






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

Muhammad Jami Husain <sup>1</sup>, Mohammad Sabbir Haider <sup>2</sup>, Renesa Tarannum,<sup>3</sup> Shamim Jubayer <sup>3</sup>, Mahfuzur Rahman Bhuiyan <sup>3</sup>, Deliana Kostova <sup>1</sup>, Andrew E Moran,<sup>4</sup> Sohel Reza Choudhury<sup>3</sup>

**To cite:** Husain MJ, Haider MS, Tarannum R, *et al*. Cost of primary care approaches for hypertension management and risk-based cardiovascular disease prevention in Bangladesh: a HEARTS costing tool application. *BMJ Open* 2022;**12**:e061467. doi:10.1136/bmjopen-2022-061467

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-061467>).

Received 27 January 2022

Accepted 03 June 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

## Correspondence to

Dr Muhammad Jami Husain; [MHusain@cdc.gov](mailto:MHusain@cdc.gov)

## ABSTRACT

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

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

**Design** Data obtained during July–August 2020 from subdistrict health complexes on the cost of medications, diagnostic materials, staff salaries and other programme components.

**Methods** Programme 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 programme from the health system perspective.

**Primary and secondary outcome measures** Programme cost, provider time.

**Results** The total annual cost for the hypertension control programme was estimated at US\$3.2 million, equivalent to US\$2.8 per capita or US\$8.9 per eligible patient. The largest cost share (US\$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 programme was projected at US\$14.4 million, entailing US\$12.9 per capita or US\$40.2 per eligible patient. The estimated annual costs per patient treated with medications for hypertension, diabetes and cholesterol were US\$18, US\$29 and US\$37, respectively.

**Conclusion** Expanding the HEARTS hypertension management and CVD prevention programme 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.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study uses the HEARTS costing tool to assess the expected cost of scaling up the programme to all eligible adults in the participating subdistricts (upazila).
- ⇒ The study assesses two programme scenarios: a hypertension management programme and an integrated risk-based hypertension, diabetes and cholesterol management programme.
- ⇒ The study disaggregates costs by function, identifying areas for efficiency improvements, such as task-sharing and bridging programme delivery from the upazila level to more localised 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 cardiovascular disease (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 subdistricts depending on the procurement arrangements and operational efficiency.

## 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.<sup>1</sup> Among people with hypertension worldwide, fewer than one in five have it under control.<sup>1</sup> High blood pressure (BP) is a leading global risk factor for premature death and disability, accounting for about 10 million (or 1 in 6) deaths worldwide each year.<sup>2 3</sup> Uncontrolled hypertension significantly increases the risk of stroke, myocardial infarction, heart failure, dementia,

renal failure, retinopathy and other diseases.<sup>4–7</sup> Almost half of all CVD events are attributable to uncontrolled hypertension.<sup>2,3</sup>

Reducing the prevalence of hypertension is a standing global health objective.<sup>8–11</sup> This objective complements the 2030 Sustainable Development Goal of reducing premature deaths from non-communicable diseases (NCDs) by 25%.<sup>12</sup> Low-income 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 BP (SBP and/or DBP  $\geq$  140/90 mm Hg) among adults in Bangladesh was 21%.<sup>13–15</sup> 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 BP levels under control.<sup>16</sup> The burden of hypertension in Bangladesh is expected to grow alongside increased population ageing, rapid urbanisation with commensurate increases in sedentary lifestyle and processed food consumption, and other socioeconomic and lifestyle changes. However, only less than 5% of the health sector programme budget is allocated for NCDs control.<sup>16</sup> 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.<sup>17</sup> 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 hyperlipidaemia. In this paper, we describe the local budgetary impact of implementing the HEARTS programme at the population level for four subdistricts in Bangladesh, based on programme cost data obtained from a representative healthcare facility in each subdistrict. Although the initial focus of the programme in the four subdistricts 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.

## METHODS

### Setting

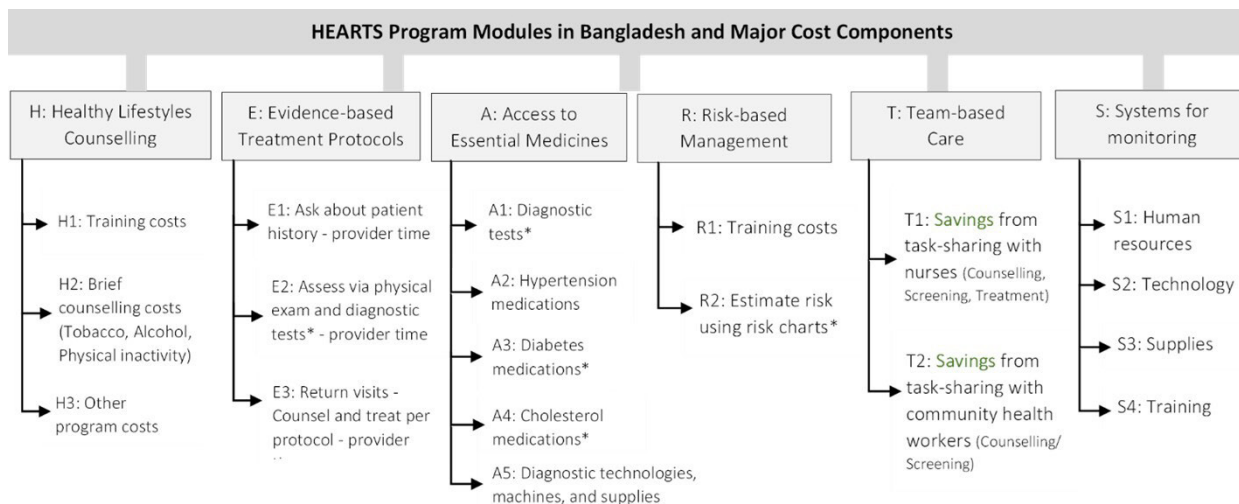
In 2018, the Directorate General of Health Services and the National Heart Foundation of Bangladesh collaborated with Resolve to Save Lives (an initiative of Vital Strategies, a non-profit global public health organisation) to implement a pilot programme to strengthen the detection, treatment and follow-up management of hypertension in primary care. The programme was introduced in four health complexes in four subdistricts (upazilas) in the Sylhet district: Golapganj, Fenchuganj, Beanibazar and Bishwanath. In Bangladesh, hospitals and health facilities that are in the subdistrict (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 100 000–400 000 population and plays a pivotal role in the provision of primary healthcare 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 (inpatient, outpatient, limited diagnostic services), management, technical support, training, coordination and patient referral services. The outpatient service is usually staffed with five outpatient general practitioners including one resident medical officer, two medical officers and two medical assistants. An 'NCD corner' was set up in the outpatient with necessary logistics and personnel for screening and treatment. We project programme costs under two intervention scenarios: a hypertension-focused programme, and a risk-based integrated hypertension, diabetes and cholesterol management programme.

### Patient and public involvement

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

### Hypertension management program

The HEARTS Technical Package for CVD prevention in primary care is organised 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.<sup>18</sup> 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 systolic blood pressure (SBP)/diastolic blood pressure (DBP)  $\geq$  140/90 mm Hg, or SBP/DBP  $\geq$  130/80 mm Hg with comorbidity or high CVD-risk)



**Figure 1** Cost components of the HEARTS programme in Bangladesh.

entailed a first line of treatment with amlodipine 5 mg daily; a second line of treatment using amlodipine 5 mg plus losartan 50 mg daily; and a third line of treatment using amlodipine 5 mg plus losartan 50 mg plus hydrochlorothiazide 12.5 mg daily. Online supplemental 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.<sup>19 20</sup> 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 BP, point-of-care testing to assess fasting blood glucose and cholesterol levels and urine dipstick for proteinuria, encourage behaviour change, assess CVD risk or initiate treatment protocol. The training sessions were conducted in one setup with a pool of selected doctors, nurses and community health workers (CHWs) trained with relevant modules. In this approach, CHWs 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.

### Risk-based integrated hypertension, diabetes and hyperlipidaemia management programme

To further strengthen CVD prevention, the HEARTS programme in Bangladesh also planned to integrate diabetes and hyperlipidaemia management in addition to hypertension management in primary care patients. The programme entails assessment of target population by total CVD risk estimation to categorise 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 ( $\geq 20\%$ ).<sup>21</sup> The treatment protocol for patients with uncomplicated type two diabetes (defined as fasting plasma glucose  $\geq 7.0$  mmol/L or routine plasma glucose  $\geq 11.1$  mmol/L or HbA1C  $\geq 6.5\%$ ) 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 Healthcare.<sup>22</sup> For managing plasma lipid levels (ie, high cholesterol), the use of statins as the primary therapy is widely recommended, however, the WHO is yet to offer any specific guidance.<sup>23</sup> For costing, the local consultants and experts proposed a statin-based treatment protocol for hyperlipidaemia 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 hyperlipidaemia 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.

### HEARTS costing tool

Programme 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 programme from the health system perspective. The tool is organised by HEARTS modules.<sup>24</sup> 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 programme at the subdistrict 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 programme 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.

The cost elements in the Healthy-lifestyle counselling module 'H' included costs of training providers in lifestyle counselling and costs of community awareness programmes and training. Counselling is based on the Assess, Advise, Agree, Assist, Arrange model, which is an evidence-based approach for promoting healthy behavioural changes to prevent NCD risk factors.<sup>25 26</sup> Total provider time to administer brief counselling was equal to the average time that the health provider spends to counsel a patient to change behaviour 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 (ie, in the absence of task-sharing allocation), the costing tool assumes a physician-led programme. In our cost projections, we assumed that doctors, nurses and CHWs will equally share the tasks (ie, provider time) when applicable. For instance, CHWs would only provide behavioural counselling and screening service, but they would not assess CVD risk (using risk-chart), or prescribe patients with pharmacologic treatments. Accordingly, the provider time allocated for behaviour counselling and screening will be shared equally among doctors, nurses and CHWs. Nurses will be trained to do major tasks (ie, counselling, screening and assessing CVD risk, and treating according to CVD risk), therefore, providers' time for performing hypertension/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.

## Data

Data on salaries of government healthcare providers and programme 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 subdistricts was obtained from census and imputed based on Bangladesh Bureau of Statistics estimates. Other population parameters (eg, primary care attendance rate and risk factor prevalence) were obtained from the nationally representative NCD Risk Factor Survey 2018.<sup>15</sup> 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 subdistrict (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. Fifteen per cent of the adult population was estimated to be at medium and high risk for CVD. The leading risk factors were tobacco use (43.7%), hyperlipidaemia (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.<sup>15</sup> 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.<sup>27-30</sup> Local currency was converted to US dollars using the Bangladesh Bank official conversion rate in June 2020.

## RESULTS

### Population coverage

The total population in the four subdistricts 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 (ie, hypertension control and risk-based integrated approach) in the four subdistricts was determined by the primary care attendance rate, the prevalence of low-CVD, medium-CVD and high-CVD risk in the population, the

**Table 1** Costing inputs and unit costs

Input description	Units	Value
Eligible population (adult population, age 18+)		
Golapganj	Persons	261 098
Fenchuganj	Persons	86 503
Beanibazar	Persons	209 454
Bishwanath	Persons	192 075
Primary healthcare attendance rate (annual)	Per cent	47.9%
Adult population with risk factors		
Use of tobacco products	Per cent	43.7%
Hazardous or harmful use of alcohol	Per cent	4.4%
Physical inactivity	Per cent	12.3%
Hypertension ( $\geq 140/90$ mm Hg)	Per cent	21.0%
Diabetes ( $\geq 7.0$ mmol/L or 126 mg/dL)	Per cent	8.3%
Hyperlipidaemia ( $\geq 6$ mmol/L or 190 mg/dL)	Per cent	28.4%
Low CVD risk (0 to $<10\%$ )	Per cent	85.1%
Medium CVD risk (10 to $<20\%$ )	Per cent	14.4%
High CVD risk ( $\geq 20\%$ )	Per cent	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 (8555)
CHWs	BDT (USD)/year	486 568 (5731)
Lab technicians	BDT (USD)/year	576 720 (6793)
Accountant	BDT (USD)/year	576 720 (6793)
Administrative assistant	BDT (USD)/year	446 242 (5256)
Clerical officer	BDT (USD)/year	446 242 (5256)
Custodian	BDT (USD)/year	446 242 (5256)
IT personnel	BDT (USD)/year	446 242 (5256)
Programme director	BDT (USD)/year	1 399 452 (16 484)
Programme manager	BDT (USD)/year	726 300 (8555)
Secretary	BDT (USD)/year	446 242 (5256)
Security officer	BDT (USD)/year	400 196 (4714)
Pharmacist/chemist	BDT (USD)/year	576 720 (6,793)
Statistician	BDT (USD)/year	576 720 (6793)

Continued

Table 1 Continued

Input description	Units	Value
Supplies manager	BDT (USD)/year	486568 (5731)
Purchasing price (in LCU (BDT) and USD) of pharmaceutical drugs		
Hypertension medicine		
Amlodipine 5 mg	BDT (USD)/tablet	1 (0.012)
Losartan 50 mg	BDT (USD)/tablet	8 (0.094)
Hydrochlorothiazide	BDT (USD)/tablet	0.35 (0.004)
Diabetes medicine		
Metformin 500 mg	BDT (USD)/tablet	4 (0.047)
Metformin 1000 mg	BDT (USD)/tablet	9 (0.106)
Gliclazide	BDT (USD)/tablet	3.5 (0.041)
Cholesteroler medicine		
Simvastatin 10 mg	BDT (USD)/tablet	7 (0.082)
Atorvastatin 20 mg	BDT (USD)/tablet	10 (0.118)
Atorvastatin 40 mg	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 behaviour		
Time to counsel a patient to change behaviour	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
No of health providers in need of training		
Counsel patients to change behaviour	Persons	30
Assess patients' total CVD risk	Persons	10
Training to counsel patients to change behaviour (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

Continued

**Table 1** Continued

Input description	Units	Value
Hours of training needed	Persons	8
No 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 (1 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 analyse a blood test	Minutes	10
Administer and analyse 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 ( $\geq 0\%$ to $< 10\%$ )	Visits	2
Medium CVD risk ( $\geq 10\%$ to $< 20\%$ )	Visits	3
High CVD risk ( $\geq 20\%$ )	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		

Continued

Table 1 Continued

Input description	Units	Value
Diabetes (complete 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 5 mg, 1 per day, 365 days)		
% of all individuals with high blood pressure who receive this treatment regimen	Percent	62%
Hypertension protocol step #2 (Amlodipine 5 mg+Losartan 50 mg)		
% 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 5 mg 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 1000 mg)		
% of all individuals with diabetes who receive this treatment regimen	Percent	15%
Diabetes protocol step #3 (metformin 1000 mg+glucicazide 8 mg)		
% of all individuals with diabetes who receive this treatment regimen	Percent	10%
Unit price of metformin 500 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	4 (0.047)
Unit price of metformin 1000 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	9 (0.106)
Unit price of glucicazide 80 mg 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%

Continued



**Table 1** Continued

Input description	Units	Value
Unit price of simvastatin 10 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	7 (0.082)
Unit price of simvastatin 20 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	10 (0.118)
Unit price of atorvastatin 40 mg in LCU (Taka or BDT) and USD	BDT (USD)/tablet	28 (0.330)

\*The '5A' model is an evidence-based approach entailing health behaviour change counselling to prevent NCD risk factors in primary care setting.<sup>25,26</sup> 5A's, Assess, Advise, Agree, Assist, Arrange; BDT, Bangladesh Taka; CHWs, community health workers; CVD, cardiovascular disease; LCU, Local currency unit; NCD, non-communicable disease.

prevalence of hypertension, diabetes and high cholesterol. The estimated number of eligible persons in the catchment area of the four subdistricts was 359 000, of which 305 000, 52 000 and 1800 were projected to be low-CVD, medium-CVD 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 programme costs.

#### Hypertension management programme cost

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

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 (US\$433 000). The estimated cost for module 'E' (Evidence-based treatment protocols) was attributable to provider time across three major activities: asking patient history (US\$180 000; 15%), patient assessment via physical exam and diagnostic tests (US\$180 000; 15%), and conducting return visits (US\$856 000, 70%). The projected cost to implement module 'S' (Systems for monitoring) was US\$147 000, primarily attributed to administration staff labour 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 programme. Implementing the programme at the full population level in all four subdistricts was estimated to require the full-time equivalent of 51 doctors, 51 nurses and 6 CHWs. The largest time requirement activities included providing initial screening and diagnosis and conducting return visits.

#### Risk-based integrated hypertension, diabetes and high cholesterol management programme cost

Table 5 reports the estimated costs of implementing the risk-based hypertension, diabetes and high cholesterol management programme 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 US\$14.4 million, equivalent to US\$12.9 per capita, US\$19.3 per adult and

**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)	261098	86503	209454	192075	749130
Adults who present at the health centre	125066	41435	100328	92004	358833
Providing brief counselling					
Eligible to receive brief advice	125066	41435	100328	92004	358833
Tobacco user	54654	18107	43844	40206	156810
Harmful alcohol	5503	1823	4414	4048	15789
Physical inactivity	15383	5096	12340	11316	44136
Screening and diagnosis of 10-year CVD risk					
Low CVD risk	106431	35261	85380	78295	305367
Medium CVD risk	18009	5967	14447	13249	51672
High CVD risk	625	207	502	460	1794
Treatment of 10-year CVD risk					
Low CVD risk	106431	35261	85380	78295	305367
Hypertension	22351	7405	17930	16442	64127
Diabetes	8834	2927	7087	6499	25345
Cholesterol	30226	10014	24248	22236	86724
Medium CVD risk	18009	5967	14447	13249	51672
Hypertension	3782	1253	3034	2782	10851
Diabetes	1495	495	1199	1100	4289
Cholesterol	5115	1695	4103	3763	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

Risk factors and disease prevalence rates were assumed uniform across subdistricts.  
CVD, cardiovascular disease.

US\$40.2 per eligible participant. Module 'A' (Access to medicines and technology) constitutes the largest cost share (US\$11.7million; 81%), followed by module 'E' (Evidence-based treatment protocols, US\$1.9million; 13%). Within module 'A', the projected costs of diagnostic tests, hypertension medications, diabetes medications and cholesterol medications were US\$5.7million (49% of module costs), US\$1.4million (12%), US\$0.9million (7%) and US\$3.8million (32%), respectively. The projected medication expenditure per patient treated with medications for hypertension, diabetes and cholesterol was US\$18, US\$29 and US\$37, respectively.

The adoption of task-sharing approach would save US\$865 000, of which US\$803 000 comes from using nurses to complete tasks customarily performed by doctors (ie, counselling, screening and assessing CVD risk, and treating according to CVD risk) and US\$62 000 comes from using CHWs to provide counselling to change behaviour. Implementing the risk-based hypertension, diabetes and high cholesterol management programme at the full population level in all four subdistricts 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.

## DISCUSSION

The HEARTS pilot project in four Bangladesh subdistricts 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 programme to all eligible adults in the participating subdistricts. We assessed two programme scenarios: a hypertension management programme and an integrated risk-based hypertension, diabetes and cholesterol management programme. The total annual cost was estimated at US\$3.2 and US\$14.4million for the hypertension and risk-based comprehensive approach,

**Table 3** Total annual cost of HEARTS hypertension control programme in four subdistricts

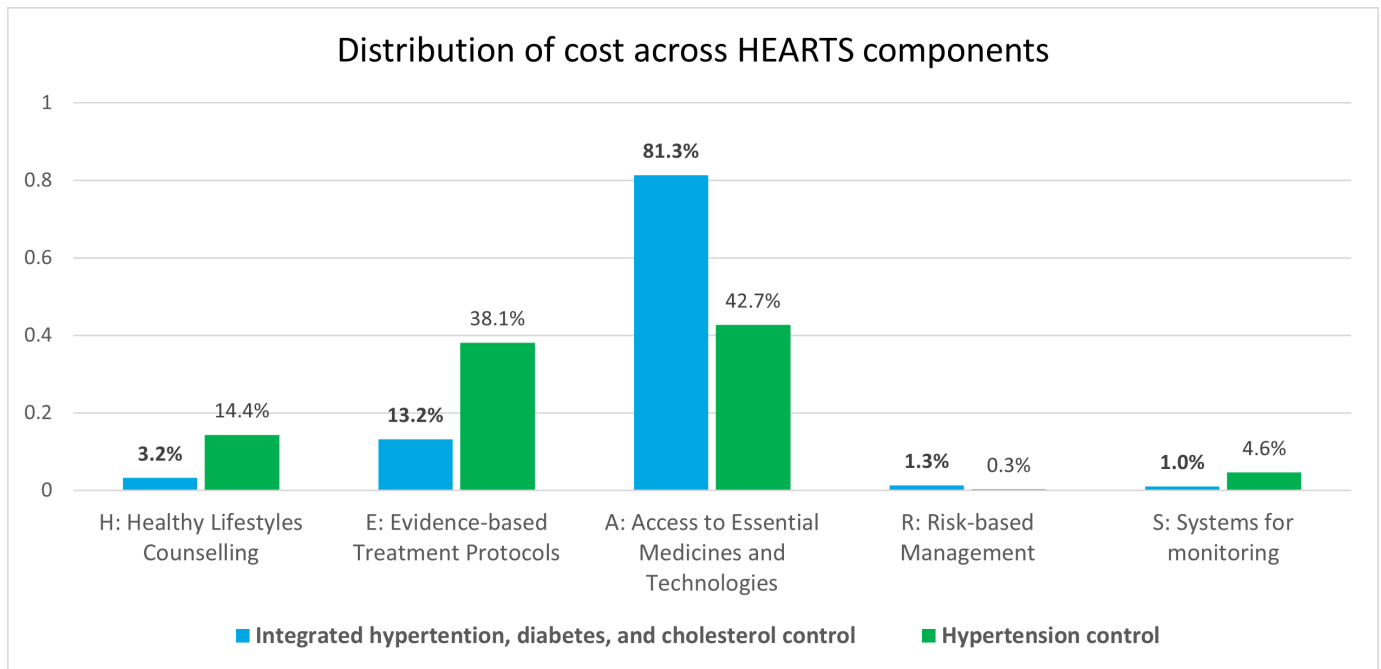
	Golaganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
H: Healthy lifestyles	13335339	157071	4765107	56126	10800324	127212	9947252	117164	38848022	457574
H1: Training costs	418990	4935	418990	4935	418990	4935	418990	4935	1675960	19740
H1.1: Facility rental (% of H1)	18000	212	18000	212	18000	212	18000	212	72000	848
H1.2: Human resources	20000	236	20000	236	20000	236	20000	236	80000	942
H1.3: Instructive handbooks	35000	412	35000	412	35000	412	35000	412	140000	1649
H1.4: Per diem/transportation	339990	4005	339990	4005	339990	4005	339990	4005	1359960	16018
H1.5: Refreshments	6000	71	6000	71	6000	71	6000	71	24000	283
H2: Brief counselling costs	12816349	150958	4246117	50013	10281334	121099	9428262	111051	36772062	433122
H2.1: Tobacco	9272756	109220	3072108	36185	7438647	87617	6821441	80347	26604952	313368
Provider time to administer 5A's	3807374	44845	1261401	14857	3054293	35975	2800870	32990	10923938	128668
Informational materials (print)	5465382	64374	1810707	21328	4384354	51641	4020572	47357	15681014	184700
H2.2: Alcohol	933641	10997	309320	3643	748971	8822	686827	8090	2678759	31552
Provider time to administer 5A's	383351	4515	127006	1496	307526	3622	282010	3322	1099893	12955
Informational materials (print)	550290	6482	182314	2147	441445	5200	404817	4768	1578866	18597
H2.3: Physical inactivity	2609952	30741	864689	10185	2093715	24661	1919994	22615	7488350	88202
Provider time to administer 5A's	1071641	12622	355040	4182	859675	10126	788345	9286	3074701	36216
Informational materials (print)	1538311	18119	509650	6003	1234040	14535	1131648	13329	4413649	51986
H3: Other programme costs	100000	1178	100000	1178	100000	1178	100000	1178	400000	4711
Community awareness meetings	50000	589	50000	589	50000	589	50000	589	200000	2356
Community health workers training	50000	589	50000	589	50000	589	50000	589	200000	2356
E: Evidence-based treatment protocols	35959415	423550	11913524	140324	28846806	339774	26453304	311582	103173049	1215230
E1: Ask about patient history - provider time	5317334	62631	1761658	20750	4265589	50243	3911661	46074	15256241	179697
E2: Assess via physical exam and diagnostic tests - provider time	5317334	62631	1761658	20750	4265589	50243	3911661	46074	15256241	179697
E3: Return visits - Counsel and treat per protocol - provider time	25324748	298289	8390209	98825	20315628	239289	18629982	219434	72660567	855837
A: Access to Essential Medicines and Technologies	40197017	473463	13429971	158186	32279509	380206	29615146	348824	115521643	1360679
A1: Hypertension medications	40028765	471481	13261719	156204	32111257	378224	29446893	346842	114848633	1352752
Amlodipine 5mg	9873894	116300	3271268	38531	7920882	93297	7263664	85556	28329707	333683
Losartan 50mg	30016637	353553	9944653	117134	24079482	283622	22081538	260089	86122310	1014397
Hydrochlorothiazide 12.5mg	138235	1628	45798	539	110892	1306	101691	1198	396616	4672
A2: Diagnostic technologies, machines and supplies	168253	1982	168253	1982	168253	1982	168253	1982	673010	7927
R: Risk-based management	172334	2030	172334	2030	172334	2030	172334	2030	689336	8119

Continued

Table 3 Continued

	Golaganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
R1: Training costs	172334	2030	172334	2030	172334	2030	172334	2030	689336	8119
T: Team-based care Savings from training nurses and CHWs to do tasks customarily performed by doctors	13815043	162721	4576989	53910	11082490	130536	10162944	119705	39637467	466872
T1: Savings from training nurses	11976134	141062	3967750	46734	9607309	113160	8810163	103771	34361355	404727
Savings from counselling to change behaviour	1355873	15970	449207	5291	1087688	12811	997439	11748	3890208	45821
Savings from screening for--and assess--CVD risk	3367235	39661	1115581	13140	2701212	31816	2477084	29176	9661112	113794
Savings from treating CVD risk	7253025	85430	2402961	28303	5818410	68533	5335639	62846	20810036	245112
T2: Savings from training CHWs	1838909	21660	609239	7176	1475181	17376	1352781	15934	5276112	62145
Savings from counselling to change behaviour	1838909	21660	609239	7176	1475181	17376	1352781	15934	5276112	62145
S: Systems for monitoring	3114636	36686	3114636	36686	3114636	36686	3114636	36686	12458546	146744
S1: Human resources	2969636	34978	2969636	34978	2969636	34978	2969636	34978	11878546	139912
S2: Technology	110000	1296	110000	1296	110000	1296	110000	1296	440000	5183
S3: Supplies	10000	118	10000	118	10000	118	10000	118	40000	471
S4: Training	25000	294	25000	294	25000	294	25000	294	100000	1178
Total Programme Cost (H+E+A+R+T+S)	92778742	1092800	33395573	393352	75213609	885908	69302672	816286	270690596	3188346

BDT, Bangladesh Taka; CHWs, community health worker; CVD, cardiovascular disease.



**Figure 2** Distribution of annual cost by HEARTS components.

respectively. The overall per capita cost was approximately US\$2.8 per capita for the hypertension control programme and US\$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 programme 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 programme cost (81%). Although the main driver of projected programme 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 (ie, 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 US\$18, US\$29 and US\$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*<sup>31</sup> estimated that hypertension treatment would cost about US\$13 (BDT1070) per patient per year.<sup>31</sup> WHO (2011) has estimated the average hypertension screening cost for LMICs at approximately US\$4 for LMICs, not including treatment but including the cost of performing CVD risk assessment and BP measurement in primary care settings.<sup>32</sup> Haque<sup>33</sup> estimated the average cost of diabetes screening in Bangladesh at approximately

US\$5 (BDT411), including glucose screening in primary care, documentation, setting up referrals and organising screening events but excluding treatment.<sup>33</sup> In this study, the cost elements in the Bangladesh HEARTS programme are wide-ranging including screening, diagnosis and treatment for multiple CVD risk conditions (hypertension, diabetes, hyperlipidaemia) and counselling for CVD risk factors (tobacco use, alcohol use and physical inactivity).

The analysis revealed that scaling up the hypertension management programme within the four subdistricts 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 programme in the four subdistricts 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 subdistrict public health complex in Bangladesh employs 20 doctors, 16 nurses and 1 medical assistant. Oftentimes, not all health provider posts are filled. This gap in provider capacity poses a significant barrier to programme expansion. Team-based care using task-sharing among doctors, nurses and CHWs 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 LMICs by Joshi *et al*<sup>34</sup> found that team-based care, including task sharing was effective in improving process outcomes (eg, hypertension and diabetes screening) and health outcomes (eg, hypertension and diabetes control) and achieving treatment concordance with doctors.<sup>16 34</sup> Krishnan *et al*<sup>35</sup> conducted a study on a community-based hypertension management programme of BP monitoring



**Table 4** Hypertension control programme: 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	FTE
Counselling to change behaviour										
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	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	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	5.8
Screening and diagnosis										
Doctor	1302 days, 1 hours	5.0	431 days, 6 hours	1.7	1045 days, 2 hours	4.0	958 days, 3 hours	3.7	14.4	14.4
Nurses	1302 days, 1 hours	5.0	431 days, 6 hours	1.7	1045 days, 2 hours	4.0	958 days, 3 hours	3.7	14.4	14.4
Return visits - counsel and treat per protocol										
Doctor	2806 days, 0 hours	10.8	929 days, 6 hours	3.6	2251 days, 1 hours	8.7	2064 days, 2 hours	7.9	31.0	31.0
Nurses	2806 days, 0 hours	10.8	929 days, 6 hours	3.6	2251 days, 1 hours	8.7	2064 days, 2 hours	7.9	31.0	31.0
Annual: total minutes/124 800. CHW, community health worker; FTE, full-time equivalent.										

and lifestyle counselling intervention undertaken by female community health volunteers in Nepal, and assessed the intervention to be highly cost-effective.<sup>35</sup> 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.<sup>36</sup>

In Bangladesh, of the four entities (ie, the government, for-profit private sector, non-profit nongovernmental organisation 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 (subdistrict), 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.<sup>16,37,38</sup> 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.<sup>39,40</sup> This emphasises 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.<sup>41,42</sup> 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 in Bangladesh.<sup>16</sup> The per capita NCD allocation is only US\$0.08.<sup>16</sup> 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.<sup>16</sup> 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 US\$7 (0.4% of GDP per capita).<sup>43</sup> 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*<sup>44</sup> highlights the lack of proper planning, implementation and monitoring of NCD health initiatives.<sup>44</sup> However, the

**Table 5** Annual cost of implementing risk-based hypertension, diabetes and high cholesterol management programme in four subdistricts

	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	4 18 990	4 935	4 18 990	4 935	4 18 990	4 935	4 18 990	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	3643	748 971	8822	686 827	8090	2 678 759	31 552
Provider time to administer 5A's	383 351	4515	127 006	1496	307 526	3622	282 010	3322	1 099 893	12 955
Informational materials (print)	550 290	6482	182 314	2147	441 445	5200	404 817	4768	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	4182	859 675	10 126	788 345	9286	3 074 701	36 216
Informational materials (print)	1 538 311	18 119	509 650	6003	1 234 040	14 535	1 131 648	13 329	4 413 649	51 986
H3: Other programme costs	100 000	1178	100 000	1178	100 000	1178	100 000	1178	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	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
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 5 mg	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

Continued

Table 5 Continued

	Golapganj		Fenchuganj		Beanibazar		Bishwanath		Total	
	BDT	USD	BDT	USD	BDT	USD	BDT	USD	BDT	USD
Losartan 50 mg	30016637	353553	9944653	117134	24079482	283622	22081538	260089	86122310	1014397
Hydrochlorothiazide 12.5mg	138235	1628	45798	539	110892	1306	101691	1198	396616	4672
A3: Diabetes medications	25366503	298781	8404042	98988	20349124	239683	18660698	219796	72780367	857248
Metformin 500mg	11707617	137899	3878789	45687	9391903	110623	8612630	101444	33590939	395653
Metformin 1000mg	12292998	144794	4072728	47971	9861498	116154	9043262	106517	35270486	415436
Gliclazide	1365889	16088	452525	5330	1095722	12906	1004807	11835	3918943	46160
A4: Cholesterol medications	111499768	1313307	36940399	435105	89445620	1053541	82024060	966126	319909847	3768078
Simvastatin 10mg	79451930	935830	26322800	310045	63736699	750727	58448282	688437	227959711	2685038
Atorvastatin 20mg	13353266	157282	4424000	52108	10712050	126173	9823241	115704	38312556	451267
Atorvastatin 40mg	18694572	220195	6193600	72952	14996870	176642	13752537	161985	53637579	631774
A5: Diagnostic tech. machines and supplies	168253	1982	168253	1982	168253	1982	168253	1982	673010	7927
R: Risk-based management	5489668	64660	1933992	22780	4437923	52272	4083995	48104	15945577	187816
R1: Training costs	172334	2030	172334	2030	172334	2030	172334	2030	689336	8119
R2: Estimate risk using risk charts	5317334	62631	1761658	20750	4265589	50243	3911661	46074	15256241	179697
T: Team-based care: Savings from training nurses and CHWs to do tasks customarily performed by doctors	25600367	301536	8481523	99900	20536731	241893	18832739	221823	73451360	865151
T1: Savings from training nurses	23761458	279876	7872283	92724	19061549	224518	17479958	205889	68175248	803006
Savings from counselling to change behaviour	1355873	15970	449207	5291	1087688	12811	997439	11748	3890208	45821
Savings from screening for – and assess – CVD risk	15152559	178475	5020114	59130	12155452	143174	11146879	131294	43475005	512073
Savings from treating CVD risk	7253025	85430	2402961	28303	5818410	68533	5335639	62846	20810036	245112
T2: Savings from training CHWs	1838909	21660	609239	7176	1475181	17376	1352781	15934	5276112	62145
Savings from counselling to change behaviour	1838909	21660	609239	7176	1475181	17376	1352781	15934	5276112	62145
S: Systems for monitoring	3114636	36686	3114636	36686	3114636	36686	3114636	36686	12458546	146744
S1: Human resources	2969636	34978	2969636	34978	2969636	34978	2969636	34978	11878546	139912
S2: Technology	110000	1296	110000	1296	110000	1296	110000	1296	440000	5183
S3: Supplies	10000	118	10000	118	10000	118	10000	118	40000	471
S4: Training	25000	294	25000	294	25000	294	25000	294	100000	1178
Total programme cost (H+E+A+R+T+S)	425197850	5008220	143527592	1690549	341881725	4026875	313844568	3696638	1,224,451,735	14422282

5 A's, Assess, Advise, Agree, Assist, Arrange; BDT, Bangladesh Taka; CHW, community health worker; CVD, cardiovascular disease.

**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	FTE
Counselling to change behaviour										
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	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	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	5.8
Screening and diagnosis										
Doctor	1302 days, 1 hours	5.0	431 days, 6 hours	1.7	1045 days, 2 hours	4.0	958 days, 3 hours	3.7	14.4	14.4
Nurses	1302 days, 1 hours	5.0	431 days, 6 hours	1.7	1045 days, 2 hours	4.0	958 days, 3 hours	3.7	14.4	14.4
Screening and diagnosis by Lab technicians	9119 days, 3 hours	35.1	3021 days, 6 hours	11.6	7315 days, 0 hours	28.1	6708 days, 1 hours	25.8	100.6	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	7.2
Nurses	2 658 667	2.5	880 829	0.8	2 132 795	2.0	1 955 830	1.8	7.2	7.2
Return visits—counsel and treat per protocol										
Doctor	2806 days, 0 hours	10.8	929 days, 6 hours	3.6	2251 days, 1 hours	8.7	2064 days, 2 hours	7.9	31.0	31.0
Nurses	2806 days, 0 hours	10.8	929 days, 6 hours	3.6	2251 days, 1 hours	8.7	2064 days, 2 hours	7.9	31.0	31.0

CHW, community health worker; CVD, cardiovascular disease; FTE, full-time equivalent.

Bangladesh Copenhagen Project assessed the benefits of managing hypertension through targeted investment and reported a high level of return on investment (BDT17 benefit for every BDT spent).<sup>31</sup>

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, distribution of CVD risk among the population, distribution of patients by treatment protocols, and frequency of patient visits by CVD risk, which were assumed to be uniform for the four subdistricts and across age or sex groups. Similarly, unit costs of supplies, wages and provider time allocations were assumed to be the same across subdistricts. Since the examined subdistricts are adjacent to each other, these unit costs may not be considerably different. While we used average medicine prices, they may vary in different subdistricts 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.<sup>19 20</sup> 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 programme delivery from the upazila level to more localised community facilities.

In 2018, the Government of Bangladesh introduced a multisectoral action plan for NCD prevention and control, which emphasises NCD risk factors including tobacco use, unhealthy diet, physical inactivity and harmful use of alcohol.<sup>42</sup> 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 programmes in Bangladesh.

## CONCLUSION

Expanding the HEARTS hypertension management and CVD prevention programme 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 CHWs would be essential for the eventual scale-up of primary care services to prevent CVD in Bangladesh.

### Author affiliations

<sup>1</sup>Division of Global Health Protection, Centers for Global Health, Centers for Disease Control and Prevention, Atlanta, Georgia, USA

<sup>2</sup>Directorate General of Health Services, Ministry of Health and Family Welfare, Dhaka, Bangladesh

<sup>3</sup>Department of Epidemiology and Research, National Heart Foundation Hospital & Research Institute, Dhaka, Bangladesh

<sup>4</sup>Resolve to Save Lives, an initiative of Vital Strategies, New York, New York, USA

**Contributors** MJH and MSH conceptualised the study, led the formal analysis, implemented the methodology and the excel-based costing tool, and wrote the draft

manuscript. DK, SRC, MRB and 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. MJH and MSH are responsible for the overall content as guarantor. All authors provided critical feedback and helped shape the research, analysis and manuscript.

**Funding** This analysis was conducted on behalf of Resolve to Save Lives, an initiative of Vital Strategies. Resolve to Save Lives is funded by grants from Bloomberg Philanthropies; the Bill & Melinda Gates Foundation; and Gates Philanthropy Partners, which is funded with support from the Chan Zuckerberg Foundation.

**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.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** All data relevant to the study are included in the article or uploaded as online supplemental information.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

### ORCID iDs

Muhammad Jami Husain <http://orcid.org/0000-0001-6049-0505>

Mohammad Sabbir Haider <http://orcid.org/0000-0003-0013-0051>

Shamim Jubayer <http://orcid.org/0000-0002-8595-1993>

Mahfuzur Rahman Bhuiyan <http://orcid.org/0000-0001-6962-7264>

Deliana Kostova <http://orcid.org/0000-0003-2414-0166>

## REFERENCES

- 1 World Health Organization. Improving hypertension control in 3 million people country experiences of programme development and implementation. Geneva; 2020.
- 2 World Health Organization. A global brief on hypertension: silent killer, global public health crisis: World health day; 2013.
- 3 Lily A, Ross HA, GBD. Risk factors collaborators. global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990-2013: a systematic analysis for the global burden of disease study 2013. *Lancet* 2013;2015:2287-323.
- 4 Rapsomaniki E, Timmis A, George J, *et al*. Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1.25 million people. *Lancet* 2014;383:1899-911.
- 5 Vaes B, Beke E, Truyers C, *et al*. The correlation between blood pressure and kidney function decline in older people: a registry-based cohort study. *BMJ Open* 2015;5:e007571.
- 6 Tzourio C. Hypertension, cognitive decline, and dementia: an epidemiological perspective. *Dialogues Clin Neurosci* 2007;9:61-70.
- 7 Bloch MJ, FASH F, Basile FJ. Cardiovascular risks of hypertension. In: *UpToDate*, 2018.
- 8 World Health Organization. Sixty-Fifth World health assembly resolutions, decisions, annexes; 2012: 21-6. <http://www.who.int/mediacentre/events/2012/wha65/en/> [Accessed 2012].



- 9 World Health Organization. Global action plan for the prevention and control of noncommunicable diseases. Geneva, Switzerland; 2013. [http://apps.who.int/iris/bitstream/10665/94384/1/97892\\_41506236\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/94384/1/97892_41506236_eng.pdf)
- 10 World Health Organization. Global status report on noncommunicable diseases; 2014.
- 11 World Health Organization. Thirteenth general programme of work (GPW13): methods for impact measurement. Geneva; 2020. <file:///C:/Research/Bangladesh%20HEARTS%20Costing%20tool/gpw13-methodology-nov9-online-version.pdf>
- 12 General Assembly 70 session. Transforming our world: the 2030 agenda for sustainable development. United Nations; 2015.
- 13 Riaz BK, Islam MZ, Islam ANMS, *et al.* Risk factors for non-communicable diseases in Bangladesh: findings of the population-based cross-sectional national survey 2018. *BMJ Open* 2020;10:e041334.
- 14 Chowdhury MZI, Rahman M, Akter T, *et al.* Hypertension prevalence and its trend in Bangladesh: evidence from a systematic review and meta-analysis. *Clin Hypertens* 2020;26:1–19.
- 15 World Health Organization. National steps survey for non-communicable diseases risk factors in Bangladesh Country Office for Bangladesh; 2018. <https://apps.who.int/iris/handle/10665/332886>
- 16 The World Bank. Hypertension and type-2 diabetes in Bangladesh: continuum of care assessment and opportunities for action. Washington DC; 2019.
- 17 World Health Organization. Hearts: technical package for cardiovascular disease management in primary health care; 2020.
- 18 World Health Organization. Hearts: technical package for cardiovascular disease management in primary health care. Geneva, Switzerland; 2016. <https://apps.who.int/iris/bitstream/handle/10665/252661/9789241511377-en>
- 19 World Health Organization. Medicines in health care delivery Bangladesh: situational analysis: 13 – 25 September 2014 report prepared using the WHO/SEARO workbook tool for undertaking a situational analysis of medicines in health care delivery in low and middle income countries. New Delhi, India Regional Office for South East Asia; 2014.
- 20 Kasonde L, Tordrup D, Naheed A, *et al.* Evaluating medicine prices, availability and affordability in Bangladesh using World health organisation and health action international methodology. *BMC Health Serv Res* 2019;19:1–12.
- 21 World Health Organization. Hearts technical package for cardiovascular disease management in primary health care: risk based CVD management. Geneva; 2020.
- 22 World Health Organization. Diagnosis and management of type 2 diabetes (HEARTS-D). Geneva, Switzerland; 2020.
- 23 Brown RE, Welsh P, Logue J. Systematic review of clinical guidelines for lipid lowering in the secondary prevention of cardiovascular disease events. *Open Heart* 2020;7:e001396.
- 24 Husain MJ, Allaire BT, Hutchinson B, *et al.* Assessing costs of a hypertension management program: an application of the hearts costing tool in a program planning workshop in Thailand. *J Clin Hypertens* 2020;22:111–7.
- 25 Glasgow RE, Emont S, Miller DC. Assessing delivery of the five as for patient-centered counseling. *Health Promot Int* 2006;21:245–55.
- 26 Whitlock EP, Orleans CT, Pender N, *et al.* Evaluating primary care behavioral counseling interventions: an evidence-based approach. *Am J Prev Med* 2002;22:267–84.
- 27 Islam JY, Zaman MM, Moniruzzaman M, *et al.* Estimation of total cardiovascular risk using the 2019 WHO CVD prediction charts and comparison of population-level costs based on alternative drug therapy guidelines: a population-based study of adults in Bangladesh. *BMJ Open* 2020;10:e035842.
- 28 Hasan MJ. Pattern of drugs prescribed for treatment of hypertensive patients: Bangladesh. *Afr J Pharmacy Pharmacol* 2016;10:521–5.
- 29 Chowdhury A, SEN N, Banik S. Prescribing pattern of antidiabetic drugs in type 2 diabetic patients of Noakhali city in Bangladesh. *Marmara Pharm J* 2017;21:1010–4.
- 30 Elnaem MH, Mohamed MHN, Huri HZ, *et al.* Effectiveness and prescription pattern of lipid-lowering therapy and its associated factors among patients with type 2 diabetes mellitus in Malaysian primary care settings. *Ther Clin Risk Manag* 2019;15:137–45.
- 31 Nugent R, Brower E, Cravioto A, *et al.* A cost-benefit analysis of a national hypertension treatment program in Bangladesh. *Prev Med* 2017;105:S56–61.
- 32 World Health Organization. Scaling up action against non-communicable diseases: how much will it cost; 2011.
- 33 Haque R. *Costs and benefits of addressing diabetes and smokeless tobacco consumption via community clinics.* Bangladesh Priorities: Copenhagen Consensus Center, 2016.
- 34 Joshi R, Alim M, Kengne AP, *et al.* Task shifting for non-communicable disease management in low and middle income countries a systematic review. *PLoS One* 2014;9:e103754.
- 35 Krishnan A, Finkelstein EA, Kallestrup P, *et al.* Cost-effectiveness and budget impact of the community-based management of hypertension in Nepal study (COBIN): a retrospective analysis. *Lancet Glob Health* 2019;7:e1367–74.
- 36 World Health Organization. Hearts technical package for cardiovascular disease management in primary health care: team-based care. Geneva; 2018.
- 37 Rawal LB, Kanda K, Biswas T, *et al.* Non-communicable disease (Ncd) corners in public sector health facilities in Bangladesh: a qualitative study assessing challenges and opportunities for improving ncd services at the primary healthcare level. *BMJ Open* 2019;9:e029562.
- 38 Directorate General of Health Services. Management information system, director General of health services, Ministry of health and family welfare Government of the People's Republic of Bangladesh Health Bulletin; 2020.
- 39 Bangladesh Bureau of Statistics (BBS). Statistics and informatics division (SID), Ministry of planning. Government of the People's Republic of Bangladesh Preliminary report on Household Income and Expenditure Survey; 2017.
- 40 Bangladesh Bureau of Statistics (BBS). Report on Health and Morbidity Status Survey 2014. In: *Statistics and informatics division (SID), Ministry of planning.* Government of the People's Republic of Bangladesh, 2015.
- 41 World Health Organization. National guidelines for management of hypertension in Bangladesh; 2013.
- 42 Director General of Health Services. Multi-sectoral action plan for prevention and control of non-communicable diseases 2018-2025. Dhaka Non-communicable Disease Control Programme; 2018.
- 43 Who global health expenditure database. Available: <https://apps.who.int/nha/database/ViewData/Indicators/en>
- 44 Biswas T, Pervin S, Tanim MIA, *et al.* Bangladesh policy on prevention and control of non-communicable diseases: a policy analysis. *BMC Public Health* 2017;17:582.