Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

# Comparing socioeconomic inequalities across hypertension and diabetes care cascades in Bangladesh: a cross-sectional analysis of the 2022 Bangladesh Demographic and Health Survey

**M A Shahed**

shahed3075@gmail.com

University of Nottingham

**Research Article**

**Keywords:**

**Posted Date:** November 4th, 2026

**DOI:** https://doi.org/10.21203/rs.3.rs-9714842/v1

**License:** This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

**Additional Declarations:** No competing interests reported.

# Title

Comparing socioeconomic inequalities across hypertension and diabetes care cascades in Bangladesh: a cross-sectional analysis of the 2022 Bangladesh Demographic and Health Survey


# Author

M A Shahed^1,2*

**Affiliation**

^1 School of Medicine, University of Nottingham, Nottingham, UK

^2 HelloDoctor, Dhaka, Bangladesh

*Correspondence: shahed3075@gmail.com

# Corresponding author

M A Shahed

Email: shahed3075@gmail.com

# ORCID

M A Shahed: 0000-0002-1661-124X

## Abstract

**Background:** Hypertension and diabetes are major public health challenges in Bangladesh, placing significant strain on the health system. This study used the care cascade framework to compare health system performance for both conditions and assess associated socioeconomic disparities.

**Methods:** This cross-sectional study analysed data from the Bangladesh Demographic and Health Survey 2022, including adults aged ≥18 years with biomarker measurements (n=14,296 for hypertension; n=13,980 for diabetes). Five-stage care cascades (prevalence, screening, diagnosis, treatment, control) were constructed for each condition. Survey-weighted descriptive and multivariable logistic regression were performed.

**Results:** The weighted prevalence estimates were 22.1% for hypertension and 16.9% for diabetes. Both cascades revealed substantial attrition, but at different stages. For hypertension, screening was relatively high (78.3%), yet only 57.7% were diagnosed. Among diagnosed adults, 71.4% were receiving treatment, and among treated adults, 43.3% achieved blood pressure control. For diabetes, the main gap occurred at the initial stage of care: only 33.6% of adults had ever undergone blood glucose measurement, 33.5% of adults with diabetes had been diagnosed, 73.7% of diagnosed individuals received treatment, and 21.7% of treated individuals achieved glycaemic control. Socioeconomic disparities were evident, particularly for diabetes. Compared with the poorest, the richest had higher odds of diabetes screening (aOR 3.2, 95% CI: 2.7-3.9), diagnosis (aOR 3.0, 95% CI: 1.8–4.8), and treatment (aOR 5.0,

95% CI: 2.2–11.4), as well as hypertension screening (aOR 2.2, 95% CI: 1.7–3.0). Higher education was associated with a twofold increase in blood pressure control compared with no education, and improved screening and diagnosis for both conditions.

**Conclusion:** Hypertension and diabetes care in Bangladesh show different system gaps, indicating that a uniform approach to non-communicable disease care is inadequate. Hypertension care is constrained mainly after screening, while diabetes care is limited by low screening and diagnosis. Both cascades show socioeconomic inequalities, particularly affecting poorer and less educated adults. Policies should prioritise disease-specific primary care strategies, integrated and targeted screening, affordable diagnostics and medicines, pro-poor financing, and targeted outreach for disadvantaged groups.

**Trial registration:** Not applicable.

**Keywords:** Bangladesh; diabetes; hypertension; care cascade; socioeconomic inequalities; non-communicable diseases; Demographic and Health Survey

## 1. Introduction

Non-communicable diseases (NCDs), particularly hypertension and diabetes, are leading causes of mortality worldwide.(1) Nearly three-quarters of all NCD-related deaths are concentrated in low- and middle-income countries (LMICs).(1–3) Bangladesh, a lower-middle-income country with 173 million people, is also experiencing this growing challenge. Recent national estimates show that hypertension and diabetes affect 26.2% and 10.0% of the adult population, respectively.(4–6) These conditions, once more common among the affluent, now affect all socioeconomic strata, placing additional strain on a health system historically focused on maternal and child health and infectious disease control.(7–9)

The “cascade of care” model provides a structured framework for this evaluation, mapping the sequential stages from screening and diagnosis to treatment and clinical control. By identifying where patients are lost along the pathway, the cascade approach highlights specific gaps in service delivery and accountability that influence long-term outcomes.(10,11) To address the growing burden of NCDs, it is not sufficient to measure disease prevalence alone; a deeper understanding of health system performance through such framework is required.

Progression through the care cascade is influenced by socioeconomic and demographic factors. Evidence shows that socioeconomic status, education, and geography are key determinants of whether an individual is screened, diagnosed, treated, and controlled.(6,12,13) These sociodemographic inequities are particularly concerning in Bangladesh, where over two-thirds of health expenditure is paid out-of-

pocket, often restricting access to those who can afford care.(14) As a result, national averages may conceal significant disparities, with the poorest and least educated groups consistently at higher risk of being excluded from care.(6) Previous studies in Bangladesh have examined NCD prevalence, management, and disease-specific care cascades, including hypertension and diabetes separately. However, comparative evidence on the full care cascade for both hypertension and diabetes using the same recent national dataset and socioeconomic framework remains limited. Therefore, less is known about how these two major non-communicable diseases differ across the care pathway. This comparison is important because hypertension and diabetes require different combinations of screening, diagnosis, treatment continuity, monitoring, and long-term control.(15–18)

This study aims to address this gap by providing a detailed comparative analysis of the hypertension and diabetes care cascades in Bangladesh, using data from the 2022 Bangladesh Demographic and Health Survey (BDHS). Specifically, the study estimates the national prevalence of hypertension and diabetes and quantifies the gaps at each stage of the care cascade: screening, diagnosis, treatment, and control. It also evaluates the independent effects of socioeconomic, demographic, and geographic factors on progression through each stage and compares the magnitude and patterns of disparities between the two cascades to draw broader implications for health system performance and equity. The findings are intended to generate evidence to support targeted interventions aimed at reducing inequities in NCD care.

## 2. Methods

## 2.1 Study design and data source

This analysis used data from the Bangladesh Demographic and Health Survey (BDHS) 2022, the ninth nationally representative, cross-sectional household survey. The BDHS is conducted every four to five years to track population and health trends. The 2022 round was implemented by the National Institute of Population Research and Training (NIPORT) with technical support from ICF International.(19)

The BDHS employed a two-stage stratified cluster sampling design. In the first stage, 674 enumeration areas (EAs) were chosen with probability proportional to their size. In the second stage, 45 households were systematically selected from each EA. This design ensures representativeness at national, divisional, and urban/rural levels. Biomarker data, including blood pressure and fasting blood glucose, were collected to assess hypertension and diabetes among adults aged ≥18 years. Hypertension was measured using the Multi-User Upper Arm Blood Pressure Monitor (UA-767F/FAC). Respondents with systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg, or a self-reported prior diagnosis by a doctor or health worker were classified as hypertensive, consistent with WHO guidelines. Diabetes was assessed using the HemoCue 201 RT analyzer. Capillary whole blood was obtained from fasting respondents, and individuals with blood glucose levels ≥7.0 mmol/L or who reported a prior diagnosis by a doctor or health worker were classified as having diabetes, following World Health Organization (WHO) criteria.(19)

## 2.2 Study population

The study included adults aged ≥18 years who participated in the biomarker component of BDHS 2022. The final analytic samples comprised 14,296 participants with valid blood pressure measurements and 13,980 with valid blood glucose measurements (Figure 1).

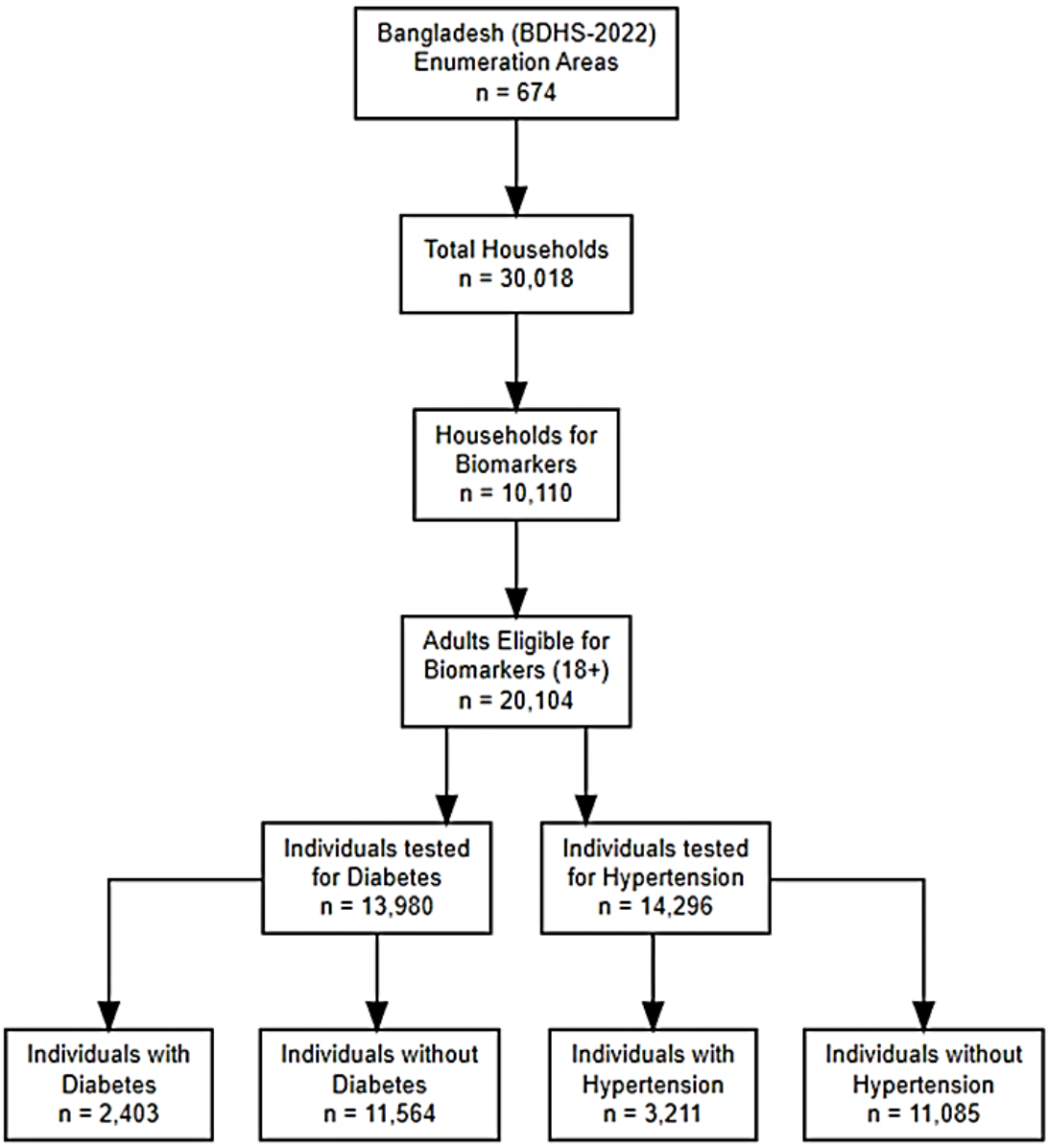



**Figure 1. Sampling procedure**

## 2.3 Variable definitions

**Outcome variables: Cascade of care indicators**

For both hypertension and diabetes, we constructed a five-stage care cascade using sequential outcome variables:

1. **Prevalence**: The proportion of participants meeting the criteria for hypertension or diabetes.
2. **Screening**: The proportion of adults who reported ever having their blood pressure or blood glucose measured by a health worker.
3. **Diagnosis**: The proportion of adults with hypertension or diabetes who had a prior diagnosis from a healthcare provider.
4. **Treatment**: The proportion of diagnosed adults who reported receiving medication for their condition.
5. **Control**: The proportion of treated adults who achieved clinical targets: systolic BP <140 mmHg and diastolic BP <90 mmHg for hypertension, and blood glucose <7.0 mmol/L for diabetes.

**Exposure variables**

The primary exposure variables included key sociodemographic and health-related characteristics, identified from previous literature (including variables known to be associated with healthcare utilization in Bangladesh),(6,13) defined as follows:

1. **Age**: Grouped into five categories (18–34, 35–44, 45–54, 55–64, ≥65 years).
2. **Gender**: Male or female.
3. **Education level**: No education, primary, secondary, or higher.
4. **Marital status**: Currently married vs. not currently married.

5. **Body Mass Index (BMI)**: Underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), obese (≥30.0 kg/m²).
6. **Wealth index**: Household asset-based quintiles (poorest, poorer, middle, richer, richest).
7. **Family size**: Nuclear family (1–3 members), medium family (4–5 members), joint family (6+ members).
8. **Place of residence**: Urban or rural.
9. **Administrative division**: Eight divisions of Bangladesh (Barisal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, Sylhet).

### 2.4 Statistical analysis

All statistical analyses were conducted using R (version 4.5.1) and the survey package.(20) The analyses incorporated stratification, primary sampling units, and normalized sampling weights to produce nationally representative estimates.(19)

#### Missing data handling

A complete case analysis was employed, which was appropriate given that missing data for covariates were minimal (<5%), thereby minimizing the potential for bias.(21) Statistical significance for all tests was considered at $p < 0.05$.

#### Descriptive and bivariate analysis

Weighted proportions and 95% confidence intervals (CIs) were calculated for each cascade stage, stratified by sociodemographic variables. Bivariate associations were assessed using survey-adjusted Chi-square tests. For ordinal predictors (e.g., age, wealth quintile), survey-weighted logistic regression was used to test for linear trends.

#### Multivariable analysis

Survey-weighted logistic regression models were fitted for each cascade stage to identify independent predictors. All sociodemographic variables were included to adjust for confounding. Overall significance for multi-level categorical predictors was evaluated using Wald tests. Model adequacy was confirmed through convergence checks, sufficient events per variable (>10), and multicollinearity (Variance Inflation Factors <2 for all models). Results are reported as adjusted odds ratio (aOR) with 95% CIs and p-values.

### 2.5 Ethical considerations

The BDHS 2022 received ethical approval from the ICF Institutional Review Board and the Bangladesh Medical Research Council.(19) This secondary analysis of de-identified, publicly available data was additionally approved by the University of Nottingham Research Ethics Committee (Reference: MPH/2025/20707667).

## 3. Results

The results are presented by care cascade stage: prevalence, screening, diagnosis, treatment, and control. Out of the 14,296 adults with valid blood pressure measurements, 3,211 (22.5%) had hypertension. Among the 13,980 adults with valid blood glucose measurements, 2,403 (17.2%) had diabetes.

### 3.1 Hypertension care cascade

Among 3,211 individuals with hypertension, 59.6% were diagnosed, 43.3% received treatment, and only 19.0% had controlled blood pressure (Figure 2). The bivariate analysis and adjusted regression results for the hypertension care cascade are presented in Tables 1 and 2, respectively.

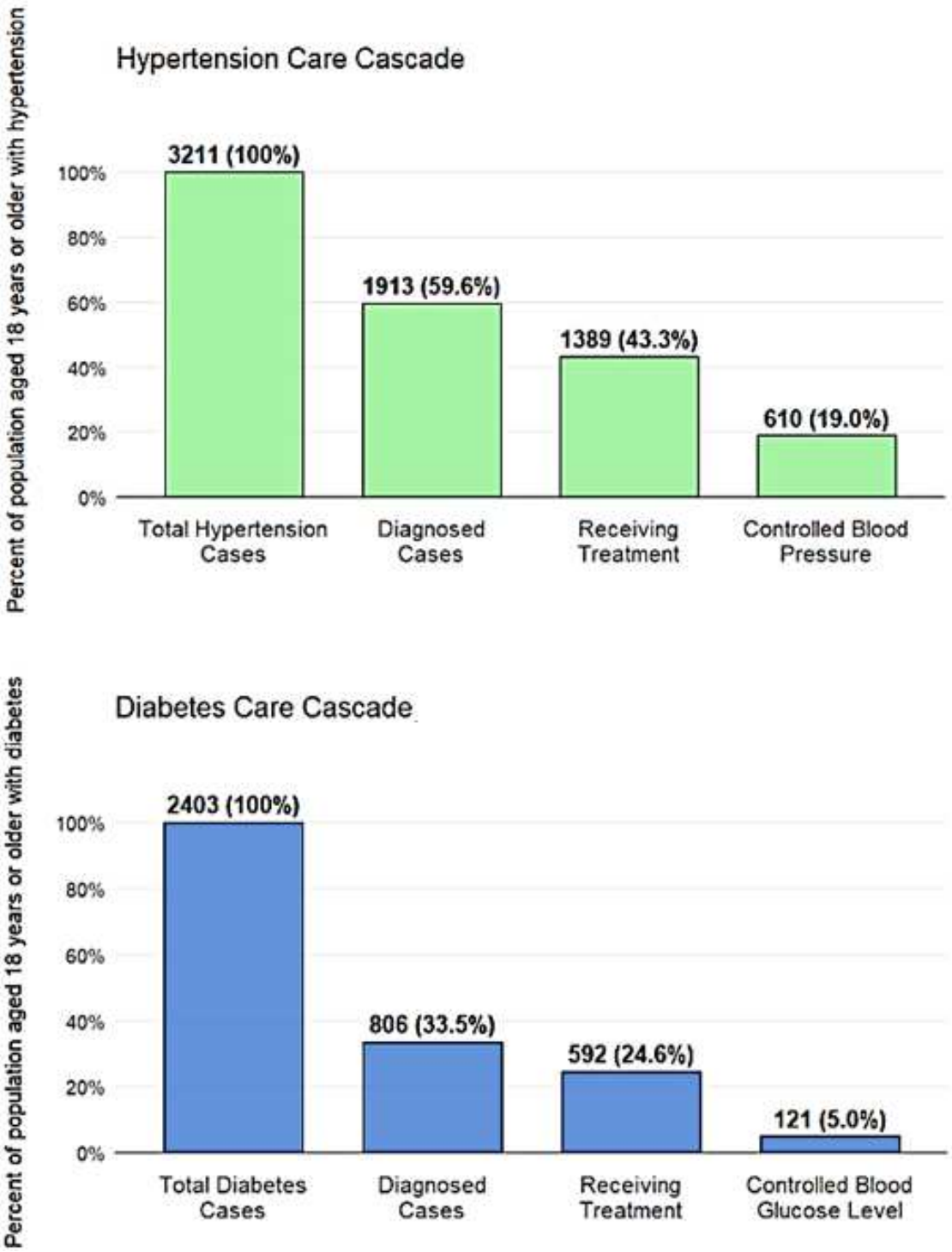



**Figure 1. Hypertension and diabetes care cascade among adults aged ≥18 years in Bangladesh**

### 3.1.1 Prevalence and screening

The weighted prevalence of hypertension was 22.1%. Prevalence increased sharply with age, rising from 8.3% in adults aged 18–34 to 46.2% in those aged ≥65 years. The adjusted odds of having hypertension were 13.5 times higher in adults aged ≥65 (95% CI: 11.2–16.3) compared with those aged 18–34 years. It was higher among women (25.2% vs. 18.3%) across all age groups (Figure 3), urban residents (24.3% vs. 21.4%), the wealthiest (28.8% vs. 16.9% in the poorest), and those with obesity

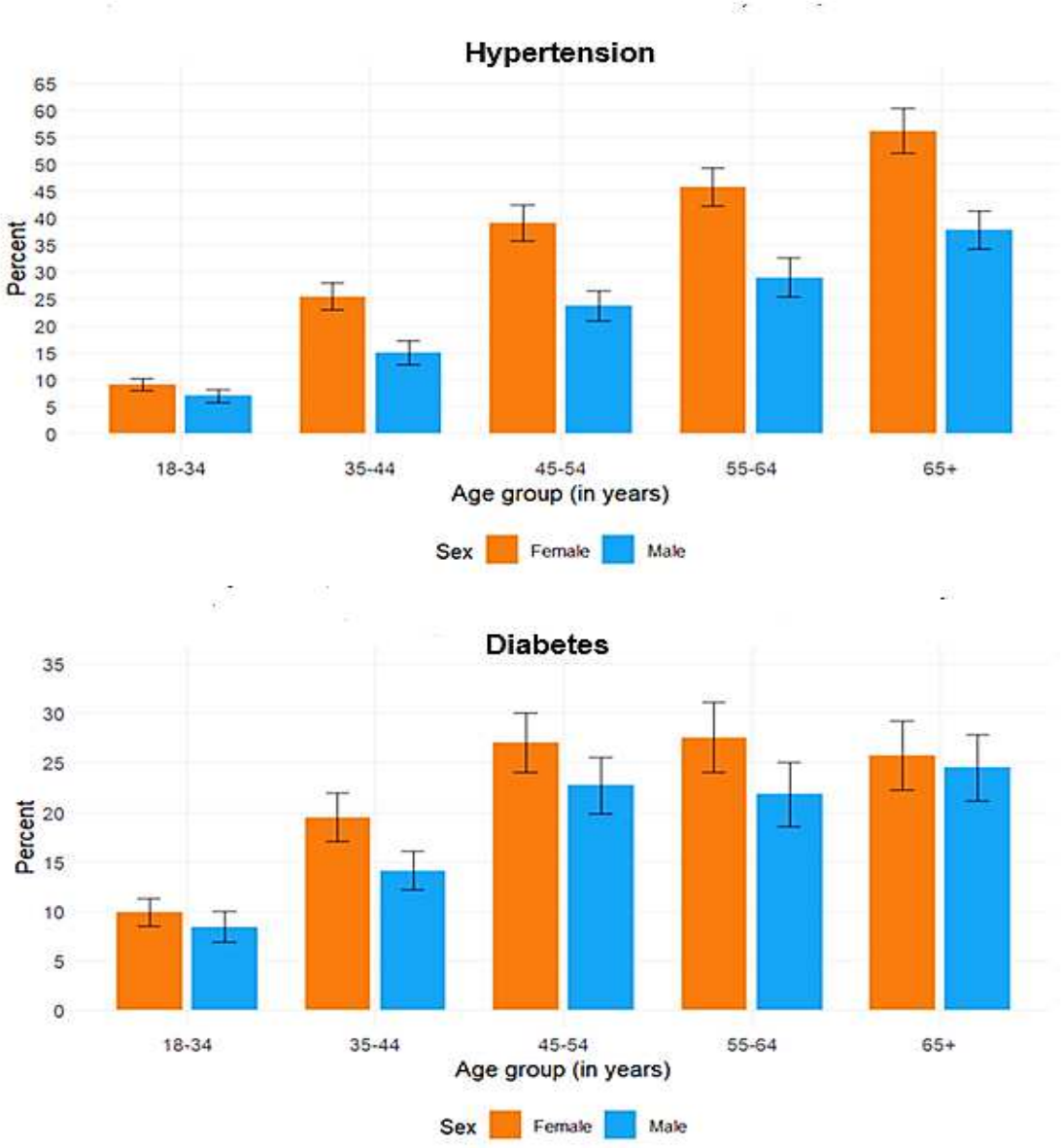



**Figure 2. Prevalence of hypertension and diabetes (95% confidence intervals) by age group and sex in Bangladesh**

(44.3% vs. 13.8% in underweight). After adjustment, obesity was associated with higher odds of hypertension (aOR 3.7, 95% CI: 3.0–4.6) compared with normal weight. Regionally, prevalence was highest in Rajshahi (25.2%) and lowest in Mymensingh (18.0%) (Figure 4).

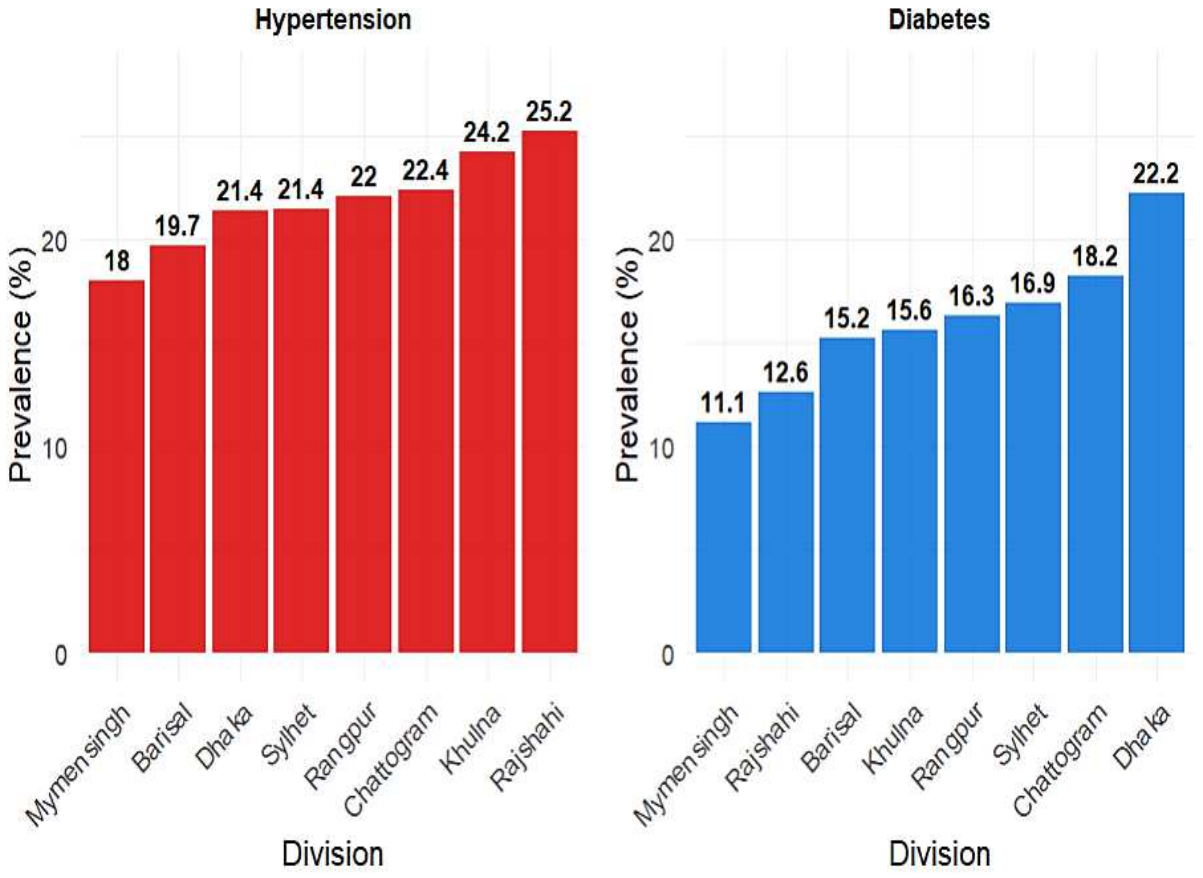



**Figure 4. Prevalence of hypertension and diabetes by division in Bangladesh**

Screening coverage was relatively high at 78.3%, but inequities persisted. Men had lower odds of being screened (aOR 0.30, 95% CI: 0.27–0.33) than women. Screening increased with age, with adults aged ≥65 years having over four times the odds (aOR 4.2, 95% CI: 3.4–5.3) compared with those aged 18–34 years. Overweight (aOR 1.4, 95% CI: 1.2–1.7) and obese adults (aOR 1.7, 95% CI: 1.2–2.4) were more likely to be screened, whereas underweight individuals had lower odds (aOR 0.8, 95% CI: 0.7–

0.9) compared with normal weight. Socioeconomic factors also predicted screening: adults in the richest quintile had more than double the odds (aOR 2.2, 95% CI: 1.7–3.0) compared with the poorest, and those with higher education nearly doubled the odds (aOR 2.0, 95% CI: 1.6–2.5) compared with individuals with no education.

**[Insert Table 1 here]**

**Table 1.** Bivariate analysis of hypertension cascade by sociodemographic characteristics among adults aged ≥18 years

| | Hypertension | | | | |
|---|---|---|---|---|---|
| **Socio-Demographic Variable** | **Hypertension Prevalence** (n=14296) [a] | **Screening Coverage** (n=14291) [b] | **Diagnosis among Hypertension Cases** (n=3211) [c] | **Treatment among Diagnosed Cases** (n=1913) [d] | **Control Among Treated Cases** (n=1389) [e] |
| | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** |
| **Overall** | 22.13 (21.19-23.07) | 78.32 (77.01-79.63) | 57.74 (55.50-59.98) | 71.38 (68.67-74.08) | 43.28 (40.21-46.35) |
| **Age Group** | ***/*** | ***/*** | ***/*** | ***/*** | NS/* |
| 18–34 | 8.29 (7.49-9.10) | 70.02 (68.32-71.73) | 43.69 (38.43-48.94) | 48.75 (40.16-57.34) | 50.45 (39.19-61.72) |
| 35–44 | 20.74 (18.95-22.53) | 81.71 (79.71-83.70) | 51.50 (47.16-55.84) | 64.30 (58.19-70.41) | 46.08 (38.26-53.91) |
| 45–54 | 31.44 (29.14-33.74) | 85.35 (83.41-87.29) | 63.18 (59.11-67.25) | 71.74 (66.63-76.85) | 44.75 (38.93-50.56) |
| 55–64 | 38.05 (35.56-40.54) | 85.86 (83.52-88.19) | 64.52 (60.29-68.75) | 78.74 (74.29-83.18) | 44.66 (38.89-50.43) |
| 65+ | 46.23 (43.31-49.14) | 84.65 (82.21-87.09) | 61.28 (56.61-65.95) | 80.06 (75.77-84.34) | 36.92 (31.38-42.46) |
| **Gender** | *** | *** | *** | NS | ** |
| Female | 25.24 (24.08-26.39) | 86.46 (85.11-87.81) | 60.63 (57.87-63.38) | 72.15 (69.06-75.23) | 40.28 (36.51-44.04) |
| Male | 18.29 (17.07-19.51) | 68.22 (66.52-69.93) | 52.80 (49.44-56.17) | 69.87 (65.41-74.33) | 49.37 (44.31-54.42) |

| | | | | | |
|---|---|---|---|---|---|
| **Education Level** | ***/*** | NS | NS | */NS | ***/*** |
| No Education | 31.30 (29.50-33.11) | 79.31 (77.44-81.18) | 56.40 (52.69-60.11) | 74.24 (70.36-78.12) | 35.83 (31.04-40.62) |
| Primary | 21.25 (19.50-22.99) | 77.76 (75.86-79.67) | 58.28 (54.46-62.10) | 66.48 (60.92-72.04) | 41.62 (35.47-47.78) |
| Secondary | 17.03 (15.75-18.31) | 77.86 (76.15-79.57) | 57.83 (53.86-61.79) | 69.24 (64.52-73.96) | 47.30 (40.87-53.74) |
| Higher | 19.10 (16.97-21.22) | 78.52 (75.95-81.08) | 60.24 (54.50-65.97) | 77.03 (71.36-82.71) | 58.20 (50.71-65.69) |
| **Currently Married** | ** | *** | NS | ** | ** |
| Yes | 21.59 (20.56-22.62) | 82.44 (81.04-83.83) | 57.17 (54.70-59.63) | 69.26 (66.06-72.46) | 45.86 (42.26-49.46) |
| No | 24.29 (22.50-26.07) | 61.93 (59.68-64.17) | 59.76 (55.40-64.12) | 78.55 (74.07-83.03) | 35.58 (29.83-41.33) |
| **BMI** | ***/*** | ***/*** | **/** | NS/* | NS |
| Underweight | 13.77 (12.17-15.37) | 68.74 (66.38-71.10) | 54.06 (47.58-60.54) | 68.00 (60.23-75.77) | 43.57 (33.09-54.05) |
| Normal Weight | 18.26 (17.21-19.32) | 76.46 (74.87-78.05) | 54.82 (51.68-57.96) | 70.59 (67.02-74.17) | 45.49 (41.11-49.87) |
| Overweight | 31.15 (29.22-33.08) | 86.34 (84.53-88.14) | 60.18 (56.65-63.72) | 70.26 (65.88-74.65) | 41.50 (36.32-46.69) |
| Obese | 44.29 (40.20-48.38) | 90.92 (88.12-93.73) | 64.11 (58.27-69.95) | 79.46 (73.12-85.81) | 42.20 (32.91-51.49) |
| **Wealth Status** | ***/*** | ***/*** | ***/*** | ***/*** | NS |
| Poorest | 16.95 (15.32-18.58) | 73.48 (71.10-75.85) | 50.27 (44.53-56.02) | 63.06 (56.54-69.58) | 43.98 (35.14-52.82) |
| Poorer | 19.95 (18.10-21.80) | 75.72 (73.45-77.99) | 48.34 (43.76-52.92) | 67.16 (61.15-73.18) | 37.71 (30.28-45.15) |
| Middle | 20.53 (18.80-22.26) | 76.76 (74.36-79.17) | 57.22 (52.55-61.88) | 65.04 (58.77-71.31) | 41.01 (33.81-48.22) |
| Richer | 23.70 (21.92-25.49) | 79.20 (76.84-81.57) | 61.41 (57.26-65.56) | 73.85 (68.73-78.97) | 39.89 (33.76-46.02) |
| Richest | 28.82 (26.61-31.04) | 85.77 (83.70-87.84) | 65.39 (61.37-69.40) | 78.73 (74.34-83.13) | 49.12 (43.79-54.45) |
| **Family Size** | ***/*** | ***/*** | */* | */** | NS |
| Nuclear Family (1–3) | 26.81 (24.93-28.68) | 81.69 (79.95-83.43) | 55.41 (51.67-59.14) | 67.65 (63.12-72.19) | 42.33 (36.52-48.14) |
| Medium Family (4-5) | 20.93 (19.65-22.20) | 77.18 (75.54-78.82) | 56.37 (53.19-59.54) | 70.82 (66.90-74.74) | 43.03 (38.48-47.59) |

| | | | | | |
|---|---|---|---|---|---|
| Joint Family (6+) | 20.34 (18.80-21.87) | 77.38 (75.46-79.31) | 61.87 (57.97-65.77) | 75.29 (71.26-79.31) | 44.31 (39.14-49.48) |
| **Place of Residence** | ** | NS | * | NS | NS |
| Rural | 21.35 (20.22-22.48) | 78.35 (76.85-79.86) | 56.00 (53.28-58.72) | 70.32 (67.10-73.55) | 41.99 (38.17-45.81) |
| Urban | 24.25 (22.55-25.95) | 78.22 (75.60-80.85) | 61.88 (57.97-65.78) | 73.65 (68.69-78.61) | 45.93 (40.81-51.06) |
| **Division** | * | *** | * | NS | NS |
| Barisal | 19.68 (17.47-21.89) | 79.35 (76.31-82.39) | 59.83 (52.69-66.97) | 76.21 (69.05-83.37) | 41.69 (32.07-51.32) |
| Chattogram | 22.37 (19.87-24.87) | 82.45 (79.73-85.18) | 59.64 (54.30-64.98) | 76.82 (70.50-83.15) | 45.47 (37.00-53.94) |
| Dhaka | 21.38 (19.28-23.49) | 74.39 (71.02-77.75) | 58.73 (52.50-64.97) | 69.90 (62.63-77.17) | 45.10 (37.67-52.53) |
| Khulna | 24.22 (21.90-26.55) | 80.40 (77.90-82.91) | 59.31 (53.79-64.82) | 73.67 (67.60-79.74) | 42.56 (35.26-49.87) |
| Mymensingh | 18.03 (15.70-20.35) | 83.74 (80.98-86.50) | 54.57 (47.30-61.84) | 63.85 (55.88-71.83) | 45.22 (33.58-56.86) |
| Rajshahi | 25.25 (22.03-28.48) | 81.04 (78.51-83.57) | 54.24 (48.85-59.63) | 66.24 (58.61-73.86) | 31.98 (25.93-38.03) |
| Rangpur | 22.04 (19.60-24.49) | 73.25 (67.33-79.17) | 50.53 (45.31-55.74) | 69.97 (62.55-77.39) | 46.19 (37.61-54.76) |
| Sylhet | 21.44 (18.86-24.01) | 72.97 (69.50-76.45) | 68.75 (62.86-74.64) | 72.72 (66.50-78.94) | 49.18 (40.21-58.15) |

- *n = raw sample size, % = weighted percentage, 95% CI = 95% Confidence Interval*
- *p-values: Chi-square test / Trend test for categorical associations and ordinal variables (where applicable)*
- *Significance Levels: * P < 0.05, ** P < 0.01, *** P < 0.001, NS = P ≥ 0.05 (Not Significant)*
- *a = total tested for hypertension, b = total participants asked whether they had ever had their blood pressure measured by a doctor/ health worker, c = total hypertension cases, d = total diagnosed hypertension cases, e = total treated hypertension cases*

### 3.1.2 Diagnosis and treatment

Only 57.7% of individuals with hypertension were diagnosed. Diagnosis was uneven: men had lower odds of being diagnosed (aOR 0.60, 95% CI: 0.50–0.73) than women. Diagnosis rates increased with age and education; adults with higher education had greater odds of diagnosis (aOR 1.7, 95% CI: 1.2–2.4) compared with those with no education.

Among those diagnosed, 71.4% were on treatment. Treatment uptake was associated with wealth: adults in the richest quintile had higher odds of receiving treatment (aOR 1.8, 95% CI: 1.1–2.8) compared with those in the poorest quintile. Uptake of treatment increased with age (aOR 6.6, 95% CI: 4.1–10.7 for adults aged ≥65 compared with 18–34 years). Men had lower odds of receiving treatment (aOR 0.7, 95% CI: 0.5–0.9) than women.

### 3.1.3 Blood pressure control

Only 43.3% of people on treatment had their blood pressure controlled. After adjustment, wealth and age were not significant predictors of control. However, individuals with higher education had more than double the odds of control (aOR 2.1, 95% CI: 1.28-3.49) compared to those with no education.

**[Insert Table 2 here]**

**Table 2.** Adjusted odds ratios for factors associated with hypertension prevalence, screening coverage, diagnosis, treatment and control among adults aged ≥18 years

| | Hypertension | | | | |
|---|---|---|---|---|---|
| **Socio-Demographic Variable** | **Hypertension Prevalence** | **Screening Coverage** | **Diagnosis among Hypertension cases** | **Treatment among Diagnosed cases** | **Control among Treated Cases** |
| | **aOR (95% CI)** | **aOR (95% CI)** | **aOR (95% CI)** | **aOR (95% CI)** | **aOR (95% CI)** |
| **Age Group** | *** | *** | *** | *** | NS |
| 18–34 | 1 | 1 | 1 | 1 | 1 |
| 35–44 | 2.93 (2.51-3.42) | 1.79 (1.54-2.07) | 1.48 (1.13-1.94) | 2.08 (1.32-3.28) | 0.91 (0.55-1.52) |
| 45–54 | 5.54 (4.69-6.54) | 2.76 (2.29-3.32) | 2.84 (2.11-3.82) | 3.46 (2.20-5.46) | 0.91 (0.54-1.51) |
| 55–64 | 8.38 | 3.31 | 3.41 | 5.43 | 0.93 |

| | | | | | |
|---|---|---|---|---|---|
| | (7.08-9.90) | (2.63-4.16) | (2.49-4.67) | (3.36-8.78) | (0.55-1.57) |
| 65+ | 13.54 (11.23-16.32) | 4.24 (3.42-5.26) | 3.29 (2.32-4.67) | 6.58 (4.06-10.67) | 0.67 (0.38-1.17) |
| **Gender** | *** | *** | *** | * | NS |
| Female | 1 | 1 | 1 | 1 | 1 |
| Male | 0.61 (0.55-0.69) | 0.30 (0.27-0.33) | 0.60 (0.50-0.73) | 0.70 (0.52-0.94) | 1.14 (0.83-1.57) |
| **Education Level** | NS | *** | ** | NS | * |
| No Education | 1 | 1 | 1 | 1 | 1 |
| Primary | 0.99 (0.86-1.15) | 1.37 (1.18-1.59) | 1.29 (1.03-1.62) | 0.84 (0.59-1.20) | 1.22 (0.86-1.74) |
| Secondary | 1.02 (0.88-1.18) | 1.53 (1.30-1.79) | 1.51 (1.16-1.96) | 1.14 (0.79-1.66) | 1.44 (0.99-2.10) |
| Higher | 1.20 (1.00-1.45) | 1.99 (1.61-2.46) | 1.68 (1.19-2.38) | 1.59 (0.97-2.59) | 2.12 (1.28-3.49) |
| **Currently Married** | NS | *** | NS | NS | NS |
| No | 1 | 1 | 1 | 1 | 1 |
| Yes | 0.90 (0.79-1.02) | 2.97 (2.60-3.41) | 1.12 (0.89-1.41) | 0.88 (0.61-1.28) | 1.15 (0.81-1.64) |
| **BMI** | *** | *** | NS | * | NS |
| Normal Weight | 1 | 1 | 1 | 1 | 1 |
| Underweight | 0.62 (0.54-0.72) | 0.79 (0.69-0.91) | 0.92 (0.69-1.23) | 0.73 (0.48-1.11) | 1.22 (0.74-2.02) |
| Overweight | 2.11 (1.88-2.38) | 1.43 (1.24-1.65) | 1.18 (0.96-1.44) | 0.98 (0.74-1.28) | 0.75 (0.55-1.01) |
| Obese | 3.69 (2.99-4.55) | 1.73 (1.24-2.43) | 1.32 (0.98-1.78) | 1.89 (1.22-2.90) | 0.74 (0.48-1.14) |
| **Wealth Status** | *** | *** | ** | * | NS |
| Poorest | 1 | 1 | 1 | 1 | 1 |
| Poorer | 1.16 (0.98-1.38) | 1.10 (0.92-1.32) | 0.82 (0.62-1.10) | 1.09 (0.72-1.64) | 0.79 (0.47-1.34) |
| Middle | 1.16 (0.98-1.38) | 1.18 (0.96-1.44) | 1.18 (0.87-1.61) | 0.98 (0.65-1.49) | 0.88 (0.55-1.41) |
| Richer | 1.36 (1.14-1.62) | 1.43 (1.16-1.76) | 1.27 (0.93-1.73) | 1.52 (0.99-2.32) | 0.78 (0.48-1.27) |
| Richest | 1.52 | 2.24 | 1.38 | 1.76 | 1.00 |

| | | | | | |
|---|---|---|---|---|---|
| | (1.25-1.85) | (1.69-2.97) | (0.97-1.96) | (1.12-2.78) | (0.61-1.64) |
| **Family Size** | ** | *** | NS | NS | NS |
| Nuclear Family (1–3) | 1 | 1 | 1 | 1 | 1 |
| Medium Family (4-5) | 0.86 (0.76-0.98) | 0.79 (0.68-0.91) | 1.08 (0.88-1.33) | 1.29 (0.98-1.70) | 1.04 (0.77-1.42) |
| Joint Family (6+) | 0.77 (0.66-0.89) | 0.74 (0.62-0.87) | 1.18 (0.93-1.51) | 1.31 (0.95-1.79) | 1.06 (0.78-1.46) |
| **Place of Residence** | NS | NS | NS | NS | NS |
| Rural | 1 | 1 | 1 | 1 | 1 |
| Urban | 1.05 (0.92-1.20) | 0.81 (0.67-1.00) | 1.15 (0.91-1.44) | 1.10 (0.80-1.51) | 1.04 (0.79-1.38) |
| **Division** | ** | *** | ** | NS | NS |
| Barisal | 1 | 1 | 1 | 1 | 1 |
| Chattogram | 1.21 (0.97-1.51) | 1.35 (0.99-1.84) | 0.96 (0.65-1.43) | 0.92 (0.52-1.63) | 1.04 (0.61-1.79) |
| Dhaka | 1.02 (0.82-1.26) | 0.65 (0.48-0.88) | 0.91 (0.60-1.38) | 0.64 (0.37-1.10) | 0.95 (0.57-1.59) |
| Khulna | 1.17 (0.94-1.46) | 0.96 (0.72-1.28) | 0.93 (0.63-1.39) | 0.74 (0.43-1.28) | 1.02 (0.61-1.70) |
| Mymensingh | 1.02 (0.81-1.28) | 1.65 (1.21-2.25) | 0.91 (0.59-1.40) | 0.55 (0.31-0.99) | 1.03 (0.55-1.94) |
| Rajshahi | 1.31 (1.03-1.68) | 1.03 (0.78-1.37) | 0.86 (0.58-1.29) | 0.53 (0.31-0.93) | 0.66 (0.40-1.08) |
| Rangpur | 1.26 (1.01-1.57) | 0.70 (0.46-1.07) | 0.71 (0.48-1.04) | 0.66 (0.37-1.17) | 1.05 (0.61-1.82) |
| Sylhet | 1.42 (1.12-1.80) | 0.89 (0.65-1.22) | 1.74 (1.10-2.74) | 0.96 (0.57-1.63) | 1.32 (0.76-2.29) |

- *aOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval*
- *p-value: Wald tests p value for overall categorical variables*
- *Significance Levels: * P < 0.05, ** P < 0.01, *** P < 0.001, NS = P ≥ 0.05 (Not Significant)*
- *Reference categories: 18-34 years, Female, No Education, Not Married, Normal Weight, Poorest, Nuclear Family, Rural, Barisal*

## 3.2 Diabetes care cascade

Among 2,403 individuals with diabetes, only 33.5% were diagnosed, 24.6% received treatment, and just 5.0% had their condition controlled (Figure 2). The bivariate analysis and adjusted regression results for the diabetes care cascade are presented in Tables 3 and 4, respectively.

### 3.2.1 Prevalence and the critical failure of screening

The weighted prevalence of diabetes was 16.9%. It increased with age in both sexes, with females showing higher rates than males up to age 55-64 (Figure 3). The odds of diabetes were higher with increasing age (aOR 4.41, 95% CI: 3.6-5.5 for age ≥65 vs. 18–34 years), wealth (aOR 2.0, 95% CI: 1.6-2.5 for richest vs. poorest), and BMI (aOR 2.1, 95% CI: 1.6-2.6 for obese vs. normal weight). Prevalence was higher among urban residents (23.2% vs. 14.7%; aOR 1.3, 95% CI: 1.1-1.6) and varied twofold across regions, from 22.2% in Dhaka to 11.1% in Mymensingh (Figure 4).

An apparent bottleneck in the diabetes care pathway was low screening coverage; only 33.6% of adults had ever undergone a blood glucose test. Access to screening was inequitable as the odds of being screened were over three times higher for the richest quintile (aOR 3.2, 95% CI: 2.7-3.9) compared to the poorest. Similarly, those with a higher education were 2.6 times more likely to be screened (95% CI: 2.2-3.2) than those with no education. Screening odds increased sharply with age (aOR 5.5, 95% CI: 4.6-6.5 for ≥65 vs. 18-34 years), while men were only half as likely as women to have ever been screened (aOR 0.5, 95% CI: 0.5–0.6).

**[Insert Table 3 here]**

**Table 3.** Bivariate analysis of diabetes cascade by sociodemographic characteristics among adults aged ≥18 years

| | Diabetes | | | | |
|---|---|---|---|---|---|
| **Socio-Demographic Variable** | **Diabetes Prevalence** (n=13980) [a] | **Screening Coverage** (n=14313) [b] | **Diagnosis among Diabetes Cases** (n=2403) [c] | **Treatment among Diagnosed Cases** (n=806) [d] | **Control among Treated Cases** (n=592) [e] |
| | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** |
| **Overall** | 16.92 (15.98-17.86) | 33.60 (32.34-34.87) | 33.49 (30.88-36.10) | 73.67 (70.08-77.27) | 21.73 (17.70-25.76) |
| **Age Group** | ***/*** | ***/*** | ***/*** | */** | **/* |
| 18–34 | 9.23 (8.17-10.30) | 23.20 (21.83-24.57) | 13.16 (9.61-16.72) | 57.30 (42.59-72.02) | 25.71 (7.44-43.99) |
| 35–44 | 17.27 (15.51-19.03) | 36.20 (33.97-38.44) | 30.55 (25.46-35.65) | 69.36 (61.26-77.45) | 17.07 (9.07-25.08) |
| 45–54 | 24.74 (22.64-26.85) | 42.94 (40.27-45.61) | 42.37 (37.33-47.41) | 75.35 (68.49-82.21) | 14.71 (8.40-21.03) |
| 55–64 | 24.93 (22.32-27.53) | 45.39 (42.46-48.32) | 45.45 (39.99-50.90) | 75.51 (69.51-81.51) | 20.72 (13.31-28.12) |
| 65+ | 25.07 (22.49-27.64) | 41.55 (38.63-44.48) | 39.94 (34.05-45.82) | 80.76 (74.00-87.51) | 35.25 (25.03-45.47) |
| **Gender** | ** | *** | * | NS | NS |
| Female | 17.79 (16.62-18.96) | 38.66 (37.16-40.16) | 35.95 (32.74-39.16) | 73.35 (68.74-77.95) | 21.70 (16.73-26.67) |
| Male | 15.84 (14.68-16.99) | 27.34 (25.85-28.84) | 30.07 (26.43-33.71) | 74.22 (68.45-79.99) | 21.78 (15.48-28.08) |
| **Education Level** | **/* | ***/*** | NS/* | */* | NS |
| No Education | 18.69 (17.08-20.30) | 31.04 (29.05-33.04) | 31.21 (26.86-35.57) | 65.81 (58.62-73.00) | 22.75 (14.47-31.03) |
| Primary | 17.02 (15.50-18.55) | 31.09 (29.21-32.96) | 31.59 (27.07-36.12) | 77.67 (71.42-83.92) | 24.03 (16.15-31.90) |
| Secondary | 15.17 (13.90-16.45) | 33.19 (31.33-35.06) | 34.12 (29.83-38.41) | 73.10 (66.61-79.59) | 15.74 (10.03-21.46) |
| Higher | 17.50 (15.49-19.52) | 43.18 (40.41-45.94) | 39.91 (33.65-46.16) | 80.86 (73.11-88.61) | 26.62 (16.41-36.83) |
| **Currently Married** | * | *** | NS | NS | NS |
| Yes | 17.37 (16.36-18.39) | 36.33 (34.87-37.79) | 33.70 (30.85-36.56) | 72.21 (68.19-76.23) | 21.40 (17.10-25.71) |

| | | | | | |
|---|---|---|---|---|---|
| No | 15.12 (13.53-16.72) | 22.74 (21.05-24.43) | 32.51 (27.31-37.71) | 80.55 (72.49-88.62) | 23.11 (14.02-32.21) |
| **BMI** | ***/*** | ***/*** | **/*** | */* | NS |
| Underweight | 10.95 (9.35-12.56) | 20.00 (18.05-21.96) | 21.41 (14.95-27.87) | 54.18 (37.94-70.43) | 37.22 (15.12-59.31) |
| Normal Weight | 14.96 (13.87-16.06) | 29.10 (27.72-30.49) | 32.89 (29.34-36.44) | 72.74 (67.48-78.01) | 23.49 (17.41-29.56) |
| Overweight | 22.18 (20.4-23.93) | 47.84 (45.43-50.26) | 37.23 (32.63-41.82) | 75.63 (69.39-81.88) | 18.15 (12.45-23.85) |
| Obese | 31.35 (26.9-35.70) | 60.35 (55.94-64.76) | 38.69 (31.32-46.06) | 82.01 (72.84-91.19) | 17.92 (6.15-29.70) |
| **Wealth Status** | ***/*** | ***/*** | ***/*** | ***/*** | NS |
| Poorest | 10.92 (9.43-12.42) | 18.44 (16.55-20.34) | 19.41 (14.21-24.61) | 46.10 (30.42-61.78) | 25.23 (6.71-43.74) |
| Poorer | 12.92 (11.3-14.46) | 25.48 (23.26-27.70) | 29.42 (24.17-34.67) | 63.59 (53.72-73.46) | 16.49 (6.71-26.28) |
| Middle | 15.83 (14.08-17.57) | 31.05 (28.80-33.29) | 26.33 (21.24-31.42) | 69.30 (59.97-78.62) | 21.66 (10.29-33.03) |
| Richer | 18.23 (16.28-20.18) | 37.49 (35.12-39.85) | 31.63 (26.72-36.53) | 71.67 (63.73-79.61) | 19.97 (11.61-28.33) |
| Richest | 26.20 (24.11-28.29) | 53.55 (50.57-56.53) | 46.54 (41.60-51.48) | 83.77 (79.17-88.37) | 23.47 (17.49-29.46) |
| **Family Size** | **/** | ***/** | **/NS | NS | NS |
| Nuclear Family (1–3) | 19.41 (17.58-21.23) | 38.28 (36.07-40.49) | 38.31 (33.68-42.94) | 73.13 (66.33-79.93) | 19.52 (12.11-26.94) |
| Medium Family (4-5) | 16.17 (15.04-17.30) | 31.35 (29.71-32.98) | 29.52 (26.16-32.88) | 73.50 (67.91-79.09) | 18.23 (12.12-24.33) |
| Joint Family (6+) | 16.11 (14.60-17.62) | 33.21 (31.23-35.19) | 34.58 (30.08-39.08) | 74.41 (68.43-80.38) | 27.79 (19.90-35.67) |
| **Place of Residence** | *** | *** | NS | NS | NS |
| Rural | 14.67 (13.66-15.69) | 30.84 (29.41-32.26) | 31.73 (28.45-35.01) | 72.19 (67.25-77.13) | 22.22 (17.05-27.38) |
| Urban | 23.16 (20.94-25.39) | 41.08 (38.40-43.77) | 36.59 (32.32-40.86) | 75.95 (70.87-81.03) | 21.03 (14.57-27.48) |
| **Division** | *** | *** | ** | * | NS |
| Barisal | 15.23 (12.76-17.70) | 28.82 (25.77-31.87) | 30.98 (24.33-37.62) | 59.62 (46.54-72.70) | 20.47 (7.79-33.15) |
| Chattogram | 18.24 (15.95-20.53) | 38.88 (35.67-42.08) | 35.02 (28.48-41.57) | 83.55 (76.26-90.85) | 15.10 (8.83-21.37) |
| Dhaka | 22.21 | 36.47 | 33.16 | 77.58 | 27.47 |

| | | | | | |
|---|---|---|---|---|---|
| | (19.44-24.98) | (33.17-39.78) | (27.52-38.80) | (70.25-84.91) | (17.98-36.95) |
| Khulna | 15.61 (13.54-17.68) | 41.99 (38.91-45.06) | 41.55 (34.71-48.38) | 71.07 (61.66-80.48) | 18.03 (7.99-28.07) |
| Mymensingh | 11.12 (9.09-13.15) | 25.82 (22.47-29.18) | 31.94 (22.39-41.49) | 69.33 (57.73-80.92) | 22.16 (8.21-36.10) |
| Rajshahi | 12.63 (10.61-14.64) | 35.05 (31.48-38.61) | 41.63 (34.95-48.32) | 63.59 (52.92-74.26) | 27.65 (15.17-40.13) |
| Rangpur | 16.30 (13.50-19.09) | 23.84 (20.60-27.08) | 21.35 (14.87-27.82) | 67.45 (55.35-79.56) | 19.83 (7.92-31.74) |
| Sylhet | 16.90 (14.00-19.81) | 23.19 (20.44-25.94) | 29.16 (22.79-35.54) | 72.41 (59.93-84.88) | 18.39 (9.30-27.49) |

- *n = raw sample size, % = weighted percentage, 95% CI = 95% Confidence Interval*
- *p-values: Chi-square test / Trend test for categorical associations and ordinal variables (where applicable)*
- *Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001, NS = p ≥ 0.05 (Not Significant)*
- *a = total tested for diabetes, b = total participants asked whether they had ever had their blood glucose measured by a doctor/ health worker, c = total diabetes cases, d = total diagnosed diabetes cases, e = total treated diabetes cases*

### 3.2.2 Diagnosis and treatment

Only one-third (33.5%) of individuals with diabetes were aware of their condition. Socioeconomic disparities observed in screening were amplified at the diagnosis stage: the richest quintile had three times the odds of being diagnosed (aOR 3.0, 95% CI: 1.8–4.8) compared with the poorest, and higher education was associated with increased odds (aOR 1.8, 95% CI: 1.2–2.8) compared with no education. The likelihood of diagnosis also increased sharply with age, with adults ≥65 years having nearly seven times the odds (aOR 6.8, 95% CI: 4.5–10.2) compared with those aged 18–34 years. Consistent with hypertension, men had 40% lower odds of being diagnosed (aOR 0.6, 95% CI: 0.5–0.8) than women.

Among the small fraction diagnosed, treatment uptake was relatively high (73.7%). However, this stage exhibited the most extreme wealth-based disparity in the study: the richest quintile had five times higher odds of receiving treatment (aOR 5.0, 95% CI: 2.2–11.4) compared with the poorest.

### 3.2.3 Glycaemic control

Among those receiving treatment, only 21.7% had their blood glucose controlled. Glycaemic control improved with age, rising from 17.1% in the 35–44 age group to 35.3% in those aged ≥65 years. In contrast to earlier cascade stages, other factors like wealth, education, gender, and place of residence did not have a significant effect on control among treated individuals.

**[Insert Table 4 here]**

**Table 4.** Adjusted odds ratios for factors associated with diabetes prevalence, screening coverage, diagnosis, treatment and control among adults aged ≥18 years

| | Diabetes | | | | |
|---|---|---|---|---|---|
| **Socio-Demographic Variable** | **Diabetes Prevalence** | **Screening Coverage** | **Diagnosis among Diabetes Cases** | **Treatment among Diagnosed Cases** | **Control among Treated Cases** |
| | **aOR (95% CI)** | **aOR (95% CI)** | **aOR (95% CI)** | **aOR (95% CI)** | **aOR (95% CI)** |
| **Age Group** | *** | *** | *** | * | * |
| 18–34 | 1 | 1 | 1 | 1 | 1 |
| 35–44 | 2.05 (1.73-2.44) | 2.10 (1.86-2.37) | 3.15 (2.16-4.61) | 1.81 (0.85-3.86) | 0.60 (0.20-1.84) |
| 45–54 | 3.54 (2.95-4.26) | 3.40 (2.91-3.97) | 6.00 (4.09-8.81) | 2.93 (1.34-6.38) | 0.56 (0.18-1.76) |
| 55–64 | 3.97 (3.29-4.78) | 4.70 (3.98-5.54) | 7.03 (4.69-10.53) | 2.92 (1.39-6.14) | 0.79 (0.25-2.49) |
| 65+ | 4.41 (3.56-5.48) | 5.50 (4.64-6.53) | 6.79 (4.50-10.24) | 4.02 (1.67-9.66) | 1.83 (0.51-6.63) |
| **Gender** | *** | *** | *** | NS | NS |
| Female | 1 | 1 | 1 | 1 | 1 |
| Male | 0.82 (0.73-0.92) | 0.50 (0.45-0.55) | 0.59 (0.45-0.76) | 0.83 (0.53-1.30) | 0.61 (0.34-1.10) |
| **Education Level** | NS | *** | ** | NS | NS |
| No Education | 1 | 1 | 1 | 1 | 1 |
| Primary | 1.15 (0.99-1.35) | 1.34 (1.17-1.54) | 1.43 (1.06-1.93) | 2.03 (1.19-3.43) | 1.47 (0.76-2.85) |
| Secondary | 1.16 | 1.64 | 1.86 | 1.39 | 0.84 |

| | | | | | |
|---|---|---|---|---|---|
| | (0.98-1.36) | (1.42-1.90) | (1.33-2.59) | (0.81-2.40) | (0.38-1.85) |
| Higher | 1.21 (0.97-1.51) | 2.62 (2.16-3.17) | 1.83 (1.20-2.79) | 1.63 (0.75-3.56) | 1.68 (0.73-3.89) |
| **Currently Married** | NS | *** | NS | NS | NS |
| No | 1 | 1 | 1 | 1 | 1 |
| Yes | 1.11 (0.97-1.28) | 2.06 (1.82-2.33) | 1.01 (0.75-1.38) | 0.63 (0.34-1.19) | 1.61 (0.81-3.19) |
| **BMI** | *** | *** | NS | NS | NS |
| Normal Weight | 1 | 1 | 1 | 1 | 1 |
| Underweight | 0.75 (0.63-0.90) | 0.74 (0.64-0.86) | 0.74 (0.49-1.13) | 0.55 (0.24-1.26) | 1.67 (0.62-4.50) |
| Overweight | 1.42 (1.25-1.62) | 1.74 (1.55-1.95) | 1.00 (0.76-1.31) | 1.09 (0.67-1.76) | 0.69 (0.39-1.20) |
| Obese | 2.05 (1.60-2.61) | 2.44 (1.99-2.99) | 0.97 (0.63-1.50) | 1.56 (0.79-3.08) | 0.64 (0.27-1.51) |
| **Wealth Status** | *** | *** | *** | *** | NS |
| Poorest | 1 | 1 | 1 | 1 | 1 |
| Poorer | 1.16 (0.97-1.39) | 1.32 (1.11-1.57) | 1.75 (1.15-2.67) | 1.94 (0.85-4.41) | 0.74 (0.20-2.68) |
| Middle | 1.33 (1.09-1.64) | 1.60 (1.34-1.90) | 1.44 (0.93-2.24) | 1.97 (0.85-4.58) | 0.84 (0.24-3.02) |
| Richer | 1.48 (1.20-1.83) | 2.05 (1.74-2.42) | 1.71 (1.09-2.70) | 2.33 (1.02-5.33) | 0.86 (0.27-2.79) |
| Richest | 1.99 (1.61-2.47) | 3.23 (2.66-3.93) | 2.97 (1.83-4.84) | 5.03 (2.22-11.40) | 0.98 (0.29-3.23) |
| **Family Size** | * | *** | NS | NS | NS |
| Nuclear Family (1–3) | 1 | 1 | 1 | 1 | 1 |
| Medium Family (4-5) | 0.88 (0.77-1.00) | 0.80 (0.71-0.90) | 0.79 (0.61-1.03) | 1.08 (0.66-1.78) | 1.09 (0.56-2.10) |
| Joint Family (6+) | 0.81 (0.69-0.95) | 0.82 (0.72-0.94) | 0.91 (0.68-1.22) | 0.920 (0.57-1.50) | 1.86 (0.94-3.68) |
| **Place of Residence** | *** | NS | NS | NS | NS |
| Rural | 1 | 1 | 1 | 1 | 1 |
| Urban | 1.34 (1.13-1.58) | 1.01 (0.88-1.16) | 0.91 (0.68-1.22) | 0.712 (0.47-1.10) | 0.87 (0.53-1.43) |
| **Division** | *** | *** | * | NS | NS |
| Barisal | 1 | 1 | 1 | 1 | 1 |
| Chattogram | 1.19 (0.92-1.56) | 1.59 (1.29-1.95) | 1.21 (0.80-1.84) | 3.99 (1.68-9.51) | 0.71 (0.26-1.95) |
| Dhaka | 1.27 (0.97-1.66) | 1.10 (0.88-1.38) | 1.05 (0.69-1.59) | 2.35 (1.09-5.06) | 1.29 (0.49-3.45) |
| Khulna | 0.83 | 1.56 | 1.48 | 1.49 | 0.93 |

| | | | | | |
|---|---|---|---|---|---|
| | (0.63-1.09) | (1.26-1.93) | (0.96-2.29) | (0.69-3.26) | (0.30-2.87) |
| Mymensingh | 0.76 (0.56-1.01) | 1.02 (0.81-1.28) | 1.15 (0.68-1.93) | 1.90 (0.79-4.57) | 0.87 (0.24-3.16) |
| Rajshahi | 0.70 (0.53-0.93) | 1.22 (0.98-1.52) | 1.58 (0.99-2.52) | 1.57 (0.75-3.30) | 1.52 (0.51-4.56) |
| Rangpur | 1.11 (0.83-1.50) | 0.78 (0.61-1.00) | 0.64 (0.39-1.04) | 1.50 (0.65-3.46) | 1.04 (0.32-3.41) |
| Sylhet | 1.26 (0.92-1.72) | 0.83 (0.66-1.04) | 1.02 (0.66-1.58) | 2.08 (0.86-5.01) | 0.71 (0.23-2.15) |

• *aOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval*
• *p-value: Wald tests p value for overall categorical variables*
• *Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001, NS = p ≥ 0.05 (Not Significant)*
• *Reference Categories: 18-34 Years, Female, No Education, Not Married, Normal Weight, Poorest, Nuclear Family, Rural, Barisal*

# 4. Discussion

## 4.1 Comparison with existing literature

This study fills a notable gap in the NCD evidence base in Bangladesh by providing a comprehensive, comparative, stage-by-stage evaluation of hypertension and diabetes care cascades. Previous work in Bangladesh largely focused on prevalence or isolated stages of care, making it difficult to visualise where patients drop out of the cascade. The 2022 BDHS data show that hypertension prevalence has modestly declined since the 2017–2018 survey (from 26.2 % to 22.1 %), whereas diabetes prevalence has risen sharply (from 10.0 % to 16.9 %).(5,6) These trends align with facility-based and cohort studies in Bangladesh and other LMICs, which report rising diabetes burdens, particularly among urban and wealthier populations.(10,22)

The hypertension cascade shows that screening coverage is high (78.3 %), yet substantial attrition occurs thereafter: only 59.6 % of individuals with hypertension report a prior diagnosis, 43.3 % report being on treatment, and 19 % achieve blood-pressure control. Although Bangladesh performs better than many LMICs in

identifying hypertensive individuals but faces challenges with sustained treatment and control. Pooled analyses of 44 LMICs and a systematic review of 95 surveys found hypertension awareness, treatment and control rates of 39–48 %, 30–35 % and 10–16 %, respectively.(23,24)

In contrast, the diabetes cascade is characterised by extremely low levels of initial access. Only about one-third of adults (33.6 %) have ever had a blood-glucose test; among all adults with diabetes, roughly 33.5 % are aware of their condition, 24.6 % receive treatment and just 5 % achieve glycaemic control. Of those treated, only 21.7 % reach glycaemic control. A pooled analysis of 28 LMICs found that 63.4% of people with diabetes had been tested, 44.3% were aware, 38.4% treated, and 22.8% controlled.(11) Similarly, a multi-country study from sub-Saharan Africa reported 54% awareness, 73% treatment among those aware, and 38% control among treated cases.(25) Bangladesh therefore lags behind comparable countries, with especially large gaps in screening, diagnosis, and glycaemic control, underscoring the need for earlier detection and stronger long-term management.

### 4.2 How the care cascades differ by disease

The difference between the two care cascades shows that a uniform approach to NCD care is insufficient.(26)

The hypertension cascade shows adequate initial access but persistent challenges in long-term management. High screening coverage (78.3%) appears opportunistic, reflecting the maternal and child health (MCH) focused primary health care system.(7) This is supported by the significant screening gap for men, who are 70% less likely to be screened, likely because they do not access routine MCH services.(27,28) Despite

353 relatively high screening rates, only 19% of all hypertensive individuals achieved
354 control, highlighting difficulties in sustaining chronic disease management.

355 Conversely, the diabetes cascade highlights a major barrier at initial access. Low
356 screening coverage (33.6%) leaves two-thirds of individuals undiagnosed and
357 untreated, exposing them to long-term complications. Previous research in
358 Bangladesh has similarly highlighted that blood glucose testing, due to its costs,
359 logistical requirements, and the lack of trained providers, has not been integrated into
360 routine primary care to the same extent as blood pressure measurement.(29,30)
361 These findings suggest that hypertension care requires strengthening the continuity
362 and quality of management, while diabetes care demands substantial improvement in
363 screening and diagnostic capacity.

364 **4.3 Socioeconomic inequalities across the care cascades**

365 This study confirms that socioeconomic status is a key determinant of NCD care in
366 Bangladesh. Low public health spending (0.7% of GDP) and high out-of-pocket (OOP)
367 expenditures (67%) limit access to care and exacerbate disparities.(14)

368 Disparities are most pronounced for diabetes. The wealthiest have twice the
369 prevalence, potentially due to lifestyle factors, and are three times more likely to be
370 screened and diagnosed, and five times more likely to receive treatment than the
371 poorest. Even after diagnosis, the lifelong medication cost, averaging US $323
372 annually, often prevents poorer individuals from accessing or adhering to
373 treatment.(31) For hypertension, the wealthiest are 2.2 times more likely to be
374 screened and 1.76 times more likely to receive treatment than the poorest. A pooled
375 analysis of 28 countries similarly found that wealth nearly doubled the odds of diabetes

testing but was not associated with treatment or control. Studies from Nepal and other countries also showed that wealth increases screening and treatment, but control rates remain persistently low across all groups.(11,32)

Education strongly influences care outcomes. Higher education more than doubles the odds of achieving blood-pressure control and substantially increases screening and diagnosis of hypertension and diabetes compared with individuals with no education. These findings align with broader evidence that greater health literacy improves adherence and disease management. A pooled analysis of 95 surveys from LMICs reported a mean hypertension control rate of 16%, with substantially higher control among more educated individuals.(24)

### 4.4 The apparent lack of clinical control

This study found low control rates among treated patients, 43.3% for hypertension and 21.7% for diabetes. These figures are nearly identical to BDHS 2017–2018 (43.6% for hypertension and 26.5% for diabetes), suggesting that despite increased policy attention to NCDs, little progress has been made in improving treatment effectiveness over the past five years.(5,33)

Socioeconomic factors were not significant predictors of control for either condition, suggesting system-wide quality issues affecting all patients who manage to access treatment. These challenges are consistent with findings from similar settings, where low control rates are linked to poor medication adherence, limited patient education, inconsistent follow-up, healthcare infrastructure constraints, and cultural barriers affecting treatment engagement.(34,35)

### 4.5 Intersecting inequities: Geography, gender, and age

NCD prevalence varies across administrative divisions and between urban and rural areas. This study found that diabetes prevalence in Dhaka is double that in Mymensingh, and urban residents consistently show higher rates than rural populations. Studies suggest these differences reflect structural inequities in healthcare infrastructure, resource availability, and service delivery across regions.(15,36) However, after adjusting for wealth and education, individual socioeconomic status emerges as a stronger predictor of care access than geography. This pattern is consistent with findings from other LMICs, where socioeconomic status often outweighs regional location in determining access to NCD care and health outcomes.(15,37)

Gender disparities were evident across the care cascades. Women had higher prevalence and were more likely to be screened and diagnosed for both hypertension and diabetes, possibly reflecting their greater engagement with routine health services, including maternal and child health platforms. However, this advantage did not translate into significantly better clinical control after adjustment. This suggests that women may have better initial contact with services, while sustained disease control remains a broader quality-of-care challenge. Similar patterns have been reported in other LMICs, highlighting the dual challenge of reaching men for early screening while improving long-term management for all patients.(5,28,33)

Age is known to be strongly associated with NCDs, and its effect is mediated by socioeconomic status.(13) Even among high-risk older groups, socioeconomic factors remain key determinants of diagnosis and treatment, indicating that access to care is influenced by age-related vulnerability and social disadvantage. This pattern has also been observed in other LMIC.(5,33)

### 4.6 The role of BMI in NCDs

The strong, dose-dependent association between rising BMI and NCDs is well-documented. Obese adults are nearly four times as likely to have hypertension and twice as likely to have diabetes compared with individuals of normal BMI. Obesity is a well-established risk factor for both conditions in LMICs.(38,39) Although overweight and obese individuals are more likely to be screened for hypertension and diabetes, this does not translate into better disease management or control. This aligns with other studies highlighting the lack of integrated weight management and nutritional counselling in routine NCD care, a critical gap in many health systems.(38,39)

### 4.7 Strengths and limitations

The primary strength is the use of data from BDHS 2022, a large, recent, and nationally representative dataset, allowing generalization to adult population and providing a robust, current assessment of the NCD situation of Bangladesh. Second, the comprehensive and comparative analysis of the full five-stage care cascade for two major NCDs provides a holistic view of health system performance, beyond prevalence alone. Third, the inclusion of biomarker data enhances prevalence accuracy and identifies undiagnosed cases, which is crucial for understanding the true burden of disease.

Several limitations should be considered. First, the cross-sectional design limits causal inferences; however, as the study aims to describe care pathways rather than causality, this is less important. Second, self-reported data on screening, diagnosis, and treatment may introduce recall or social desirability bias.(40) Large sample size and biomarker verification mitigate these concerns. Third, diabetes diagnosis was based on a single fasting blood glucose measurement rather than clinical standard of

an HbA1c test, and blood pressure was measured on a single day resulting in missing long-term variability.(41,42) This may misclassify some cases. However, the persistently high underdiagnosis, poor treatment, and low control rates suggest minimal impact on overall conclusions. Finally, absence of lifestyle data (diet, physical activity, smoking, alcohol use) may limit contextual understanding, but does not affect the study's focus on socioeconomic disparities and care gaps.(43)

# 5. Conclusion and policy implications

## 5.1 Summary of findings

The hypertension and diabetes care cascades in Bangladesh reveal notable gaps. The hypertension care pathway faces challenges in clinical management after screening, whereas the diabetes care pathway is hindered by low screening and diagnosis rates, preventing many adults from entering the care pathway. Both cascades show substantial socioeconomic inequalities, systematically excluding the poor and those with lower levels of education.

This exclusion is largely due to a health system that has focused less on chronic care and relies heavily on out-of-pocket payments, while rising obesity rates contribute to the NCD burden.(7,14,39) As a result, many individuals with NCDs remain undiagnosed, disproportionately affecting vulnerable populations.

## 5.2 Policy recommendations

The findings indicate that a uniform approach to NCD care is inadequate. The policy response should match the stage at which each disease shows the greatest attrition. To address these gaps, this study proposes four key recommendations:

I. **Integrated and targeted screening**

For hypertension, existing opportunistic screening within MCH programs should be supplemented with targeted outreach to engage men, reinforced with standardized protocols for referral and linkage to care to ensure continuity across the cascade.(13)

For diabetes, passive testing should be replaced with mandated, integrated screening at all primary health care centres, particularly in rural areas. Screening resources should be prioritized in regions with higher prevalence of hypertension and diabetes.(7,29)

II. **Health financing reform**

The extreme wealth disparities highlight the urgent need to reduce the burden of OOP expenditures. The most direct intervention is to expand the provision of free essential NCD medicines at PHC centres. Long-term sustainability requires financing reforms, including social health insurance, to remove financial barriers that constrain access to life-saving care.(14,31,44)

III. **Strengthen primary health care (PHC)**

Effective NCD management requires a robust PHC system. Full operationalization of government “NCD corners” is essential, with trained staff, reliable diagnostic capacity (e.g., glucometers, test strips), and consistent medicine supply.(7,45) Given the strong association between BMI and NCD risk, services should integrate nutritional counselling and weight management support.(39)

IV. **Launch targeted health literacy and awareness campaigns**

The strong influence of education on screening, diagnosis, and control underscores the importance of health literacy. Awareness campaigns should specifically target younger individuals, men, and those with low educational attainment, who consistently show lower engagement with health services.(46,47)

### 5.3 Directions for future research

This study identifies several priorities for future research. First, longitudinal cohort studies are needed to track patient attrition across the care cascade and clarify causal pathways between socioeconomic status and NCD outcomes.(48) Second, qualitative research should explore patient and provider perspectives on the barriers and facilitators to care, which can inform the design of more patient-centred models.(49) Third, economic evaluations are required to demonstrate which different screening and/or treatment strategies offer the best value for money to guide equitable resource allocation in Bangladesh.(50) Finally, health service readiness assessments should evaluate PHC capacity for NCD management, focusing on workforce, supply chains, and referral systems.(51,52)

## List of abbreviations

| Abbreviation | Full Term |
|---|---|
| aOR | Adjusted Odds Ratio |
| BDHS | Bangladesh Demographic and Health Survey |
| BMI | Body Mass Index |
| BP | Blood Pressure |
| CI | Confidence Interval |
| HbA1c | Haemoglobin A1c |
| LMICs | Low- and Middle-Income Countries |
| MCH | Maternal and Child Health |
| NCDs | Non-Communicable Diseases |
| OOP | Out-of-Pocket (health expenditure) |
| PHC | Primary Health care |
| US$ | United States Dollar |
| WHO | World Health Organization |

# Declarations

## Ethics approval and consent to participate

The 2022 Bangladesh Demographic and Health Survey received ethical approval from the ICF Institutional Review Board and the Bangladesh Medical Research Council. The present secondary analysis used de-identified, publicly available data and was approved by the University of Nottingham Research Ethics Committee (Reference: MPH/2025/20707667).

## Consent for publication

Not applicable.

## Availability of data and materials

This study analysed publicly available secondary data from the Bangladesh Demographic and Health Survey (BDHS) 2022 dataset. https://microdata.worldbank.org/index.php/catalog/6290.

## Competing interests

The author declares that he has no competing interests.

## Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## Authors' contributions

M A Shahed conceptualised the study, conducted the literature review, managed and analysed the data, constructed the care cascades, interpreted the findings, prepared the tables and figures, and wrote and approved the final manuscript.

## Acknowledgements

The author acknowledges the academic supervision and feedback received during the original MPH dissertation at the University of Nottingham, from which this manuscript was developed.

## Authors' information

M A Shahed is an MPH graduate of the University of Nottingham, UK and a public health researcher with experience at Projahnmo Research Foundation (PRF), Bangladesh, and the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b).

# References


1. Bai J, Cui J, Shi F, Yu C. Global Epidemiological Patterns in the Burden of Main Non-Communicable Diseases, 1990–2019: Relationships With Socio-Demographic Index. Int J Public Health. 2023 Jan 16;68:1605502. doi:10.3389/ijph.2023.1605502 PubMed PMID: 36726528; PubMed Central PMCID: PMC9884670.

2. Non communicable diseases [Internet]. [cited 2025 Aug 24]. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

3. Ndubuisi NE. Noncommunicable Diseases Prevention In Low- and Middle-Income Countries: An Overview of Health in All Policies (HiAP). Inq J Med Care Organ Provis Financ. 2021 Aug 23;58:0046958020927885. doi:10.1177/0046958020927885 PubMed PMID: 34420412; PubMed Central PMCID: PMC8385577.

4. The burden of diseases and risk factors in Bangladesh, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Glob Health. 2023 Nov 14;11(12):e1931–42. doi:10.1016/S2214-109X(23)00432-1 PubMed PMID: 37973341; PubMed Central PMCID: PMC10664824.

5. Khan MdN, Oldroyd JC, Chowdhury EK, Hossain MB, Rana J, Renzetti S, et al. Prevalence, awareness, treatment, and control of hypertension in Bangladesh: Findings from National Demographic and Health Survey, 2017–2018. J Clin Hypertens. 2021 Sep 7;23(10):1830–42. doi:10.1111/jch.14363 PubMed PMID: 34492733; PubMed Central PMCID: PMC8678656.

6. Ahsan KZ, Iqbal A, Jamil K, Haider MM, Khan SH, Chakraborty N, et al. Socioeconomic disparities in diabetes prevalence and management among the adult population in Bangladesh. PLOS ONE. 2022 Dec 20;17(12):e0279228. doi:10.1371/journal.pone.0279228

7. Kabir A, Karim MN, Billah B. Primary healthcare system readiness to prevent and manage non-communicable diseases in Bangladesh: a mixed-method study protocol. BMJ Open. 2021 Sep 1;11(9):e051961. doi:10.1136/bmjopen-2021-051961 PubMed PMID: 34493524.

8. Ezzati M, Vander Hoorn S, Lawes CMM, Leach R, James WPT, Lopez AD, et al. Rethinking the “Diseases of Affluence” Paradigm: Global Patterns of Nutritional Risks in Relation to Economic Development. PLoS Med. 2005 May;2(5):e133. doi:10.1371/journal.pmed.0020133 PubMed PMID: 15916467; PubMed Central PMCID: PMC1088287.

9. Singh Thakur J, Nangia R, Singh S. Progress and challenges in achieving noncommunicable diseases targets for the sustainable development goals. FASEB BioAdvances. 2021 Apr 29;3(8):563–8. doi:10.1096/fba.2020-00117 PubMed PMID: 34377953; PubMed Central PMCID: PMC8332469.

10. LaMonica LC, McGarvey ST, Rivara AC, Sweetman CA, Naseri T, Reupena MS, et al. Cascades of diabetes and hypertension care in Samoa: Identifying gaps in the diagnosis, treatment, and control continuum – a cross-sectional study. Lancet Reg Health - West Pac. 2022 Jan 1;18:100313. doi:10.1016/j.lanwpc.2021.100313

11. Manne-Goehler J, Geldsetzer P, Agoudavi K, Andall-Brereton G, Aryal KK, Bicaba BW, et al. Health system performance for people with diabetes in 28 low- and middle-income countries: A cross-sectional study of nationally representative surveys. PLoS Med. 2019 Mar 1;16(3):e1002751. doi:10.1371/journal.pmed.1002751 PubMed PMID: 30822339; PubMed Central PMCID: PMC6396901.

12. Rad J. Health inequities: a persistent global challenge from past to future. Int J Equity Health. 2025 May 23;24(1):148. doi:10.1186/s12939-025-02526-y

13. Iqbal A, Ahsan KZ, Jamil K, Haider MM, Khan SH, Chakraborty N, et al. Demographic, socioeconomic, and biological correlates of hypertension in an adult population: evidence from the Bangladesh demographic and health survey 2017–18. BMC Public Health. 2021 Jun 26;21(1):1229. doi:10.1186/s12889-021-11234-5

14. Awal Chowdhury NMR, Urme SA, Hridoy A, Nusrat F, Miah MS. Exploring the effects catastrophic health expenditure due to non-communicable diseases and coping strategies: A case study among households in Bangladesh. Public Health Pract. 2025 Jul 10;10:100642. doi:10.1016/j.puhip.2025.100642 PubMed PMID: 40697185; PubMed Central PMCID: PMC12281525.

15. Hossain A, Suhel SA, Islam S, Dhor NR, Akther N, Sanjoy SS, et al. Prevalence and regional disparities of undiagnosed diabetes mellitus in Bangladesh: Results from the Bangladesh Demographic and Health Survey data. PLOS One. 2025 Apr 2;20(4):e0321069. doi:10.1371/journal.pone.0321069 PubMed PMID: 40173172; PubMed Central PMCID: PMC11964274.

16. Mwangi KJ, Mwenda V, Gathecha G, Beran D, Guessous I, Ombiro O, et al. Socio-economic and demographic determinants of non-communicable diseases in Kenya: a secondary analysis of the Kenya stepwise survey. Pan Afr Med J. 2020 Dec 16;37:351. doi:10.11604/pamj.2020.37.351.21167 PubMed PMID: 33796165; PubMed Central PMCID: PMC7992900.

17. Anika US, Rafi MdA, Hossain MdG. Diabetes care cascade in Bangladesh: Identifying gaps and social determinants. Diabetes Res Clin Pract. 2025 Jun 1;224:112227. doi:10.1016/j.diabres.2025.112227

18. Nahin KSA, Rony AR, Tasnim SJ, Islam T, Hossen A, Asha AS. The Hypertension Care Cascade in Bangladesh: A Nationally Representative Analysis of BDHS 2022 [Internet]. Research Square; 2026 [cited 2026 May 13]. Available from: https://www.researchsquare.com/article/rs-9260596/v1 doi:10.21203/rs.3.rs-9260596/v1

19. Bangladesh - Demographic and Health Survey 2022 [Internet]. [cited 2025 Aug 24]. Available from: https://microdata.worldbank.org/index.php/catalog/6290

20. R: The R Project for Statistical Computing [Internet]. [cited 2025 Sep 12]. Available from: https://www.r-project.org/

21. Popoola PA, Tapamo JR, Honoré Assounga AG. Effective and Efficient Handling of Missing Data in Supervised Machine Learning. Data Sci Manag. 2024 Dec 14. doi:10.1016/j.dsm.2024.12.002

634 22. Lam AA, Lepe A, Wild SH, Jackson C. Diabetes comorbidities in low- and middle-
635 income countries: An umbrella review. J Glob Health. 11:04040.
636 doi:10.7189/jogh.11.04040 PubMed PMID: 34386215; PubMed Central PMCID:
637 PMC8325931.

638 23. Schutte AE, Venkateshmurthy NS, Mohan S, Prabhakaran D. Hypertension in
639 Low- and Middle-Income Countries. Circ Res. 2021 Apr 2;128(7):808–26.
640 doi:10.1161/CIRCRESAHA.120.318729 PubMed PMID: 33793340; PubMed Central
641 PMCID: PMC8091106.

642 24. Lamloum D, Fassio F, Osetinsky B, Tediosi F. Care Cascades for Hypertension in
643 Low-Income Settings: A Systematic Review and Meta-Analysis. Int J Public Health.
644 2023 Oct 12;68:1606428. doi:10.3389/ijph.2023.1606428 PubMed PMID: 37901590;
645 PubMed Central PMCID: PMC10600349.

646 25. Wade AN, Maposa I, Agongo G, Asiki G, Boua P, Choma SSR, et al. Diabetes care
647 cascade and associated factors in 10 700 middle-aged adults in four sub-Saharan
648 African countries: a cross-sectional study. BMJ Open. 2023 Apr 27;13(4):e069193.
649 doi:10.1136/bmjopen-2022-069193 PubMed PMID: 37105688; PubMed Central
650 PMCID: PMC10151877.

651 26. Breda J, Wickramasinghe K, Peters DH, Rakovac I, Oldenburg B, Mikkelsen B, et
652 al. One size does not fit all: implementation of interventions for non-communicable
653 diseases. BMJ. 2019 Dec 6;367:l6434. doi:10.1136/bmj.l6434 PubMed PMID:
654 31810904.

27. Billah SM, Khan ANS, Rokonuzzaman SM, Huq NL, Khan MA, Priyanka SS, et al. Competency of health workers in detecting and managing gestational hypertension, pre-eclampsia, severe pre-eclampsia and eclampsia during antenatal check-ups in primary care health facilities in Bangladesh: a cross-sectional study. BMJ Open. 2021 Jul 1;11(7):e046638. doi:10.1136/bmjopen-2020-046638 PubMed PMID: 34321295.

28. Rahman M, Williams G, Al Mamun A. Gender differences in hypertension awareness, antihypertensive use and blood pressure control in Bangladeshi adults: findings from a national cross-sectional survey. J Health Popul Nutr. 2017 May 25;36(1):23. doi:10.1186/s41043-017-0101-5

29. Jennings HM, Morrison J, Akter K, Haghparast-Bidgoli H, King C, Ahmed N, et al. Care-seeking and managing diabetes in rural Bangladesh: a mixed methods study. BMC Public Health. 2021 Jul 22;21(1):1445. doi:10.1186/s12889-021-11395-3

30. Farzana N, Islam MS, Selim S, Lakshmi JK, Kappor D, Sharma A, et al. The pattern of diabetic care and glycemic control among the ambulatory diabetic patients in tertiary care settings in Bangladesh. Sci Rep. 2024 Nov 25;14(1):29220. doi:10.1038/s41598-024-67036-3

31. Kasonde L, Tordrup D, Naheed A, Zeng W, Ahmed S, Babar ZUD. Evaluating medicine prices, availability and affordability in Bangladesh using World Health Organisation and Health Action International methodology. BMC Health Serv Res. 2019 Jun 13;19(1):383. doi:10.1186/s12913-019-4221-z

675 32. Dhungana RR, Pedisic Z, Dhimal M, Bista B, de Courten M. Hypertension
676 screening, awareness, treatment, and control: a study of their prevalence and
677 associated factors in a nationally representative sample from Nepal. Glob Health
678 Action. 15(1):2000092. doi:10.1080/16549716.2021.2000092 PubMed PMID:
679 35132939; PubMed Central PMCID: PMC8843246.

680 33. Khan N, Oldroyd JC, Hossain MB, Islam RM. Awareness, Treatment, and Control
681 of Diabetes in Bangladesh: Evidence from the Bangladesh Demographic and Health
682 Survey 2017/18. Int J Clin Pract. 2022 Apr 22;2022:8349160.
683 doi:10.1155/2022/8349160 PubMed PMID: 35685557; PubMed Central PMCID:
684 PMC9159140.

685 34. Mannan A, Hasan MdM, Akter F, Rana MdM, Chowdhury NA, Rawal LB, et al.
686 Factors associated with low adherence to medication among patients with type 2
687 diabetes at different healthcare facilities in southern Bangladesh. Glob Health
688 Action. 2021 Jan 1;14(1):1872895. doi:10.1080/16549716.2021.1872895 PubMed
689 PMID: 33475476.

690 35. Hossain A, Ahsan GU, Hossain MZ, Hossain MA, Sutradhar P, Alam SE, et al.
691 Medication adherence and blood pressure control in treated hypertensive patients:
692 first follow-up findings from the PREDIcT-HTN study in Northern Bangladesh. BMC
693 Public Health. 2025 Jan 21;25(1):250. doi:10.1186/s12889-025-21409-z

694 36. Akter S, Parvin S, Soni MSM, Hossain MI, Ireen S, Sultana R, et al. Assessing Risk
695 Factors of Diabetes Mellitus based on Rural-urban Residence in Bangladesh:

Findings from Two Cross Sectional Surveys. Asian J Probab Stat. 2023 Sep 25;25(1):57–65. doi:10.9734/ajpas/2023/v25i1538

37. Hasan MdR, Islam MdM, Noor FM, Ali M, Alam MdM. Analyzing hypertension and diabetes mellitus status among Bangladeshi adults: evidence from Bangladesh Demographic Health Survey (BDHS) 2017–18 data. J Public Health. 2024 Dec 1;32(12):2289–97. doi:10.1007/s10389-023-01987-1

38. Ahmed SK, Mohammed RA. Obesity: Prevalence, causes, consequences, management, preventive strategies and future research directions. Metab Open. 2025 Sep 1;27:100375. doi:10.1016/j.metop.2025.100375

39. Das S, Debnath M, Das S, Sarkar S, Rumana AS. Association of overweight and obesity with hypertension, diabetes and comorbidity among adults in Bangladesh: evidence from nationwide Demographic and Health Survey 2017-2018 data. BMJ Open. 2022 Jul 6;12(7):e052822. doi:10.1136/bmjopen-2021-052822 PubMed PMID: 35793916; PubMed Central PMCID: PMC9260812.

40. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. J Multidiscip Healthc. 2016 May 4;9:211–7. doi:10.2147/JMDH.S104807 PubMed PMID: 27217764; PubMed Central PMCID: PMC4862344.

41. Sherwani SI, Khan HA, Ekhzaimy A, Masood A, Sakharkar MK. Significance of HbA1c Test in Diagnosis and Prognosis of Diabetic Patients. Biomark Insights. 2016

716 Jul 3;11:95–104. doi:10.4137/BMI.S38440 PubMed PMID: 27398023; PubMed Central
717 PMCID: PMC4933534.

718 42. BrJCardiol. Long-term blood pressure variability: an emerging cardiovascular risk
719 factor [Internet]. [cited 2025 Sep 7]. Available from:
720 https://bjcardio.co.uk/2024/10/long-term-blood-pressure-variability-an-emerging-
721 cardiovascular-risk-factor/

722 43. Allen L, Williams J, Townsend N, Mikkelsen B, Roberts N, Foster C, et al.
723 Socioeconomic status and non-communicable disease behavioural risk factors in
724 low-income and lower-middle-income countries: a systematic review. Lancet Glob
725 Health. 2017 Feb 11;5(3):e277–89. doi:10.1016/S2214-109X(17)30058-X PubMed
726 PMID: 28193397; PubMed Central PMCID: PMC5673683.

727 44. Jubayer S, Hasan MM, Luna M, Al Mamun MA, Bhuiyan MR, Sayem NN, et al.
728 Availability of Hypertension and Diabetes Mellitus Care Services at Subdistrict Level
729 in Bangladesh. WHO South-East Asia J Public Health. 2023;12(2):99–103. Located at:
730 Scopus. doi:10.4103/WHO-SEAJPH.WHO-SEAJPH_53_22

731 45. Ahmed SM, Krishnan A, Karim O, Shafique K, Naher N, Srishti SA, et al. Delivering
732 non-communicable disease services through primary health care in selected south
733 Asian countries: are health systems prepared? Lancet Glob Health. 2024 Oct
734 1;12(10):e1706–19. doi:10.1016/S2214-109X(24)00118-9 PubMed PMID: 39178879.

735 46. Salwa M, Islam S, Tasnim A, Al Mamun MA, Bhuiyan MR, Choudhury SR, et al.
736 Health Literacy Among Non-Communicable Disease Service Seekers: A Nationwide

737 Finding from Primary Health Care Settings of Bangladesh. HLRP Health Lit Res Pract.
738 8(1):e12–20. doi:10.3928/24748307-20240119-01 PubMed PMID: 38329843; PubMed
739 Central PMCID: PMC10849776.

740 47. Goel S, Verma M, Mohapatra A, Popovic S. Editorial: Raising awareness around
741 trends in noncommunicable diseases and their risk factors to promote global
742 prevention and control. Front Public Health. 2025 Jan 28;13.
743 doi:10.3389/fpubh.2025.1553630

744 48. Mudie K, Jin MM, Tan, Kendall L, Addo J, dos-Santos-Silva I, et al. Non-
745 communicable diseases in sub-Saharan Africa: a scoping review of large cohort
746 studies. J Glob Health. 9(2):020409. doi:10.7189/jogh.09.020409 PubMed PMID:
747 31448113; PubMed Central PMCID: PMC6684871.

748 49. Ramani-Chander A, Thrift AG, van Olmen J, Wouters E, Delobelle P, Vedanthan R,
749 et al. Strengthening policy engagement when scaling up interventions targeting non-
750 communicable diseases: insights from a qualitative study across 20 countries.
751 Health Policy Plan. 2024 Nov 18;39(Supplement_2):i39–53.
752 doi:10.1093/heapol/czae043

753 50. Hoque ME, Khan JA, Hossain SS, Gazi R, Rashid H ar, Koehlmoos TP, et al. A
754 systematic review of economic evaluations of health and health-related interventions
755 in Bangladesh. Cost Eff Resour Alloc CE. 2011 Jul 20;9:12. doi:10.1186/1478-7547-9-
756 12 PubMed PMID: 21771343; PubMed Central PMCID: PMC3158529.

757 51. Kabir A, Karim MN, Islam RM, Romero L, Billah B. Health system readiness for
758 non-communicable diseases at the primary care level: a systematic review. BMJ
759 Open. 2022 Feb 1;12(2):e060387. doi:10.1136/bmjopen-2021-060387 PubMed PMID:
760 35140165.

761 52. Akinwumi AF, Esimai OA, Arije O, Ojo TO, Esan OT. Preparedness of primary
762 health care facilities on implementation of essential non-communicable disease
763 interventions in Osun State South-West Nigeria: a rural–urban comparative study.
764 BMC Health Serv Res. 2023 Feb 14;23(1):154. doi:10.1186/s12913-023-09138-8

765