	335(72.2)
Diabetes mellitus	14(3.02)	15(3.23)	29(6.25)
Hypertension	47(10.13)	53(11.42)	100(21.55)

Table 2: Factors associated with falls in the multiple logic regression analysis

Characteristics	Fall n(%)	Non-Fall n(%)	COR	AOR	95%CI	p-value
Sex						
Male	40 (8.62)	170 (36.64)	Ref.			
Female	63 (13.58)	191 (41.16)	1.40	0.85	0.50-1.47	0.580
Age (Years)						
60-69	28 (6.03)	229 (49.36)	Ref.			
70-79	42 (9.05)	101 (21.77)	3.40	3.26	1.83-5.78	<0.001
80+	33 (7.11)	31 (6.68)	8.70	4.37	2.08-9.19	<0.001
Income (Baht)						
>20,000	1 (0.22)	24 (5.17)	Ref.			
15,001-20,000	5 (1.08)	20 (4.31)	6.00	3.44	0.34-34.25	0.291
10,001-15,000	7 (1.51)	47 (10.12)	3.57	2.27	0.25-20.48	0.463
5,001-10,000	27 (5.82)	127 (27.37)	5.10	3.50	0.43-28.09	0.238
<5,000	63 (13.58)	143 (30.82)	10.57	3.39	0.41-27.96	0.256
Occupation						
Unemployed	43 (9.27)	58 (12.50)	Ref.			
Casual worker	7 (1.50)	40 (8.62)	0.24	0.50	0.18-1.35	0.174
Merchant	3 (0.65)	11 (2.37)	0.37	0.85	0.19-3.77	0.840
Agriculture	50 (10.78)	252 (54.31)	0.27	0.47	0.25-0.88	0.019
Comorbidity						
None	42 (9.05)	293 (63.15)	Ref.			
Diabetes mellitus	14 (3.02)	15 (3.23)	6.51	5.77	2.43-13.69	<0.001
Hypertension	47 (10.13)	53 (11.42)	6.19	5.24	3.02-9.09	<0.001

These findings directly informed the development of a community-based fall prevention model emphasizing multi-level interventions for older adults with chronic diseases and socioeconomic vulnerability. Age and comorbidities emerged as key predictors, while higher income was protective; sex and living status were not significant. These results identified high-risk groups and guided the creation of an evidence-based, locally tailored model integrating family, community, and health services, with community participation as the core mechanism for sustainable fall prevention.

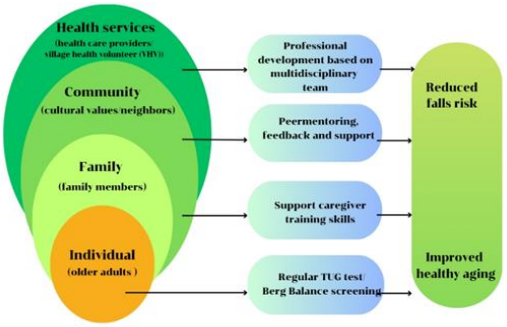

Figure 1. The socio-ecological model for falls prevention strategy

7. Conclusion and Future Work: This study found a fall prevalence of 22.2% among older adults in Arankamwaree subdistrict. Age, sex, income, occupation, and comorbidity were identified as significant risk factors of fall. These findings highlight the importance of implementing targeted community-based interventions and evidence-based policies to promote healthy aging.

Acknowledgement: We would extend sincere appreciation to all participants, healthcare personnel, caregivers, and local health units in Arankamwaree subdistrict for their invaluable cooperation.

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Assessment of Patients Suffering from Lung-related Difficulties Due to Post COVID-19 in Dhaka City, Bangladesh

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1. Background of the Research: COVID-19 has left an enduring mark on global health systems, not only through acute infections but also through its long-term effects, particularly on respiratory health. For many patients, especially in densely populated and resource-limited urban centers like Dhaka, recovery from COVID-19 does not mean a return to normalcy. Persistent lung-related difficulties often classified under "long COVID" or post-acute sequelae of SARS-CoV-2 infection (PASC) have emerged as a serious public health concern (Nalbandian et al., 2021). However, in Bangladesh, these post-COVID complications remain poorly documented, with limited access to follow-up care and awareness among both healthcare providers and patients (Hasan et al., 2022). This research addresses the urgent need for evidence-based insight into the extent and nature of respiratory complications among survivors, and aims to support the development of inclusive, sustainable healthcare solutions aligned with Universal Health Coverage goals (WHO, 2021).

2. Research Objectives: This study aims to assess the prevalence and characteristics of post-COVID-19 lung-related difficulties among adults in Dhaka City. It further explores the socio-demographic and clinical profiles of affected individuals, their psychological and economic status, and their access to care, with the goal of informing scalable public health strategies.

3. Research Problem/ Research Questions: In the aftermath of the pandemic, a significant number of individuals continue to suffer from breathing issues, physical weakness, and reduced quality of life. However, healthcare systems in countries like Bangladesh are underprepared to manage these long-term outcomes. Lack of systematic screening, limited rehabilitation services, and social stigma have compounded the burden on patients. This study fills a critical knowledge gap by documenting real-world patient experiences to help guide health planning and intervention in similar urban low-resource settings.

4. Approach: A descriptive cross-sectional approach was adopted to capture both clinical outcomes and patient experiences in a low-resource urban context. This design ensured integration of epidemiological assessment with patient-reported outcomes, offering a holistic understanding of the post-COVID burden.

5. Experiment/Methodology: The study surveyed 149 recovered COVID-19 patients in Dhaka who reported post-recovery lung-related difficulties. Data were collected through structured interviews and questionnaires covering symptoms, comorbidities, hospitalization history, socio-economic conditions, and psychosocial experiences. Data analysis was performed using SPSS to identify patterns and associations.

6. Results: The study revealed that 53.7% of participants were male and 46.3% female, spanning a wide range of professions and backgrounds. Most resided in densely populated neighborhoods, with over one-third reporting severe physical weakness post-recovery. Notably, 24.2% continued to suffer from chest pain, while only 47% were able to return to their normal daily life. Approximately 34.9% had been hospitalized for post-infection respiratory complications. Social discrimination was widespread, with 88.5% of participants reporting stigmatization due to their COVID-19 history. More than half also experienced financial hardship related to their illness and recovery.

7. Conclusion and Future Work: The findings demonstrate a high prevalence of unresolved lung-related symptoms among post-COVID patients in Dhaka, with profound implications for health and livelihood. There is a clear need for integrated, patient-centered follow-up care that includes respiratory assessments, psychosocial support, and economic rehabilitation. Community-based awareness programs and improved access to care can play a pivotal role in restoring dignity and health to these patients. This study contributes critical data for shaping sustainable, inclusive healthcare models that align with the Sustainable Development Goals (SDGs), particularly in underserved urban settings.

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Effectiveness of a health education program in increasing the confidentiality of health cadres in Indonesia

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1. **Background of the Research:** The rate of maternal mortality is still high in Indonesia compared to other countries in Southeast Asia. The ratio of pregnant women to midwives in Banjarnegara are far from the expected ratio targeting in 2025. Therefore, the role of health cadres within the health system is imperative to provide quality of care for pregnant women.
2. **Research Objectives:** The purpose of this study is to improve the health cadre's confidence in monitoring the risks of pregnant women to reducing the maternal mortality rate.
3. **Research Problem/ Research Questions:** Can the health education program increase the confidence of health cadres?
4. **Approach:** Cadres who received training and health education gained a better understanding of health materials, communication techniques and practical skills. This makes them feel more prepared and competent in carrying out their duties, which increases their confidence. Education and training not only increase knowledge but also empower cadres. In a supportive environment, cadres feel valued and supported by health workers and peers, so they are more confident in taking an active role in the community.
5. **Methodology:** A cluster non-randomized controlled trial was conducted in six Public Health Centers (PHCs) in Banjarnegara Regency, Indonesia, from November 2023 to February 2024. Health cadres in the intervention group (IG) received educational programs over one month with their usual orientation session, while the control group (CG) received the usual orientation session. The primary endpoint was to improve the confidentiality of health cadres
6. **Results:** A total of 133 participants were enrolled, with 130 (97.7%) completing the study (IG:64, CG:66). When comparing the differences between the two groups, the CG showed significant improvement at endline ($p=0.031$).
7. **Conclusion and Future Work:** This research shows that the health education program is effective in increasing the confidence of health cadres. We recommend to conducting this regularly, so health cadres can always be well maintained in carrying out monitoring to find risks to pregnant women.

Therefore, they can prevent and reduce the risk of maternal death.

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Insights of unsafe sound exposure among the motor vehicle Drivers of Dhaka city, Bangladesh

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Background: Noise pollution imposes significant health effects, which cause burdens that coincide with the Non non-communicable diseases. Road traffic noise pollution is a dominating factor for the deleterious health conditions of the high-risk population in Dhaka city, Bangladesh. Traffic noise pollution due to 'barking' of hydraulic horn has been increasing in a double manner from the standard level in Dhaka as well as other cities in Bangladesh [1, 2]. Noise pollution seems to be a common problem found almost everywhere in the world. As a miserable fate, noise from the hydraulic horn might reach 30 dB hearing power of Dhaka city dwellers [3]. The sound level of hydraulic horns measured 95 dB, while it is indicated that exposure to 80-85 dB for 2 hours causes temporary hearing loss, and permanent hearing loss can be caused by the sound of 120 decibels [4, 5].

Objective: To assess the predictors associated with the unsafe exposure of traffic noise pollution among the drivers of Dhaka city, Bangladesh.

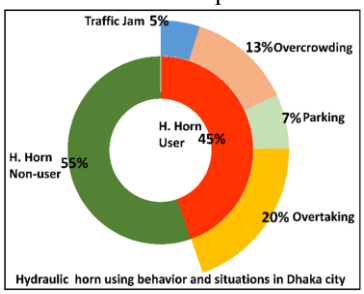
Research Problem: Hydraulic horn is one type of blow horn, which produces high-frequency noise by compressing the air stored in a rubber-like chamber of the device. Frequent hydraulic honking is a dominating factor of noise pollution in Dhaka city, Bangladesh [2]. An approach to reveal the nature and vulnerability of road traffic noise pollution in Dhaka city identified the noisiest places [6]. As the major environmental sources of noise pollution in Dhaka city, it encompasses transportation, vehicular horns, including hydraulic horns, loud audio systems, and commercial activities, along with some other human activities [7]. The majority of drivers in the Jamalpur area of Bangladesh (31%) used to honking during traffic jams, while parking (27%), overcrowding (19%), and overtaking (13%) were also claimed by the respondents. In addition, respondents mostly suffered from headaches (41%) and heartbeat (30%), and a comparatively lesser number were affected by hearing problems (12%) due to traffic noise pollution [8].

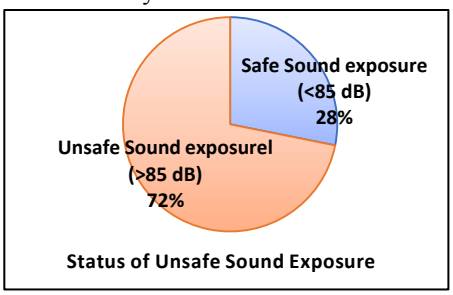
Approach: We studied specifically the status of unsafe sound exposure and hydraulic horn use in Dhaka city, as well as the factors that provoke the use among the driver population in Bangladesh, which is a unique approach. The outcome from this study might guide policymakers to plan effectively in minimizing road traffic noise pollution as well as the health-related consequences both among drivers and the general city dwellers.

Method: The study was a descriptive type of cross-sectional design and conducted in Dhaka city of Bangladesh. The participants were adult drivers who met the inclusion criteria: aged 18 years or more, and were willing to participate in the study. Data were collected from the drivers available in ten zones of Dhaka district, Bangladesh. The zones were selected according to the size of traffic flow in the areas, which were Uttara, Ashulia, Savar, Shahbag, Motijhil, Dhanmondi, Banani, Gulshan, Mirpur, and Gulistan. According to the Bangladesh Road Transport Authority, a total of 1,01,808 registered transports (5 types selected for this study) were available in the city [9]. A total of 1912 vehicles were taken into account from each of 10 zones, and one percent of vehicle drivers, i.e., 19 drivers, were selected from each area. The calculated number 190 was added with the eight percent assumed non-response rate. Finally, 206 motor vehicle drivers were selected from the target zones by using random sampling. Data were collected through an interviewer-administered method using a semi-structured and pre-tested questionnaire. All independent variables were tested individually by the Chi-square (X2) test at a $p \leq 0.05$ level of significance. Unadjusted and adjusted logistic regression models were used to identify predictors responsible for using the hydraulic horn. The study complied with the ethical considerations, and informed consent was obtained from the subjects.

Results: The Study revealed that the majority (71.8%) of the respondents had exposure to unsafe sound levels (>85 dB) for a day-long period. Mostly (80.1%), they accused hydraulic honking as a major source of noise pollution compared to other road traffic sources. In addition, most of them (75.2%) were found to be sensitive towards hydraulic honking. The majority (84.5%) of the divers who had problematic aftereffect on unsafe sound exposure, reported that they faced general disturbance (64.2%), headache (39.3%), hypertension (17.9%), stress (28.3%), and hearing loss

(18.5%) on long term unsafe sound exposure. Exposure of unsafe sound level was significantly found among the respondents with less (<10 years) driving experience (COR/p= 2.54/0.01, 95% CI: 1.29-5.02), who were indulgent towards hydraulic honking (AOR/p= 3.41/0.01; 95% CI= 1.71-6.82) and had good attitude (COR/p= 3.66/0.02, 95% CI: 1.26-10.60) to reduce traffic noise pollution through the band of hydraulic horn use in their motor vehicles.





Conclusion: The Study revealed an alarming scenario of unsafe sound level exposure with an astute insight into the relative factors among the drivers in Dhaka city, which is dangerous for their health. To protect the health of the citizens from the devastating effects of traffic noise pollution, proper interventions can be planned from the outcome of this research.

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Title: Preliminary Report on the Impact of a Mobile-Based Telenutrition Education Program on Enhancing Knowledge Among Rural Adolescent Girls in Bangladesh: A Quasi-Experimental Study

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1. Background of the Research: The period of life between childhood and adulthood known as adolescence lasts from the ages of 10 to 19. Usually, it is separated into two stages: early adolescence (10–14 years) and late adolescence (15–19 years) [1]. Nutritional deficiencies among adolescents significantly contribute to the global disease burden, particularly in low- and middle-income countries. During this time, up to 45% of skeletal growth occurs, and 15% to 25% of adult height is attained [2]. In Bangladesh's rural areas, adolescent girls continue to struggle with iron-deficiency anemia, stunting, and a poor dietary habit. Initiatives for mobile-based telenutrition have shown promise as solutions to bridge these gaps. According to a 2025 randomized controlled study conducted in the Chandpur district, mHealth education greatly enhanced the knowledge, attitudes, and practices of anemic teenage girls, with major improvements in mid-upper arm circumference and BMI [3]. Overall, anemia recovery was greater in the intervention group (25.8%) than in the controls (13.6%), despite hemoglobin levels showing just a slight improvement [3]. Telenutrition, which utilizes mobile or digital technologies to deliver remote nutritional care and counseling, has emerged as a promising strategy to address these challenges, especially in resource-limited rural settings. Nevertheless, evidence regarding its effectiveness among adolescent girls in Bangladesh remains limited.

2. Research Objectives: This study aims to evaluate the effectiveness of a mobile-based telenutrition education program in enhancing nutritional knowledge, attitudes, and dietary diversity among adolescent schoolgirls in rural Bangladesh. The primary objective is to ascertain whether such interventions can increase awareness and positively influence dietary behaviors to mitigate nutritional deficiencies.

3. Research Problems/Research Questions: Despite the acknowledged importance of adolescent nutrition, access to reliable, evidence-based nutritional education remains insufficient in rural Bangladesh. Barriers include limited health infrastructure, a lack of trained personnel, and socio-cultural factors. There is an urgent need to explore scalable, cost-effective solutions such as telenutrition to bridge this gap.

4. Approach: To evaluate the effectiveness of the mobile-based telenutrition education program, a school-based, quasi-experimental pre- and post-test design was implemented. Two higher secondary schools (Boharatoil Gano High School and Gohailbari Abdul Gani High School) in Sakhipur, Tangail district were purposefully selected based on accessibility, student population, and administrative consent. We recruited 190 participants who fulfilled inclusion criteria pertaining to mobile device access and parental consent. These participants ranged in age from 10 to 19 and attended two schools (classes 6–9). The intervention group received structed telenurition education via video sessions and counselling, phone calls and short messages. On the other hand, the control group received usual care without any health education. They used a researcher-developed pretested questionnaire, which was divided into two sections. The first section focused on socioeconomic data, including age, grade, religion, family structure, parents' education, occupation, and monthly income, as well as the lifestyle, food hygiene, sanitation, menstrual hygiene knowledge of the adolescent schoolgirls. In the second section, to evaluate nutritional awareness, attitude, and practice, the researcher utilized a validated questionnaire developed by the Food and Agriculture Organization (FAO) [4].

5. Methods: This school-based quasi-experimental pre and post-test intervention study was conducted at two higher secondary schools in rural Bangladesh between December 2024 and July 2025. We enrolled 190 participants at baseline (95 in the intervention group and 95 in the control group). The intervention comprised six video sessions and telehealth education, including short text messages and periodic phone calls to the intervention group. The control group received the usual care. The primary endpoint is to enhance nutritional awareness to reduce nutritional deficiencies. Data collects twice using a structured questionnaire on knowledge, attitudes, and practices related to nutrition and dietary diversity in both groups. All statistical analyses were conducted using STATA software 18.5. A chi-square test was performed for baseline analysis.

6. Results: The study initially included 190 participants. At baseline, 72.7% of participants in the control group and 85.3% in the intervention group were aged between 10 and 14 years. In the control group, 60.0% of participants' fathers had attained primary education, compared to 42.1% in the intervention group. Furthermore, 56.9% of participants in the intervention group and 61.0% in the control group reported that their fathers were employed in various occupations. In both groups, 97.9% of participants' mothers were housewives. Additionally, 45.3% of participants in the intervention group resided in joint families, while 67.4% in the control group did so. Moreover, 49.8% of participants in the control group belonged to middle-income families, whereas 45.3% of participants in the intervention group were from higher-income families.

7. Conclusions: In rural Bangladesh, the implementation of targeted telenutrition interventions may effectively address adolescent nutritional deficiencies. Initiatives such as school-based nutritional education, digital health programs, and policy-driven strategies are crucial for enhancing nutritional awareness. This is particularly significant given the high prevalence of undernutrition and micronutrient deficiencies among adolescent girls in these regions.

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Title: Enhancing Child Health and Educational Outcomes in Bangladesh: A Comprehensive Review of School-Based Interventions and the "Little Doctors" Initiative

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1. Background of the Research: Bangladesh has made progress in child health, but disparities persist, especially in rural and low-income areas. Preventable diseases and malnutrition impact both survival and education, highlighting gaps in the healthcare system. School-based health programs, like the "Little Doctors" initiative, are cost-effective and empower children to promote hygiene and nutrition, though cultural barriers remain. Broader implementation faces challenges like inadequate teacher training, poor infrastructure, and funding shortfalls. Sustainable success requires increased investment, community engagement, and fostering critical health literacy for lasting behavioral change.

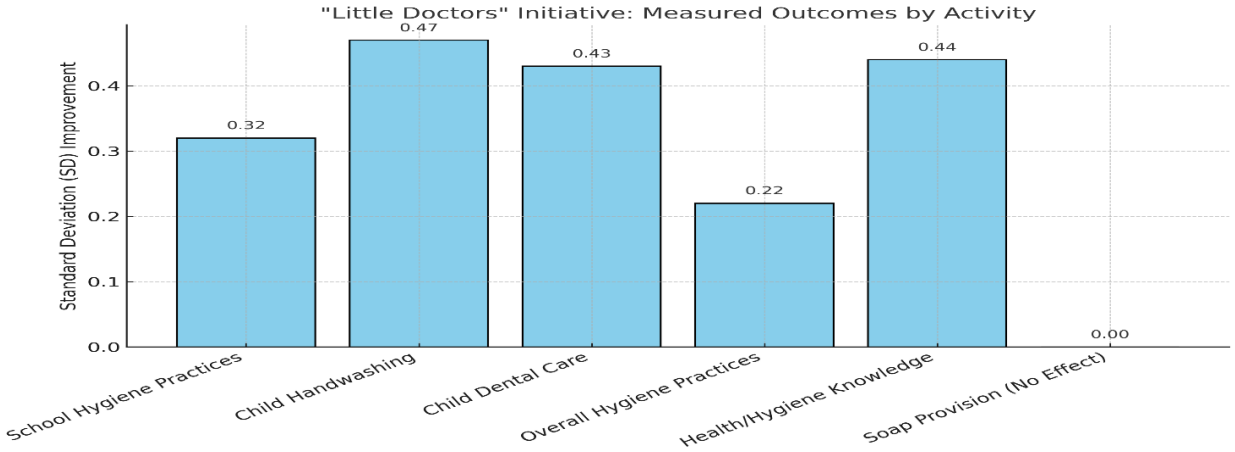
2. Research Objectives: This study sought to identify and analyze the interconnected barriers hindering effective school health program implementation in Bangladesh. By evaluating a child-led peer-teaching model, we aimed to propose a holistic framework that addresses these challenges and lays the groundwork for a scalable, sustainable approach to improving child health and well-being.

3. Research Problem/ Research Questions: A core challenge in Bangladesh is the profound gap between the recognized value of school health programs and their successful implementation. This problem is rooted in a complex, mutually reinforcing set of barriers. We observe a critical human resource deficit, where untrained and unmotivated teachers struggle with an additional workload. This is compounded by severe inadequate school infrastructure, especially the absence of basic WASH facilities. When combined with persistent socio-cultural resistance and a lack of systemic support, these factors create a hostile environment where even promising programs cannot thrive.

4. Approach: To tackle these multifaceted challenges, we propose a strategic framework centered on a "whole-school, whole-community" approach. Our solution is designed to move beyond fragmented interventions and instead address the systemic weaknesses simultaneously. This framework focuses on three core pillars: first, formalizing teacher involvement through enhanced training and incentives to transform health education from a burden into a valued part of their curriculum. Second, upgrading essential infrastructure, with a specific emphasis on providing functional WASH facilities, which are indispensable for practical hygiene education. Finally, we must actively engage parents and community leaders to navigate socio-cultural barriers and ensure positive health behaviors learned in school are reinforced and sustained at home. This comprehensive strategy is designed to create a supportive ecosystem where programs can genuinely take root and flourish.

5. Experiment/Methodology: To investigate the effectiveness of a peer-led model within this context, a quasi-experimental pilot study was conducted in a rural district of Bangladesh. We employed a pre-test/post-test design, comparing an intervention group (implementing a "Little Doctors" style program) with a control group. A total of 200 students from 10 primary schools participated. Structured surveys were administered at the start and end of a six-month intervention period to measure changes in students' health knowledge and self-reported hygiene practices. The data analysis, including statistical t-tests, allowed us to quantify the program's impact, while qualitative interviews with teachers and parents provided critical insights into the real-world implementation barriers.

6. Results: Our findings provided strong quantitative evidence of the program's positive impact. Students in the intervention group showed substantial improvements in key health metrics compared to their peers. We observed a 0.47 SD increase in child handwashing, a 0.43 SD enhancement in child dental care, and a 0.44 SD improvement in overall health and hygiene knowledge. Despite these gains, our qualitative findings confirmed that without a broader systemic approach, the program's scalability remained constrained by the lack of teacher incentives and inadequate school infrastructure.



7. Conclusion and Future Work: This research affirms that child-led, peer-teaching models are a highly effective and cost-efficient strategy for improving public health outcomes in schools. However, their full potential remains untapped due to a complex set of interrelated systemic barriers. For lasting change, our efforts must shift towards a holistic, multi-pronged framework. Future work should focus on piloting the proposed integrated approach to assess its feasibility and effectiveness, with the ultimate goal of developing a scalable and sustainable model for school health that can be adopted nationwide.

Acknowledgement: The authors thank the Ministry of Primary and Mass Education, Ministry of Health and Family Welfare, USAID, and participating primary schools for their cooperation in implementing and evaluating the program.

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Determinants of presenteeism: multi-center study among physicians and nurses in Mongolia

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1. Background of the Research: Presenteeism, defined as an act of working despite poor physical or mental health, poses risks to healthcare workers' well-being and patient safety [1]. While widely studied in high-income countries, evidence from low-resource settings such as Mongolia is limited [2]. Despite policies to promote workplace health, sociocultural and organizational pressures sustain this behavior. Understanding its magnitude and drivers is essential for designing interventions aligned with global workforce well-being and Sustainable Development Goals (SDGs)[3].

2. Research Objectives: This research aimed to examine the prevalence and determinants of presenteeism among doctors and nurses in Mongolia, with particular attention to underlying organizational and sociocultural factors.

3. Research Problem/ Research Questions: Presenteeism among healthcare professionals in Mongolia is insufficiently studied, though it affects workforce health, productivity, and patient safety. Existing policies often neglect underlying factors that sustain this behavior. The study asked: What is its prevalence among doctors and nurses, and what organizational and sociocultural determinants drive it?

4. Approach: This study employed an explanatory sequential mixed-methods approach, which combined quantitative and qualitative methods to capture both measurable associations and deeper contextual drivers [4]. Presenteeism was examined not only as a quantifiable occupational health outcome but also as a behavior shaped by workplace dynamics. The quantitative phase provided statistical evidence on prevalence and key determinants, while the qualitative phase offered in-depth insights into hidden drivers. Integrating both datasets ensured a comprehensive understanding, making the findings statistically robust and contextually meaningful. This serves as a basis for practical and tailored interventions at the organizational and policy levels.

5. Methodology: The explanatory sequential mixed-methods design was implemented with a quantitative phase followed by a qualitative phase. In the quantitative phase, a cross-sectional online survey was conducted at three referral-level hospitals. The survey took place in June and July 2024 and assessed presenteeism, particularly the work-functionality impairment, health-related quality of life, job stressors, and additional items on demographics, workload, and perceived organizational support using standard instruments, including the Work Functioning Impairment Scale (WFun), Health-Related Quality of Life (HRQOL), and Brief Job Stress Questionnaire (BJSQ). These are internationally validated and pilot-tested locally to ensure reliability and relevance. Descriptive statistics performed on the RStudio software measured the prevalence, and regression analysis identified associations between presenteeism and individual, organizational, and physio-psychological factors. Multicollinearity diagnostics (GVIF) ensured model robustness. In the qualitative phase, semi-structured interviews with doctors and nurses in managerial roles were conducted between February and May 2025, and explored the drivers of presenteeism. Transcripts were analyzed thematically using MAXQDA [5]. Findings from both phases were then integrated through triangulation, providing a comprehensive understanding of presenteeism as a multidimensional phenomenon shaped by physical and mental health burdens, workplace environment, and sociocultural norms. Ethical approvals were obtained prior to data collection from the Medical Ethics Review Board at the Ministry of Health, Mongolia, and the Research Ethics Board at Hiroshima University, Japan. All participants provided informed consents. To ensure the trustworthiness of the findings, Lincoln and Cuba`s criteria: credibility, dependability, confirmability, and transferability were applied.

6. Results: A total of 465 doctors and nurses participated, most of whom were female (87.5%), under 40 years old (61.1%), and married (68.6%). Nurses represented the majority (64.5%), and more than half had 11< years of work experience (51.0%). Nearly two-thirds (64.5%) reported presenteeism, indicating moderate to severe work impairment. Multivariable logistic regression identified 3 significant predictors of presenteeism: High workload (OR = 2.08, 95% CI: 1.40–3.13, p = 0.0003), Psycho-physical complaints such as fatigue, anxiety, and depression (OR = 4.51, 95% CI: 2.57–8.26, p < 0.001), and Poor coworker relationships (OR = 2.38, 95% CI: 1.52–3.80, p = 0.0002). The individual interviews were conducted with 14 participants, who had an average of 18.7 years of work experience, with 5.9 years in a leadership role within the health sector. A total of 5 themes emerged: Physical and mental health burdens, Informal workplace practices and professional norms, Staff shortages and heavy workloads, Shortcomings in occupational health infrastructure, and Inadequate policy for occupational health. The integrated findings are displayed in Table 1.

Table 1. Integrated results of the quantitative and qualitative findings using a triangulation approach

Quantitative result	Qualitative evidence	Themes	Triangulation insight
Psycho-physical complaint OR=4.51, p < 0.001	Doctors and nurses push through illness or fatigue due to chronic physical and mental strain.	Physical and mental health burdens	**Strong alignment:** Quantitative data show high OR for health burdens, supported by qualitative evidence of strain.
Coworker support OR=2.38, p = 0.002 Superiors' support OR=1.03, p = 0.908	Peer dynamics and expectations sustain a culture of showing up, even when unwell. Leadership support lacks consistency or enforcement, failing to counteract presenteeism.	Informal workplace practices and professional norms	**Consistent:** Peer support is quantitatively linked to presenteeism, qualitatively explained by workplace norms and pressure. Quantitative data show no significant effect, but qualitative data suggest inconsistent leadership support.
Quantity of workload OR=2.08, p = 0.0005	Due to understaffing and high demands, staff feel compelled to work regardless of their condition.	Staff shortages and heavy workloads	**Clear link:** Heavy workload quantitatively significant, qualitatively tied to staff shortages and workload pressures.
Not directly measured; indirectly captured	Inadequate rest spaces, breaks, and policies discourage recovery and promote presenteeism.	Shortcomings in occupational health infrastructure	**Complementary**: Highlights unmeasured dimensions of working through harmful work conditions.
No policy-specific items or direct measures	Broader structural gaps, such as weak policies and inconsistent implementation, underlie risks.	Inadequate policy for occupational health	**Supplementary**: A systemic weakness clearly emerging from interviews, calling for policy-level intervention measures.

7. Conclusion and Future Work: This study demonstrates that presenteeism among Mongolian healthcare professionals is driven mainly by organizational and psychosocial factors rather than individual characteristics. Our findings further highlighted hierarchical culture, human resource shortages, moral obligation, weak leadership support, and poor workplace environments. Integrated analysis confirmed that presenteeism results from a complex interplay of health, organizational, and sociocultural dynamics. Addressing it requires leadership reform, a supportive workplace culture, and stronger policy measures. Future research should extend to a nationwide setting for greater generalizability and focus on multilevel interventions within healthcare systems.

Acknowledgement: We sincerely thank the participants for their valuable time and insights, and acknowledge the support of the National Cancer Center of Mongolia, Khan-Uul District General Hospital, and Darkhan-Uul Province General Hospital in facilitating this study.

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Exploring risk factors associated with oral cancer among adult population of Bangladesh: A case-control study followed by mixed-method approach.

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Background of the Research: Oral cancer is a significant public health concern, ranking as one of the most prevalent cancers worldwide, particularly in low- and middle-income countries (LMICs) like Bangladesh. According to the Global Cancer Observatory (GLOBOCAN), oral cancer is the 13th most common cancer globally, with approximately 377,000 new cases and 177,000 deaths reported in 2020.[1] In Bangladesh, oral cancer is the leading cancer type, accounting for over 30% of all cancers, with a notable rise in incidence among elderly adults.[2,3] Studies indicate that tobacco consumption, alcohol consumption, betel quid chewing, poor oral hygiene, and nutritional deficiencies are key contributors to the development of oral cancer in this demographic.[4] In Bangladesh, cultural practices such as betel quid chewing are deeply ingrained, further exacerbating the risk.

Research Objectives: To assess the risk factors associated with oral cancer among the adult population in Bangladesh, including the association between oral cancer and lifestyle, oral care, and oral health conditions.

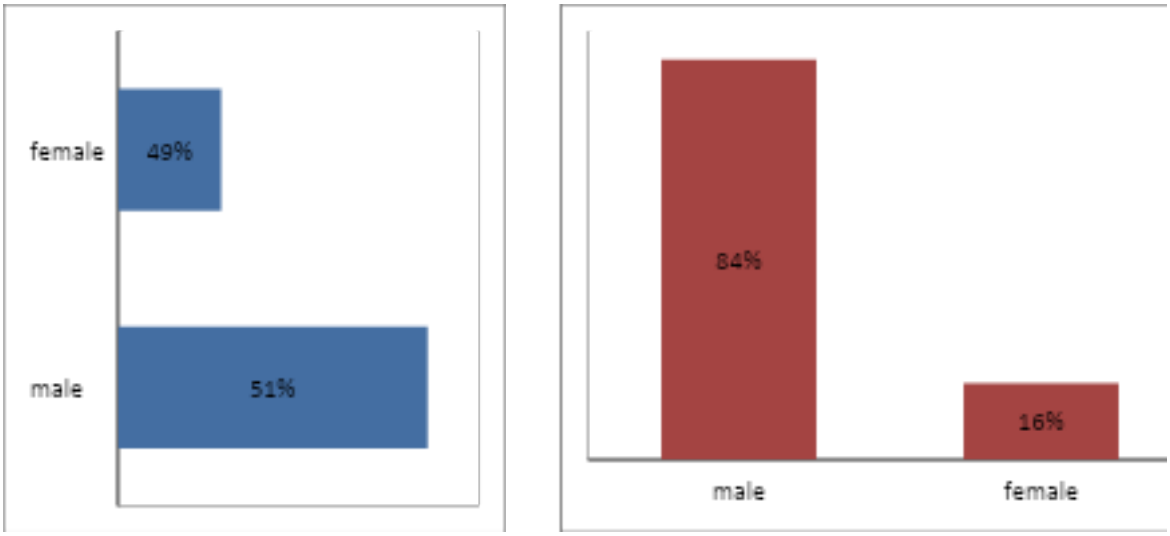
Research problems: Adult populations often lack access to timely healthcare and oral cancer screening due to financial and infrastructural barriers, leading to late-stage diagnosis and poor outcomes. Oral cancer often begins as a small sore in the mouth, but as it progresses, it can lead to severe complications and ultimately death. Oral cancer also creates financial and social burdens, particularly in low-income settings like Bangladesh. Despite all these problems we do not have enough advance researches on oral cancer in our country.

Approach: Addressing the challenges of oral cancer requires a comprehensive approach, including robust policy implementation, awareness campaigns, and improved access to preventive and curative services. Future research should focus on longitudinal studies and the effectiveness of targeted interventions to mitigate the burden of oral cancer in this vulnerable population. In this study we could see most of the people of our community do not have good knowledge on oral health and they are not aware about it and a significant number of them are consuming tobacco and other deleterious items (betel quid, gul, raw tobacco leaf). So we should work on these to inform people about importance of oral care and to control tobacco.

Methodology: This study is an analytical type of case-control study followed by mixed-method approach. The study population in quantitative approach were the patients with oral cancer diagnosed and admitted in cancer department of Dhaka medical college hospital, Dhaka dental college hospital and Kumudini women's medical college as cases group and **r**elatives or neighbours from peer circle of the cases, who had similar age range, demography or lifestyle as controls group and sample for case was selected randomly. On the other hand sample in Qualitative approach were selected purposively from the mentioned hospitals. Conversely population of qualitative approach was considered as all the OMS doctors appointed for the oral cancer treatment in the selected hospitals. Total sample size was 98 (Cases 49 and Controls 49) for qualitative approach and purposively 5 OMS doctors were selected for the qualitative approach and Key Informant Interviews (KII) were taken from them. A pre-tested, semi-structured questionnaire was designed to collect the information from the sample population in quantitative approach who were interviewed through face-to-face interview method. Statistical Package for Social Science (SPSS) version 16.0 (Chicago) a computer program was used to entry and analyzes the collected data in quantitative approach and in qualitative approach Manual data analysis was done, Matrix was developed, using Excel sheets, according to

specific objectives and variables.

Results: This study reflected that most of the cases were ≤59 years old (53%) and rest of the cases were >59 years old, on the other hand more than half of the controls were >59 years old (59%) and 41% were ≤59 years old. Majority of the cases were male (51%) and 49% cases were female, conversely most of the control were male (84%) and 16% of the control were female. If we compile both the quantitative and qualitative results we can see some similarities. In both studies we revealed some common reasons of oral cancer like betel quid, smokeless tobacco (zorda). In quantitative approach we identified four predictors of oral cancer, Such as- other deleterious items (betel quid, gul, raw tobacco leaf) (AOR=23.87, p=<0.01*, 95% CI= 2.27-249.98), having >3 children (AOR= 45.35, p=<0.01*, 95% CI= 4.04-509.63), sleeping ≤6 hours (AOR=53.65, p=<0.01*, 95% CI= 5.87-409.02), and having oral diseases (AOR= 7.05, p=<0.01*, 95% CI= 1.67-29.79).



Case (49) **Control (49)**

Figure 1: Distribution of the respondents by their sex (n=98)

Conclusion and Future Work: Oral cancer among adult population in Bangladesh is a multifaceted issue, driven by behavioral, socioeconomic, environmental, and healthcare-related factors. This study was conducted to find risk factors associated with oral cancer like tobacco consumption, alcohol consumption, betel quid chewing, poor oral hygiene etc. By informing people about importance of oral care and by controlling tobacco consumption we can reduce oral cancer. We can use mass media to inform people about the right practices of oral care and inform them about the severities and reasons of oral cancer.

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Predictors Linked to Poor Quality of Life in Hypertensive Patients of Bangladesh: A Cross-Sectional Study

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1. Background of the Research: Hypertension is often called the "silent killer," as it generally remains asymptomatic until it leads to severe health complications such as heart disease, kidney failure, or stroke [1]. According to estimates by the World Health Organization (WHO), approximately 1.28 billion adults globally suffer from hypertension, with a considerable portion residing in low- and middle-income countries like Bangladesh [2]. In Bangladesh, nearly one in five adults is affected by hypertension, making it a pressing public health issue with lasting implications for both individuals and society [3]. For people with hypertension, QOL often worsens due to the long-term nature of the disease, other health conditions, and the stress it brings [4]. In Bangladesh, researchers have used the health-related quality of life (HRQoL) tool to assess QOL in hypertensive patients [5]. In several countries except Bangladesh, during the pandemic, QOL among hypertensive patients was evaluated using the HRQoL, WHOQOL, European Quality of Life-5 Dimensions (EQ-5D) tool [6, 7, 8].

2. Research Objectives: This study aimed to measure QOL among hypertensive people in a selected tertiary hospital in Dhaka city, and its association with the basic characteristics of the patients.

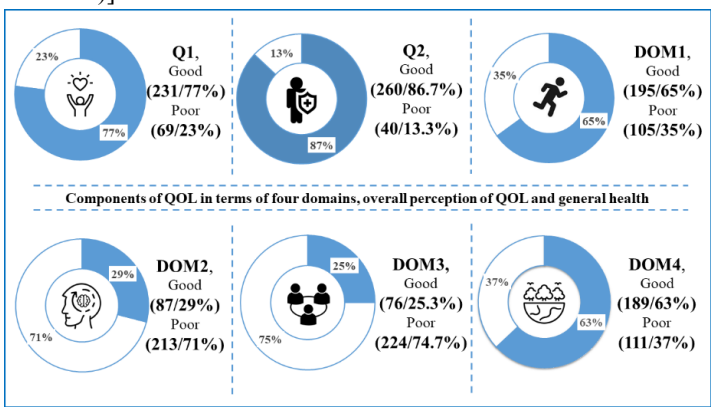
3. Research Problem/ Research Questions: Research shows that when people with high blood pressure have a lower quality of life, they are less likely to stick to their treatment, which leads to higher medical costs and worse health outcomes [9,10]. The COVID-19 pandemic made this even more challenging by reducing physical activity, increasing stress, and limiting access to healthcare [5,6]. Despite these issues, there is very little research in Bangladesh on how hypertension affects quality of life, especially using reliable tools like the WHOQOL-BREF in last couple of years. Without this data, it's hard to develop effective and culturally appropriate strategies to support and improve the well-being of hypertensive patients.

4. Approach: The growing number of hypertension cases in Bangladesh is seriously affecting people's quality of life, highlighting the need for stronger public health efforts. This approach can provide culturally relevant insights to guide effective healthcare interventions and improve the well-being of individuals living with hypertension. Addressing this gap, the present study aims to evaluate the QOL of hypertensive patients in a post-pandemic Bangladeshi setting using the WHOQOL-BREF instrument. By focusing on Square Hospitals Limited, a leading tertiary care facility in Dhaka, the study explores how quality of life (QOL) is influenced by various sociodemographic, lifestyle, and clinical factors among hypertensive patients.

5. Methodology: This study was conducted among randomly selected 300 hypertensive patients from two departments of Square Hospitals Limited, using the patient register record. Data were collected through face-to-face interview methods. The WHOQOL-BREF questionnaire was used to assess the QOL of the subjects. Descriptive statistics were used to examine mean scores of quality of life. Cronbach's alpha coefficient and Pearson's correlation coefficient were applied to estimate the internal consistency, and the level of agreement among different domains of WHOQOL-BREF, respectively. Chi-square test followed by binary regression analysis was used to measure the association between QOL domains and independent variables. The scores for the four domains (DOM 1, DOM 2, DOM 3, DOM 4), as well as overall perception of QOL (Q1) and general health (Q2) were divided into two groups considering the 50% as the cutoff point. Scores above 50% were considered as 'Good/higher QOL'; while below 50% as 'Poor to moderate/lower QOL' [11].

6. Results: Overall perception of QOL (Q1), overall perception of general health (Q2) and four domains were significantly and positively interrelated with low to moderate relationships ($r = 0.13–0.77$, $p< 0.01$). The QOL among hypertensive patients was found to be poor in the psychological (71%) and social (74.7%) domains and good in the environmental (63%) and physical (65%) domains. The bivariate cross-tabulation analysis unveiled that some socio-demographic and lifestyle related factors like age, education, family type, monthly family income, status of DM, and

lifestyle status were significantly associated with the domains of QOL (p= 0.01). Backward binary regression analysis revealed that being older (p=0.01), diabetic (p=0.02), having history of COVID-19 (p=0.01), and poor monthly income (USD ≤853.14) (p=0.01) were significantly associated with poor QOL in all domain. Moreover, older age (p=0.01) and poor lifestyle (p=0.02) were significantly associated with poor overall quality of life and poor general health perception. [DOM1: (DM-Yes: AOR/p=2.35/0.01), (aged over 55: AOR/p= 3.33/0.01); DOM2 (>55 years age: AOR/p=2.92/0.01; Income USD ≤853.14: AOR/p= 2.34/0.01; diabetic: AOR/p= 2.63/0.01; COVID-19 'yes': AOR/p=3.14/0.01); DOM3 (>55 years age: AOR/p=2.62/0.01; Income USD ≤853.14: AOR/p= 2.87/0.01; diabetic: AOR/p= 2.22/0.03; COVID-19 'yes': AOR/p=3.45/0.01), and DOM 4 (Income USD ≤853.14: AOR/p= 16.89/0.01), (>55 years age: AOR/p=2.85/0.03)].



7. Conclusion and Future Work: The results revealed low QOL in the psychological and social domain including significant factors associated with the poor QOL in all domains. To enhance the quality of life for hypertensive patients especially those who are older, diabetic, have lower incomes, experienced COVID-19, and maintain poor lifestyles effective interventions and health system strengthening are crucial. Outcome of this study may guide for the future nationwide research which include more patients over time to find better ways and determinants to improve their quality of life

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Distribution of gingivitis among the patients reporting to few selected dental clinics in Noakhali district of Bangladesh

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1. Background of the research: Gingivitis is a prevalent oral health issue in Bangladesh, affecting a significant portion of the population. Periodontal diseases, with gingivitis included, pose a substantial public health challenge due to their high global prevalence and the complications they may lead to. The World Health Organization (WHO) estimates that severe forms of periodontal disease affect nearly 19% of adults worldwide, amounting to over one billion cases globally.[1]Gingivitis is a widespread condition that affects peop6le of all ages around the world. Altho6ugh determining exact global prevalenc6e is challenging due to inconsistent d6efinitions, diagnostic standards, and 6assessment methods, epidemiological da6ta indicate that between 50% and 90% o6f the global population experiences mi6ld to moderate gingivitis at any given6 time.[2] In wealthier nations, early detection and effective treatment are more common thanks to greater access to dental care and public awareness. In contrast, low- and middle-income countries (LMICs) face a heavier burden due to insufficient dental services, a lack of preventive initiatives, and inadequate oral hygiene. For example, a systematic review found that gingivitis prevalence can reach up to 97% among specific age groups in regions like sub-Saharan Africa and South Asia.[2]

2. Research Objective: This study aims to assess Distribution of gingivitis among the patients reporting to few selected dental clinics in Noakhali district of Bangladesh.

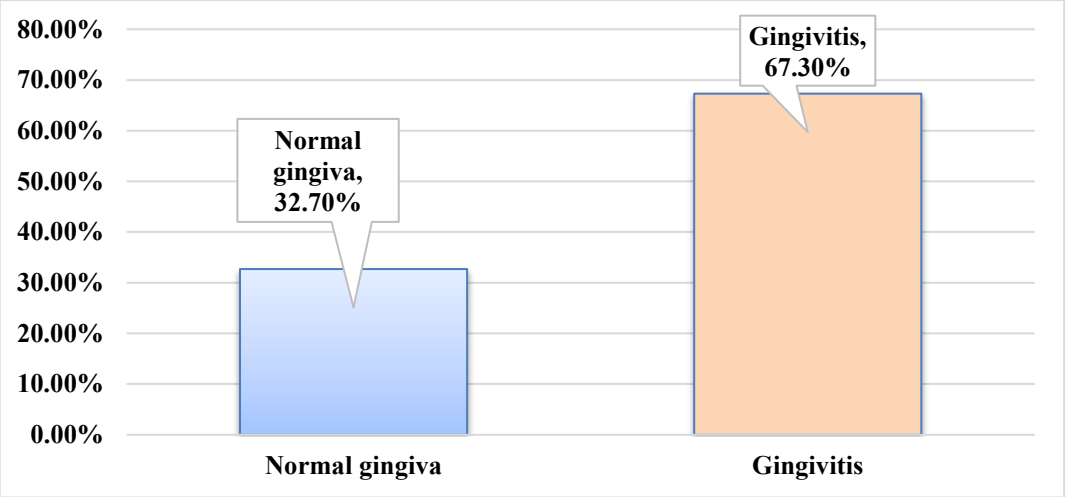
3. Research Problem: In Bangladesh, oral health has traditionally been a neglected aspect of public health policy.[3] While comprehensive national data remain limited, several regional studies shed light on the prevalence of gingivitis across different groups. One cross-sectional study conducted among schoolchildren in Dhaka revealed that more than 82% showed clinical signs of gingivitis, primarily linked to inadequate oral hygiene and a lack of awareness about dental care. Similarly high prevalence rates have been documented in rural and peri -urban areas. For instance, a 2019 study in the Rajshahi district, focusing on adults aged 20 to 60, found that 74% exhibited gingivitis, with a strong association observed between plaque levels and gum inflammation.[4] These results highlight the pressing need for comprehensive national monitoring and preventive oral health programs.[4]

4. Approach: An increased understanding of the association of poor health outcomes with poor oral hygiene practice is coming from the national and international comparisons of several gingival diseases among adult people and prevention of gingivitis. Therefore, this study was aimed to assess the proportion of gingivitis and its associated factors among the patients in selected few dental clinics of Noakhali district. From the current study and other studies of gingivitis, it is possible to draw some tentative conclusions.

5. Methodology: It was a descriptive type of cross-sectional study conducted among the purposively selected 254 dental patients who are attended renowned city based dental clinics of Noakhali district as these clinics are more acceptable to the dwellers and deliver the dental care service to the majority of the residents of that district. Data were collected through face-to-face interview method by using a pre-tested modified and semi-structured questionnaire. Data collection procedure was conducted from January 2025 to April 2025. Gingivitis status was scored manually using dental kits by the registered dental surgeon. Data analysis was done using SPSS software through frequency distribution, chi-square analysis followed by binary regression analysis which was used to measure the association. Oral hygiene knowledge was scored using the mean and SD value. Ethical considerations were maintained according to the declaration of Helsinki.

6. Results: This study showed that nearly half of the respondents (44.5%) were ≤36 years of age, while 55.5% were >36 years old. Among them, 57% were female, most had up to secondary education (63%), belonged to extended families (60.2%), and came from lower-income groups (67.7%). The study also revealed that 44.1% of respondents

had poor knowledge of oral hygiene maintenance, while 41.7% had poor practices. Furthermore, the majority (67.3%) were found to have gingivitis, whereas 32.7% had normal gingiva. To identify the determinants of gingivitis, a binary regression analysis with adjusted modeling and backward elimination was conducted. Gingivitis was found to be significantly associated with lower education (up to secondary: AOR = 1.93, p = 0.01, 95% CI: 1.12–3.37), belonging to an extended family (AOR = 2.02, p = 0.01, 95% CI: 1.17–3.50), and being overweight/obese (AOR = 1.77, p = 0.04, 95% CI: 1.01–3.07).



7. Conclusion: The findings emphasize the need for targeted preventive measures and awareness campaign among the affected group with gingivitis. Improving oral hygiene education and promoting healthier lifestyles can help to reduce gingivitis in the community. Future large scale study is recommended for the sustainable solution regarding improvement of oral and dental condition of the ordinary people of Bangladesh.

8. Acknowledgement: We would like to thank our study participants and their caregivers for their generous support. We extend our thanks to the Northern university of Bangladesh and the research staff for their unwavering assistance.

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Distribution and determinants of iron deficiency anemia among school-going adolescent girls residing in some selected communities of the southeastern region, Bangladesh

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1. Background of the Research: Iron Deficiency Anemia (IDA) remains a critical public health concern among adolescent girls, particularly in low-resource settings such as southeastern Bangladesh. In 2021, approximately 24.3% of the global population, or 1.92 billion individuals, were reported to be anemic[1]. Adolescent girls are especially vulnerable to IDA due to inadequate dietary intake, limited nutritional knowledge, and insufficient access to micronutrient interventions, which can negatively affect their health, academic performance, and future reproductive outcomes[2-4]. The host community, Cox's Bazar, is characterized by poverty, food insecurity, limited healthcare infrastructure, and entrenched gender inequalities, along with the burden of nearly 1.3 million Rohingya refugees residing in this area. Despite these risk factors, the prevalence and determinants of IDA among adolescent girls in this region remain poorly documented [5-8].

2. Research Objectives: This study aimed to determine the prevalence of IDA along with its associated factors among school-going adolescent girls in selected communities of the southeastern region of Bangladesh.

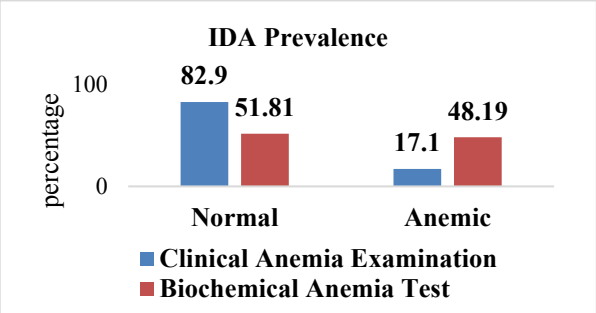
Research Problem/Research Question: The southeastern region of Cox's Bazar, Bangladesh, presents several risk factors for IDA, including inadequate consumption of Iron Folic Acid (IFA) supplements, insufficient intake of iron-rich foods, irregular meal patterns, the practice of consuming tea or coffee with meals, limited awareness of IDA, and cultural barriers such as menstrual taboos. These determinants have not been systematically investigated in this context. Furthermore, the presence of approximately 1.3 million Rohingya refugees in Cox's Bazar has significantly transformed the living environment and socio-demographic conditions of the host communities. Considering this situation, the present study seeks to evaluate the prevalence of IDA and identify associated risk factors among school-going adolescent girls in the Teknaf and Ukhiya Upazilas of the Cox's Bazar district. The findings from this study are anticipated to provide evidence to guide policymakers in designing and implementing context-specific health education interventions aimed at enhancing IDA-related knowledge and practices within this vulnerable population.

4. Approach: This cross-sectional study identified the prevalence and key determinants of IDA among school-going adolescent girls in southeastern Bangladesh through biochemical and clinical analysis and interviews. By exploring dietary habits, meal-skipping, and socio-cultural factors, the study will generate context-specific evidence. Its strength lies in combining biological, behavioral, and other quantitative and qualitative data to understand the multifactorial nature of IDA. Findings will inform targeted nutrition programs, school-based interventions, and policy recommendations to improve adolescent girls' health and break the intergenerational cycle of malnutrition.

5. Methodology: A cross-sectional study was conducted among 386 school-going adolescent girls using semi-structured questionnaires, clinical assessments, and hemoglobin testing. Data were collected through face-to-face interviews, and information was taken on socio-demographics, dietary practices, menstrual health, perceived iron and folic acid (IFA) consumption, anemia-related knowledge, and lifestyle behaviors. Descriptive statistics, chi-square tests, and both bivariate and multivariate logistic regression analyses were performed, and a backward elimination

process was done to adjust the confounding factors to explore the associations between independent variables and IDA status at a 95% confidence level, where the p-value was set as 0.05.

6. Results: Biochemical assessments showed that 48.19% of participants were anemic, whereas 17.10% were anemic based on clinical examination. The outcome from Regression analysis revealed that IDA was significantly associated with IFA consumption (COR = 1.63, 95% CI: 1.09–2.43), physical activity (COR = 1.74, 95% CI: 1.09–2.80), menstruation onset (COR = 1.63, 95% CI: 1.00–2.66), anemia related knowledge (COR = 2.30, 95% CI: 1.35–3.93), iron-rich food knowledge (COR = 2.14, 95% CI: 1.38–3.31), older age (≥14 years) (COR = 2.19, 95% CI: 1.44–3.32), and higher education grades Grade 9 (COR = 3.09, 95% CI: 1.63–5.85), and 10 (COR = 3.07, 95% CI: 1.58–5.96). As final predictors, model adjustment and backward elimination procedure of regression analysis revealed that meal skipping behavior at least once in a week, iron-rich food knowledge, and age had a significant impact on the status of IDA respectively (AOR = 1.71, 95% CI: 1.12–2.59, p = 0.013), (AOR = 2.08, 95% CI: 1.33–3.26, p = 0.001) and (AOR = 1.93, 95% CI: 1.26–2.97, p = 0.003) among the respondents. Other factors, including IFA intake, physical activity, IDA, menstruation onset, and level of education, were identified as the confounders in the adjusted model.



7. Conclusion and Future Work: The present study highlights a high burden of IDA among school-going adolescent girls in the southeastern region of Bangladesh, with 48.19% of participants identified as anemic through biochemical assessment. IDA was significantly associated with modifiable behavioral and knowledge-related factors, including meal skipping, low knowledge of iron-rich foods, and older age. Despite high awareness of anemia-related issues, adherence to iron supplementation and optimal dietary practices remained suboptimal, indicating a gap between knowledge and behavior. Other factors, such as IFA intake, physical activity, menstruation onset, and educational level, acted as confounders, reflecting the multifactorial etiology of IDA. Based on these findings, interventions should prioritize improving dietary behaviors and adherence to iron supplementation, particularly among older adolescents and those in higher grades. School- and community-based nutrition education programs should focus on enhancing knowledge and practical skills related to iron-rich food consumption and regular meal patterns. Behavioral interventions, such as counseling, parental engagement, and reminder systems, may help reduce meal skipping and improve IFA adherence. Furthermore, integrating anemia prevention strategies into existing adolescent health and school nutrition programs can enhance their reach and effectiveness.

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Persona-Based Synthetic Data Generation for Training GPT Application

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1. Background of the Research: Recruiting large, diverse participant pools for UI/UX and social-science studies is slow and costly. In healthcare UI, the challenge is urgent: poor EHR usability increases cognitive load and contributes to errors. AI-generated **personas**—realistic, role-grounded user simulacra—offer a way to explore design alternatives quickly, at scale, and without handling sensitive data. This work tests whether such personas can provide **credible, role-specific evaluations** of medical software and whether their **cognitive load** ratings align with real clinicians.

2. Research Objectives:

- Construct detailed, role-specific personas (doctor, nurse, lab technician, administrative coordinator) for a medical software workflow.
- Use these personas to **compare two UI/UX designs** via **NASA-TLX** workload ratings and qualitative feedback.
- **Validate** persona-generated results against human data to assess whether personas can substitute (fully or partially) for early-phase user studies.

3. Research Problem/ Research Questions:

- RQ1 (Fidelity): Can AI-generated personas realistically model professional characteristics, workflows, and priorities for distinct clinical roles?
- RQ2 (Differentiation): Do personas provide **role-specific** feedback that reflects distinct cognitive demands?
- RQ3 (Validation): How do persona NASA-TLX and qualitative judgments correlate with human participants evaluating the same tasks?

4. Experiment/Methodology:

Phase 1 — Persona Generation

- Use a large language model to instantiate **base personas** for:
  - Doctors (senior/mid/junior; multiple specialties & countries),
  - Nurses (senior/mid; emergency/ward; multiple countries),
  - One lab technician, one administrative coordinator.
- Expand into a **larger, varied sample** by adding demographic, workflow, proficiency, goals, and frustration factors; ensure personas know they are in a research study and can be addressed individually.
- Deliver output in a **structured table** for downstream analysis.

Phase 2 — Simulated UI Evaluation & NASA-TLX

- Present each persona with **two UI designs** for the same clinical task: a **legacy/Epic-style dashboard** vs. a **modernized UI**.
- Capture (a) **comparative critique** from each persona, and (b) **NASA-TLX** ratings on six subscales: Mental, Physical, Temporal, Performance, Effort, Frustration.

Phase 3 — Analysis & Validation

- Aggregate persona TLX scores; visualize per role and per design.

- **Benchmark** against human data: Compare with published physician NASA-TLX results on baseline vs. enhanced EHRs.
- Perform **comparative statistics** (differences, correlations) and **thematic analysis** of qualitative feedback to assess realism and nuance.

6. Results:

Synthetic Persona Cohort (n = 100 doctors):

- Legacy UI average overall NASA-TLX ≈ **75** vs. modern UI ≈ **51** → **~24-point** reduction (lower is better).
- Clear cross-role preference for the modern design; feedback emphasized reduced information clutter, clearer task flow, and improved recognition over recall.

Validation with Real-World Data (Physicians, published study):

- Human physicians showed a comparable pattern: a **~23-point** reduction from baseline to enhanced EHR.
- **Trend alignment:** personas and clinicians both rate modern/enhanced UI as substantially less demanding (addresses **RQ2**).
- **Magnitude proximity:** strongest alignment on **Mental Demand** and **Effort**; largest divergence in **Physical Demand** and **Frustration** (personas slightly higher).
- **Inference:** persona-based evaluation **mirrors** real users on direction and relative magnitude, supporting **RQ3** (preliminary validity)

7. Conclusion and Future Work: AI-generated, role-specific personas **differentiate UI designs** in healthcare and produce **NASA-TLX patterns** that closely track real clinicians. This supports using personas for **early-phase evaluation**, accelerating iteration while reducing recruitment burden—particularly valuable where access to clinicians is limited.

- **Direct head-to-head**: run identical prototypes with new personas **and** a recruited clinician cohort.
- **Broaden roles**: include nurses, lab techs, administrators; vary tech proficiency and experience.
- **Richer qual**: "think-aloud" and interview-style prompts to extract actionable design rationales.
- **Model comparisons**: replicate across LLMs to test robustness and identify best-performing setups.

Acknowledgement: We thank colleagues at Kyushu University and collaborators engaged in medical UI/UX research.

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Anxiety and Academic Performance among Private Medical College Students

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1. **Background of the Research:** Mental disorders are projected to account for over half of the total economic burden from non-communicable diseases worldwide and 35 percent of lost global output, yet their true cost is likely higher given strong links to cardiovascular, respiratory, and metabolic conditions.[1] Despite official "mentorship" programs, medical students continue to report elevated distress, anxiety, and depression, with little evidence that existing initiatives alleviate these problems.[2] Anxiety in this population impairs concentration, motivation, attendance, and physical well-being, contributing to a spectrum of psychological morbidity—from interpersonal conflicts to suicidal ideation.[3] Prior research shows that low-achieving students exhibit significantly higher levels of depression, anxiety, and stress compared to their high-achieving peers, while factors like peer pressure, study skills, and time management also influence outcomes.[4, 5] Building on these insights, the present study examines the relationship between anxiety and academic performance among students in selective private medical colleges in Bangladesh.
2. **Research Objectives**: To assess the relationship between anxiety & academic performance, to identify the level of anxiety and find out the factors related to anxiety among private medical students.
3. **Research Problem/ Research Questions**: Medical students in private medical colleges in Bangladesh face high rates of anxiety that often co-occur with other chronic health concerns and undermine cognitive function, study habits, and empathy. This psychological distress can contribute to risk behaviors, substance use, and even suicidal ideation, with first-year students particularly vulnerable as they adjust to major life transitions alongside rigorous academic demands. Global evidence links untreated anxiety and depression to poor academic outcomes, course failures, and dropout, yet routine mental health screening and targeted support remain inadequate in these institutions. Addressing this gap is essential for informing interventions that integrate mental and physical health care and promote parity in research, training, and prevention. This study conducted to evaluate if there is any relationship between anxiety and academic performance among students of the selective private medical colleges in Bangladesh?
4. **Approach:** The study adopted a simple random sampling strategy from the roster of all enrolled students across three selective private medical colleges in Dhaka. Informed consents were secured for all respondents to ensure confidentiality before each interview. Face-to-face interviews were conducted using a structured questionnaire that integrates the 44-item Burns Anxiety Inventory and a 3-item academic-performance checklist. Sample size was adjusted to 200 participants due to resource constraints, yielding a precision (d) of 0.08 at 95% confidence. Instruments were pre-tested on 10 students at a pilot college. The final tools consisted of a 44-item anxiety scale (scored 0–99) and 3-item checklist for grades, exam pass rates, and course failures. Daily data-quality checks were done to ensure completeness and consistency. Figure 1 illustrates the sampling and interview workflow.

Parameter	Details
Sampling method	Simple Random Sampling
Target sample size	384 (calculated); 200 (achieved)
Instruments	Burns Anxiety Inventory; Academic Performance Checklist
Interview duration	25 minutes
Daily throughput	10-12 students

Figure 1: Sampling and interview workflow

5. **Experiment/Methodology**: Between January and December 2013, we carried out a cross-sectional survey among MBBS students at three selective private medical colleges in Dhaka, employing simple random sampling stratified by year of study. The calculated sample size is 384 considering prevalence of 49%.[4] However, due to the limited time frame, 220 students were approached, 200 consented and completed the face-to-face interviews (91% response rate), with sessions conducted in private rooms around class schedules to preserve confidentiality. Each 25-minute interview used a 44-item Burns Anxiety Inventory (scored 0–99 across six severity bands) alongside a three-item academic-performance checklist capturing cumulative GPA, recent exam scores, and course failure history. Prior to full rollout, we pre-tested the tools on ten students at a pilot college and refined wording and flow based on feedback. Data were recorded on paper, double-entered into SPSS v.22, and cleaned for outliers and missing values. Anxiety scores were computed by summing item responses; categorical variables were numerically coded. We generated descriptive statistics (means, medians, SDs, frequencies) and performed inferential analyses using chi-square tests to examine

anxiety category versus pass/fail rates, and multiple linear regression to assess the impact of anxiety scores on GPA controlling for gender and year of study. Statistical significance was set at $p<0.05$. Ethical approval was secured from the NIPSOM Ethical Review Committee, and written permissions were obtained from each college's administration.

6. **Results**: The descriptive cross-sectional study was conducted among 200 students at three private medical colleges of Uttara, Dhaka. Among all students, majority were female 160 (80%) and male 40 (20%) with a mean age of 22 years. It was revealed that about 47% respondent's father were businessman, 79% respondent's mother were housewife. About 65% of the student's parents' monthly incomes were ≤ 50000 Taka. 83% were come from nuclear type of family and 68% live in hostel. Among all students, 31% were in moderate anxiety period and 13% crossed the severe anxiety period to extreme. In First Professional Exam; students passed 68% in Anatomy, 73% in physiology and 76% in Biochemistry as well as referred 32% in Anatomy, 24% in physiology and 23% in Biochemistry. Regarding their class attendance; majorities were regular in their class in respective subjects. Female students more (96%) suffered from moderate to extreme anxiety than male (80%). Those students were suffered from moderate to extreme anxiety period their academic performance were good in specific subjects (Table 1). Among the students, residing in nuclear family were passed about 69% and in hostel about 73%. Study showed that respondents referred more (54%) whose monthly family incomes ≤ 50000 and it was statistically significant ($P < 0.05$). The control of anxiety level of a medical student plays a great role to improve their academic performance related co-morbidity and disability like extreme anxiety. Large scale follows up study should be conducted to reduce the burden of extreme anxiety in the medical population.

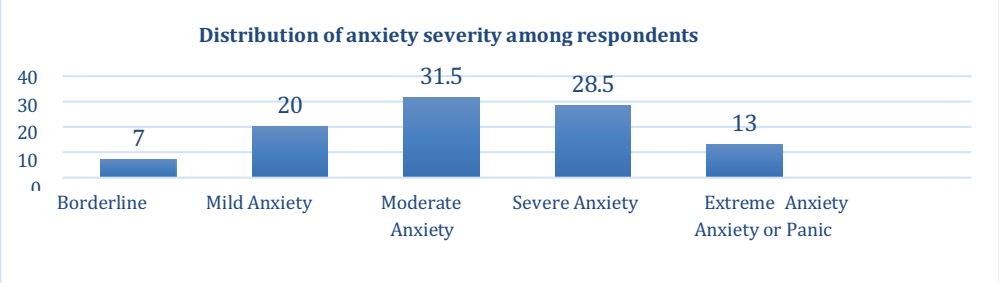

Figure 2: Anxiety level vs. percent of students

Table 1: Anxiety level and exam outcomes

n=200		Performance of 1st professional exam [f (%)]		x^2	df	p value
		Passed	Referred			
Score of Anxiety	Minimal to Mild Anxiety	6 (42.86)	8 (57.14)	8.67	1	.003
	Moderate to Extreme Anxiety	145 (77.96)	41 (22.04)			
	Total	151 (75.5)	49 (24.5)			

7. **Conclusion and Future Work**: Our findings indicate that students reporting moderate-to-extreme anxiety achieved higher pass rates and maintained strong class attendance and better exam preparation, particularly those living in hostels. Conversely, students from lower-income families (≤ 50,000 BDT/month) exhibited poorer academic outcomes and higher referral rates. To manage test anxiety effectively, we recommend a framework combining cognitive, affective, and behavioral strategies—such as relaxation training, time-management workshops, and peer-support groups. Faculty and administrators should deliver orientation sessions on course structure, assessment timelines, and study expectations. Embedding brief anxiety-reduction modules into the curriculum and ensuring easy access to mental-health services will bolster student resilience. Parents and mentors can reinforce positive coping skills and provide ongoing encouragement. Longitudinal research is needed to clarify causal pathways between anxiety trajectories and performance, informing targeted interventions that enhance both student well-being and future clinical competence.

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