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Cost of primary care approaches for hypertension management and risk-based cardiovascular disease prevention in Bangladesh

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Abstract

Objective: To estimate the costs of scaling up the HEARTS pilot project for hypertension management and risk-based cardiovascular disease prevention at the full population level in the four sub-districts (upazilas) in Bangladesh.

Settings: Two intervention scenarios in sub-district health complexes: hypertension management only, and risk-based integrated hypertension, diabetes, and cholesterol management.

Methods: Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual costs of implementing the HEARTS program from the health system perspective.

Data: Data were obtained in July-August 2020 from sub-district health complexes on the cost of medications, diagnostic materials, staff salaries, and other program components.

Results: The total annual cost for the hypertension control program was estimated at USD 3.3 million, equivalent to USD 2.9 per capita or, USD 9.1 per eligible patient. The largest cost share (USD 1.35 million; 42%) was attributed to the cost of provider time to administer treatment, followed by the cost of medications (40%). The total annual cost of the risk-based integrated management program was projected at USD 15.7 million, entailing USD 14 per capita or USD 44 per eligible patient. The estimated annual costs per patient treated with medications for hypertension, diabetes, and cholesterol were USD 17, USD 34, and USD 48, respectively.

Conclusion: Expanding the HEARTS hypertension management and CVD prevention program to provide services to the entire eligible population in the catchment area may face constraints in physician capacity. A task-sharing model involving shifting of select tasks from doctors to nurses and local community health workers would be essential for the eventual scale-up of primary care services to prevent CVD in Bangladesh.

Key Words: Program cost; HEARTS hypertension management and CVD prevention program; scale-up of primary care services; Bangladesh.

Word Count: 3903

Strengths and limitations of this study

- This is the first study that assesses the costs of scaling up two program scenarios at the full population level in the four sub-districts in Bangladesh: a hypertension management program and an integrated risk-based hypertension, diabetes, and cholesterol management program.
- Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual costs of implementing the HEARTS program from the health system perspective.
- The strength of the study lies in its ability to disaggregate costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging program delivery from the upazila level to more localized community facilities.
- Understanding the cost drivers of CVD prevention approaches in the Bangladesh primary care system can support budgeting, procurement, evaluation, cost-effectiveness analyses, and planning for scale-up, with the goal of increasing population outreach for CVD prevention.
- Due to lack of data at a local level, the cost projections rely on assumptions regarding population coverage, risk factor prevalence, primary care attendance rate, and frequency of patient visits by CDV risk.

1. BACKGROUND

Hypertension is a major and preventable risk factor for cardiovascular disease (CVD). An estimated 1.13 billion people (1 in 4 men and 1 in 5 women) worldwide has hypertension. Among people with hypertension worldwide, fewer than 1 in 5 have it under control.[1] High blood pressure is a leading global risk factor for premature death and disability, accounting for about 10 million (or 1 in 6) deaths worldwide each year.[2, 3) Uncontrolled hypertension significantly increases the risk of stroke, myocardial infarction, cardiac failure, dementia, renal failure, blindness, and other diseases.[4-7] Almost half of all CVD deaths are attributable to uncontrolled hypertension.[2, 3]

Reducing the prevalence of raised blood pressure is a standing global health objective.[8-11] This objective complements the 2030 Sustainable Development Goal (SDG) of reducing premature deaths from noncommunicable diseases (NCDs) by 25%.[12] Low- and middle-income countries (LMICs), where two-thirds of global hypertension cases reside, are increasingly cognizant of the long-term benefits of addressing hypertension in their populations. However, implementing population-level measures targeting hypertension may present challenges for many LMICs where health systems have traditionally focused on infectious diseases and where the capacity for NCD care may be limited.

Bangladesh is among lower-middle-income countries with a high burden of hypertension. In 2018, the prevalence of elevated blood pressure (SBP and/or DBP ≥ 140/90 mmHg) among adults in Bangladesh was 21%.[13-15]. According to the 2011 Bangladesh National Demographic and Health Survey, of 14.4 million hypertensive people, only 7.3 million (51%) were aware of their condition, 41% were treated, and 18% had their blood pressure levels under control.[16] The burden of hypertension in Bangladesh is expected to grow alongside increased population aging, rapid urbanization with commensurate increases in sedentary lifestyle and processed food consumption, and other socio-economic and lifestyle changes. However, only a less than 5 percent of the health sector program budget is allocated for NCDs control.[17] This demonstrates the need for population-level approaches to addressing hypertension that are effective, low-cost, and efficient.

In 2016, WHO introduced the HEARTS technical package as a framework for CVD prevention at the primary care level.[18] The HEARTS technical package consists of guidelines for implementing a primary-care approach to CVD management, focusing on screening and management of CVD risk factors, including lifestyle modification and pharmaceutical treatment of metabolic risk factors such as hypertension, diabetes, and hyperlipidemia. In this paper, we describe the local budgetary impact of implementing the HEARTS program at the population level for four sub-districts in Bangladesh, based on program cost data obtained from a representative health care facility in each sub-district. Although the initial focus of the program in the four sub-districts is presently limited to hypertension control, scaling-up of the initiative may include screening, diagnosis, and treatment of diabetes and high cholesterol. Understanding the cost drivers of CVD prevention approaches in the Bangladesh primary care system can support budgeting, procurement, evaluation, and planning for scale-up.

2. METHODS

2.1. Setting

In 2018, the Directorate General of Health Services and the National Heart Foundation of Bangladesh collaborated with Resolve to Save Lives (RTSL, an initiative of Vital Strategies, a non-profit global public health organization) to implement a pilot program to strengthen the detection, treatment, and follow-up management of hypertension in primary care. The program was introduced in four health complexes in four sub-districts (upazilas) in the Sylhet district: Golapganj, Fenchuganj, Beanibazar, and Bishwanath. In Bangladesh, hospitals and health facilities that are in the sub-district (upazila) level or below are termed as primary health complexes. A typical upazila health complex is a 50-bed hospital with service coverage in the range of 100,000 to 400,000 population and plays a pivotal role in the provision of primary health care. The upazila health complex has a wide range of functions that include preventive, promotive, curative (in-patient, out-patient, limited diagnostic services), management, technical support, training, coordination, and patient referral services. We project program costs under two intervention scenarios: a hypertension-focused program, and a risk-based integrated hypertension, diabetes, and cholesterol management program.

2.2. Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

2.3. Hypertension management program

The HEARTS Technical Package for CVD prevention in primary care is organized around six modules: H–Healthy-lifestyle counselling, E—Evidence-based treatment protocols, A—Access to essential medicines and technology, R—Risk-based CVD management, T—Team-based Care, and S—Systems for monitoring.[19] Components of these modules are described in Figure 1. In the four upazila primary care complexes in Bangladesh, programmatic activities included: training of staff in following a standard treatment protocol, record keeping and reporting; ensuring adequate supply of necessary drugs; community outreach to increase awareness of the need for hypertension screening; introduction of patient monitoring tools and a monthly reporting system; and establishing a mechanism for patient referral from primary care to secondary care and tertiary care at MAG Osmani Medical College. The clinical management protocol for adults with hypertension entailed a first line of treatment with amlodipine 5mg daily; a second line of treatment using amlodipine 5mg plus losartan 50mg daily; and a third line of treatment using amlodipine 5mg plus losartan 50mg plus hydrochlorothiazide 12.5mg daily. The prescribed medicines are typically procured by public health facilities, generic, domestically manufactured, and provided free of charge to patients. The national drug policy recommends that 70% of the public sector medicines be purchased from the state-owned Essential Drug Company Limited (EDCL), 25% from the Central Medical Stores Depot (CMSD), and 5% from local sources.[20, 21] In order to provide continuous care more sustainably and to reduce burden on physicians, a team-based care strategy was implemented. In this approach, community

health workers (CHW) were trained to provide counselling and some screening services along with the doctors and nurses. For the costing estimate, equal burden sharing in terms of provider time was assumed.

2.4. Risk-based integrated hypertension, diabetes, and hyperlipidemia management program

To further strengthen CVD prevention, the HEARTS program in Bangladesh also integrated diabetes and hyperlipidemia management in addition to hypertension management in primary care patients. The treatment protocol for patients with uncomplicated type 2 diabetes managed at the primary care level included Metformin (500 mg), Metformin (1000 mg), then Metformin (1000 mg), and Gliclazide (80 mg) as the first, second, and third lines of treatments, respectively. The treatment protocol for hyperlipidemia included simvastatin (10 mg) as first, atorvastatin (20 mg) as second, and atorvastatin (40 mg) as the third line of treatment. Costs associated with implementing integrated hypertension, diabetes, and hyperlipidemia treatment protocols include provider time spent on estimating CVD risk using risk charts during an annual primary care visit; training in CVD risk estimation, in addition to time spent collecting patient history; medication costs; and diagnostic test costs including provider (technician) time, complete blood count panel, fasting blood glucose, and blood lipid panel tests.

2.5. HEARTS Costing Tool

Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual cost of implementing the HEARTS program from the health system perspective. The tool is organized by HEARTS modules.[22]. In July-August 2020, we obtained unit costs from four upazila complexes and used these to project annual resource needs for implementing the CVD prevention program at the sub-district population level. The researchers completed in-person collection of data from the four facilities on human resource and time costs, diagnostic prices, time-motion on laboratory diagnostics, market price of medicines, and others.

Figure 1 shows major cost categories within HEARTS modules. Once program costs and other inputs such as population coverage, risk factor prevalence, and planned provider numbers were entered into the costing tool, the cost calculations were allocated across different HEARTS modules.

Figure 1: Cost components of the HEARTS program in Bangladesh

The cost elements in the Healthy-lifestyle counselling module ‘H’ included costs of training providers in lifestyle counseling and costs of community awareness programs and training. Counselling is based on the ‘5 As’ (Assess, Advise, Agree, Assist, Arrange) model, which is an evidence-based approach for promoting healthy behavioral changes to prevent NCD risk factors.[23, 24] Total provider time to administer brief counseling was equal to the average time that the health provider spends to counsel a patient to change behavior multiplied by the total number of patients who would receive counselling. The cost of total provider time was calculated as the total provider time, multiplied by the weighted average salary of the health providers who have been trained to provide counselling.

The cost elements in Module 'E' included provider time devoted to assessing patient history, conducting physical exams and diagnostic tests, and return visits. The costs of diagnostic tests (complete blood count panel, blood lipid panel, fasting blood glucose), medications (hypertension, diabetes, and cholesterol), and on-site diagnostic technologies and supplies were assessed under Module 'A'. Module 'R' reports the costs of training providers in conducting risk-based management and the cost of provider time for estimating patient CVD risk using risk charts. Module "T' reports cost savings from task-sharing by comparing the cost that could have been incurred if the tasks were performed solely by the physicians with costs incurred through task-sharing among physicians, nurses, and CHW. Therefore, in the baseline scenario (i.e., in the absence of task-sharing allocation), the costing tool assumes a physician-led program. In our cost projections, we assumed that doctors, nurses, and CHWs will equally share the tasks (i.e., provider time) where applicable. For instance, CHWs would only provide behavioral counselling and screening service, but they would not assess CVD risk (using risk-cart), or prescribe patients with pharmacologic treatments. Accordingly, the provider time allocated for behavior counselling and screening will be shared equally among doctors, nurses, and CHWs. Nurses will be trained to do major tasks (i.e., counselling, screening, and assessing CVD risk, and treating according to CVD risk), therefore providers' time for performing HTN/CVD risk-assessment, prescribing suitable treatment, and return-visits were allocated equally between doctors and nurses. While the 'T' module reports the cost savings from team-based care, The accrued cost of provider time (inclusive of doctors, nurses, and CHWs) spent on various tasks is included in the corresponding 'H', 'E', and 'R' modules. Module 'S' reports costs related to human resources, technology (software and hardware), supplies, and training for patient monitoring.

2.6. Data

Data on salaries of government healthcare providers and program staff were collected from in-person interviews and/or records. Total salary was calculated according to the Government of Bangladesh National pay scale. Size of the population in the examined sub-districts was obtained from census and imputed based on Bangladesh Bureau of Statistics (BBS) estimates. Other population parameters (e.g., primary care attendance rate and risk factor prevalence) were obtained from the nationally representative NCD Risk Factor Survey 2018.[15] Medicine prices were collected from the medicine outlets in the public hospitals. The unit prices represent the average price of domestically manufactured generic medicines procured by health facilities from EDCL or CMSD. Prices of laboratory diagnostics were collected from diagnostic labs at the district (Sylhet district) and sub-district (upazila) levels. Data on time needed to conduct laboratory tests were collected from in-person interviews of laboratory personnel. Training data, including number of training and participants, per-diem costs of staff, costs related to rent, transport, refreshments, and other logistics, were collected from the respective project records.

Table 1 presents the prevalence of CVD risk factors as well as cost inputs used to populate the HEARTS costing tool. 15% of the adult population was estimated to be at high risk for CVD. The leading risk factors were tobacco use (43.7%), hyperlipidemia (28.4%) and hypertension (21%), followed by physical inactivity (12.3%), diabetes (8.3%) and alcohol consumption (4.4%).; The primary care attendance rate was assumed to be 47.9% in each upazila.[15] Local currency was converted to US dollars using the Bangladesh Bank official conversion rate in June 2020.

Table 1: Costing inputs and unit costs

Input Description	Units	Value
Eligible population (Adult population (18+)		
- Golapganj	Persons	261098
- Fenchuganj	Persons	86503
- Beanibazar	Persons	209454
- Bishwanath	Persons	192075
Primary healthcare attendance rate (annual)	Percent	47.9%
Adult population with risk factors		
- Use of tobacco products	Percent	43.7%
- Hazardous or harmful use of alcohol	Percent	1.3%
- Physical inactivity	Percent	29.1%
- Hypertension (≥140/90mmHg)	Percent	21.0%
- Diabetes (≥7.0 mmol/L or 126 mg/dl)	Percent	8.3%
- Hyperlipidemia (≥ 6 mmol/L or 190 mg/dl)	Percent	28.4%
- Low CVD risk (0 to <10%)	Percent	65.0%
- Medium CVD risk (10 to <20%)	Percent	20.0%
- High CVD risk (≥20%)	Percent	15.0%
Annual wage (in LCU (BDT) and USD, including benefits)		
- Doctors	BDT (USD)/year	1,399,452 (16,484)
- Nurses	BDT (USD)/year	726,360 (8,555)
- CHWs	BDT (USD)/year	486,568 (5,731)
- Lab technicians	BDT (USD)/year	576,720 (6,793)
- Accountant	BDT (USD)/year	576,720 (6,793)
- Administrative Assistant	BDT (USD)/year	446,242 (5,256)
- Clerical Officer	BDT (USD)/year	446,242 (5,256)
- Custodian	BDT (USD)/year	446,242 (5,256)
- IT Personnel	BDT (USD)/year	446,242 (5,256)
- Program Director	BDT (USD)/year	1,399,452 (16,484)
- Program Manager	BDT (USD)/year	726,300 (8,555)
- Secretary	BDT (USD)/year	446,242 (5,256)
- Security officer	BDT (USD)/year	400,196 (4,714)
- Pharmacist/Chemist	BDT (USD)/year	576,720 (6,793)
- Statistician	BDT (USD)/year	576,720 (6,793)
- Supplies manager	BDT (USD)/year	486,568 (5,731)
Purchasing price (in LCU (BDT) and USD) of pharmaceutical drugs		
Hypertension Medicine		
- amlodipine 5mg	BDT (USD)/tablet	1 (0.012)
- losartan 50mg	BDT (USD)/tablet	8 (0.094)
- hydrochlorothiazide	BDT (USD)/tablet	0.35 (0.004)
Diabetes Medicine		
- metformin 500mg	BDT (USD)/tablet	4 (0.047)
- metforminn 1000mg	BDT (USD)/tablet	9 (0.106)
- gliclazide	BDT (USD)/tablet	3.5 (0.041)
Cholesteror Medicine		
- simvastatin 10mg	BDT (USD)/tablet	7 (0.082)
- atorvastatin 20mg	BDT (USD)/tablet	10 (0.118)
- atorvastatin 40mg	BDT (USD)/tablet	28 (0.330)
Purchasing price (in LCU) of diagnostic tests		
- Diabetes (Complete blood count - panel)	BDT (USD)/test	400 (4.71)
- Diabetes (Fasting blood glucose)	BDT (USD)/test	120 (1.41)
- Diabetes and Cholesterol (Blood lipid panel)	BDT (USD)/test	800 (9.42)
Counselling patients to change behavior		
- Time to counsel a patient to change behavior	Minutes	10
- # of 'How to quit' informational materials disseminated per person, annually (print)	Print	5
- Cost of 'How to quit' informational materials, per unit (print materials)	BDT (USD)/print	20 (0.24)
LCU to USD exchange rate	BDT/USD	84.9
"Safety stock" required to be on hand for medicines	Percent	3.0
Number of health providers in need of training		
- Counsel patients to change behavior	Persons	30
- Assess patients' total CVD risk	Persons	10
Training to counsel patients to change behavior (5A's)*		
- Classroom size	Persons	30
- Hours of training needed	Persons	16
Training to screen/diagnosis/treat patients Hypertension/CVD patients		
- Classroom size	Persons	30
- Hours of training needed	Persons	8
Number of Trainers		

- Professional trainer(s)	Persons	2
- Administrative staff	Persons	1
Input costs for training		
Hourly wage		
- Professional trainer	BDT (USD)/hour	500 (5.89)
- Administrative staff	BDT (USD)/hour	250 (2.94)
Per unit cost of materials		
- Instructive handbooks	BDT (USD)/book	1000 (11.8)
- Facility rental for training (one day)	BDT (USD)/day	9000 (106)
- Refreshments	BDT (USD)/day	6000 (70.7)
- Per diem for staff	BDT (USD)/day	3500 (41.2)
- Per diem and/or salary of trainees	BDT (USD)/day	5000 (58.9)
- Transportation stipend for staff	BDT (USD)/training	3165 (37.3)
CVD Risk Screening and Diagnosis		
Time (in minutes) a health provider spends to:		
- Screen patients for total CVD risk	Minutes	5
- Provide a physical exam to assess patients' total CVD risk	Minutes	5
- Assess patient risk using a CVD risk chart	Minutes	5
Time (in minutes) a lab technician spends to:		
- Administer and analyze a blood test	Minutes	10
- Administer and analyze a urine test	Minutes	10
Treatment for High CVD Risk		
# follow-up visits for a person annually with the following levels of CVD risk annually		
- Low CVD risk (≥0% to <10%)	Visits	2
- Medium CVD risk (≥10% to <20%)	Visits	3
- High CVD risk (≥20%)	Visits	4
Time health providers spend with a patient during a visit?		
- Generalists/primary care doctors	Minutes	5
- Nurses	Minutes	5
Screen for CVD risk: Diagnostics cost in LCU (BDT) and USD		
- Diabetes (compete blood count panel)	BDT (USD)/test	400 (4.7)
- Diabetes (Fasting blood glucose)	BDT (USD)/test	120 (1.4)
- Diabetes and Cholesterol (Blood lipid panel)	BDT (USD)/test	80 (0.9)
Pharmacological treatment for hypertension		
- Hypertension Protocol Step #1 (Amlodipine 5mg, 1 per day, 365 days)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	65%
- Hypertension Protocol Step #2 (Amlodipine 5mg + Losartan 50mg)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	20%
- Hypertension Protocol Step #3 (Amlodipine+Losartan+Hydrochlorothiazide)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	15%
- Unit price of amlodipine 5mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	1 (0.012)
- Unit price of losartan 50 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	8 (0.094)
- Unit price of hydrochlorothiazide in LCU (Taka or BDT) and USD	BDT (USD)/tablet	0.35 (0.004)
Pharmacological treatment for diabetes		
- Diabetes Protocol Step #1 (metformin 500mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	65
- Diabetes Protocol Step #2 (metformin 1000mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	20
- Diabetes Protocol Step #3 (metformin 1000mg+gliclazide 8mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	15
- Unit price of metformin 500mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	4 (0.047)
- Unit price of metformin 1000mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	9 (0.106)
- Unit price of gliclazide 80mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	3.5 (0.041)
Pharmacological treatment for high cholesterol (default regimens)		
- High Cholesterol Protocol Step #1 (low intensity, simvastatin 10mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	65%
- High Cholesterol Protocol Step #3 (moderate intensity, atorvastatin 20mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	20%
- High Cholesterol Protocol Step #4 (high intensity, atorvastatin 40mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	15%
- Unit price of simvastatin 10mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	7 (0.082)
- Unit price of simvastatin 20mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	10 (0.118)
- Unit price of atorvastatin 40mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	28 (0.330)

Note: * The '5A' (Assess, Advise, Agree, Assist, Arrange) model is an evidence-based approach entailing health behavior change counselling to prevent NCD risk factors in primary care setting (Glasgow et al., 2006; Whitlock et al, 2002). LCU: Local currency unit; BDT: Bangladesh Taka.

3. RESULTS

3.1. Population coverage

The total population in the four sub-districts was 1.12 million, of which 749,000 were adults aged 18 and above (Table 2). The total number of people eligible to receive counselling, screening, diagnosis, and treatment under the two types of HEARTS intervention packages (i.e., hypertension control and risk-based integrated approach) in the four sub-districts was determined by the primary care attendance rate, the prevalence of low-, medium-, and high- CDV risk in the population, the prevalence of hypertension, diabetes, and high cholesterol. The estimated number of eligible persons in the catchment area of the four sub-districts was 359,000, of which 233,000, 72,000, and 54,000 were projected to be low-, medium, and high- CVD risk patients. The estimated number of persons undergoing treatment for hypertension, diabetes, and high cholesterol was 75,000, 30,000, and 102,000, respectively (Table 2). Unit costs and other cost inputs were applied to these population parameters to project total program costs.

Table 2: Population coverage: Care cascade for counselling, screening, diagnosis, and treatment

	Golapganj	Fenchuganj	Beanibazar	Bishwanath	Total
Total population	390688	129436	313412	287404	1120940
Adult population in need (18+ years)	261,098	86,503	209454	192075	749130
Adults who present at the health center	125,066	41,435	100,328	92,004	358833
Providing brief counseling					
Eligible to receive brief advice	125,066	41,435	100,328	92,004	358833
Tobacco user	*54,654*	*18,107*	*43,844*	*40,206*	156810
Harmful alcohol	*5,503*	*1,823*	*4,414*	*4,048*	15789
Physical inactivity	*15,383*	*5,096*	*12,340*	*11,316*	44136
Screening and diagnosis of 10-year CVD risk					
Low CVD risk	81,293	26,933	65,214	59,803	233242
Medium CVD risk	25,013	8,287	20,066	18,401	71767
High CVD risk	18,760	6,215	15,049	13,801	53825
Treatment of 10-year CVD risk					
Low CVD risk	81,293	26,933	65,214	59,803	233242
Hypertension	*17,072*	*5,656*	*13,695*	*12,559*	*48981*
Diabetes	*6,747*	*2,235*	*5,413*	*4,964*	*19359*
Cholesterol	*23,087*	*7,649*	*18,521*	*16,984*	*66241*
Medium CVD risk	25,013	8,287	20,066	18,401	71767
Hypertension	*5,253*	*1,740*	*4,214*	*3,864*	*15071*
Diabetes	*2,076*	*688*	*1,665*	*1,527*	*5957*

	Cholesterol	*7,104*	*2,354*	*5,699*	*5,226*	*20382*
High CVD risk		18,760	6,215	15,049	13,801	53825
	Hypertension	*3,940*	*1,305*	*3,160*	*2,898*	*11303*
	Diabetes	*1,557*	*516*	*1,249*	*1,145*	*4467*
	Cholesterol	*5,328*	*1,765*	*4,274*	*3,919*	*15286*

Note: Risk factors and disease prevalence rates were assumed uniform across sub-districts.

3.2. Hypertension management program cost

Table 3 reports the estimated annual costs, in 2020 USD and Bangladesh Taka (BDT), of implementing the HEARTS hypertension management program in four upazilas at the population level (adults aged 18 and above). Figure 2 presents the distribution of costs by HEARTS components and sub-components**.** The total annual cost was estimated at USD 3.3 million, equivalent to USD 2.9 per capita, USD 4.3 per adult, and USD 9.1 per eligible participant. Module 'E' (Evidence-based treatment protocols) constitutes the largest cost share (USD 1.35 million; 42%), followed by Module 'A' (Access to medicines and technology, 40%). The projected medication expenditure per patient treated with medications for hypertension was USD 17.

Table 3: Total annual cost of HEARTS hypertension control program in four sub-districts

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy Lifestyles	**13,335,339**	**157071**	**4,765,107**	**56126**	**10,800,324**	**127212**	**9,947,252**	**117164**	**38848022**	**457574**
H1: Training costs	**418,990**	**4935**	**418,990**	**4935**	**418,990**	**4935**	**418,990**	**4935**	**1675960**	**19740**
H1.1: Facility rental (% of H1)	18,000	212	18,000	212	18,000	212	18,000	212	72000	848
H1.2: Human resources	20,000	236	20,000	236	20,000	236	20,000	236	80000	942
H1.3: Instructive handbooks	35,000	412	35,000	412	35,000	412	35,000	412	140000	1649
H1.4: Per diem/transportation	339,990	4005	339,990	4005	339,990	4005	339,990	4005	1359960	16018
H1.5: Refreshments	6,000	71	6,000	71	6,000	71	6,000	71	24000	283
H2: Brief counselling costs	**12,816,349**	**150958**	**4,246,117**	**50013**	**10,281,334**	**121099**	**9,428,262**	**111051**	**36772062**	**433122**
H2.1: Tobacco	9,272,756	109220	3,072,108	36185	7,438,647	87617	6,821,441	80347	26604952	313368
Provider time to administer 5A's	*3,807,374*	*44845*	*1,261,401*	*14857*	*3,054,293*	*35975*	*2,800,870*	*32990*	10923938	128668
Informational materials (print)	*5,465,382*	*64374*	*1,810,707*	*21328*	*4,384,354*	*51641*	*4,020,572*	*47357*	15681014	184700
H2.2: Alcohol	933,641	10997	309,320	3643	748,971	8822	686,827	8090	2678759	31552
Provider time to administer 5A's	*383,351*	*4515*	*127,006*	*1496*	*307,526*	*3622*	*282,010*	*3322*	1099893	12955
Informational materials (print)	*550,290*	*6482*	*182,314*	*2147*	*441,445*	*5200*	*404,817*	*4768*	1578866	18597
H2.3: Physical inactivity	2,609,952	30741	864,689	10185	2,093,715	24661	1,919,994	22615	7488350	88202
Provider time to administer 5A's	1,071,641	*12622*	355,040	*4182*	859,675	*10126*	788,345	*9286*	3074701	36216
Informational materials (print)	1,538,311	*18119*	509,650	*6003*	1,234,040	*14535*	1,131,648	*13329*	4413649	51986
H3: Other program costs	**100,000**	**1178**	**100,000**	**1178**	**100,000**	**1178**	**100,000**	**1178**	**400000**	**4711**
Community awareness meetings	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	200000	2356
Community health workers training	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	200000	2356
E: Evidence-based Treatment Protocols	**40,027,365**	**471465**	**13,261,255**	**156199**	**32,110,134**	**378211**	**29,445,864**	**346830**	**114844617**	**1352705**
E1: Ask about patient history - provider time	**5,317,334**	**62631**	**1,761,658**	**20750**	**4,265,589**	**50243**	**3,911,661**	**46074**	15256241	179697
E2: Assess via physical exam and diagnostic tests - provider time	**5,317,334**	**62631**	**1,761,658**	**20750**	**4,265,589**	**50243**	**3,911,661**	**46074**	15256241	179697
E3: Return visits - Counsel and treat per protocol - provider time	**29,392,698**	**346204**	**9,737,939**	**114699**	**23,578,955**	**277726**	**21,622,542**	**254682**	84332134	993311
A: Access to Essential Medicines and Technologies	**38,207,428**	**450029**	**12,770,811**	**150422**	**30,683,451**	**361407**	**28,151,518**	**331584**	**109813207**	**1293442**
A1: Hypertension medications	**38,039,175**	**448047**	**12,602,558**	**148440**	**30,515,199**	**359425**	**27,983,265**	**329603**	**109140197**	**1285515**
Amlodipine 5mg	*9,873,894*	*116300*	*3,271,268*	*38531*	*7,920,882*	*93297*	*7,263,664*	*85556*	*28329707*	*333683*
Losartan 50mg	*27,646,902*	*325641*	*9,159,549*	*107886*	*22,178,470*	*261231*	*20,338,259*	*239555*	*79323180*	*934313*
Hydrochlorothiazide 12.5mg	*518,379*	*6106*	*171,742*	*2023*	*415,846*	*4898*	*381,342*	*4492*	*1487310*	*17518*

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
A2: Diagnostic technologies, machines, and supplies	**168,253**	**1982**	**168,253**	**1982**	**168,253**	**1982**	**168,253**	**1982**	673010	7927
R: Risk-based Management	**172,334**	**2030**	**172,334**	**2030**	**172,334**	**2030**	**172,334**	**2030**	**689336**	**8119**
R1: Training costs	**172,334**	**2030**	**172,334**	**2030**	**172,334**	**2030**	**172,334**	**2030**	689336	8119
T: Team-based care Savings from training nurses and CHWs to do tasks customarily performed by doctors	**14,980,107**	**176444**	**4,962,980**	**58457**	**12,017,110**	**141544**	**11,020,015**	**129800**	**42980212**	**506245**
T1: Savings from training nurses	**13,141,197**	**154784**	**4,353,741**	**51281**	**10,541,928**	**124169**	**9,667,234**	**113866**	37704100	444100
Savings from counselling to change behavior	*1,355,873*	*15970*	*449,207*	*5291*	*1,087,688*	*12811*	*997,439*	*11748*	*3890208*	*45821*
Savings from screening for--and assess--CVD risk	*3,367,235*	*39661*	*1,115,581*	*13140*	*2,701,212*	*31816*	*2,477,084*	*29176*	*9661112*	*113794*
Savings from treating CVD risk	*8,418,089*	*99153*	*2,788,952*	*32850*	*6,753,029*	*79541*	*6,192,711*	*72941*	*24152780*	*284485*
T2: Savings from training CHWs	**1,838,909**	**21660**	**609,239**	**7176**	**1,475,181**	**17376**	**1,352,781**	**15934**	5276112	62145
Savings from counselling to change behavior	*1,838,909*	*21660*	*609,239*	*7176*	*1,475,181*	*17376*	*1,352,781*	*15934*	*5276112*	*62145*
S: Systems for monitoring	**3,114,636**	**36686**	**3,114,636**	**36686**	**3,114,636**	**36686**	**3,114,636**	**36686**	**12458546**	**146744**
S1: Human resources	**2,969,636**	**34978**	**2,969,636**	**34978**	**2,969,636**	**34978**	**2,969,636**	**34978**	**11878546**	**139912**
S2: Technology	**110,000**	**1296**	**110,000**	**1296**	**110,000**	**1296**	**110,000**	**1296**	**440000**	**5183**
S3: Supplies	**10,000**	**118**	**10,000**	**118**	**10,000**	**118**	**10,000**	**118**	**40000**	**471**
S4: Training	**25,000**	**294**	**25,000**	**294**	**25,000**	**294**	**25,000**	**294**	**100000**	**1178**
Total Program Cost (H+E+A+R+T+S)	**94,857,102**	**1117280**	**34,084,143**	**401462**	**76,880,879**	**905546**	**70,831,603**	**834295**	**276653727**	**3258583**

[Insert Figure 2 here]

Figure 2: Distribution of annual cost by HEARTS components

Most of the projected annual cost (94%) of implementing Module 'H' (Healthy-lifestyles counselling) was attributable to the cost of provider time and information materials for counselling patients (USD 433,000). The estimated cost for Module 'E' (Evidence-based treatment protocols) was attributable to provider time across three major activities: asking patient history (USD 180,000; 13%), patient assessment via physical exam and diagnostic tests (USD 180,000; 13%), and conducting return visits (USD 993,000, 74%). The projected cost to implement Module 'S' (Systems for monitoring) was USD 147,000, primarily attributed to administration staff labor costs (95%), with the remaining cost allocated to technology (software/hardware).

Table 4 highlights an important programmatic aspect by describing health providers' time needed to implement the hypertension control program. Implementing the program at the full population level in all four sub-districts was estimated to require the full time equivalent of 56 doctors, 56 nurses, and 6 community health workers. The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

Table 4: Hypertension control program: estimated health provider time for counselling, screening, diagnosis, and treatment

Activity	Golapganj		Fenchugonj		Beanibazar		Bishwanath		Total
	Workdays	**FTE**	Workdays	FTE	**Workdays**	**FTE**	Workdays	FTE	**FTE**
Counselling to change behavior									
Doctor	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Nurses	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
CHW	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Screening and diagnosis									
Doctor	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Nurses	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Return visits - Counsel and treat per protocol									
Doctor	3,256 days, 4 hours	12.5	1,079 days, 0 hours	4.2	2,612 days, 1 hours	10.0	2,395 days, 1 hours	9.2	**35.9**
Nurses	3,256 days, 4 hours	12.5	1,079 days, 0 hours	4.2	2,612 days, 1 hours	10.0	2,395 days, 1 hours	9.2	**35.9**

Note: FTE: Full-time equivalent (annual: total minutes/124800).

3.3. Risk-based integrated hypertension, diabetes, and high cholesterol management program cost

Table 5 reports the estimated costs of implementing the risk-based hypertension, diabetes, and high cholesterol management program in four upazilas at the population level (adults aged 18 and above). Figure 2 presents the distribution of costs by HEARTS components**.** The total annual cost was estimated at USD 15.7 million, equivalent to USD 14 per capita, USD 21 per adult, and USD 44 per eligible participant. Module 'A' (Access to medicines and technology) constitutes the largest cost share (USD 12.9 million; 82%), followed by Module 'E' (Evidence-based treatment protocols, USD 2 million; 13%). Within Module 'A', the projected costs of diagnostic tests, hypertension medications, diabetes medications, and cholesterol medications were USD 5.7 million (45% of module costs), USD 1.3 million (10%), USD 1 million (8%), and USD 4.9 million (38%), respectively. The projected medication expenditure per patient treated with medications for hypertension, diabetes, and cholesterol was USD 17, USD 34, and USD 48, respectively.

Table 5: Annual cost of implementing risk-based hypertension, diabetes, and high cholesterol management program in four sub-districts

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy Lifestyles Counselling	**13,335,339**	**121,116**	**4,765,107**	**56126**	**10,800,324**	**127212**	**9,947,252**	**117164**	**38848022**	**457574**
H1: Training costs	**418,990**	**4,287**	**418,990**	**4935**	**418,990**	**4935**	**418,990**	**4935**	1675960	19740
H1.1: Facility rental (% of H1)	18,000	212	18,000	212	18,000	212	18,000	212	72000	848
H1.2: Human resources	20,000	236	20,000	236	20,000	236	20,000	236	80000	942
H1.3: Instructive handbooks	35,000	353	35,000	412	35,000	412	35,000	412	140000	1649
H1.4: Per diem/transportation	339,990	3,416	339,990	4005	339,990	4005	339,990	4005	1359960	16018
H1.5: Refreshments	6,000	71	6,000	71	6,000	71	6,000	71	24000	283
H2: Brief counselling costs	**12,816,349**	**115,651**	**4,246,117**	**50013**	**10,281,334**	**121099**	**9,428,262**	**111051**	**36772062**	**433122**
H2.1: Tobacco	9,272,756	83,675	3,072,108	36185	7,438,647	87617	6,821,441	80347	26604952	313368
Provider time to administer 5A's	*3,807,374*	*30,030*	*1,261,401*	14857	*3,054,293*	35975	*2,800,870*	32990	10923938	128668
Informational materials (print)	*5,465,382*	*53,645*	*1,810,707*	21328	*4,384,354*	51641	*4,020,572*	47357	15681014	184700
H2.2: Alcohol	933,641	8,425	309,320	3643	748,971	8822	686,827	8090	2678759	31552
Provider time to administer 5A's	*383,351*	*3,024*	*127,006*	1496	*307,526*	3622	*282,010*	3322	1099893	12955
Informational materials (print)	*550,290*	*5,401*	*182,314*	2147	*441,445*	5200	*404,817*	4768	1578866	18597
H2.3: Physical inactivity	2,609,952	23,552	864,689	10185	2,093,715	24661	1,919,994	22615	7488350	88202
Provider time to administer 5A's	*1,071,641*	*8,452*	*355,040*	*4182*	*859,675*	*10126*	*788,345*	*9286*	*3074701*	*36216*
Informational materials (print)	*1,538,311*	*15,099*	*509,650*	*6003*	*1,234,040*	*14535*	*1,131,648*	*13329*	*4413649*	*51986*
H3: Other program costs	**100,000**	**1,178**	**100,000**	**1178**	**100,000**	**1178**	**100,000**	**1178**	**400000**	**4711**
Community awareness meetings	*50,000*	*589*	*50,000*	589	*50,000*	589	*50,000*	589	200000	2356
Community health workers training	*50,000*	*589*	*50,000*	589	*50,000*	589	*50,000*	589	200000	2356
E: Evidence-based Treatment Protocols	**60,223,213**	**601,090**	**19,952,235**	**235009**	**48,311,335**	**569038**	**44,302,805**	**521823**	**172789587**	**2035213**
E1: Ask about patient history - provider time	**5,317,334**	**68,718**	**1,761,658**	**20750**	**4,265,589**	**50243**	**3,911,661**	**46074**	**15256241**	**179697**
E2: Assess via physical exam and diagnostic tests - provider time	**25,513,182**	**266,949**	**8,452,638**	**99560**	**20,466,790**	**241069**	**18,768,602**	**221067**	**73201212**	**862205**
E3: Return visits - Counsel and treat per protocol - provider time	**29,392,698**	**265,423**	**9,737,939**	**114699**	**23,578,955**	**277726**	**21,622,542**	**254682**	**84332134**	**993311**
A: Access to Essential Medicines and tech.	**381,551,547**	**3,745,438**	**126,522,338**	**1490251**	**306,115,661**	**3605603**	**280,730,326**	**3306600**	**1094919872**	**12896583**
A1: Diagnostic tests	**170,039,655**	**1,669,019**	**56,334,940**	**663545**	**136,406,582**	**1606674**	**125,088,536**	**1473363**	**487869714**	**5746404**
Complete blood count (panel)	*51,527,168*	*505,763*	*17,071,194*	201074	*41,335,328*	486871	*37,905,617*	446474	147839307	1741335
Blood lipid panel	*103,054,336*	*1,011,527*	*34,142,388*	402148	*82,670,656*	973742	*75,811,234*	892947	295678614	3482669
Fasting blood glucose (FPG)	*15,458,150*	*151,729*	*5,121,358*	60322	*12,400,598*	146061	*11,371,685*	133942	44351792	522400

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
A2: Hypertension medications	**38,039,175**	**373,372**	**12,602,558**	**148440**	**30,515,199**	**359425**	**27,983,265**	**329603**	**109140197**	**1285515**
Amlodipine 5mg	*9,873,894*	*96,917*	*3,271,268*	38531	*7,920,882*	93297	*7,263,664*	85556	28329707	333683
Losartan 50mg	*27,646,902*	*271,367*	*9,159,549*	107886	*22,178,470*	261231	*20,338,259*	239555	79323180	934313
Hydrochlorothiazide 12.5mg	*518,379*	*5,088*	*171,742*	2023	*415,846*	4898	*381,342*	4492	1487310	17518
A3: Diabetes medications	**29,756,859**	**292,078**	**9,858,588**	**116120**	**23,871,087**	**281167**	**21,890,435**	**257838**	**85376969**	**1005618**
Metformin 500mg	*10,146,601*	*99,594*	*3,361,617*	39595	*8,139,649*	95873	*7,464,279*	87918	29112147	342899
Metformin 1000mg	*17,561,425*	*172,374*	*5,818,183*	68530	*14,087,855*	165935	*12,918,945*	152167	50386408	593479
Gliclazide	*2,048,833*	*20,110*	*678,788*	7995	*1,643,583*	19359	*1,507,210*	17753	5878414	69239
A4: Cholesterol medications	**143,547,605**	**1,408,987**	**47,557,999**	**560165**	**115,154,540**	**1356355**	**105,599,837**	**1243814**	**411859982**	**4851119**
Simvastatin 10mg	*60,757,359*	*596,362*	*20,129,200*	237093	*48,739,829*	574085	*44,695,745*	526452	174322132	2053264
Atorvastatin 20mg	*26,706,531*	*262,137*	*8,848,000*	104217	*21,424,100*	252345	*19,646,481*	231407	76625113	902534
Atorvastatin 40mg	*56,083,716*	*550,488*	*18,580,800*	218855	*44,990,611*	529925	*41,257,611*	485955	160912737	1895321
A5: Diagnostic tech. machines, and supplies	**168,253**	**1,982**	**168,253**	**1982**	**168,253**	**1982**	**168,253**	**1982**	**673010**	**7927**
R: Risk-based Management	**5,489,668**	**73,005**	**1,933,992**	**22780**	**4,437,923**	**52272**	**4,083,995**	**48104**	**15945577**	**187816**
R1: Training costs	**172,334**	**4,287**	**172,334**	**2030**	**172,334**	**2030**	**172,334**	**2030**	**689336**	**8119**
R2: Estimate risk using risk charts	**5,317,334**	**68,718**	**1,761,658**	**20750**	**4,265,589**	**50243**	**3,911,661**	**46074**	**15256241**	**179697**
T: Team-based care: Savings from training nurses and CHWs to do tasks customarily performed by doctors	**26,765,431**	**315258**	**8,867,514**	**104447**	**21,471,350**	**252902**	**19,689,810**	**231918**	**76794104**	**904524**
T1: Savings from training nurses	**24,926,521**	**293599**	**8,258,274**	**97271**	**19,996,168**	**235526**	**18,337,029**	**215984**	**71517993**	**842379**
Savings from counselling to change behavior	1,355,873	**15970**	449,207	**5291**	1,087,688	**12811**	997,439	**11748**	3890208	45821
Savings from screening for--and assess--CVD risk	15,152,559	**178475**	5,020,114	**59130**	12,155,452	**143174**	11,146,879	**131294**	43475005	512073
Savings from treating CVD risk	8,418,089	**99153**	2,788,952	**32850**	6,753,029	**79541**	6,192,711	**72941**	24152780	284485
T2: Savings from training CHWs	**1,838,909**	**21660**	**609,239**	**7176**	**1,475,181**	**17376**	**1,352,781**	**15934**	**5276112**	**62145**
Savings from counselling to change behavior	**1,838,909**	**21660**	**609,239**	**7176**	**1,475,181**	**17376**	**1,352,781**	**15934**	5276112	62145
S: Systems for monitoring	**3,114,636**	**36686**	**3,114,636**	**36686**	**3,114,636**	**36686**	**3,114,636**	**36686**	**12458546**	**146744**
S1: Human resources	**2,969,636**	**34978**	**2,969,636**	**34978**	**2,969,636**	**34978**	**2,969,636**	**34978**	11878546	139912
S2: Technology	**110,000**	**1296**	**110,000**	**1296**	**110,000**	**1296**	**110,000**	**1296**	440000	5183
S3: Supplies	**10,000**	**118**	**10,000**	**118**	**10,000**	**118**	**10,000**	**118**	40000	471
S4: Training	**25,000**	**294**	**25,000**	**294**	**25,000**	**294**	**25,000**	**294**	100000	1178
Total Program Cost (H+E+A+R+T+S)	**463,714,403**	**5461889**	**156,288,308**	**1840852**	**372,779,879**	**4390811**	**342,179,014**	**4030377**	**1334961604**	**15723929**

The adoption of task-sharing approach would save USD 905,000, of which USD 842,000 comes from using nurses to complete tasks customarily performed by doctors (i.e., counselling, screening, and assessing CVD risk, and treating according to CVD risk) and USD 62,000 comes from using CHWs to provide counselling to change behavior. Implementing the risk-based hypertension, diabetes, and high cholesterol management program at the full population level in all four sub-districts was estimated to require the full time equivalent of 63 doctors, 63 nurses, 6 CHWs, and 101 lab technicians (Table 6). The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

Table 6: Integrated risk-based approach: estimated health provider time for counselling, screening, diagnosis, and treatment

Activity	Golapganj		Fenchugonj		Beanibazar		Bishwanath		Total
	Workdays	**FTE**	Workdays	FTE	**Workdays**	**FTE**	Workdays	FTE	**FTE**
Counselling to change behavior									
Doctor	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Nurses	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
CHW	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Screening and diagnosis									
Doctor	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Nurses	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Screening and diagnosis by Lab technicians	9,119 days, 3 hours	35.1	3,021 days, 6 hours	11.6	7,315 days, 0 hours	28.1	6,708 days, 1 hours	25.8	**100.6**
Estimating CVD risk using risk charts									
Doctor	2,658,667	2.5	880,829	0.8	2,132,795	2.0	1,955,830	1.8	**7.2**
Nurses	2,658,667	2.5	880,829	0.8	2,132,795	2.0	1,955,830	1.8	**7.2**
Return visits - Counsel and treat per protocol									
Doctor	3,256 days, 4 hours	12.5	1,079 days, 0 hours	4.2	2,612 days, 1 hours	10.0	2,395 days, 1 hours	9.2	**35.9**
Nurses	3,256 days, 4 hours	12.5	1,079 days, 0 hours	4.2	2,612 days, 1 hours	10.0	2,395 days, 1 hours	9.2	**35.9**

4. Discussion

The HEARTS pilot project in four Bangladesh sub-districts launched a framework for hypertension management in primary care, with a potential for expanding into a comprehensive CVD prevention approach that incorporates hypertension, diabetes, and cholesterol management. This study projects the expected cost of scaling up the program to all eligible adults in the participating sub-districts. We assessed two program scenarios: a hypertension management program and an integrated risk-based hypertension, diabetes, and cholesterol management program. The total annual cost was estimated at USD 3.3 and 15.7 million USD for the hypertension and risk-based comprehensive approach, respectively. The overall per capita cost was approximately USD 2.9 per capita for the hypertension control program and USD 14 per capita for the risk-based comprehensive approach. These estimates correspond to 0.15% and 0.7% of the 2020 gross domestic product per capita in Bangladesh, respectively. The main cost drivers for the hypertension control program were medication expenditures (40%) and the cost of provider time for providing care during multiple visits (42%). In the risk-based integrated approach, the combined costs of hypertension, diabetes, and cholesterol medications make up the largest share of the overall program cost (82%). Although the main driver of projected program costs for the integrated approach was expenditure on essential medicines and diagnostic tests, hypertension and diabetes medications contributed a relatively small portion (18%) to this expenditure, whereas cholesterol medications contributed nearly 40%. Hypertension treatment remains among the leading cost-effective ways to combat heart disease. In this study, the annual medication expenditure per patient treated with medications for hypertension, diabetes, and cholesterol was USD 17, USD 34, and USD 48, respectively.

Though based on observations gathered in one district of Bangladesh, our results are consistent with those reported by past studies. A previous study on Bangladesh by Koehlmoos et al. (2016) estimated that hypertension treatment would cost about USD 13 (BDT 1,070) per patient per year.[25] WHO (2011) has estimated the average hypertension screening cost for LMICs at approximately USD 4 for LMICs, not including treatment but including the cost of performing CVD risk assessment and BP measurement in primary care settings.[26] Haque (2016) estimated the average cost of diabetes screening in Bangladesh at approximately USD 5 (BDT 411), including glucose screening in primary care, documentation, setting up referrals, and organizing screening events but excluding treatment.[27] In this study, the cost elements in the Bangladesh HEARTS program are wide-ranging including screening, diagnosis, and treatment for multiple CVD risk conditions (hypertension, diabetes, hyperlipidemia) and counseling for CVD risk factors (tobacco use, alcohol use, and physical inactivity).

The analysis revealed that scaling up the hypertension management program within the four sub-districts would require an additional full-time equivalent of 56 doctors, 56 nurses, and 6 CHWs. Population-level scale-up of the risk-based hypertension, diabetes, and high cholesterol management program in the four sub-districts was estimated to require the full time equivalent of 63 doctors, 63 nurses, 6 CHWs, and 101 lab technicians. To put this in context, a typical 50-bed sub-district public health complex in Bangladesh employs 20 doctors, 16 nurses, and one medical assistant. Oftentimes, not all health provider posts are filled. This gap in provider capacity poses a significant barrier to program

expansion. Team-based care using task-sharing among doctors, nurses and community health workers and volunteers can accomplish the activities required by the HEARTS package more affordably, including NCD-related health promotion, prevention, screening, and patient navigation through the health system. A systematic review of intervention trials in low- and middle-income countries by Joshi et al. (2014) found that team-based care, including task sharing was effective in improving process outcomes (e.g., hypertension and diabetes screening) and health outcomes (e.g., hypertension and diabetes control), and achieving treatment concordance with doctors.[28, 17] Krishnan et al. (2019) conducted a study on a community-based hypertension management program of blood pressure monitoring and lifestyle counselling intervention undertaken by female community health volunteers (FCHVs) in Nepal, and assessed the intervention to be highly cost-effective.[29]

In Bangladesh, there are six tiers of public healthcare infrastructure: national, divisional, district, upazila (sub-district), union, and ward levels. The government of Bangladesh has plans to expand 'NCD corners' at the upazila level, and the upazila primary care setting is well-positioned to bridge the link the health care providers down to the union, ward (and community) levels by harnessing community support and delegating suitable activities under task-sharing principles.[17, 30, 31] This will enhance healthcare access among disadvantaged populations and mitigate health disparities. Further, in Bangladesh, according to the 2016 Household Income Expenditure Survey and 2014 Health and Morbidity Status Survey, one in three patients received treatment from a pharmacy or medical shop, while about one in five received treatment from public health providers.[32, 33] This emphasizes the need for partnerships with various types of public-private health providers.

The models of care introduced in the Bangladesh national hypertension guidelines and NCD operational plan are encouraging; however, there are capacity challenges to the scaling-up of NCD care in Bangladesh.[34, 35] The fiscal year 2021 budget allocation to the health sector stands just above 5%, which is less than 1% of GDP. Further, less than 5% of public sector funding for health covers NCDs, despite NCDs being responsible for almost two-thirds (63% in 2016) of disability-adjusted life years (DALYs) in Bangladesh.[17] The per capita NCD allocation is only USD 0.08.[17] There is a need for better coordination of non-state stakeholders in NCD control with the public sector with a stronger focus of the public sector on NCD prevention and health promotion.[17] The health sector in Bangladesh is financed 93% from domestic sources (74% out-of-pocket, 17% government health expenditure, and 3% other private sources) and 7% from external health expenditures. Domestic general government health expenditure per capita is only USD 7 (0.4% of GDP per capita).[36] Due to insufficient public sector funding, out-of-pocket expenditure for NCD care is large in Bangladesh, contributing to the impoverishment of patients and their families. Moreover, a recent policy review by Biswas et al (2017) highlights the lack of proper planning, implementation, and monitoring of NCD health initiatives.[37] However, the Bangladesh Copenhagen Project assessed the benefits of managing hypertension through targeted investment and reported a high level of return on investment (BDT 37 benefit for every BDT spent).[25]

This report has several limitations. Due to lack of data at a local level, the cost projections rely on assumptions regarding population coverage, risk factor prevalence, primary care attendance rate, and frequency of patient visits by CDV risk, which were assumed to be uniform for the four sub-districts and across age or sex groups. Similarly, unit costs of supplies, wages, and provider time allocations were assumed to be the same across sub-districts. Since the examined sub-districts are adjacent to each other, these unit costs may not be considerably different. While we used average medicine prices, they may vary in different sub-districts depending on the procurement arrangement and sources. However, in Bangladesh, the price variations are minimal or low in the public health facilities, given the medicines are procured mainly from EDCL and/or CMSD (WHO 2014[19]; Kasonde L et al. 2019[20]). The strength of the study lies in its ability to disaggregate costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging program delivery from the upazila level to more localized community facilities.

In 2018, the Government of Bangladesh introduced a multisectoral action plan for NCD prevention and control, which emphasizes NCD risk factors including tobacco use, unhealthy diet, physical inactivity, and harmful use of alcohol.[35] This study can inform approaches to scaling up this action plan nationally, with the goal of increasing population outreach for CVD prevention at the primary care level. Using the costs reported in this study for future cost-effectiveness analyses can further support evidence-based decision making for CVD prevention programs in Bangladesh.

Disclaimer

The findings and conclusions of this report are those of authors only and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Author Contribution

MJH and MSH conceptualized the study, led the formal analysis, implemented the methodology and the excel-based costing tool, and wrote the draft manuscript. DK, SRC, MRB, AEM contributed to the study concept, analytical aspects, manuscript write-up and critical review. RT and SJ contributed to data collection and critical review of the manuscript. MJH, MSH, SRC, RT, SJ, and MRB contributed to data collection. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

Ethics Approval

Ethics approval was not required because this research neither involved human or animal participation nor required consent from human participants.

Conflict of Interest

The authors declare non conflict of interest

Data Statement

Data used in this study is included in table 1 of this article.

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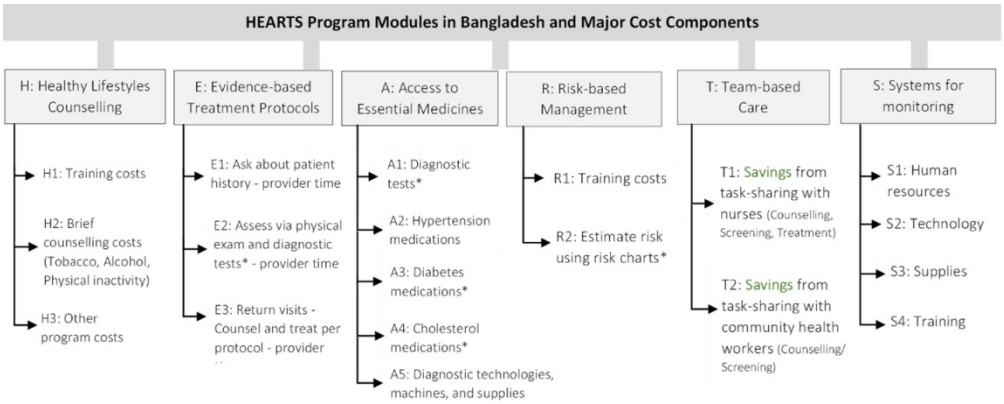

Figure 1: Cost components of HEARTS program in Bangladesh

Note: * These cost components are included in the risk-based integrated hypertension, diabetes, and cholesterol program.

165x67mm (220 x 220 DPI)

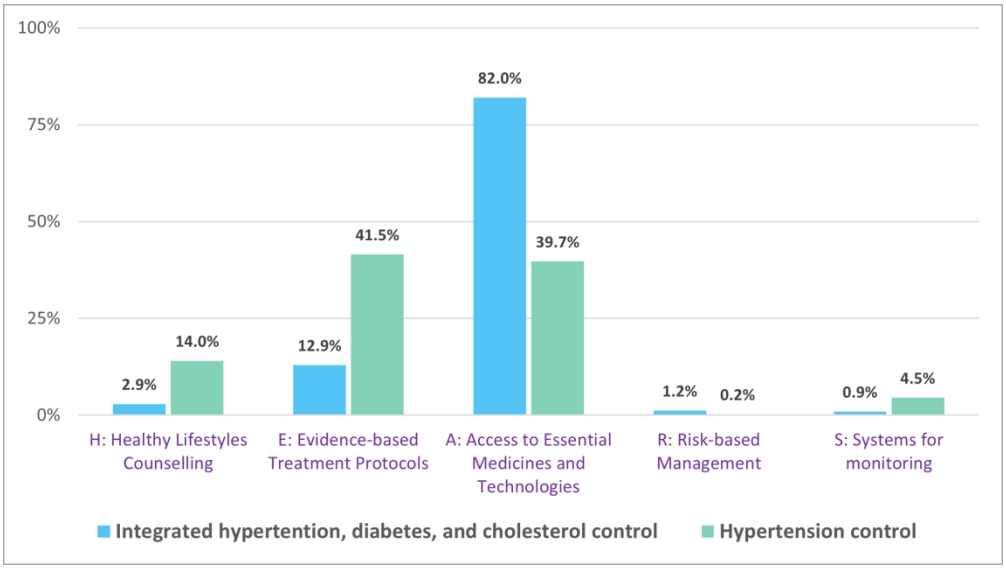

Figure 2: Distribution of annual cost by HEARTS components

419x235mm (130 x 130 DPI)

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Cost of primary care approaches for hypertension management and risk-based cardiovascular disease prevention in Bangladesh

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Abstract

Objective: To estimate the costs of scaling up the HEARTS pilot project for hypertension management and risk-based cardiovascular disease prevention at the full population level in the four sub-districts (upazilas) in Bangladesh.

Settings: Two intervention scenarios in sub-district health complexes: hypertension management only, and risk-based integrated hypertension, diabetes, and cholesterol management.

Design: Data obtained during July-August 2020 from sub-district health complexes on the cost of medications, diagnostic materials, staff salaries, and other program components.

Methods: Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual costs of implementing the HEARTS program from the health system perspective.

Primary and secondary outcome measures: Program cost, provider time.

Results: The total annual cost for the hypertension control program was estimated at USD 3.2 million, equivalent to USD 2.8 per capita or, USD 8.9 per eligible patient. The largest cost share (USD 1.35 million; 43%) was attributed to the cost of medications, followed by the cost of provider time to administer treatment (38%). The total annual cost of the risk-based integrated management program was projected at USD 14.4 million, entailing USD 12.9 per capita or USD 40.2 per eligible patient. The estimated annual costs per patient treated with medications for hypertension, diabetes, and cholesterol were USD 18, USD 29, and USD 37, respectively.

Conclusion: Expanding the HEARTS hypertension management and CVD prevention program to provide services to the entire eligible population in the catchment area may face constraints in physician capacity. A task-sharing model involving shifting of select tasks from doctors to nurses and local community health workers would be essential for the eventual scale-up of primary care services to prevent CVD in Bangladesh.

Key Words: Program cost; HEARTS hypertension management and CVD prevention program; scale-up of primary care services; Bangladesh.

Word Count: 4429

Strengths and limitations of this study

- The study assesses the costs of scaling up two program scenarios at the full population level in the four sub-districts in Bangladesh: a hypertension management program and an integrated risk-based hypertension, diabetes, and cholesterol management program.
- Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual costs of implementing the HEARTS program from the health system perspective.
- The study disaggregates costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging program delivery from the upazila level to more localized community facilities.
- Due to lack of data at a local level, the cost projections rely on assumptions regarding population coverage, risk factor prevalence, primary care attendance rate, distribution of CVD risk among patients, distribution of patients by treatment protocols, and frequency of patient visits by CVD risk.

1. BACKGROUND

Hypertension is a major and preventable risk factor for cardiovascular disease (CVD). An estimated 1.13 billion people (1 in 4 men and 1 in 5 women) worldwide have hypertension. [1] Among people with hypertension worldwide, fewer than 1 in 5 have it under control.[1] High blood pressure is a leading global risk factor for premature death and disability, accounting for about 10 million (or 1 in 6) deaths worldwide each year.[2, 3] Uncontrolled hypertension significantly increases the risk of stroke, myocardial infarction, heart failure, dementia, renal failure, retinopathy, and other diseases.[4-7] Almost half of all CVD events are attributable to uncontrolled hypertension.[2, 3]

Reducing the prevalence of hypertension is a standing global health objective.[8-11] This objective complements the 2030 Sustainable Development Goal (SDG) of reducing premature deaths from noncommunicable diseases (NCDs) by 25%.[12] Low- and middle-income countries (LMICs), where two-thirds of all hypertension cases reside, are increasingly cognizant of the long-term benefits of addressing hypertension in their populations. However, implementing population-level measures targeting hypertension may present challenges for many LMICs where health systems have traditionally focused on infectious diseases and where the capacity for NCD care may be limited.

Bangladesh is among lower-middle-income countries with a high burden of hypertension. In 2018, the prevalence of elevated blood pressure (SBP and/or DBP ≥ 140/90 mmHg) among adults in Bangladesh was 21%.[13-15]. According to the 2011 Bangladesh National Demographic and Health Survey, of 14.4 million hypertensive people, only 7.3 million (51%) were aware of their condition, 41% were treated, and 18% had their blood pressure levels under control.[16] The burden of hypertension in Bangladesh is expected to grow alongside increased population aging, rapid urbanization with commensurate increases in sedentary lifestyle and processed food consumption, and other socio-economic and lifestyle changes. However, only less than 5 percent of the health sector program budget is allocated for NCDs control.[17] This demonstrates the need for an effective, low-cost and efficient population-level approach in addressing hypertension.

In 2016, WHO introduced the HEARTS technical package as a framework for CVD prevention at the primary care level.[18] The HEARTS technical package consists of guidelines for implementing a primary-care approach to CVD management, focusing on screening and management of CVD risk factors, including lifestyle modification and pharmacological treatment of metabolic risk factors such as hypertension, diabetes, and hyperlipidemia. In this paper, we describe the local budgetary impact of implementing the HEARTS program at the population level for four sub-districts in Bangladesh, based on program cost data obtained from a representative health care facility in each sub-district. Although the

initial focus of the program in the four sub-districts is presently limited to hypertension control, scaling-up of the initiative may include screening, diagnosis, and treatment of diabetes and high cholesterol. Understanding the cost drivers of CVD prevention approaches in the Bangladesh primary care system can support budgeting, procurement, evaluation, and planning for scale-up.

2. METHODS

2.1. Setting

In 2018, the Directorate General of Health Services and the National Heart Foundation of Bangladesh collaborated with Resolve to Save Lives (RTSL, an initiative of Vital Strategies, a non-profit global public health organization) to implement a pilot program to strengthen the detection, treatment, and follow-up management of hypertension in primary care. The program was introduced in four health complexes in four sub-districts (upazilas) in the Sylhet district: Golapganj, Fenchuganj, Beanibazar, and Bishwanath. In Bangladesh, hospitals and health facilities that are in the sub-district (upazila) level or below are termed as primary health complexes. A typical upazila health complex is a 50-bed hospital with service coverage in the range of 100,000 to 400,000 population and plays a pivotal role in the provision of primary health care through a three-tier system consisting of the ward level, union level, and upazila level. The upazila health complex, performs a wide range of functions that includes prevention, promotion, treatment (in-patient, out-patient, limited diagnostic services), management, technical support, training, coordination, and patient referral services. The outpatient service is usually staffed with five outpatient general practitioners including 1 resident medical officer, 2 medical officers, and 2 medical assistants. An 'NCD corner' was set-up in the outpatient with necessary logistics and personnel for screening and treatment. We project program costs under two intervention scenarios: a hypertension-focused program, and a risk-based integrated hypertension, diabetes, and cholesterol management program.

2.2. Patient and Public Involvement

Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

2.3. Hypertension management program

The HEARTS Technical Package for CVD prevention in primary care is organized around six modules: H–Healthy-lifestyle counselling, E—Evidence-based treatment protocols, A—Access to essential medicines and technology, R—Risk-based CVD management, T—Team-based Care, and S—Systems for monitoring.[19] Components of these modules are described in Figure 1. In the four upazila primary care

complexes in Bangladesh, programmed activities included: training of staff in following a standard treatment protocol, record keeping and reporting; ensuring adequate supply of necessary drugs; community outreach to increase awareness of the need for hypertension screening; introduction of patient monitoring tools and a monthly reporting system; and establishing a mechanism for patient referral from primary care to secondary care and tertiary care at MAG Osmani Medical College. The clinical management protocol for adults with hypertension (defined as SBP/DBP <= 140/90 mmHg, or SBP/DBP <= 130/80 mmHg with co-morbidity or high CVD-risk) entailed a first line of treatment with amlodipine 5mg daily; a second line of treatment using amlodipine 5mg plus losartan 50mg daily; and a third line of treatment using amlodipine 5mg plus losartan 50mg plus hydrochlorothiazide 12.5mg daily. Appendix 1 depicts the hypertension treatment protocol. The prescribed medicines are typically obtained by public health facilities, generic, domestically manufactured, and provided free of charge to patients. The national drug policy recommends that 70% of the public sector medicines be purchased from the state-owned Essential Drug Company Limited (EDCL), 25% from the Central Medical Stores Depot (CMSD), and 5% from local sources.[20, 21] In order to provide continuous care more sustainably and to reduce burden on physicians, a team-based care strategy was implemented. The healthcare providers were trained to acquire the necessary skills to provide brief interventions to record patients' medical history, measuring blood pressure (BP), point-of-care testing to assess fasting blood glucose and cholesterol levels and urine dipstick for proteinuria, encourage behavior change, assess CVD risk, or initiate treatment protocol. The training sessions were conducted in one set-up with a pool of selected doctors, nurses, and community health workers trained with relevant modules. In this approach, community health workers (CHW) were trained to provide counselling and some screening services along with the doctors and nurses. For the costing estimate, equal burden sharing in terms of provider time was assumed.

2.4. Risk-based integrated hypertension, diabetes, and hyperlipidemia management program

To further strengthen CVD prevention, the HEARTS program in Bangladesh also planned to integrate diabetes and hyperlipidemia management in addition to hypertension management in primary care patients. The program entails assessment of target population by total CVD risk estimation to categorize their risk for CVD. The risk-stratification is based on WHO and International Society of Hypertension cardiovascular risk prediction charts and expressed as the probability of developing CVD over 10 years: low CVD risk (0 to <10%); medium CVD risk (10 to 20%); and high CVD risk (>=20%).[22] The treatment protocol for patients with uncomplicated type 2 diabetes (defined as fasting plasma glucose (FPG) ≥ 7.0 mmol/l or routine plasma glucose (RPG) ≥ 11.1 mmol/l or HbA1C ≥ 6.5%) managed at the primary care level included Metformin (500 mg), Metformin (1000 mg), then Metformin (1000 mg) and Gliclazide (80 mg) as the first, second, and third lines of treatments, respectively. The protocol is based on the WHO guidance on diagnosis, classification, and management of diabetes (HEARTS - D), which is

aligned with the WHO Package of Essential Noncommunicable Disease Interventions in Primary Health Care (WHO-PEN).[23] For managing plasma lipid levels (i.e., high cholesterol), the use of statins as the primary therapy is widely recommended, however, the WHO is yet to offer any specific guidance.[24] For costing, the local consultants and experts proposed a statin based treatment protocol for hyperlipidemia including simvastatin (10 mg) as first, atorvastatin (20 mg) as second, and atorvastatin (40 mg) as the third line of treatment. Costs associated with implementing integrated hypertension, diabetes, and hyperlipidemia treatment protocols include provider time spent on estimating CVD risk using risk charts during an annual primary care visit; training in CVD risk estimation, in addition to time spent collecting patient history; medication costs; and diagnostic test costs including provider (technician) time, complete blood count panel, fasting blood glucose, and blood lipid panel tests.

2.5. HEARTS Costing Tool

Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual cost of implementing the HEARTS program from the health system perspective. The tool is organized by HEARTS modules.[25] In July-August 2020, we obtained unit costs from four upazila complexes and used these to project annual resource needs for implementing the CVD prevention program at the sub-district population level. The researchers completed in-person collection of data from the four facilities on human resource and time costs, diagnostic prices, time-motion on laboratory diagnostics, market price of medicines, and others.

Figure 1 shows major cost categories within HEARTS modules. Once program costs and other inputs such as population coverage, risk factor prevalence, and planned provider numbers were entered into the costing tool, the cost calculations were allocated across different HEARTS modules.

Figure 1: Cost components of the HEARTS program in Bangladesh

The cost elements in the Healthy-lifestyle counselling module ‘H’ included costs of training providers in lifestyle counseling and costs of community awareness programs and training. Counselling is based on the ‘5 As’ (Assess, Advise, Agree, Assist, Arrange) model, which is an evidence-based approach for promoting healthy behavioral changes to prevent NCD risk factors.[26, 27] Total provider time to administer brief counseling was equal to the average time that the health provider spends to counsel a patient to change behavior multiplied by the total number of patients who would receive counselling. The cost of total provider time was calculated as the total provider time, multiplied by the weighted average salary of the health providers who have been trained to provide counselling.

The cost elements in Module 'E' included provider time devoted to assessing patient history, conducting physical exams and diagnostic tests, and return visits. The costs of diagnostic tests (complete blood count panel, blood lipid panel, fasting blood glucose), medications (hypertension, diabetes, and cholesterol), and on-site diagnostic technologies and supplies were assessed under Module 'A'. Module 'R' reports the costs of training providers in conducting risk-based management and the cost of provider time for estimating patient CVD risk using risk charts. Module "T' reports cost savings from task-sharing by comparing the cost that could have been incurred if the tasks were performed solely by the physicians with costs incurred through task-sharing among physicians, nurses, and CHW. Therefore, in the baseline scenario (i.e., in the absence of task-sharing allocation), the costing tool assumes a physician-led program. In our cost projections, we assumed that doctors, nurses, and CHWs will equally share the tasks (i.e., provider time) when applicable. For instance, CHWs would only provide behavioral counselling and screening service, but they would not assess CVD risk (using risk-cart), or prescribe patients with pharmacologic treatments. Accordingly, the provider time allocated for behavior counselling and screening will be shared equally among doctors, nurses, and CHWs. Nurses will be trained to do major tasks (i.e., counselling, screening, and assessing CVD risk, and treating according to CVD risk), therefore providers' time for performing HTN/CVD risk-assessment, prescribing suitable treatment, and return-visits were allocated equally between doctors and nurses. While the 'T' module reports the cost savings from team-based care, The accrued cost of provider time (inclusive of doctors, nurses, and CHWs) spent on various tasks is included in the corresponding 'H', 'E', and 'R' modules. Module 'S' reports costs related to human resources, technology (software and hardware), supplies, and training for patient monitoring.

2.6. Data

Data on salaries of government healthcare providers and program staff were collected from in-person interviews and/or records. Total salary was calculated according to the Government of Bangladesh National pay scale. Size of the population in the examined sub-districts was obtained from census and imputed based on Bangladesh Bureau of Statistics (BBS) estimates. Other population parameters (e.g., primary care attendance rate and risk factor prevalence) were obtained from the nationally representative NCD Risk Factor Survey 2018.[15] Medicine prices were collected from the medicine outlets in the public hospitals. The unit prices represent the average price of domestically manufactured generic medicines procured by health facilities from EDCL or CMSD. Prices of laboratory diagnostics were collected from diagnostic labs at the district (Sylhet district) and sub-district (upazila) levels. Data on time needed to conduct laboratory tests were collected from in-person interviews of laboratory personnel. Training data, including number of training and participants, per-diem costs of staff, costs related to rent, transport, refreshments, and other logistics, were collected from the respective project records.

Table 1 presents the prevalence of CVD risk factors as well as cost inputs used to populate the HEARTS costing tool. The leading risk factors were tobacco use (43.7%), hyperlipidemia (28.4%) and hypertension (21%), followed by physical inactivity (12.3%), diabetes (8.3%) and alcohol consumption (4.4%).; The primary care attendance rate was assumed to be 47.9% in each upazila.[15] The distributions of patients by CVD risks and for the pharmacological treatment of hypertension, diabetes, and cholesterol by different treatment lines were adopted from the literature and/or based on local physician consensus. [28, 29, 30, 31] Local currency was converted to US dollars using the Bangladesh Bank official conversion rate in June 2020.

Table 1: Costing inputs and unit costs

Input Description	Units	Value
Eligible population (Adult population (18+)		
- Golapganj	Persons	261098
- Fenchuganj	Persons	86503
- Beanibazar	Persons	209454
- Bishwanath	Persons	192075
Primary healthcare attendance rate (annual)	Percent	47.9%
Adult population with risk factors		
- Use of tobacco products	Percent	43.7%
- Hazardous or harmful use of alcohol	Percent	1.3%
- Physical inactivity	Percent	29.1%
- Hypertension (≥140/90mmHg)	Percent	21.0%
- Diabetes (≥7.0 mmol/L or 126 mg/dl)	Percent	8.3%
- Hyperlipidemia (≥ 6 mmol/L or 190 mg/dl)	Percent	28.4%
- Low CVD risk (0 to <10%)	Percent	85.1%
- Medium CVD risk (10 to <20%)	Percent	14.4%
- High CVD risk (≥20%)	Percent	0.5%
Annual wage (in LCU (BDT) and USD, including benefits)		
- Doctors	BDT (USD)/year	1,399,452 (16,484)
- Nurses	BDT (USD)/year	726,360 (8,555)
- CHWs	BDT (USD)/year	486,568 (5,731)
- Lab technicians	BDT (USD)/year	576,720 (6,793)
- Accountant	BDT (USD)/year	576,720 (6,793)
- Administrative Assistant	BDT (USD)/year	446,242 (5,256)
- Clerical Officer	BDT (USD)/year	446,242 (5,256)
- Custodian	BDT (USD)/year	446,242 (5,256)
- IT Personnel	BDT (USD)/year	446,242 (5,256)
- Program Director	BDT (USD)/year	1,399,452 (16,484)
- Program Manager	BDT (USD)/year	726,300 (8,555)
- Secretary	BDT (USD)/year	446,242 (5,256)
- Security officer	BDT (USD)/year	400,196 (4,714)
- Pharmacist/Chemist	BDT (USD)/year	576,720 (6,793)
- Statistician	BDT (USD)/year	576,720 (6,793)
- Supplies manager	BDT (USD)/year	486,568 (5,731)
Purchasing price (in LCU (BDT) and USD) of pharmaceutical drugs		
Hypertension Medicine		
- amlodipine 5mg	BDT (USD)/tablet	1 (0.012)
- losartan 50mg	BDT (USD)/tablet	8 (0.094)
- hydrochlorothiazide	BDT (USD)/tablet	0.35 (0.004)
Diabetes Medicine		
- metformin 500mg	BDT (USD)/tablet	4 (0.047)
- metforminn 1000mg	BDT (USD)/tablet	9 (0.106)
- gliclazide	BDT (USD)/tablet	3.5 (0.041)
Cholesteror Medicine		
- simvastatin 10mg	BDT (USD)/tablet	7 (0.082)
- atorvastatin 20mg	BDT (USD)/tablet	10 (0.118)
- atorvastatin 40mg	BDT (USD)/tablet	28 (0.330)
Purchasing price (in LCU) of diagnostic tests		
- Diabetes (Complete blood count - panel)	BDT (USD)/test	400 (4.71)
- Diabetes (Fasting blood glucose)	BDT (USD)/test	120 (1.41)

- Diabetes and Cholesterol (Blood lipid panel)	BDT (USD)/test	800 (9.42)
Counselling patients to change behavior		
- Time to counsel a patient to change behavior	Minutes	10
- # of 'How to quit' informational materials disseminated per person, annually (print)	Print	5
- Cost of 'How to quit' informational materials, per unit (print materials)	BDT (USD)/print	20 (0.24)
LCU to USD exchange rate	BDT/USD	84.9
"Safety stock" required to be on hand for medicines	Percent	3.0
Number of health providers in need of training		
- Counsel patients to change behavior	Persons	30
- Assess patients' total CVD risk	Persons	10
Training to counsel patients to change behavior (5A's)*		
- Classroom size	Persons	30
- Hours of training needed	Persons	16
Training to screen/diagnosis/treat patients Hypertension/CVD patients		
- Classroom size	Persons	30
- Hours of training needed	Persons	8
Number of Trainers		
- Professional trainer(s)	Persons	2
- Administrative staff	Persons	1
Input costs for training		
Hourly wage		
- Professional trainer	BDT (USD)/hour	500 (5.89)
- Administrative staff	BDT (USD)/hour	250 (2.94)
Per unit cost of materials		
- Instructive handbooks	BDT (USD)/book	1000 (11.8)
- Facility rental for training (one day)	BDT (USD)/day	9000 (106)
- Refreshments	BDT (USD)/day	6000 (70.7)
- Per diem for staff	BDT (USD)/day	3500 (41.2)
- Per diem and/or salary of trainees	BDT (USD)/day	5000 (58.9)
- Transportation stipend for staff	BDT (USD)/training	3165 (37.3)
CVD Risk Screening and Diagnosis		
Time (in minutes) a health provider spends to:		
- Screen patients for total CVD risk	Minutes	5
- Provide a physical exam to assess patients' total CVD risk	Minutes	5
- Assess patient risk using a CVD risk chart	Minutes	5
Time (in minutes) a lab technician spends to:		
- Administer and analyze a blood test	Minutes	10
- Administer and analyze a urine test	Minutes	10
Treatment for High CVD Risk		
# follow-up visits for a person annually with the following levels of CVD risk annually		
- Low CVD risk (≥0% to <10%)	Visits	2
- Medium CVD risk (≥10% to <20%)	Visits	3
- High CVD risk (≥20%)	Visits	4
Time health providers spend with a patient during a visit?		
- Generalists/primary care doctors	Minutes	5
- Nurses	Minutes	5
Screen for CVD risk: Diagnostics cost in LCU (BDT) and USD		
- Diabetes (compete blood count panel)	BDT (USD)/test	400 (4.7)
- Diabetes (Fasting blood glucose)	BDT (USD)/test	120 (1.4)
- Diabetes and Cholesterol (Blood lipid panel)	BDT (USD)/test	80 (0.9)
Pharmacological treatment for hypertension		
- Hypertension Protocol Step #1 (Amlodipine 5mg, 1 per day, 365 days)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	62%
- Hypertension Protocol Step #2 (Amlodipine 5mg + Losartan 50mg)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	34%
- Hypertension Protocol Step #3 (Amlodipine + Losartan+ Hydrochlorothiazide)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	4%
- Unit price of amlodipine 5mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	1 (0.012)
- Unit price of losartan 50 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	8 (0.094)
- Unit price of hydrochlorothiazide in LCU (Taka or BDT) and USD	BDT (USD)/tablet	0.35 (0.004)
Pharmacological treatment for diabetes		
- Diabetes Protocol Step #1 (metformin 500mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	75%
- Diabetes Protocol Step #2 (metformin 1000mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	15%
- Diabetes Protocol Step #3 (metformin 1000mg+gliclazide 8mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	10%
- Unit price of metformin 500mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	4 (0.047)

- Unit price of metformin 1000mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	9 (0.106)
- Unit price of gliclazide 80mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	3.5 (0.041)
Pharmacological treatment for high cholesterol (default regimens)		
- High Cholesterol Protocol Step #1 (low intensity, simvastatin 10mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	85%
- High Cholesterol Protocol Step #2 (moderate intensity, atorvastatin 20mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	10%
- High Cholesterol Protocol Step #3 (high intensity, atorvastatin 40mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	5%
- Unit price of simvastatin 10mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	7 (0.082)
- Unit price of simvastatin 20mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	10 (0.118)
- Unit price of atorvastatin 40mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	28 (0.330)

Note: * The '5A' (Assess, Advise, Agree, Assist, Arrange) model is an evidence-based approach entailing health behavior change counselling to prevent NCD risk factors in primary care setting (Glasgow et al., 2006; Whitlock et al., 2002). LCU: Local currency unit; BDT: Bangladesh Taka.

3. RESULTS

3.1. Population coverage

The total population in the four sub-districts was 1.12 million, of which 749,000 were adults aged 18 and above (Table 2). The total number of people eligible to receive counselling, screening, diagnosis, and treatment under the two types of HEARTS intervention packages (i.e., hypertension control and risk-based integrated approach) in the four sub-districts was determined by the primary care attendance rate, the prevalence of low-, medium-, and high- CVD risk in the population, the prevalence of hypertension, diabetes, and high cholesterol. The estimated number of eligible persons in the catchment area of the four sub-districts was 359,000, of which 305,000, 52,000, and 1,800 were projected to be low-, medium, and high- CVD risk patients. The estimated number of persons undergoing treatment for hypertension, diabetes, and high cholesterol was 75,000, 30,000, and 102,000, respectively (Table 2). Unit costs and other cost inputs were applied to these population parameters to project total program costs.

Table 2: Population coverage: Care cascade for counselling, screening, diagnosis, and treatment

	Golapganj	**Fenchuganj**	**Beanibazar**	**Bishwanath**	**Total**
Total population	390688	129436	313412	287404	1120940
Adult population in need (18+ years)	261,098	86,503	209454	192075	749130
Adults who present at the health center	125,066	41,435	100,328	92,004	358833
Providing brief counseling					
Eligible to receive brief advice	125,066	41,435	100,328	92,004	358833
Tobacco user	*54,654*	*18,107*	*43,844*	*40,206*	156810
Harmful alcohol	*5,503*	*1,823*	*4,414*	*4,048*	15789
Physical inactivity	*15,383*	*5,096*	*12,340*	*11,316*	44136
Screening and diagnosis of 10-year CVD risk					
Low CVD risk	106,431	35,261	85,380	78,295	305367

Medium CVD risk		18,009	5,967	14,447	13,249	51672
High CVD risk		625	207	502	460	1794
Treatment of 10-year CVD risk						
Low CVD risk		106,431	35,261	85,380	78,295	305,367
	Hypertension	22,351	7,405	17,930	16,442	64127
	Diabetes	8,834	2,927	7,087	6,499	25345
	Cholesterol	30,226	10,014	24,248	22,236	86724
Medium CVD risk		18,009	5,967	14,447	13,249	51672
	Hypertension	3,782	1,253	3,034	2,782	10851
	Diabetes	1,495	495	1,199	1,100	4289
	Cholesterol	5,115	1,695	4,103	3,763	14675
High CVD risk		625	207	502	460	1794
	Hypertension	131	44	105	97	377
	Diabetes	52	17	42	38	149
	Cholesterol	178	59	142	131	510

Note: Risk factors and disease prevalence rates were assumed uniform across sub-districts.

3.2. Hypertension management program cost

Table 3 reports the estimated annual costs, in 2020 USD and Bangladesh Taka (BDT), of implementing the HEARTS hypertension management program in four upazilas at the population level (adults aged 18 and above). Figure 2 presents the distribution of costs by HEARTS components and sub-components**.** The total annual cost was estimated at USD 3.2 million, equivalent to USD 2.8 per capita, USD 4.3 per adult, and USD 8.9 per eligible participant. Module 'A' (Access to medicines and technology) constitutes the largest cost share (USD 1.36 million; 43%), followed by Module 'E' (Evidence-based treatment protocols; USD 1.22 million; 38%). The projected medication expenditure per patient treated with medications for hypertension was USD 18.

Table 3: Total annual cost of HEARTS hypertension control program in four sub-districts

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy Lifestyles	**13,335,339**	**157,071**	**4,765,107**	**56,126**	**10,800,324**	**127,212**	**9,947,252**	**117,164**	**38,848,022**	**457,574**
H1: Training costs	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	**1,675,960**	**19,740**
H1.1: Facility rental (% of H1)	18,000	212	18,000	212	18,000	212	18,000	212	72,000	848
H1.2: Human resources	20,000	236	20,000	236	20,000	236	20,000	236	80,000	942
H1.3: Instructive handbooks	35,000	412	35,000	412	35,000	412	35,000	412	140,000	1,649
H1.4: Per diem/transportation	339,990	4005	339,990	4,005	339,990	4,005	339,990	4,005	1,359,960	16,018
H1.5: Refreshments	6,000	71	6,000	71	6,000	71	6,000	71	24,000	283
H2: Brief counselling costs	**12,816,349**	**150,958**	**4,246,117**	**50,013**	**10,281,334**	**121,099**	**9,428,262**	**111,051**	**36,772,062**	**433,122**
H2.1: Tobacco	9,272,756	109,220	3,072,108	36,185	7,438,647	87,617	6,821,441	80,347	26,604,952	313,368
Provider time to administer 5A's	*3,807,374*	*44,845*	*1,261,401*	*14,857*	*3,054,293*	*35,975*	*2,800,870*	*32,990*	10,923,938	128,668
Informational materials (print)	*5,465,382*	*64,374*	*1,810,707*	*21,328*	*4,384,354*	*51,641*	*4,020,572*	*47,357*	15,681,014	184,700
H2.2: Alcohol	933,641	10,997	309,320	3,643	748,971	8,822	686,827	8,090	2,678,759	31,552
Provider time to administer 5A's	*383,351*	*4,515*	*127,006*	*1,496*	*307,526*	*3,622*	*282,010*	*3,322*	1,099,893	12,955
Informational materials (print)	*550,290*	*6,482*	*182,314*	*2,147*	*441,445*	*5,200*	*404,817*	*4,768*	1,578,866	18,597
H2.3: Physical inactivity	2,609,952	30,741	864,689	10,185	2,093,715	24,661	1,919,994	22,615	7,488,350	88,202
Provider time to administer 5A's	1,071,641	*12,622*	355,040	*4,182*	859,675	*10,126*	788,345	*9,286*	3,074,701	36,216
Informational materials (print)	1,538,311	*18,119*	509,650	*6,003*	1,234,040	*14,535*	1,131,648	*13,329*	4,413,649	51,986
H3: Other program costs	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**400,000**	**4,711**
Community awareness meetings	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	200,000	2,356
Community health workers training	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	200,000	2,356
E: Evidence-based Treatment Protocols	**35,959,415**	**423,550**	**11,913,524**	**140,324**	**28,846,806**	**339,774**	**26,453,304**	**311,582**	**103,173,049**	**1,215,230**
E1: Ask about patient history - provider time	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
E2: Assess via physical exam and diagnostic tests - provider time	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
E3: Return visits - Counsel and treat per protocol - provider time	25,324,748	298,289	8,390,209	98,825	20,315,628	239,289	18,629,982	219,434	72,660,567	855,837
A: Access to Essential Medicines and Technologies	**40,197,017**	**473,463**	**13,429,971**	**158,186**	**32,279,509**	**380,206**	**29,615,146**	**348,824**	**115,521,643**	**1,360,679**
A1: Hypertension medications	40,028,765	471,481	13,261,719	156,204	32,111,257	378,224	29,446,893	346,842	114,848,633	1,352,752
Amlodipine 5mg	9,873,894	116,300	3,271,268	38,531	7,920,882	93,297	7,263,664	85,556	28,329,707	333,683
Losartan 50mg	30,016,637	353,553	9,944,653	117,134	24,079,482	283,622	22,081,538	260,089	86,122,310	1,014,397
Hydrochlorothiazide 12.5mg	138,235	1,628	45,798	539	110,892	1,306	101,691	1,198	396,616	4,672

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	**USD**	**BDT**	**USD**	**BDT**	**USD**	**BDT**	**USD**	**BDT**	**USD**
A2: Diagnostic technologies, machines, and supplies	40,028,765	471,481	13,261,719	156,204	32,111,257	378,224	29,446,893	346,842	114,848,633	1,352,752
R: Risk-based Management	**172,334**	**2,030**	**172,334**	**2,030**	**172,334**	**2,030**	**172,334**	**2,030**	**689,336**	**8,119**
R1: Training costs	172,334	2,030	172,334	2030	172,334	2,030	172,334	2,030	689,336	8,119
T: Team-based care Savings from training nurses and CHWs to do tasks customarily performed by doctors	**13,815,043**	**162,721**	**4,576,989**	**53,910**	**11,082,490**	**130,536**	**10,162,944**	**119,705**	**39,637,467**	**466,872**
T1: Savings from training nurses	**11,976,134**	**141,062**	**3,967,750**	**46,734**	**9,607,309**	**113,160**	**8,810,163**	**103,771**	**34,361,355**	**404,727**
Savings from counselling to change behavior	1,355,873	15,970	449,207	5,291	1,087,688	12,811	997,439	11,748	3,890,208	45,821
Savings from screening for--and assess--CVD risk	3,367,235	39,661	1,115,581	13,140	2,701,212	31,816	2,477,084	29,176	9,661,112	113,794
Savings from treating CVD risk	7,253,025	85,430	2,402,961	28,303	5,818,410	68,533	5,335,639	62,846	20,810,036	245,112
T2: Savings from training CHWs	**1,838,909**	**21,660**	**609,239**	**7,176**	**1,475,181**	**17,376**	**1,352,781**	**15,934**	**5,276,112**	**62,145**
Savings from counselling to change behavior	1,838,909	21,660	609,239	7,176	1,475,181	17,376	1,352,781	15,934	5,276,112	62,145
S: Systems for monitoring	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**12,458,546**	**146,744**
S1: Human resources	2,969,636	34,978	2,969,636	34,978	2,969,636	34,978	2,969,636	34,978	11,878,546	139,912
S2: Technology	110,000	1,296	110,000	1,296	110,000	1,296	110,000	1,296	440,000	5,183
S3: Supplies	10,000	118	10,000	118	10,000	118	10,000	118	40,000	471
S4: Training	25,000	294	25,000	294	25,000	294	25,000	294	100,000	1,178
Total Program Cost (H+E+A+R+T+S)	**92,778,742**	**1,092,800**	**33,395,573**	**393,352**	**75,213,609**	**885,908**	**69,302,672**	**816,286**	**270,690,596**	**3,188,346**

[Insert Figure 2 here]

Figure 2: Distribution of annual cost by HEARTS components

Most of the projected annual cost (95%) of implementing Module 'H' (Healthy-lifestyles counselling) was attributable to the cost of provider time and information materials for counselling patients (USD 433,000). The estimated cost for Module 'E' (Evidence-based treatment protocols) was attributable to provider time across three major activities: asking patient history (USD 180,000; 15%), patient assessment via physical exam and diagnostic tests (USD 180,000; 15%), and conducting return visits (USD 856,000, 70%). The projected cost to implement Module 'S' (Systems for monitoring) was USD 147,000, primarily attributed to administration staff labor costs (95%), with the remaining cost allocated to technology (software/hardware).

Table 4 highlights an important programmatic aspect by describing health providers' time needed to implement the hypertension control program. Implementing the program at the full population level in all four sub-districts was estimated to require the full time equivalent of 51 doctors, 51 nurses, and 6 community health workers. The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

Table 4: Hypertension control program: estimated health provider time for counselling, screening, diagnosis, and treatment

Activity	Golapganj		Fenchugonj		Beanibazar		Bishwanath		Total
	Workdays	**FTE**	Workdays	FTE	**Workdays**	**FTE**	Workdays	FTE	**FTE**
Counselling to change behavior									
Doctor	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Nurses	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
CHW	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Screening and diagnosis									
Doctor	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Nurses	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Return visits - Counsel and treat per protocol									
Doctor	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	**31.0**
Nurses	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	**31.0**

Note: FTE: Full-time equivalent (annual: total minutes/124800).

3.3. Risk-based integrated hypertension, diabetes, and high cholesterol management program cost

Table 5 reports the estimated costs of implementing the risk-based hypertension, diabetes, and high cholesterol management program in four upazilas at the population level (adults aged 18 and above). Figure 2 presents the distribution of costs by HEARTS components**.** The total annual cost was estimated at USD 14.4 million, equivalent to USD 12.9 per capita, USD 19.3 per adult, and USD 40.2 per eligible participant. Module 'A' (Access to medicines and technology) constitutes the largest cost share (USD 11.7 million; 81%), followed by Module 'E' (Evidence-based treatment protocols, USD 1.9 million; 13%). Within Module 'A', the projected costs of diagnostic tests, hypertension medications, diabetes medications, and cholesterol medications were USD 5.7 million (49% of module costs), USD 1.4 million (12%), USD 0.9 million (7%), and USD 3.8 million (32%), respectively. The projected medication expenditure per patient treated with medications for hypertension, diabetes, and cholesterol was USD 18, USD 29, and USD 37, respectively.

Table 5: Annual cost of implementing risk-based hypertension, diabetes, and high cholesterol management program in four sub-districts

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy Lifestyles Counselling	**13,335,339**	**157,071**	**4,765,107**	**56,126**	**10,800,324**	**127,212**	**9,947,252**	**117,164**	**38,848,022**	**457,574**
H1: Training costs	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	**1,675,960**	**19,740**
H1.1: Facility rental (% of H1)	18,000	212	18,000	212	18,000	212	18,000	212	72,000	848
H1.2: Human resources	20,000	236	20,000	236	20,000	236	20,000	236	80,000	942
H1.3: Instructive handbooks	35,000	412	35,000	412	35,000	412	35,000	412	140,000	1,649
H1.4: Per diem/transportation	339,990	4,005	339,990	4,005	339,990	4,005	339,990	4,005	1,359,960	16,018
H1.5: Refreshments	6,000	71	6,000	71	6,000	71	6,000	71	24,000	283
H2: Brief counselling costs	**12,816,349**	**150,958**	**4,246,117**	**50,013**	**10,281,334**	**121,099**	**9,428,262**	**111,051**	**36,772,062**	**433,122**
H2.1: Tobacco	9,272,756	109,220	3,072,108	36,185	7,438,647	87,617	6,821,441	80,347	26,604,952	313,368
Provider time to administer 5A's	3,807,374	44,845	1,261,401	14,857	3,054,293	35,975	2,800,870	32,990	10,923,938	128,668
Informational materials (print)	5,465,382	64,374	1,810,707	21,328	4,384,354	51,641	4,020,572	47,357	15,681,014	184,700
H2.2: Alcohol	933,641	10,997	309,320	3,643	748,971	8,822	686,827	8,090	2,678,759	31,552
Provider time to administer 5A's	383,351	4,515	127,006	1,496	307,526	3,622	282,010	3,322	1,099,893	12,955
Informational materials (print)	550,290	6,482	182,314	2,147	441,445	5,200	404,817	4,768	1,578,866	18,597
H2.3: Physical inactivity	2,609,952	30,741	864,689	10,185	2,093,715	24,661	1,919,994	22,615	7,488,350	88,202
Provider time to administer 5A's	1,071,641	12,622	355,040	4,182	859,675	10,126	788,345	9,286	3,074,701	36,216
Informational materials (print)	1,538,311	18,119	509,650	6,003	1,234,040	14,535	1,131,648	13,329	4,413,649	51,986
H3: Other program costs	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**400,000**	**4,711**
Community awareness meetings	50,000	589	50,000	589	50,000	589	50,000	589	200,000	2,356
Community health workers training	50,000	589	50,000	589	50,000	589	50,000	589	200,000	2,356
E: Evidence-based Treatment Protocols	**56,155,264**	**661,428**	**18,604,504**	**219,134**	**45,048,007**	**530,601**	**41,310,245**	**486,575**	**161,118,020**	**1,897,739**
E1: Ask about patient history - provider time	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
E2: Assess via physical exam and diagnostic tests - provider time	25,513,182	300,509	8,452,638	99,560	20,466,790	241,069	18,768,602	221,067	73,201,212	862,205
E3: Return visits - Counsel and treat per protocol - provider time	25,324,748	298,289	8,390,209	98,825	20,315,628	239,289	18,629,982	219,434	72,660,567	855,837
A: Access to Essential Medicines and tech.	**347,102,943**	**4,088,374**	**115,109,353**	**1,355,823**	**278,480,835**	**3,280,104**	**255,388,440**	**3,008,109**	**996,081,571**	**11,732,410**
A1: Diagnostic tests	**170,039,655**	**2,002,823**	**56,334,940**	**663,545**	**136,406,582**	**1,606,674**	**125,088,536**	**1,473,363**	**487,869,714**	**5,746,404**
Complete blood count (panel)	51,527,168	606,916	17,071,194	201,074	41,335,328	486,871	37,905,617	446,474	147,839,307	1,741,335
Blood lipid panel	103,054,336	1,213,832	34,142,388	402,148	82,670,656	973,742	75,811,234	892,947	295,678,614	3,482,669
Fasting blood glucose (FPG)	15,458,150	182,075	5,121,358	60,322	12,400,598	146,061	11,371,685	133,942	44,351,792	522,400

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
A2: Hypertension medications	**40,028,765**	**471,481**	**13,261,719**	**156,204**	**32,111,257**	**378,224**	**29,446,893**	**346,842**	**114,848,633**	**1,352,752**
Amlodipine 5mg	9,873,894	116,300	3,271,268	38,531	7,920,882	93,297	7,263,664	85,556	28,329,707	333,683
Losartan 50mg	30,016,637	353,553	9,944,653	117,134	24,079,482	283,622	22,081,538	260,089	86,122,310	1,014,397
Hydrochlorothiazide 12.5mg	138,235	1,628	45,798	539	110,892	1,306	101,691	1,198	396,616	4,672
A3: Diabetes medications	**25,366,503**	**298,781**	**8,404,042**	**98,988**	**20,349,124**	**239,683**	**18,660,698**	**219,796**	**72,780,367**	**857,248**
Metformin 500mg	11,707,617	137,899	3,878,789	45,687	9,391,903	110,623	8,612,630	101,444	33,590,939	395,653
Metformin 1000mg	12,292,998	144,794	4,072,728	47,971	9,861,498	116,154	9,043,262	106,517	35,270,486	415,436
Gliclazide	1,365,889	16,088	452,525	5,330	1,095,722	12,906	1,004,807	11,835	3,918,943	46,160
A4: Cholesterol medications	**111,499,768**	**1,313,307**	**36,940,399**	**435,105**	**89,445,620**	**1,053,541**	**82,024,060**	**966,126**	**319,909,847**	**3,768,078**
Simvastatin 10mg	79,451,930	935,830	26,322,800	310,045	63,736,699	750,727	58,448,282	688,437	227,959,711	2,685,038
Atorvastatin 20mg	13,353,266	157,282	4,424,000	52,108	10,712,050	126,173	9,823,241	115,704	38,312,556	451,267
Atorvastatin 40mg	18,694,572	220,195	6,193,600	72,952	14,996,870	176,642	13,752,537	161,985	53,637,579	631,774
A5: Diagnostic tech. machines, and supplies	**168,253**	**1,982**	**168,253**	**1,982**	**168,253**	**1,982**	**168,253**	**1,982**	**673,010**	**7,927**
R: Risk-based Management	**5,489,668**	**64,660**	**1,933,992**	**22,780**	**4,437,923**	**52,272**	**4,083,995**	**48,104**	**15,945,577**	**187,816**
R1: Training costs	172,334	2,030	172,334	2,030	172,334	2,030	172,334	2,030	689,336	8,119
R2: Estimate risk using risk charts	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
T: Team-based care: Savings from training nurses and CHWs to do tasks customarily performed by doctors	**25,600,367**	**301,536**	**8,481,523**	**99,900**	**20,536,731**	**241,893**	**18,832,739**	**221,823**	**73,451,360**	**865,151**
T1: Savings from training nurses	**23,761,458**	**279,876**	**7,872,283**	**92,724**	**19,061,549**	**224,518**	**17,479,958**	**205,889**	**68,175,248**	**803,006**
Savings from counselling to change behavior	1,355,873	15,970	449,207	5,291	1,087,688	12,811	997,439	11,748	3,890,208	45,821
Savings from screening for--and assess--CVD risk	15,152,559	178,475	5,020,114	59,130	12,155,452	143,174	11,146,879	131,294	43,475,005	512,073
Savings from treating CVD risk	7,253,025	85,430	2,402,961	28,303	5,818,410	68,533	5,335,639	62,846	20,810,036	245,112
T2: Savings from training CHWs	**1,838,909**	**21,660**	**609,239**	**7,176**	**1,475,181**	**17,376**	**1,352,781**	**15,934**	**5,276,112**	**62,145**
Savings from counselling to change behavior	1,838,909	21,660	609,239	7,176	1,475,181	17,376	1,352,781	15,934	5,276,112	62,145
S: Systems for monitoring	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**12,458,546**	**146,744**
S1: Human resources	2,969,636	34,978	2,969,636	34,978	2,969,636	34,978	2,969,636	34,978	11,878,546	139,912
S2: Technology	110,000	1,296	110,000	1,296	110,000	1,296	110,000	1,296	440,000	5,183
S3: Supplies	10,000	118	10,000	118	10,000	118	10,000	118	40,000	471
S4: Training	25,000	294	25,000	294	25,000	294	25,000	294	100,000	1,178
Total Program Cost (H+E+A+R+T+S)	**425,197,850**	**5,008,220**	**143,527,592**	**1,690,549**	**341,881,725**	**4,026,875**	**313,844,568**	**3,696,638**	**1,224,451,735**	**14,422,282**

The adoption of task-sharing approach would save USD 865,000, of which USD 803,000 comes from using nurses to complete tasks customarily performed by doctors (i.e., counselling, screening, and assessing CVD risk, and treating according to CVD risk) and USD 62,000 comes from using CHWs to provide counselling to change behavior. Implementing the risk-based hypertension, diabetes, and high cholesterol management program at the full population level in all four sub-districts was estimated to require the full time equivalent of 58 doctors, 58 nurses, 6 CHWs, and 101 lab technicians (Table 6). The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

Table 6: Integrated risk-based approach: estimated health provider time for counselling, screening, diagnosis, and treatment

Activity	Golapganj		Fenchugonj		Beanibazar		Bishwanath		Total
	Workdays	**FTE**	Workdays	FTE	**Workdays**	**FTE**	Workdays	FTE	**FTE**
Counselling to change behavior									
Doctor	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Nurses	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
CHW	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Screening and diagnosis									
Doctor	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Nurses	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Screening and diagnosis by Lab technicians	9,119 days, 3 hours	35.1	3,021 days, 6 hours	11.6	7,315 days, 0 hours	28.1	6,708 days, 1 hours	25.8	**100.6**
Estimating CVD risk using risk charts									
Doctor	2,658,667	2.5	880,829	0.8	2,132,795	2.0	1,955,830	1.8	**7.2**
Nurses	2,658,667	2.5	880,829	0.8	2,132,795	2.0	1,955,830	1.8	**7.2**
Return visits - Counsel and treat per protocol									
Doctor	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	**31.0**
Nurses	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	**31.0**

4. Discussion

The HEARTS pilot project in four Bangladesh sub-districts launched a framework for hypertension management in primary care, with a potential for expanding into a comprehensive CVD prevention approach that incorporates hypertension, diabetes, and cholesterol management. This study projects the expected cost of scaling up the program to all eligible adults in the participating sub-districts. We assessed two program scenarios: a hypertension management program and an integrated risk-based hypertension, diabetes, and cholesterol management program. The total annual cost was estimated at USD 3.2 and 14.4 million USD for the hypertension and risk-based comprehensive approach, respectively. The overall per capita cost was approximately USD 2.8 per capita for the hypertension control program and USD 12.9 per capita for the risk-based comprehensive approach. These estimates correspond to 0.14% and 0.7% of the 2020 gross domestic product per capita in Bangladesh, respectively. The main cost drivers for the hypertension control program were medication expenditures (43%) and the cost of provider time for providing care during multiple visits (38%). In the risk-based integrated approach, the combined costs of hypertension, diabetes, and cholesterol medications and diagnostic tests make up the largest share of the overall program cost (81%). Although the main driver of projected program costs for the integrated approach was expenditure on essential medicines and diagnostic tests, hypertension and diabetes medications contributed a relatively small portion (19%) to this expenditure (i.e., Module A), whereas cholesterol medications contributed nearly 32%. Hypertension treatment remains among the leading cost-effective ways to combat heart disease. In this study, the annual medication expenditure per patient treated with medications for hypertension, diabetes, and cholesterol was USD 18, USD 29, and USD 37, respectively.

Though based on observations gathered in one district of Bangladesh, our results are consistent with those reported by past studies. A previous study on Bangladesh by Nugent et al. (2017) estimated that hypertension treatment would cost about USD 13 (BDT 1,070) per patient per year.[32] WHO (2011) has estimated the average hypertension screening cost for LMICs at approximately USD 4 for LMICs, not including treatment but including the cost of performing CVD risk assessment and BP measurement in primary care settings.[33] Haque (2016) estimated the average cost of diabetes screening in Bangladesh at approximately USD 5 (BDT 411), including glucose screening in primary care, documentation, setting up referrals, and organizing screening events but excluding treatment.[34] In this study, the cost elements in the Bangladesh HEARTS program are wide-ranging including screening, diagnosis, and treatment for multiple CVD risk conditions (hypertension, diabetes, hyperlipidemia) and counseling for CVD risk factors (tobacco use, alcohol use, and physical inactivity).

The analysis revealed that scaling up the hypertension management program within the four sub-districts would require an additional full-time equivalent of 51 doctors, 51 nurses, and 6 CHWs. Population-level scale-up of the risk-based hypertension, diabetes, and high cholesterol management program in the four sub-districts was estimated to require the full time equivalent of 58 doctors, 58 nurses, 6 CHWs, and 101 lab technicians. To put this in context, a typical 50-bed sub-district public health complex in Bangladesh employs 20 doctors, 16 nurses, and one medical assistant. Oftentimes, not all health provider posts are filled. This gap in provider capacity poses a significant barrier to program expansion. Team-based care using task-sharing among doctors, nurses and community health workers and volunteers can accomplish the activities required by the HEARTS package more affordably, including NCD-related health promotion, prevention, screening, and patient navigation through the health system. A systematic review of intervention trials in low- and middle-income countries by Joshi et al. (2014) found that team-based care, including task sharing was effective in improving process outcomes (e.g., hypertension and diabetes screening) and health outcomes (e.g., hypertension and diabetes control), and achieving treatment concordance with doctors.[35, 17] Krishnan et al. (2019) conducted a study on a community-based hypertension management program of blood pressure monitoring and lifestyle counselling intervention undertaken by female community health volunteers (FCHVs) in Nepal, and assessed the intervention to be highly cost-effective.[36] However, there are several barriers to team-based care with task sharing, including staff attrition and turnover, retention of training, patient perception and acceptance toward non-physician health workers, lack of delegation of work by physicians, legislation and policy etc.[37]

In Bangladesh, of the four entities (i.e., the government, for-profit private sector, non-profit nongovernmental organization, and donor agencies) involved in the primary healthcare provision, the government plays the leading role, mainly in rural areas. There are six tiers of public healthcare infrastructure: national, divisional, district, upazila (sub-district), union, and ward levels. To tackle NCDs, the government of Bangladesh introduced ‘NCD Corners’ initiative in 2012 dedicated to providing prevention and care services for common NCDs and related conditions. The government has plans to expand ‘NCD corners’ at the upazila level, and the upazila primary care setting is well-positioned to bridge the link the health care providers down to the union, ward (and community) levels by harnessing community support and delegating suitable activities under task-sharing principles.[17, 38, 39] This will enhance healthcare access among disadvantaged populations and mitigate health disparities. Further, in Bangladesh, according to the 2016 Household Income Expenditure Survey and 2014 Health and Morbidity Status Survey, one in three patients received treatment from a pharmacy or medical shop, while about one in five received treatment from public health providers.[40, 41] This emphasizes the need for partnerships with various types of public-private health providers.

The models of care introduced in the Bangladesh national hypertension guidelines and NCD operational plan are encouraging; however, there are capacity challenges to the scaling-up of NCD care in Bangladesh.[42, 43] The fiscal year 2021 budget allocation to the health sector stands just above 5%, which is less than 1% of GDP. Further, less than 5% of public sector funding for health covers NCDs, despite NCDs being responsible for almost two-thirds (63% in 2016) of disability-adjusted life years (DALYs) in Bangladesh.[17] The per capita NCD allocation is only USD 0.08.[17] There is a need for better coordination of non-state stakeholders in NCD control with the public sector with a stronger focus of the public sector on NCD prevention and health promotion.[17] The health sector in Bangladesh is financed 93% from domestic sources (74% out-of-pocket, 17% government health expenditure, and 3% other private sources) and 7% from external health expenditures. Domestic general government health expenditure per capita is only USD 7 (0.4% of GDP per capita).[44] Due to insufficient public sector funding, out-of-pocket expenditure for NCD care is large in Bangladesh, contributing to the impoverishment of patients and their families. Moreover, a recent policy review by Biswas et al (2017) highlights the lack of proper planning, implementation, and monitoring of NCD health initiatives.[45] However, the Bangladesh Copenhagen Project assessed the benefits of managing hypertension through targeted investment and reported a high level of return on investment (BDT 17 benefit for every BDT spent).[32]

This report has several limitations. Due to lack of data at a local level, the cost projections rely on assumptions regarding population coverage, risk factor prevalence, primary care attendance rate, and frequency of patient visits by CVD risk, which were assumed to be uniform for the four sub-districts and across age or sex groups. Similarly, unit costs of supplies, wages, and provider time allocations were assumed to be the same across sub-districts. Since the examined sub-districts are adjacent to each other, these unit costs may not be considerably different. While we used average medicine prices, they may vary in different sub-districts depending on the procurement arrangement and sources. However, in Bangladesh, the price variations are minimal or low in the public health facilities, given the medicines are procured mainly from EDCL and/or CMSD.[20, 21] The strength of the study lies in its ability to disaggregate costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging program delivery from the upazila level to more localized community facilities.

In 2018, the Government of Bangladesh introduced a multisectoral action plan for NCD prevention and control, which emphasizes NCD risk factors including tobacco use, unhealthy diet, physical inactivity, and harmful use of alcohol.[43] This study can inform approaches to scaling up this action plan nationally, with the goal of increasing population outreach for CVD prevention at the primary care level.

Using the costs reported in this study for future cost-effectiveness analyses can further support evidence-based decision making for CVD prevention programs in Bangladesh.

5. Conclusion

Expanding the HEARTS hypertension management and CVD prevention program to provide services to the entire eligible population in the catchment area may face constraints in physician capacity. A task-sharing model involving shifting of select tasks from doctors to nurses and local community health workers would be essential for the eventual scale-up of primary care services to prevent CVD in Bangladesh.

Disclaimer

The findings and conclusions of this report are those of authors only and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Author Contribution

MJH and MSH conceptualized the study, led the formal analysis, implemented the methodology and the excel-based costing tool, and wrote the draft manuscript. DK, SRC, MRB, AEM contributed to the study concept, analytical aspects, manuscript write-up and critical review. RT and SJ contributed to data collection and critical review of the manuscript. MJH, MSH, SRC, RT, SJ, and MRB contributed to data collection. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

Ethics Approval

Ethics approval was not required because this research neither involved human or animal participation nor required consent from human participants.

Conflict of Interest

The authors declare non conflict of interest

Data Statement

Data used in this study is included in table 1 of this article.

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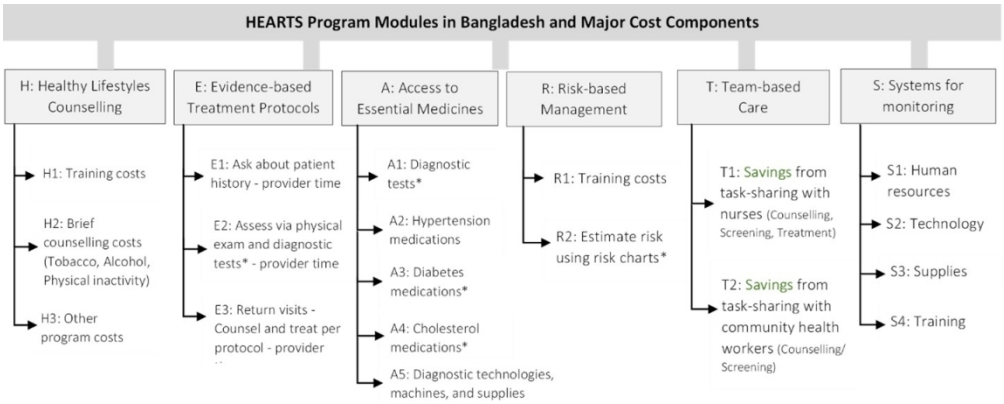

Cost components of the HEARTS program in Bangladesh

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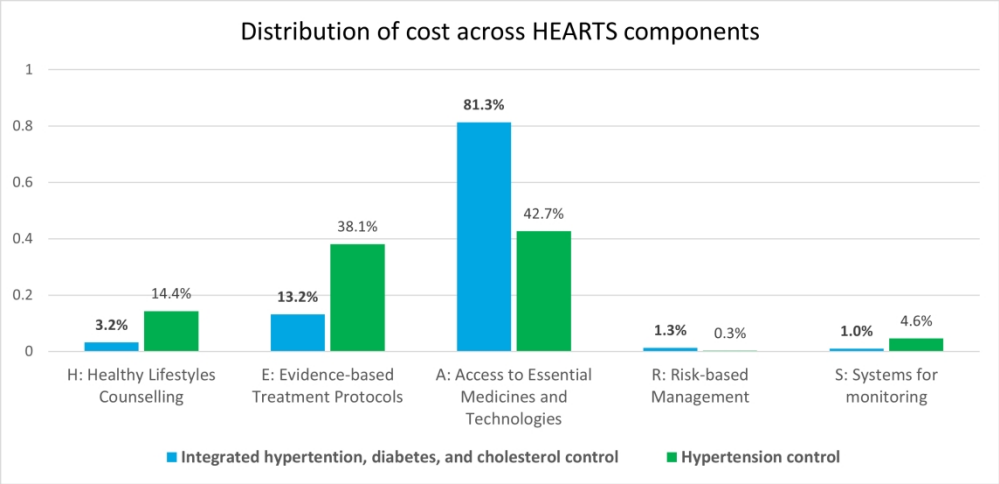
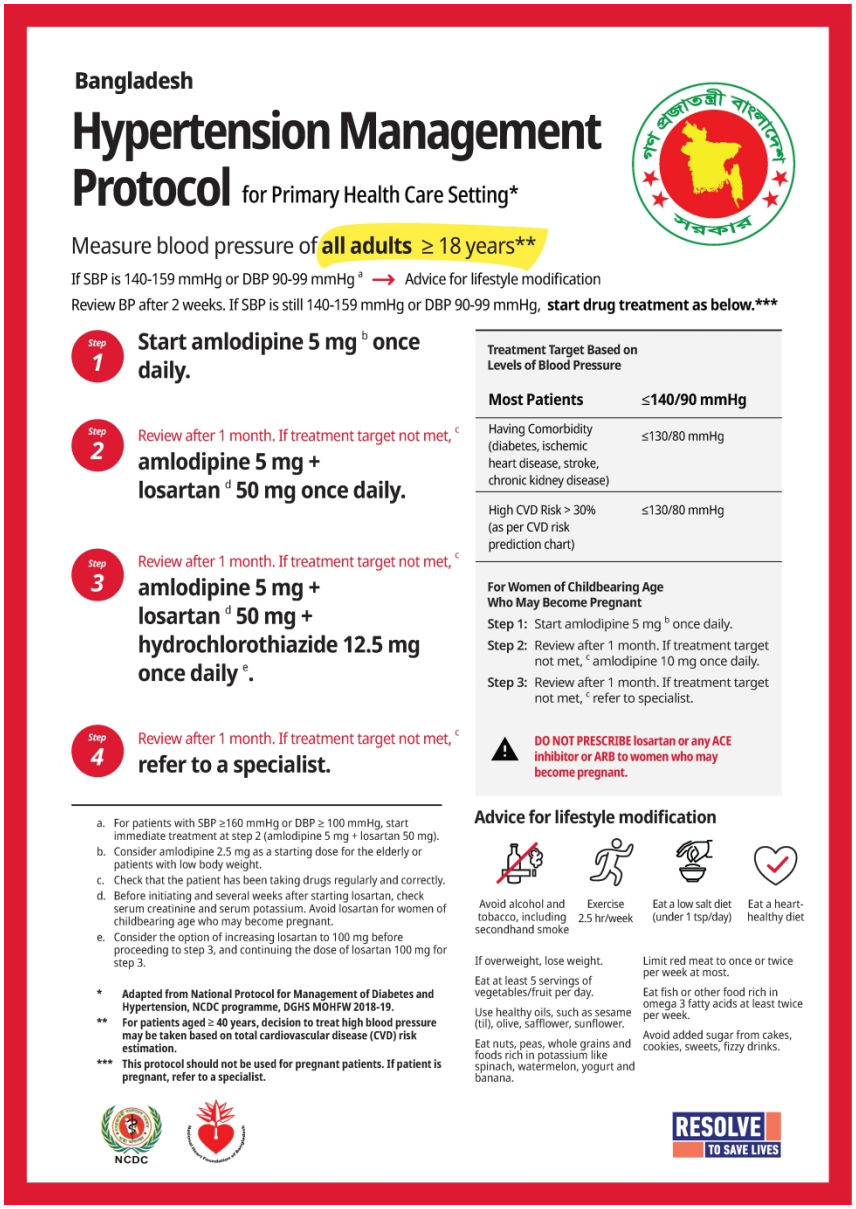


Distribution of annual cost by HEARTS components

495x240mm (130 x 130 DPI)



533x753mm (173 x 173 DPI)

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Cost of primary care approaches for hypertension management and risk-based cardiovascular disease prevention in Bangladesh: a HEARTS costing tool application

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Abstract

Objective: To estimate the costs of scaling up the HEARTS pilot project for hypertension management and risk-based cardiovascular disease prevention at the full population level in the four sub-districts (upazilas) in Bangladesh.

Settings: Two intervention scenarios in sub-district health complexes: hypertension management only, and risk-based integrated hypertension, diabetes, and cholesterol management.

Design: Data obtained during July-August 2020 from sub-district health complexes on the cost of medications, diagnostic materials, staff salaries, and other program components.

Methods: Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual costs of implementing the HEARTS program from the health system perspective.

Primary and secondary outcome measures: Program cost, provider time.

Results: The total annual cost for the hypertension control program was estimated at USD 3.2 million, equivalent to USD 2.8 per capita or, USD 8.9 per eligible patient. The largest cost share (USD 1.35 million; 43%) was attributed to the cost of medications, followed by the cost of provider time to administer treatment (38%). The total annual cost of the risk-based integrated management program was projected at USD 14.4 million, entailing USD 12.9 per capita or USD 40.2 per eligible patient. The estimated annual costs per patient treated with medications for hypertension, diabetes, and cholesterol were USD 18, USD 29, and USD 37, respectively.

Conclusion: Expanding the HEARTS hypertension management and CVD prevention program to provide services to the entire eligible population in the catchment area may face constraints in physician capacity. A task-sharing model involving shifting of select tasks from doctors to nurses and local community health workers would be essential for the eventual scale-up of primary care services to prevent CVD in Bangladesh.

Key Words: Program cost; HEARTS hypertension management and CVD prevention program; scale-up of primary care services; Bangladesh.

Word Count: 4430

Strengths and limitations of this study

- This study uses the HEARTS costing tool to assess the expected cost of scaling up the program to all eligible adults in the participating sub-districts (upazila).
- The study assesses two program scenarios: a hypertension management program and an integrated risk-based hypertension, diabetes, and cholesterol management program.
- The study disaggregates costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging program delivery from the upazila level to more localized community facilities.
- Due to lack of data at a local level, the cost projections rely on assumptions regarding population coverage, risk factor prevalence, primary care attendance rate, distribution of CVD risk among the population, distribution of patients by treatment protocols, and frequency of patient visits by CVD risk.
- The study uses average medicine prices, unit costs of supplies, wages, and provider time, which may vary across sub-districts depending on the procurement arrangements and operational efficiency.

1. BACKGROUND

Hypertension is a major and preventable risk factor for cardiovascular disease (CVD). An estimated 1.13 billion people (1 in 4 men and 1 in 5 women) worldwide have hypertension. [1] Among people with hypertension worldwide, fewer than 1 in 5 have it under control.[1] High blood pressure is a leading global risk factor for premature death and disability, accounting for about 10 million (or 1 in 6) deaths worldwide each year.[2, 3] Uncontrolled hypertension significantly increases the risk of stroke, myocardial infarction, heart failure, dementia, renal failure, retinopathy, and other diseases.[4-7] Almost half of all CVD events are attributable to uncontrolled hypertension.[2, 3]

Reducing the prevalence of hypertension is a standing global health objective.[8-11] This objective complements the 2030 Sustainable Development Goal (SDG) of reducing premature deaths from noncommunicable diseases (NCDs) by 25%.[12] Low- and middle-income countries (LMICs), where two-thirds of all hypertension cases reside, are increasingly cognizant of the long-term benefits of addressing hypertension in their populations. However, implementing population-level measures targeting hypertension may present challenges for many LMICs where health systems have traditionally focused on infectious diseases and where the capacity for NCD care may be limited.

Bangladesh is among lower-middle-income countries with a high burden of hypertension. In 2018, the prevalence of elevated blood pressure (SBP and/or DBP ≥ 140/90 mmHg) among adults in Bangladesh was 21%.[13-15]. According to the 2011 Bangladesh National Demographic and Health Survey, of 14.4 million hypertensive people (adults aged 35 and above), only 7.3 million (51%) were aware of their condition, 41% were treated, and 18% had their blood pressure levels under control.[16] The burden of hypertension in Bangladesh is expected to grow alongside increased population aging, rapid urbanization with commensurate increases in sedentary lifestyle and processed food consumption, and other socio-economic and lifestyle changes. However, only less than 5 percent of the health sector program budget is allocated for NCDs control.[16] This demonstrates the need for an effective, low-cost and efficient population-level approach in addressing hypertension.

In 2016, WHO introduced the HEARTS technical package as a framework for CVD prevention at the primary care level.[17] The HEARTS technical package consists of guidelines for implementing a primary-care approach to CVD management, focusing on screening and management of CVD risk factors, including lifestyle modification and pharmacological treatment of metabolic risk factors such as hypertension, diabetes, and hyperlipidemia. In this paper, we describe the local budgetary impact of implementing the HEARTS program at the population level for four sub-districts in Bangladesh, based on program cost data obtained from a representative health care facility in each sub-district. Although the

initial focus of the program in the four sub-districts is presently limited to hypertension control, scaling-up of the initiative may include screening, diagnosis, and treatment of diabetes and high cholesterol. Understanding the cost drivers of CVD prevention approaches in the Bangladesh primary care system can support budgeting, procurement, evaluation, and planning for scale-up.

2. METHODS

2.1. Setting

In 2018, the Directorate General of Health Services and the National Heart Foundation of Bangladesh collaborated with Resolve to Save Lives (RTSL, an initiative of Vital Strategies, a non-profit global public health organization) to implement a pilot program to strengthen the detection, treatment, and follow-up management of hypertension in primary care. The program was introduced in four health complexes in four sub-districts (upazilas) in the Sylhet district: Golapganj, Fenchuganj, Beanibazar, and Bishwanath. In Bangladesh, hospitals and health facilities that are in the sub-district (upazila) level or below are termed as primary health complexes. A typical upazila health complex is a 50-bed hospital with service coverage in the range of 100,000 to 400,000 population and plays a pivotal role in the provision of primary health care through a three-tier system consisting of the ward level, union level, and upazila level. The upazila health complex performs a wide range of functions that includes prevention, promotion, treatment (in-patient, out-patient, limited diagnostic services), management, technical support, training, coordination, and patient referral services. The outpatient service is usually staffed with five outpatient general practitioners including 1 resident medical officer, 2 medical officers, and 2 medical assistants. An 'NCD corner' was set-up in the outpatient with necessary logistics and personnel for screening and treatment. We project program costs under two intervention scenarios: a hypertension-focused program, and a risk-based integrated hypertension, diabetes, and cholesterol management program.

2.2. Patient and Public Involvement

Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

2.3. Hypertension management program

The HEARTS Technical Package for CVD prevention in primary care is organized around six modules: H–Healthy-lifestyle counselling, E—Evidence-based treatment protocols, A—Access to essential medicines and technology, R—Risk-based CVD management, T—Team-based Care, and S—Systems for monitoring.[18] Components of these modules are described in Figure 1. In the four upazila primary care

complexes in Bangladesh, programmed activities included: training of staff in following a standard treatment protocol, record keeping and reporting; ensuring adequate supply of necessary drugs; community outreach to increase awareness of the need for hypertension screening; introduction of patient monitoring tools and a monthly reporting system; and establishing a mechanism for patient referral from primary care to secondary care and tertiary care at MAG Osmani Medical College. The clinical management protocol for adults with hypertension (defined as SBP/DBP <= 140/90 mmHg, or SBP/DBP <= 130/80 mmHg with co-morbidity or high CVD-risk) entailed a first line of treatment with amlodipine 5mg daily; a second line of treatment using amlodipine 5mg plus losartan 50mg daily; and a third line of treatment using amlodipine 5mg plus losartan 50mg plus hydrochlorothiazide 12.5mg daily. Appendix 1 depicts the hypertension treatment protocol. The prescribed medicines are typically obtained by public health facilities, generic, domestically manufactured, and provided free of charge to patients. The national drug policy recommends that 70% of the public sector medicines be purchased from the state-owned Essential Drug Company Limited (EDCL), 25% from the Central Medical Stores Depot (CMSD), and 5% from local sources.[19, 20] In order to provide continuous care more sustainably and to reduce burden on physicians, a team-based care strategy was implemented. The healthcare providers were trained to acquire the necessary skills to provide brief interventions to record patients' medical history, measuring blood pressure (BP), point-of-care testing to assess fasting blood glucose and cholesterol levels and urine dipstick for proteinuria, encourage behavior change, assess CVD risk, or initiate treatment protocol. The training sessions were conducted in one set-up with a pool of selected doctors, nurses, and community health workers trained with relevant modules. In this approach, community health workers (CHW) were trained to provide counselling and some screening services along with the doctors and nurses. For the costing estimate, equal burden sharing in terms of provider time was assumed.

2.4. Risk-based integrated hypertension, diabetes, and hyperlipidemia management program

To further strengthen CVD prevention, the HEARTS program in Bangladesh also planned to integrate diabetes and hyperlipidemia management in addition to hypertension management in primary care patients. The program entails assessment of target population by total CVD risk estimation to categorize their risk for CVD. The risk-stratification is based on WHO and International Society of Hypertension cardiovascular risk prediction charts and expressed as the probability of developing CVD over 10 years: low CVD risk (0 to <10%); medium CVD risk (10 to 20%); and high CVD risk (>=20%).[21] The treatment protocol for patients with uncomplicated type 2 diabetes (defined as fasting plasma glucose (FPG) ≥ 7.0 mmol/l or routine plasma glucose (RPG) ≥ 11.1 mmol/l or HbA1C ≥ 6.5%) managed at the primary care level included Metformin (500 mg), Metformin (1000 mg), then Metformin (1000 mg) and Gliclazide (80 mg) as the first, second, and third lines of treatments, respectively. The protocol is based on the WHO guidance on diagnosis, classification, and management of diabetes (HEARTS - D), which is

aligned with the WHO Package of Essential Noncommunicable Disease Interventions in Primary Health Care (WHO-PEN).[22] For managing plasma lipid levels (i.e., high cholesterol), the use of statins as the primary therapy is widely recommended, however, the WHO is yet to offer any specific guidance.[23]. For costing, the local consultants and experts proposed a statin-based treatment protocol for hyperlipidemia including simvastatin (10 mg) as first, atorvastatin (20 mg) as second, and atorvastatin (40 mg) as the third line of treatment. Costs associated with implementing integrated hypertension, diabetes, and hyperlipidemia treatment protocols include provider time spent on estimating CVD risk using risk charts during an annual primary care visit; training in CVD risk estimation, in addition to time spent collecting patient history; medication costs; and diagnostic test costs including provider (technician) time, complete blood count panel, fasting blood glucose, and blood lipid panel tests.

2.5. HEARTS Costing Tool

Program costs were assessed using the HEARTS costing tool, an Excel-based instrument to collect, track, and evaluate the incremental annual cost of implementing the HEARTS program from the health system perspective. The tool is organized by HEARTS modules.[24]. In July-August 2020, we obtained unit costs from four upazila complexes and used these to project annual resource needs for implementing the CVD prevention program at the sub-district population level. The researchers completed in-person collection of data from the four facilities on human resource and time costs, diagnostic prices, time-motion on laboratory diagnostics, market price of medicines, and others.

Figure 1 shows major cost categories within HEARTS modules. Once program costs and other inputs such as population coverage, risk factor prevalence, and planned provider numbers were entered into the costing tool, the cost calculations were allocated across different HEARTS modules.

Figure 1: Cost components of the HEARTS program in Bangladesh

The cost elements in the Healthy-lifestyle counselling module ‘H’ included costs of training providers in lifestyle counseling and costs of community awareness programs and training. Counselling is based on the ‘5 As’ (Assess, Advise, Agree, Assist, Arrange) model, which is an evidence-based approach for promoting healthy behavioral changes to prevent NCD risk factors.[25, 26] Total provider time to administer brief counseling was equal to the average time that the health provider spends to counsel a patient to change behavior multiplied by the total number of patients who would receive counselling. The cost of total provider time was calculated as the total provider time, multiplied by the weighted average salary of the health providers who have been trained to provide counselling.

The cost elements in Module 'E' included provider time devoted to assessing patient history, conducting physical exams and diagnostic tests, and return visits. The costs of diagnostic tests (complete blood count panel, blood lipid panel, fasting blood glucose), medications (hypertension, diabetes, and cholesterol), and on-site diagnostic technologies and supplies were assessed under Module 'A'. Module 'R' reports the costs of training providers in conducting risk-based management and the cost of provider time for estimating patient CVD risk using risk charts. Module "T' reports cost savings from task-sharing by comparing the cost that could have been incurred if the tasks were performed solely by the physicians with costs incurred through task-sharing among physicians, nurses, and CHW. Therefore, in the baseline scenario (i.e., in the absence of task-sharing allocation), the costing tool assumes a physician-led program. In our cost projections, we assumed that doctors, nurses, and CHWs will equally share the tasks (i.e., provider time) when applicable. For instance, CHWs would only provide behavioral counselling and screening service, but they would not assess CVD risk (using risk-cart), or prescribe patients with pharmacologic treatments. Accordingly, the provider time allocated for behavior counselling and screening will be shared equally among doctors, nurses, and CHWs. Nurses will be trained to do major tasks (i.e., counselling, screening, and assessing CVD risk, and treating according to CVD risk), therefore providers' time for performing HTN/CVD risk-assessment, prescribing suitable treatment, and return-visits were allocated equally between doctors and nurses. While the 'T' module reports the cost savings from team-based care, The accrued cost of provider time (inclusive of doctors, nurses, and CHWs) spent on various tasks is included in the corresponding 'H', 'E', and 'R' modules. Module 'S' reports costs related to human resources, technology (software and hardware), supplies, and training for patient monitoring.

2.6. Data

Data on salaries of government healthcare providers and program staff were collected from in-person interviews and/or records. Total salary was calculated according to the Government of Bangladesh National pay scale. Size of the population in the examined sub-districts was obtained from census and imputed based on Bangladesh Bureau of Statistics (BBS) estimates. Other population parameters (e.g., primary care attendance rate and risk factor prevalence) were obtained from the nationally representative NCD Risk Factor Survey 2018.[15] Medicine prices were collected from the medicine outlets in the public hospitals. The unit prices represent the average price of domestically manufactured generic medicines procured by health facilities from EDCL or CMSD. Prices of laboratory diagnostics were collected from diagnostic labs at the district (Sylhet district) and sub-district (upazila) levels. Data on time needed to conduct laboratory tests were collected from in-person interviews of laboratory personnel. Training data, including number of training and participants, per-diem costs of staff, costs related to rent, transport, refreshments, and other logistics, were collected from the respective project records.

Table 1 presents the prevalence of CVD risk factors as well as cost inputs used to populate the HEARTS costing tool. 15% of the adult population was estimated to be at high risk for CVD. The leading risk factors were tobacco use (43.7%), hyperlipidemia (28.4%) and hypertension (21%), followed by physical inactivity (12.3%), diabetes (8.3%) and alcohol consumption (4.4%).; The primary care attendance rate was assumed to be 47.9% in each upazila.[15] The distributions of patients by CVD risks and for the pharmacological treatment of hypertension, diabetes, and cholesterol by different treatment lines were adopted from the literature and/or based on local physician consensus. [27-30] Local currency was converted to US dollars using the Bangladesh Bank official conversion rate in June 2020.

Table 1: Costing inputs and unit costs

Input Description	Units	Value
Eligible population (Adult population (18+)		
- Golapganj	Persons	261,098
- Fenchuganj	Persons	86,503
- Beanibazar	Persons	209,454
- Bishwanath	Persons	192,075
Primary healthcare attendance rate (annual)	Percent	47.9%
Adult population with risk factors		
- Use of tobacco products	Percent	43.7%
- Hazardous or harmful use of alcohol	Percent	4.4%
- Physical inactivity	Percent	12.3%
- Hypertension (≥140/90mmHg)	Percent	21.0%
- Diabetes (≥7.0 mmol/L or 126 mg/dl)	Percent	8.3%
- Hyperlipidemia (≥ 6 mmol/L or 190 mg/dl)	Percent	28.4%
- Low CVD risk (0 to <10%)	Percent	85.1%
- Medium CVD risk (10 to <20%)	Percent	14.4%
- High CVD risk (≥20%)	Percent	0.5%
Annual wage (in LCU (BDT) and USD, including benefits)		
- Doctors	BDT (USD)/year	1,399,452 (16,484)
- Nurses	BDT (USD)/year	726,360 (8,555)
- CHWs	BDT (USD)/year	486,568 (5,731)
- Lab technicians	BDT (USD)/year	576,720 (6,793)
- Accountant	BDT (USD)/year	576,720 (6,793)
- Administrative Assistant	BDT (USD)/year	446,242 (5,256)
- Clerical Officer	BDT (USD)/year	446,242 (5,256)
- Custodian	BDT (USD)/year	446,242 (5,256)
- IT Personnel	BDT (USD)/year	446,242 (5,256)
- Program Director	BDT (USD)/year	1,399,452 (16,484)
- Program Manager	BDT (USD)/year	726,300 (8,555)
- Secretary	BDT (USD)/year	446,242 (5,256)
- Security officer	BDT (USD)/year	400,196 (4,714)
- Pharmacist/Chemist	BDT (USD)/year	576,720 (6,793)
- Statistician	BDT (USD)/year	576,720 (6,793)
- Supplies manager	BDT (USD)/year	486,568 (5,731)
Purchasing price (in LCU (BDT) and USD) of pharmaceutical drugs		
Hypertension Medicine		
- amlodipine 5mg	BDT (USD)/tablet	1 (0.012)
- losartan 50mg	BDT (USD)/tablet	8 (0.094)
- hydrochlorothiazide	BDT (USD)/tablet	0.35 (0.004)
Diabetes Medicine		
- metformin 500mg	BDT (USD)/tablet	4 (0.047)
- metforminn 1000mg	BDT (USD)/tablet	9 (0.106)
- gliclazide	BDT (USD)/tablet	3.5 (0.041)
Cholesteror Medicine		
- simvastatin 10mg	BDT (USD)/tablet	7 (0.082)
- atorvastatin 20mg	BDT (USD)/tablet	10 (0.118)
- atorvastatin 40mg	BDT (USD)/tablet	28 (0.330)
Purchasing price (in LCU) of diagnostic tests		
- Diabetes (Complete blood count - panel)	BDT (USD)/test	400 (4.71)
- Diabetes (Fasting blood glucose)	BDT (USD)/test	120 (1.41)

- Diabetes and Cholesterol (Blood lipid panel)	BDT (USD)/test	800 (9.42)
Counselling patients to change behavior		
- Time to counsel a patient to change behavior	Minutes	10
- # of 'How to quit' informational materials disseminated per person, annually (print)	Print	5
- Cost of 'How to quit' informational materials, per unit (print materials)	BDT (USD)/print	20 (0.24)
LCU to USD exchange rate	BDT/USD	84.9
"Safety stock" required to be on hand for medicines	Percent	3.0
Number of health providers in need of training		
- Counsel patients to change behavior	Persons	30
- Assess patients' total CVD risk	Persons	10
Training to counsel patients to change behavior (5A's)*		
- Classroom size	Persons	30
- Hours of training needed	Persons	16
Training to screen/diagnosis/treat patients Hypertension/CVD patients		
- Classroom size	Persons	30
- Hours of training needed	Persons	8
Number of Trainers		
- Professional trainer(s)	Persons	2
- Administrative staff	Persons	1
Input costs for training		
Hourly wage		
- Professional trainer	BDT (USD)/hour	500 (5.89)
- Administrative staff	BDT (USD)/hour	250 (2.94)
Per unit cost of materials		
- Instructive handbooks	BDT (USD)/book	1000 (11.8)
- Facility rental for training (one day)	BDT (USD)/day	9000 (106)
- Refreshments	BDT (USD)/day	6000 (70.7)
- Per diem for staff	BDT (USD)/day	3500 (41.2)
- Per diem and/or salary of trainees	BDT (USD)/day	5000 (58.9)
- Transportation stipend for staff	BDT (USD)/training	3165 (37.3)
CVD Risk Screening and Diagnosis		
Time (in minutes) a health provider spends to:		
- Screen patients for total CVD risk	Minutes	5
- Provide a physical exam to assess patients' total CVD risk	Minutes	5
- Assess patient risk using a CVD risk chart	Minutes	5
Time (in minutes) a lab technician spends to:		
- Administer and analyze a blood test	Minutes	10
- Administer and analyze a urine test	Minutes	10
Treatment for High CVD Risk		
# follow-up visits for a person annually with the following levels of CVD risk annually		
- Low CVD risk (≥0% to <10%)	Visits	2
- Medium CVD risk (≥10% to <20%)	Visits	3
- High CVD risk (≥20%)	Visits	4
Time health providers spend with a patient during a visit?		
- Generalists/primary care doctors	Minutes	5
- Nurses	Minutes	5
Screen for CVD risk: Diagnostics cost in LCU (BDT) and USD		
- Diabetes (compete blood count panel)	BDT (USD)/test	400 (4.7)
- Diabetes (Fasting blood glucose)	BDT (USD)/test	120 (1.4)
- Diabetes and Cholesterol (Blood lipid panel)	BDT (USD)/test	80 (0.9)
Pharmacological treatment for hypertension		
- Hypertension Protocol Step #1 (Amlodipine 5mg, 1 per day, 365 days)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	62%
- Hypertension Protocol Step #2 (Amlodipine 5mg + Losartan 50mg)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	34%
- Hypertension Protocol Step #3 (Amlodipine + Losartan+ Hydrochlorothiazide)		
- % of all individuals with high blood pressure who receive this treatment regimen	Percent	4%
- Unit price of amlodipine 5mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	1 (0.012)
- Unit price of losartan 50 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	8 (0.094)
- Unit price of hydrochlorothiazide in LCU (Taka or BDT) and USD	BDT (USD)/tablet	0.35 (0.004)
Pharmacological treatment for diabetes		
- Diabetes Protocol Step #1 (metformin 500mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	75%
- Diabetes Protocol Step #2 (metformin 1000mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	15%
- Diabetes Protocol Step #3 (metformin 1000mg+gliclazide 8mg)		
- % of all individuals with diabetes who receive this treatment regimen	Percent	10%
- Unit price of metformin 500mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	4 (0.047)

- Unit price of metformin 1000mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	9 (0.106)
- Unit price of gliclazide 80mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	3.5 (0.041)
Pharmacological treatment for high cholesterol (default regimens)		
- High Cholesterol Protocol Step #1 (low intensity, simvastatin 10mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	85%
- High Cholesterol Protocol Step #2 (moderate intensity, atorvastatin 20mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	10%
- High Cholesterol Protocol Step #3 (high intensity, atorvastatin 40mg)		
- Percent of all individuals with high cholesterol who receive this treatment	Percent	5%
- Unit price of simvastatin 10mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	7 (0.082)
- Unit price of simvastatin 20mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	10 (0.118)
- Unit price of atorvastatin 40mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	28 (0.330)

Note: * The '5A' (Assess, Advise, Agree, Assist, Arrange) model is an evidence-based approach entailing health behavior change counselling to prevent NCD risk factors in primary care setting (Glasgow et al., 2006; Whitlock et al., 2002). LCU: Local currency unit; BDT: Bangladesh Taka.

3. RESULTS

3.1. Population coverage

The total population in the four sub-districts was 1.12 million, of which 749,000 were adults aged 18 and above (Table 2). The total number of people eligible to receive counselling, screening, diagnosis, and treatment under the two types of HEARTS intervention packages (i.e., hypertension control and risk-based integrated approach) in the four sub-districts was determined by the primary care attendance rate, the prevalence of low-, medium-, and high- CVD risk in the population, the prevalence of hypertension, diabetes, and high cholesterol. The estimated number of eligible persons in the catchment area of the four sub-districts was 359,000, of which 305,000, 52,000, and 1,800 were projected to be low-, medium, and high- CVD risk patients. The estimated number of persons undergoing treatment for hypertension, diabetes, and high cholesterol was 75,000, 30,000, and 102,000, respectively (Table 2). Unit costs and other cost inputs were applied to these population parameters to project total program costs.

Table 2: Population coverage: Care cascade for counselling, screening, diagnosis, and treatment

	Golapganj	Fenchuganj	Beanibazar	Bishwanath	Total
Total population	390,688	129,436	313,412	287,404	1,120,940
Adult population in need (18+ years)	261,098	86,503	209,454	192,075	749,130
Adults who present at the health center	125,066	41,435	100,328	92,004	358,833
Providing brief counseling					
Eligible to receive brief advice	125,066	41,435	100,328	92,004	358,833
Tobacco user	*54,654*	*18,107*	*43,844*	*40,206*	156,810
Harmful alcohol	*5,503*	*1,823*	*4,414*	*4,048*	15,789
Physical inactivity	*15,383*	*5,096*	*12,340*	*11,316*	44,136
Screening and diagnosis of 10-year CVD risk					

Low CVD risk		106,431	35,261	85,380	78,295	305,367
Medium CVD risk		18,009	5,967	14,447	13,249	51,672
High CVD risk		625	207	502	460	1,794
Treatment of 10-year CVD risk						
Low CVD risk		106,431	35,261	85,380	78,295	305,367
	Hypertension	22,351	7,405	17,930	16,442	64,127
	Diabetes	8,834	2,927	7,087	6,499	25,345
	Cholesterol	30,226	10,014	24,248	22,236	86,724
Medium CVD risk		18,009	5,967	14,447	13,249	51,672
	Hypertension	3,782	1,253	3,034	2,782	10,851
	Diabetes	1,495	495	1,199	1,100	4,289
	Cholesterol	5,115	1,695	4,103	3,763	14,675
High CVD risk		625	207	502	460	1,794
	Hypertension	131	44	105	97	377
	Diabetes	52	17	42	38	149
	Cholesterol	178	59	142	131	510

Note: Risk factors and disease prevalence rates were assumed uniform across sub-districts.

3.2. Hypertension management program cost

Table 3 reports the estimated annual costs, in 2020 USD and Bangladesh Taka (BDT), of implementing the HEARTS hypertension management program in four upazilas at the population level (adults aged 18 and above). Figure 2 presents the distribution of costs by HEARTS components and sub-components**.** The total annual cost was estimated at USD 3.2 million, equivalent to USD 2.8 per capita, USD 4.3 per adult, and USD 8.9 per eligible participant. Module 'A' (Access to medicines and technology) constitutes the largest cost share (USD 1.36 million; 43%), followed by Module 'E' (Evidence-based treatment protocols; USD 1.22 million; 38%). The projected medication expenditure per patient treated with medications for hypertension was USD 18.

Table 3: Total annual cost of HEARTS hypertension control program in four sub-districts

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy Lifestyles	**13,335,339**	**157,071**	**4,765,107**	**56,126**	**10,800,324**	**127,212**	**9,947,252**	**117,164**	**38,848,022**	**457,574**
H1: Training costs	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	**1,675,960**	**19,740**
H1.1: Facility rental (% of H1)	18,000	212	18,000	212	18,000	212	18,000	212	72,000	848
H1.2: Human resources	20,000	236	20,000	236	20,000	236	20,000	236	80,000	942
H1.3: Instructive handbooks	35,000	412	35,000	412	35,000	412	35,000	412	140,000	1649
H1.4: Per diem/transportation	339,990	4,005	339,990	4,005	339,990	4,005	339,990	4,005	1,359,960	16,018
H1.5: Refreshments	6,000	71	6,000	71	6,000	71	6,000	71	24,000	283
H2: Brief counselling costs	**12,816,349**	**150,958**	**4,246,117**	**50,013**	**10,281,334**	**121,099**	**9,428,262**	**111,051**	**36,772,062**	**433,122**
H2.1: Tobacco	9,272,756	109,220	3,072,108	36,185	7,438,647	87,617	6,821,441	80,347	26,604,952	313,368
Provider time to administer 5A's	*3,807,374*	*44,845*	*1,261,401*	*14,857*	*3,054,293*	*35,975*	*2,800,870*	*32,990*	10,923,938	128,668
Informational materials (print)	*5,465,382*	*64,374*	*1,810,707*	*21,328*	*4,384,354*	*51,641*	*4,020,572*	*47,357*	15,681,014	184,700
H2.2: Alcohol	933,641	10,997	309,320	3,643	748,971	8,822	686,827	8,090	2,678,759	31,552
Provider time to administer 5A's	*383,351*	*4,515*	*127,006*	*1,496*	*307,526*	*3,622*	*282,010*	*3,322*	1,099,893	12,955
Informational materials (print)	*550,290*	*6,482*	*182,314*	*2,147*	*441,445*	*5,200*	*404,817*	*4,768*	1,578,866	18,597
H2.3: Physical inactivity	2,609,952	30,741	864,689	10,185	2,093,715	24,661	1,919,994	22,615	7,488,350	88,202
Provider time to administer 5A's	1,071,641	*12,622*	355,040	*4,182*	859,675	*10,126*	788,345	*9,286*	3,074,701	36,216
Informational materials (print)	1,538,311	*18,119*	509,650	*6,003*	1,234,040	*14,535*	1,131,648	*13,329*	4,413,649	51,986
H3: Other program costs	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**400,000**	**4,711**
Community awareness meetings	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	200,000	2,356
Community health workers training	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	*50,000*	*589*	200,000	2,356
E: Evidence-based Treatment Protocols	**35,959,415**	**423,550**	**11,913,524**	**140,324**	**28,846,806**	**339,774**	**26,453,304**	**311,582**	**103,173,049**	**1,215,230**
E1: Ask about patient history - provider time	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
E2: Assess via physical exam and diagnostic tests - provider time	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
E3: Return visits - Counsel and treat per protocol - provider time	25,324,748	298,289	8,390,209	98,825	20,315,628	239,289	18,629,982	219,434	72,660,567	855,837
A: Access to Essential Medicines and Technologies	**40,197,017**	**473,463**	**13,429,971**	**158,186**	**32,279,509**	**380,206**	**29,615,146**	**348,824**	**115,521,643**	**1,360,679**
A1: Hypertension medications	40,028,765	471,481	13,261,719	156,204	32,111,257	378,224	29,446,893	346,842	114,848,633	1,352,752
Amlodipine 5mg	9,873,894	116,300	3,271,268	38,531	7,920,882	93,297	7,263,664	85,556	28,329,707	333,683
Losartan 50mg	30,016,637	353,553	9,944,653	117,134	24,079,482	283,622	22,081,538	260,089	86,122,310	1,014,397
Hydrochlorothiazide 12.5mg	138,235	1,628	45,798	539	110,892	1,306	101,691	1,198	396,616	4,672

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	**USD**	**BDT**	**USD**	**BDT**	**USD**	**BDT**	**USD**	**BDT**	**USD**
A2: Diagnostic technologies, machines, and supplies	40,028,765	471,481	13,261,719	156,204	32,111,257	378,224	29,446,893	346,842	114,848,633	1,352,752
R: Risk-based Management	**172,334**	**2,030**	**172,334**	**2,030**	**172,334**	**2,030**	**172,334**	**2,030**	**689,336**	**8,119**
R1: Training costs	172,334	2,030	172,334	2,030	172,334	2,030	172,334	2,030	689,336	8,119
T: Team-based care Savings from training nurses and CHWs to do tasks customarily performed by doctors	**13,815,043**	**162,721**	**4,576,989**	**53,910**	**11,082,490**	**130,536**	**10,162,944**	**119,705**	**39,637,467**	**466,872**
T1: Savings from training nurses	11,976,134	141,062	3,967,750	46,734	9,607,309	113,160	8,810,163	103,771	34,361,355	404,727
Savings from counselling to change behavior	1,355,873	15,970	449,207	5,291	1,087,688	12,811	997,439	11,748	3,890,208	45,821
Savings from screening for--and assess--CVD risk	3,367,235	39,661	1,115,581	13,140	2,701,212	31,816	2,477,084	29,176	9,661,112	113,794
Savings from treating CVD risk	7,253,025	85,430	2,402,961	28,303	5,818,410	68,533	5,335,639	62,846	20,810,036	245,112
T2: Savings from training CHWs	1,838,909	21,660	609,239	7,176	1,475,181	17,376	1,352,781	15,934	5,276,112	62,145
Savings from counselling to change behavior	1,838,909	21,660	609,239	7,176	1,475,181	17,376	1,352,781	15,934	5,276,112	62,145
S: Systems for monitoring	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**12,458,546**	**146,744**
S1: Human resources	**2,969,636**	**34,978**	**2,969,636**	**34,978**	**2,969,636**	**34,978**	**2,969,636**	**34,978**	**11,878,546**	**139,912**
S2: Technology	**110,000**	**1,296**	**110,000**	**1,296**	**110,000**	**1,296**	**110,000**	**1,296**	**440,000**	**5,183**
S3: Supplies	**10,000**	**118**	**10,000**	**118**	**10,000**	**118**	**10,000**	**118**	**40,000**	**471**
S4: Training	**25,000**	**294**	**25,000**	**294**	**25,000**	**294**	**25,000**	**294**	**100,000**	**1,178**
Total Program Cost (H+E+A+R+T+S)	**92,778,742**	**1,092,800**	**33,395,573**	**393,352**	**75,213,609**	**885,908**	**69,302,672**	**816,286**	**270,690,596**	**3,188,346**

[Insert Figure 2 here]

Figure 2: Distribution of annual cost by HEARTS components

Most of the projected annual cost (95%) of implementing Module 'H' (Healthy-lifestyles counselling) was attributable to the cost of provider time and information materials for counselling patients (USD 433,000). The estimated cost for Module 'E' (Evidence-based treatment protocols) was attributable to provider time across three major activities: asking patient history (USD 180,000; 15%), patient assessment via physical exam and diagnostic tests (USD 180,000; 15%), and conducting return visits (USD 856,000, 70%). The projected cost to implement Module 'S' (Systems for monitoring) was USD 147,000, primarily attributed to administration staff labor costs (95%), with the remaining cost allocated to technology (software/hardware).

Table 4 highlights an important programmatic aspect by describing health providers' time needed to implement the hypertension control program. Implementing the program at the full population level in all four sub-districts was estimated to require the full time equivalent of 51 doctors, 51 nurses, and 6 community health workers. The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

Table 4: Hypertension control program: estimated health provider time for counselling, screening, diagnosis, and treatment

Activity	Golapganj		Fenchugonj		Beanibazar		Bishwanath		Total
	Workdays	**FTE**	Workdays	FTE	**Workdays**	**FTE**	Workdays	FTE	**FTE**
Counselling to change behavior									
Doctor	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Nurses	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
CHW	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Screening and diagnosis									
Doctor	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Nurses	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Return visits - Counsel and treat per protocol									
Doctor	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	31.0
Nurses	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	31.0

Note: FTE: Full-time equivalent (annual: total minutes/124800).

3.3. Risk-based integrated hypertension, diabetes, and high cholesterol management program cost

Table 5 reports the estimated costs of implementing the risk-based hypertension, diabetes, and high cholesterol management program in four upazilas at the population level (adults aged 18 and above). Figure 2 presents the distribution of costs by HEARTS components**.** The total annual cost was estimated at USD 14.4 million, equivalent to USD 12.9 per capita, USD 19.3 per adult, and USD 40.2 per eligible participant. Module 'A' (Access to medicines and technology) constitutes the largest cost share (USD 11.7 million; 81%), followed by Module 'E' (Evidence-based treatment protocols, USD 1.9 million; 13%). Within Module 'A', the projected costs of diagnostic tests, hypertension medications, diabetes medications, and cholesterol medications were USD 5.7 million (49% of module costs), USD 1.4 million (12%), USD 0.9 million (7%), and USD 3.8 million (32%), respectively. The projected medication expenditure per patient treated with medications for hypertension, diabetes, and cholesterol was USD 18, USD 29, and USD 37, respectively.

Table 5: Annual cost of implementing risk-based hypertension, diabetes, and high cholesterol management program in four sub-districts

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy Lifestyles Counselling	**13,335,339**	**121,116**	**4,765,107**	**56,126**	**10,800,324**	**127,212**	**9,947,252**	**117,164**	**38,848,022**	**457,574**
H1: Training costs	**418,990**	**4,287**	**418,990**	**4,935**	**418,990**	**4,935**	**418,990**	**4,935**	1,675,960	19,740
H1.1: Facility rental (% of H1)	18,000	212	18,000	212	18,000	212	18,000	212	72,000	848
H1.2: Human resources	20,000	236	20,000	236	20,000	236	20,000	236	80,000	942
H1.3: Instructive handbooks	35,000	353	35,000	412	35,000	412	35,000	412	140,000	1,649
H1.4: Per diem/transportation	339,990	3,416	339,990	4,005	339,990	4,005	339,990	4,005	1,359,960	16,018
H1.5: Refreshments	6,000	71	6,000	71	6,000	71	6,000	71	24,000	283
H2: Brief counselling costs	**12,816,349**	**115,651**	**4,246,117**	**50,013**	**10,281,334**	**121,099**	**9,428,262**	**111,051**	**36,772,062**	**433,122**
H2.1: Tobacco	9,272,756	83,675	3,072,108	36,185	7,438,647	87,617	6,821,441	80,347	26,604,952	313,368
Provider time to administer 5A's	*3,807,374*	*30,030*	*1,261,401*	14,857	*3,054,293*	35,975	*2,800,870*	32,990	10,923,938	128,668
Informational materials (print)	*5,465,382*	*53,645*	*1,810,707*	21,328	*4,384,354*	51,641	*4,020,572*	47,357	1,5681,014	184,700
H2.2: Alcohol	933,641	8,425	309,320	3,643	748,971	8,822	686,827	8,090	2,678,759	31,552
Provider time to administer 5A's	*383,351*	*3,024*	*127,006*	1,496	*307,526*	3,622	*282,010*	3,322	1,099,893	12,955
Informational materials (print)	*550,290*	*5,401*	*182,314*	2,147	*441,445*	5,200	*404,817*	4,768	1,578,866	18,597
H2.3: Physical inactivity	2,609,952	23,552	864,689	10,185	2,093,715	24,661	1,919,994	22,615	7,488,350	88,202
Provider time to administer 5A's	*1,071,641*	*8,452*	*355,040*	*4,182*	*859,675*	*10,126*	*788,345*	*9,286*	*3,074,701*	*36,216*
Informational materials (print)	*1,538,311*	*15,099*	*509,650*	*6,003*	*1,234,040*	*14,535*	*1,131,648*	*13,329*	*4,413,649*	*51,986*
H3: Other program costs	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**100,000**	**1,178**	**400,000**	**4,711**
Community awareness meetings	*50,000*	*589*	*50,000*	589	*50,000*	589	*50,000*	589	200,000	2,356
Community health workers training	*50,000*	*589*	*50,000*	589	*50,000*	589	*50,000*	589	200,000	2,356
E: Evidence-based Treatment Protocols	**56,155,264**	**661,428**	**18,604,504**	**219,134**	**45,048,007**	**530,601**	**41,310,245**	**486,575**	**161,118,020**	**1,897,739**
E1: Ask about patient history - provider time	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
E2: Assess via physical exam and diagnostic tests - provider time	25,513,182	300,509	8,452,638	99,560	20,466,790	241,069	18,768,602	221,067	73,201,212	862,205
E3: Return visits - Counsel and treat per protocol - provider time	25,324,748	298,289	8,390,209	98,825	20,315,628	239,289	18,629,982	219,434	72,660,567	855,837
A: Access to Essential Medicines and tech.	**347,102,943**	**4,088,374**	**115,109,353**	**1,355,823**	**278,480,835**	**3,280,104**	**255,388,440**	**3,008,109**	**996,081,571**	**11,732,410**
A1: Diagnostic tests	170,039,655	2,002,823	56,334,940	663,545	136,406,582	1,606,674	125,088,536	1,473,363	487,869,714	5,746,404
Complete blood count (panel)	51,527,168	606,916	17,071,194	201,074	41,335,328	486,871	37,905,617	446,474	147,839,307	1,741,335
Blood lipid panel	103,054,336	1,213,832	34,142,388	402,148	82,670,656	973,742	75,811,234	892,947	295,678,614	3,482,669
Fasting blood glucose (FPG)	15,458,150	182,075	5,121,358	60,322	12,400,598	146,061	11,371,685	133,942	44,351,792	522,400

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
A2: Hypertension medications	40,028,765	471,481	13,261,719	156,204	32,111,257	378,224	29,446,893	346,842	114,848,633	1,352,752
Amlodipine 5mg	9,873,894	116,300	3,271,268	38,531	7,920,882	93,297	7,263,664	85,556	28,329,707	333,683
Losartan 50mg	30,016,637	353,553	9,944,653	117,134	24,079,482	283,622	22,081,538	260,089	86,122,310	1,014,397
Hydrochlorothiazide 12.5mg	138,235	1,628	45,798	539	110,892	1,306	101,691	1,198	396,616	4,672
A3: Diabetes medications	25,366,503	298,781	8,404,042	98,988	20,349,124	239,683	18,660,698	219,796	72,780,367	857,248
Metformin 500mg	11,707,617	137,899	3,878,789	45,687	9,391,903	110,623	8,612,630	101,444	33,590,939	395,653
Metformin 1000mg	12,292,998	144,794	4,072,728	47,971	9,861,498	116,154	9,043,262	106,517	35,270,486	415,436
Gliclazide	1,365,889	16,088	452,525	5,330	1,095,722	12,906	1,004,807	11,835	3,918,943	46,160
A4: Cholesterol medications	111,499,768	1,313,307	36,940,399	435,105	89,445,620	1,053,541	82,024,060	966,126	319,909,847	3,768,078
Simvastatin 10mg	79,451,930	935,830	26,322,800	310,045	63,736,699	750,727	58,448,282	688,437	227,959,711	2,685,038
Atorvastatin 20mg	13,353,266	157,282	4,424,000	52,108	10,712,050	126,173	9,823,241	115,704	38,312,556	451,267
Atorvastatin 40mg	18,694,572	220,195	6,193,600	72,952	14,996,870	176,642	13,752,537	161,985	53,637,579	631,774
A5: Diagnostic tech. machines, and supplies	168,253	1,982	168,253	1,982	168,253	1,982	168,253	1,982	673,010	7,927
R: Risk-based Management	5,489,668	64,660	1,933,992	22,780	4,437,923	52,272	4,083,995	48,104	15,945,577	187,816
R1: Training costs	172,334	2,030	172,334	2,030	172,334	2,030	172,334	2,030	689,336	8,119
R2: Estimate risk using risk charts	5,317,334	62,631	1,761,658	20,750	4,265,589	50,243	3,911,661	46,074	15,256,241	179,697
T: Team-based care: Savings from training nurses and CHWs to do tasks customarily performed by doctors	**25,600,367**	**301,536**	**8,481,523**	**99,900**	**20,536,731**	**241,893**	**18,832,739**	**221,823**	**73,451,360**	**865,151**
T1: Savings from training nurses	23,761,458	279,876	7,872,283	92,724	19,061,549	224,518	17,479,958	205,889	68,175,248	803,006
Savings from counselling to change behavior	1,355,873	15,970	449,207	5,291	1,087,688	12,811	997,439	11,748	3,890,208	45,821
Savings from screening for--and assess--CVD risk	15,152,559	178,475	5,020,114	59,130	12,155,452	143,174	11,146,879	131,294	43,475,005	512,073
Savings from treating CVD risk	7,253,025	85,430	2,402,961	28,303	5,818,410	68,533	5,335,639	62,846	20,810,036	245,112
T2: Savings from training CHWs	1,838,909	21,660	609,239	7,176	1,475,181	17,376	1,352,781	15,934	5,276,112	62,145
Savings from counselling to change behavior	1,838,909	21,660	609,239	7,176	1,475,181	17,376	1,352,781	15,934	5,276,112	62,145
S: Systems for monitoring	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**3,114,636**	**36,686**	**12,458,546**	**146,744**
S1: Human resources	2,969,636	34,978	2,969,636	34,978	2,969,636	34,978	2,969,636	34,978	11,878,546	139,912
S2: Technology	110,000	1,296	110,000	1,296	110,000	1,296	110,000	1,296	440,000	5,183
S3: Supplies	10,000	118	10,000	118	10,000	118	10,000	118	40,000	471
S4: Training	25,000	294	25,000	294	25,000	294	25,000	294	100,000	1,178
Total Program Cost (H+E+A+R+T+S)	**425,197,850**	**5,008,220**	**143,527,592**	**1,690,549**	**341,881,725**	**4,026,875**	**313,844,568**	**3,696,638**	**1,224,451,735**	**14,422,282**

The adoption of task-sharing approach would save USD 865,000, of which USD 803,000 comes from using nurses to complete tasks customarily performed by doctors (i.e., counselling, screening, and assessing CVD risk, and treating according to CVD risk) and USD 62,000 comes from using CHWs to provide counselling to change behavior. Implementing the risk-based hypertension, diabetes, and high cholesterol management program at the full population level in all four sub-districts was estimated to require the full time equivalent of 58 doctors, 58 nurses, 6 CHWs, and 101 lab technicians (Table 6). The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

Table 6: Integrated risk-based approach: estimated health provider time for counselling, screening, diagnosis, and treatment

Activity	Golapganj		Fenchugonj		Beanibazar		Bishwanath		Total
	Workdays	**FTE**	Workdays	FTE	**Workdays**	**FTE**	Workdays	FTE	**FTE**
Counselling to change behavior									
Doctor	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Nurses	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
CHW	524 days, 7 hours	2.0	173 days, 6 hours	0.7	420 days, 2 hours	1.6	385 days, 2 hours	1.5	**5.8**
Screening and diagnosis									
Doctor	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Nurses	1,302 days, 1 hours	5.0	431 days, 6 hours	1.7	1,045 days, 2 hours	4.0	958 days, 3 hours	3.7	**14.4**
Screening and diagnosis by Lab technicians	9,119 days, 3 hours	35.1	3,021 days, 6 hours	11.6	7,315 days, 0 hours	28.1	6,708 days, 1 hours	25.8	**100.6**
Estimating CVD risk using risk charts									
Doctor	2,658,667	2.5	880,829	0.8	2,132,795	2.0	1,955,830	1.8	**7.2**
Nurses	2,658,667	2.5	880,829	0.8	2,132,795	2.0	1,955,830	1.8	**7.2**
Return visits - Counsel and treat per protocol									
Doctor	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	31.0
Nurses	2,806 days, 0 hours	10.8	929 days, 6 hours	3.6	2,251 days, 1 hours	8.7	2,064 days, 2 hours	7.9	31.0

4. Discussion

The HEARTS pilot project in four Bangladesh sub-districts launched a framework for hypertension management in primary care, with a potential for expanding into a comprehensive CVD prevention approach that incorporates hypertension, diabetes, and cholesterol management. This study projects the expected cost of scaling up the program to all eligible adults in the participating sub-districts. We assessed two program scenarios: a hypertension management program and an integrated risk-based hypertension, diabetes, and cholesterol management program. The total annual cost was estimated at USD 3.2 and 14.4 million USD for the hypertension and risk-based comprehensive approach, respectively. The overall per capita cost was approximately USD 2.8 per capita for the hypertension control program and USD 12.9 per capita for the risk-based comprehensive approach. These estimates correspond to 0.14% and 0.7% of the 2020 gross domestic product per capita in Bangladesh, respectively. The main cost drivers for the hypertension control program were medication expenditures (43%) and the cost of provider time for providing care during multiple visits (38%). In the risk-based integrated approach, the combined costs of hypertension, diabetes, and cholesterol medications and diagnostic tests make up the largest share of the overall program cost (81%). Although the main driver of projected program costs for the integrated approach was expenditure on essential medicines and diagnostic tests, hypertension and diabetes medications contributed a relatively small portion (19%) to this expenditure (i.e., Module A), whereas cholesterol medications contributed nearly 32%. Hypertension treatment remains among the leading cost-effective ways to combat heart disease. In this study, the annual medication expenditure per patient treated with medications for hypertension, diabetes, and cholesterol was USD 18, USD 29, and USD 37, respectively.

Though based on observations gathered in one district of Bangladesh, our results are consistent with those reported by past studies. A previous study on Bangladesh by Nugent et al. (2017) estimated that hypertension treatment would cost about USD 13 (BDT 1,070) per patient per year.[31] WHO (2011) has estimated the average hypertension screening cost for LMICs at approximately USD 4 for LMICs, not including treatment but including the cost of performing CVD risk assessment and BP measurement in primary care settings.[32] Haque (2016) estimated the average cost of diabetes screening in Bangladesh at approximately USD 5 (BDT 411), including glucose screening in primary care, documentation, setting up referrals, and organizing screening events but excluding treatment.[33] In this study, the cost elements in the Bangladesh HEARTS program are wide-ranging including screening, diagnosis, and treatment for multiple CVD risk conditions (hypertension, diabetes, hyperlipidemia) and counseling for CVD risk factors (tobacco use, alcohol use, and physical inactivity).

The analysis revealed that scaling up the hypertension management program within the four sub-districts would require an additional full-time equivalent of 51 doctors, 51 nurses, and 6 CHWs. Population-level scale-up of the risk-based hypertension, diabetes, and high cholesterol management program in the four sub-districts was estimated to require the full time equivalent of 58 doctors, 58 nurses, 6 CHWs, and 101 lab technicians. To put this in context, a typical 50-bed sub-district public health complex in Bangladesh employs 20 doctors, 16 nurses, and one medical assistant. Oftentimes, not all health provider posts are filled. This gap in provider capacity poses a significant barrier to program expansion. Team-based care using task-sharing among doctors, nurses and community health workers and volunteers can accomplish the activities required by the HEARTS package more affordably, including NCD-related health promotion, prevention, screening, and patient navigation through the health system. A systematic review of intervention trials in low- and middle-income countries by Joshi et al. (2014) found that team-based care, including task sharing was effective in improving process outcomes (e.g., hypertension and diabetes screening) and health outcomes (e.g., hypertension and diabetes control), and achieving treatment concordance with doctors.[34, 16] Krishnan et al. (2019) conducted a study on a community-based hypertension management program of blood pressure monitoring and lifestyle counselling intervention undertaken by female community health volunteers (FCHVs) in Nepal, and assessed the intervention to be highly cost-effective.[35] However, there are several barriers to team-based care with task sharing, including staff attrition and turnover, retention of training, patient perception and acceptance toward non-physician health workers, lack of delegation of work by physicians, legislation and policy etc. [36]

In Bangladesh, of the four entities (i.e., the government, for-profit private sector, non-profit nongovernmental organization, and donor agencies) involved in the primary healthcare provision, the government plays the leading role, mainly in rural areas. There are six tiers of public healthcare infrastructure: national, divisional, district, upazila (sub-district), union, and ward levels. To tackle NCDs, the government of Bangladesh introduced ‘NCD Corners’ initiative in 2012 dedicated to providing prevention and care services for common NCDs and related conditions. The government has plans to expand ‘NCD corners’ at the upazila level, and the upazila primary care setting is well-positioned to bridge the link the health care providers down to the union, ward (and community) levels by harnessing community support and delegating suitable activities under task-sharing principles.[16, 37, 38] This will enhance healthcare access among disadvantaged populations and mitigate health disparities. Further, in Bangladesh, according to the 2016 Household Income Expenditure Survey and 2014 Health and Morbidity Status Survey, one in three patients received treatment from a pharmacy or medical shop, while about one in five received treatment from public health providers.[39, 40] This emphasizes the need for partnerships with various types of public-private health providers.

The models of care introduced in the Bangladesh national hypertension guidelines and NCD operational plan are encouraging; however, there are capacity challenges to the scaling-up of NCD care in Bangladesh.[41, 42] The fiscal year 2021 budget allocation to the health sector stands just above 5%, which is less than 1% of GDP. Further, less than 5% of public sector funding for health covers NCDs, despite NCDs being responsible for almost two-thirds (63% in 2016) of disability-adjusted life years (DALYs) in Bangladesh.[16] The per capita NCD allocation is only USD 0.08.[16] There is a need for better coordination of non-state stakeholders in NCD control with the public sector with a stronger focus of the public sector on NCD prevention and health promotion.[16] The health sector in Bangladesh is financed 93% from domestic sources (74% out-of-pocket, 17% government health expenditure, and 3% other private sources) and 7% from external health expenditures. Domestic general government health expenditure per capita is only USD 7 (0.4% of GDP per capita).[43] Due to insufficient public sector funding, out-of-pocket expenditure for NCD care is large in Bangladesh, contributing to the impoverishment of patients and their families. Moreover, a recent policy review by Biswas et al (2017) highlights the lack of proper planning, implementation, and monitoring of NCD health initiatives.[44] However, the Bangladesh Copenhagen Project assessed the benefits of managing hypertension through targeted investment and reported a high level of return on investment (BDT 17 benefit for every BDT spent).[31]

This report has several limitations. Due to lack of data at a local level, the cost projections rely on assumptions regarding population coverage, risk factor prevalence, primary care attendance rate, and frequency of patient visits by CVD risk, which were assumed to be uniform for the four sub-districts and across age or sex groups. Similarly, unit costs of supplies, wages, and provider time allocations were assumed to be the same across sub-districts. Since the examined sub-districts are adjacent to each other, these unit costs may not be considerably different. While we used average medicine prices, they may vary in different sub-districts depending on the procurement arrangement and sources. However, in Bangladesh, the price variations are minimal or low in the public health facilities, given the medicines are procured mainly from EDCL and/or CMSD.[19, 20] The strength of the study lies in its ability to disaggregate costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging program delivery from the upazila level to more localized community facilities.

In 2018, the Government of Bangladesh introduced a multisectoral action plan for NCD prevention and control, which emphasizes NCD risk factors including tobacco use, unhealthy diet, physical inactivity, and harmful use of alcohol.[42] This study can inform approaches to scaling up this action plan nationally, with the goal of increasing population outreach for CVD prevention at the primary care level.

Using the costs reported in this study for future cost-effectiveness analyses can further support evidence-based decision making for CVD prevention programs in Bangladesh.

5. Conclusion

Expanding the HEARTS hypertension management and CVD prevention program to provide services to the entire eligible population in the catchment area may face constraints in physician capacity. A task-sharing model involving shifting of select tasks from doctors to nurses and local community health workers would be essential for the eventual scale-up of primary care services to prevent CVD in Bangladesh.

Disclaimer

The findings and conclusions of this report are those of authors only and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Author Contribution

MJH and MSH conceptualized the study, led the formal analysis, implemented the methodology and the excel-based costing tool, and wrote the draft manuscript. DK, SRC, MRB, AEM contributed to the study concept, analytical aspects, manuscript write-up and critical review. RT and SJ contributed to data collection and critical review of the manuscript. MJH, MSH, SRC, RT, SJ, and MRB contributed to data collection. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

Ethics Approval

Ethics approval was not required because this research neither involved human or animal participation nor required consent from human participants.

Conflict of Interest

The authors declare non conflict of interest

Data Statement

The study used publicly available secondary data sources. No proprietary data were used for the analysis.

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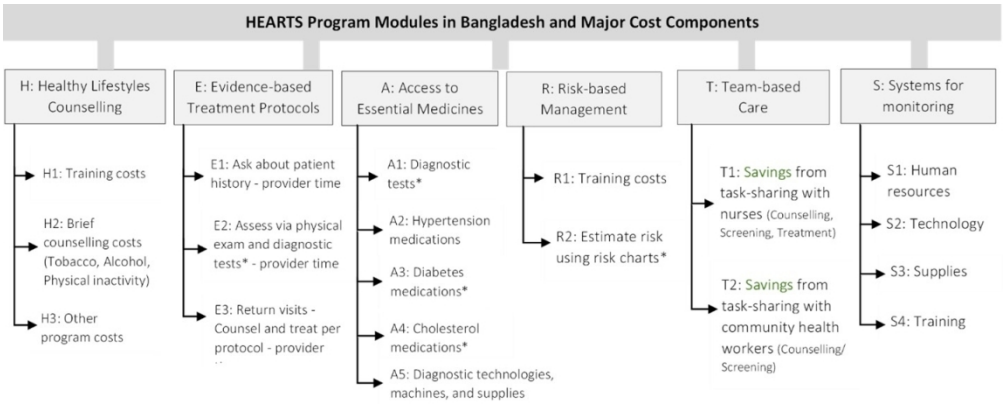
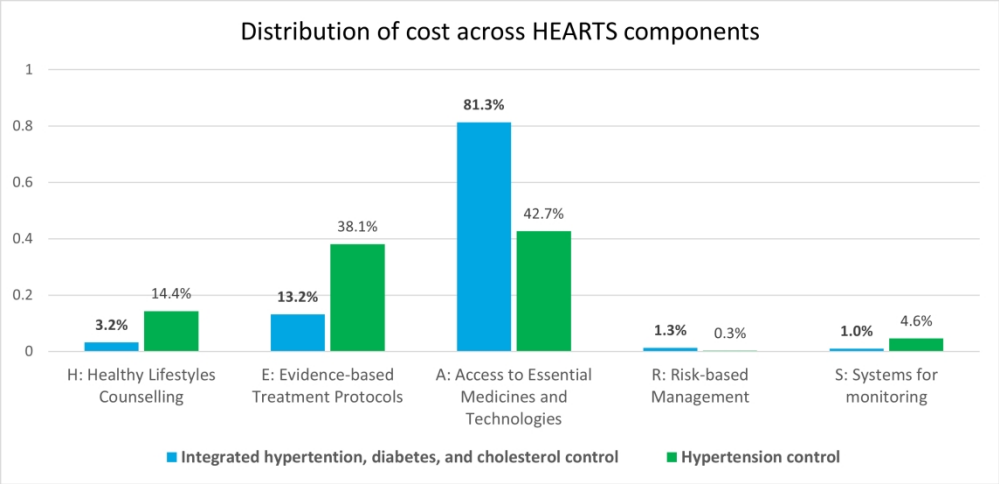


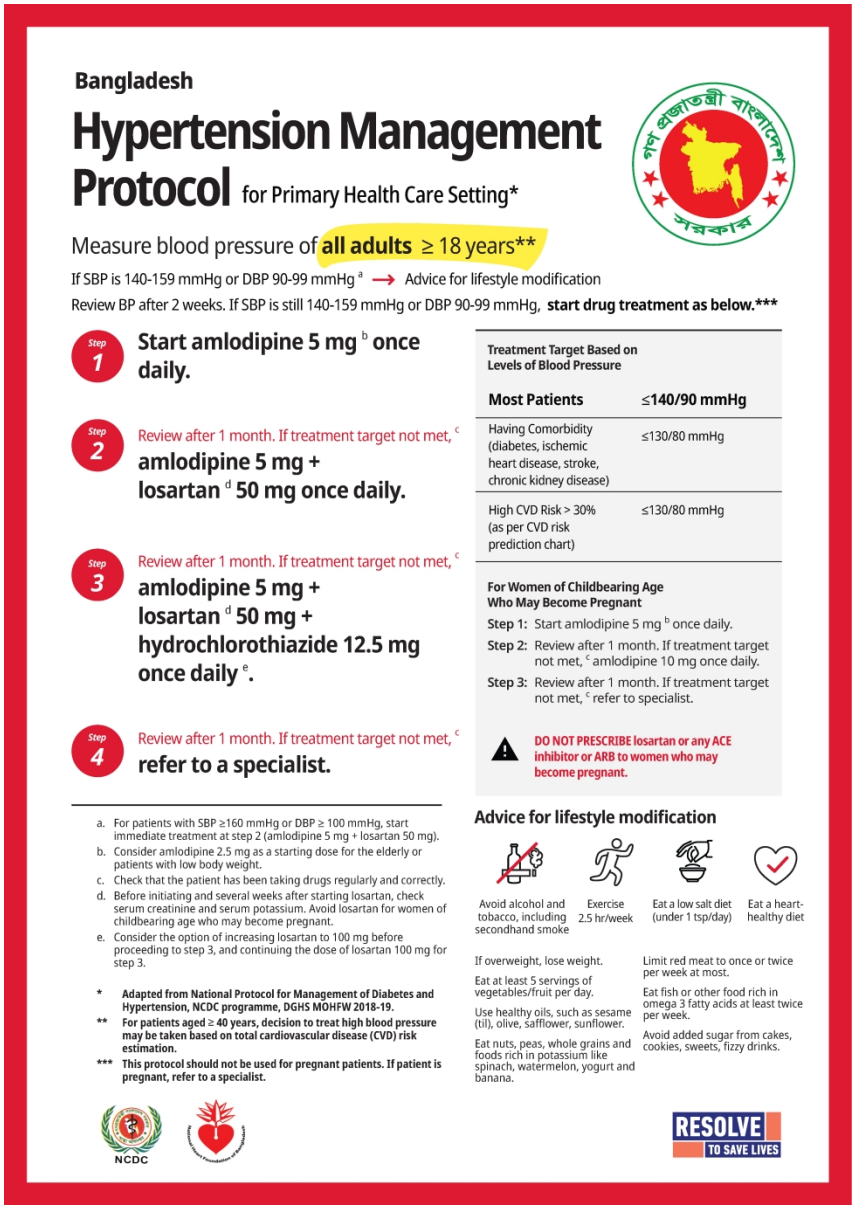
Cost components of the HEARTS program in Bangladesh

165x67mm (220 x 220 DPI)



Distribution of annual cost by HEARTS components

495x240mm (130 x 130 DPI)



533x753mm (173 x 173 DPI)