

# CONTROLLING THE BURDEN OF NON-COMMUNICABLE DISEASES IN BANGLADESH: BENEFIT-COST ANALYSIS OF PREVENTION POLICIES AND INTERVENTIONS

TRACEY KOEHLMOOS, DIVISION DIRECTOR AND ASSOCIATE PROFESSOR, HAS, UNIFORMED SERVICES UNIVERSITY

ELIZABETH BROUWER, HEALTH ECONOMICS ANALYST, DISEASE CONTROL PRIORITIES

ALEJANDRO CRAVIOTO, SENIOR EPIDEMIOLOGIST AT GLOBAL EVALUATIVE SCIENCES, SEATTLE.

RACHEL NUGENT, CLINICAL ASSOCIATE PROFESSOR IN THE DEPARTMENT OF GLOBAL HEALTH, UNIVERSITY OF WASHINGTON AND DIRECTOR OF THE DISEASE CONTROL PRIORITIES NETWORK



Benefits and Costs of Controlling the Spread of Tobacco Use, Cervical Cancer and Hypertension in Bangladesh



SMARTER SOLUTIONS FOR  
BANGLADESH





# Controlling the Burden of Non-Communicable Diseases in Bangladesh: Benefit-cost Analysis of Prevention Policies and Interventions

---

## Bangladesh Priorities

**Tracey Koehlmoos**

*Division Director and Associate Professor, HAS, Uniformed Services University*

**Elizabeth Brouwer**

*Health Economics Analyst, Disease Control Priorities*

**Alejandro Cravioto**

*Senior Epidemiologist at Global Evaluative Sciences, Seattle*

**Rachel Nugent**

*Clinical Associate Professor in the Department of Global Health, University of Washington and Director of the Disease Control Priorities Network*

Bangladesh Priorities project was supported by a grant from the C&A Foundation.  
Working paper as of February 28, 2017

© 2016 Copenhagen Consensus Center

[info@copenhagenconsensus.com](mailto:info@copenhagenconsensus.com)

[www.copenhagenconsensus.com](http://www.copenhagenconsensus.com)

This work has been produced as a part of the Bangladesh Priorities project, a collaboration between Copenhagen Consensus Center and BRAC Research and Evaluation Department.

The Bangladesh Priorities project was made possible by a generous grant from the C&A Foundation.

Some rights reserved



This work is available under the Creative Commons Attribution 4.0 International license ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)). Under the Creative Commons Attribution license, you are free to copy, distribute, transmit, and adapt this work, including for commercial purposes, under the following conditions:

#### Attribution

Please cite the work as follows: #AUTHOR NAME#, #PAPER TITLE#, Bangladesh Priorities, Copenhagen Consensus Center, 2016. License: Creative Commons Attribution CC BY 4.0.

#### Third-party content

Copenhagen Consensus Center does not necessarily own each component of the content contained within the work. If you wish to re-use a component of the work, it is your responsibility to determine whether permission is needed for that re-use and to obtain permission from the copyright owner. Examples of components can include, but are not limited to, tables, figures, or images.

<b>EXECUTIVE SUMMARY .....</b>	<b>2</b>
THE 20-YEAR RISE OF CHRONIC NCDs IN BANGLADESH.....	2
<b>PRIORITY INTERVENTIONS .....</b>	<b>2</b>
RESULTS FROM BENEFIT-COST ANALYSIS.....	3
<b>NCD RISKS AND PREVALENCE IN THE BANGLADESH POPULATION .....</b>	<b>5</b>
ISSUE #1: TOBACCO CONTROL.....	5
ISSUE #2: CERVICAL CANCER .....	6
<i>Primary prevention of cervical cancer.....</i>	<i>7</i>
<i>Secondary prevention of cervical cancer.....</i>	<i>7</i>
ISSUE #3: HYPERTENSION .....	8
<b>INTERVENTIONS TO REDUCE NCD RISKS AND BURDEN .....</b>	<b>11</b>
ASSUMPTIONS AND METHODS.....	11
<i>Intervention #1: Tobacco Taxation .....</i>	<i>11</i>
<i>Intervention #2: HPV Vaccination and Cervical Cancer Screening and Treatment .....</i>	<i>12</i>
<i>Intervention #3: Screening and Treatment for Hypertension .....</i>	<i>13</i>
<i>Diabetes .....</i>	<i>14</i>
<b>CONCLUSION .....</b>	<b>16</b>
<b>REFERENCES.....</b>	<b>17</b>
<b>APPENDIX .....</b>	<b>19</b>

## Executive Summary

### The 20-year Rise of Chronic NCDs in Bangladesh

Bangladesh is in the midst of the epidemiologic transition like other South Asian nations. The burden of non-communicable diseases (NCDs) now account for a larger proportion of foregone disability adjusted life years than communicable disease, maternal and child health issues and nutrition-related causes combined (59% versus 41%) (WHO 2008). An estimated 59% of deaths in Bangladesh are due to NCDs (WHO 2014). Further, Bangladesh's demographic transition indicates that 18.8% of the population will be over age 60 by mid-century (Streatfield & Karar 2008). The combination of longer lives and greater burden of non-communicable disease mean that the time is ripe for action in prevention, diagnosis and treatment of these conditions. As the burden shifts from surviving birth, childhood and childbirth, so must the focus of the Bangladesh health system shift to continue to meet the needs of people, especially the poor (El Saharty 2013).

### Priority Interventions

Success in lowering non-communicable disease (NCD) mortality rates in high-income countries (HIC) has been dramatic (Yusuf, 2002). Much of the gains can be attributed to good population policies and individual-level interventions for secondary prevention of cardiovascular disease (CVD) events. The solutions that work in HIC, as well as others, can work in low and middle income countries (LMIC).

The Bangladesh government and non-government organizations have taken several steps to implement appropriate NCD programs, but there are many areas where efforts could be strengthened. Key among them is improved evaluation of NCD programs. This paper reports on an economic benefit-cost evaluation of three interventions to prevent and control NCDs in Bangladesh. In section 1, we provide background concerning the NCD health risks and burden in the Bangladesh population from tobacco consumption, cervical cancer, and hypertension. In the second section, we propose a specific intervention to address each of those risks, and provide modeled results of our economic analysis. The interventions include a doubling of tobacco taxes, increased coverage of human papilloma virus (HPV) vaccine along with screening and treatment for cervical cancer, and increased coverage of anti-hypertensive drugs for patients at high-risk of acute events such as stroke. All three interventions have been shown to be highly effective and cost-effective in many settings

(Jamison et al, 2006, Denny et al, 2015, Yusuf et al, 2011). These three NCD interventions were selected because they have been tested and the infrastructure exists to support them in Bangladesh.

## Results from Benefit-Cost Analysis

We estimate that the three NCD interventions would save roughly 12 million DALYs by 2021 and 29 million DALYs by 2030 in Bangladesh, for a total value of \$36.7 billion in saved lives in 2030. In 2030, the benefit-cost ratio of 60% coverage for treatment of hypertension is 17:8, for increased tobacco taxation is 21:9, and for HPV vaccination and cervical cancer treatment it is 1.4:1 (assuming GAVI support for the vaccine). These results suggest a highly favorable benefit-cost ratio for the first two interventions. This scenario assumes a 5% discount rate.

Large health benefits are derived from higher coverage of hypertension treatment, in part because of the large numbers of people with hypertension and the substantial ramp-up of treatment we assume. In addition, benefits are immediate, while the health benefits of reduced tobacco consumption are gradual over time, and the benefits of HPV vaccination for young girls occur only after 40 years, although cancer treatment for adult women will yield immediate benefits. The undiscounted BCR for cervical cancer of 6:1 suggests a more positive return if the Bangladesh society chooses not to discount girls' future lives saved.

The cost profile of the three chosen interventions is quite different. Like the benefits, the costs of anti-hypertension treatment far exceed the costs of the two other interventions. We estimate a \$1 per capita cost (across the entire population of Bangladesh) of delivering and maintaining treatment. The cost of screening women for cervical cancer is \$5 and the cost of cancer treatment is \$70 per woman treated, while vaccination costs zero with a subsidy from GAVI. The tobacco tax is assumed to cost \$0.05 per capita each year.

**Table 1: 2021 Benefit to Cost Ratios (6 years in the future)****All costs and benefits in taka, Discounts apply only to benefits**

Intervention	No discount Rate			5% Discount Rate	
	Benefit (millions)	Cost (millions)	BCR	Benefit (millions)	BCR
Tobacco tax					
With tax revenue		337	23.3	5,436	16.1
Without tax revenue	7,855	661	9.5		8.2
HPV vaccine and cervical cancer					
With GAVI funding	11,963	2,279	5.2	2,809	1.2
Without GAVI funding		7,706	1.6		0.4
Hypertension management					
Total	1,349,187	75,778	17.8	1,152,052	17.8
Men	471,085	27,577	17.1	402,253	17.1
Women	849,353	46,449	18.3	725,250	18.3

**Table 2: 2030 Benefit to Cost Ratios (15 years in the future)****All costs and benefits in taka, Discounts apply only to benefits**

Intervention	No discount Rate			5% Discount Rate	
	Benefit (millions)	Cost (millions)	BCR	Benefit (millions)	BCR
Tobacco tax					
With tax revenue	23,384	268	87.3	16,181	60.4
Without tax revenue		737	31.7		21.9
HPV vaccine and cervical cancer					
With GAVI funding	15,185	2,565	5.9	3,566	1.4
Without GAVI funding		8,623	1.8		0.4
Hypertension management					
Total	3,939,146	75,778	17.8	2,738,304	17.8
Men	1,375,400	27,577	17.1	956,112	17.1
Women	2,479,809	46,449	18.3	1,723,843	18.3

\*To see benefits and costs discounted at 3% and 10%, please see appendix file.

# NCD Risks and Prevalence in the Bangladesh Population

## Issue #1: Tobacco Control

According to the WHO report on the Global Tobacco Epidemic, 2008, nearly two-thirds of the world's smokers live in 10 countries including Bangladesh. Bangladesh Global Adult Tobacco Survey (GATS) 2009 estimated that current tobacco use (smoking or smokeless) among all adults aged 15 years and over is 43.3%, which translates into 41.3 million tobacco users, making Bangladesh the most prevalent country with adult tobacco use among the 14 countries that completed GATS during 2008-2010 (WHO 2011b). The proportion is higher in males (58.0%) than females (28.7%) and in rural areas (45.1%) than urban areas (38.1%). Tobacco use is higher among persons with no formal education (62.9%) and in the lowest quintiles of socioeconomic status (SES) (55.6%). The survey also found that 23.0% (21.9 million) of adults currently smoke tobacco (for males 44.7% and for females 1.5%), and 27.2% (25.9 million) of the adult population currently use smokeless tobacco in Bangladesh (WHO BD 2009). The Bangladesh NCD Risk Factor Survey 2010 reported that 32.8 million people in Bangladesh (22.1 million men and 10.7 million females) use any form of tobacco (WHO BD 2011).

Prevalence of smoking tends to increase with age. There are over 1.2 million cases of tobacco-attributable illness in Bangladesh each year and around 9% of all deaths in a year (57,000 deaths) in the country are result of tobacco use (WHO 2008). In addition, exposure to secondhand smoking kills tens of thousands of non-smokers every year in Bangladesh (WHO SEARO 2007).

Female rates of smoking are generally low (0.8% urban and 1.8% rural) but increase slightly with age. Anecdotal evidence points to potentially hidden rates of smoking among college women and the urban elite (Koehlmoos 2010). Because of cultural norms against female smoking, women are more likely to partake of locally available smoke-free tobacco products to include jarda and shada pata (dried tobacco leaves) (DGHS 2007). Again, an increase in product use can be seen with age and setting from rural (29.7%) to urban (43.1%) (WHO 2007).

A further complication in Bangladesh concerning tobacco usage is the impact of household tobacco use on consumption of essential household needs, such as household food security and child malnutrition. The average cigarette expenditure per month among cigarette smokers was approximately US\$5.4/month and among bidi smokers it was US\$1.9, and the total expenditure on cigarettes and bidis is 1.4% of gross domestic product (GDP) of Bangladesh (WHO BD 2009). About 5% of household expenditure in the homes of smokers goes toward tobacco (WHO SEARO 2007). That

more tobacco use occurs among lower socioeconomic groups is a common finding in Bangladesh-based tobacco studies (Choudhury et al. 2007, DGHS 2007). It was estimated that if poor people did not smoke, 10.5 million fewer people would be malnourished in Bangladesh (Efroymson et al. 2001). Nonnemaker and Sur (2007) evaluated the relationship between tobacco prices and child health outcomes. They found that higher tobacco prices were associated with better height for age and weight for age; with the exception of boys (ages 2-10) who experienced more wasting during periods of higher tobacco prices.

One of the leading efforts to control tobacco underway in the public sector with technical assistance from WHO is to modifying the risk factor of tobacco. Bangladesh was the first nation to ratify the WHO Framework Convention on Tobacco Control (FCTC) in 14 June 2004 and in March 2005 enacted the Smoking and Tobacco Product Usage (Control) Act 2005, which restricted smoking in public places, including hospitals, schools, government buildings, airports, and movie theaters. The law also severely restricted tobacco advertising in publications and on billboards, on television, and movie theatres. It also implemented health-warning labels on tobacco products which were required to take up at least 30% of the packaging with one of six warning messages. The law also allowed for loans to be distributed for farmers who wished to switch from growing tobacco to growing other crops.

More than ten years after the signing of the FCTC, tobacco consumption remains high. There is inadequate enforcement of the law and ample loop holes in the tobacco control program that require closing. Strengthening the tobacco control program through the National Tobacco Control Cell (NTCC) is a priority area described in the Health Population & Nutrition Sector Development Program 2011-2016.

## Issue #2: Cervical Cancer

From the total global burden of cervical cancer, one third of all cervical cancers are in South Asian nations yet there are not well developed strategies for prevention, screening or treating the disease let alone efforts to target high risk groups (Sankaranarayanan R, et al. 2008). A small study (n=472) of histopathology of cases in the Mymensing region of Bangladesh reported that cervical cancer was the leading cancer reported among females (Talukdar 2007).

According to the National Cancer Control Strategy and Plan of Action 2009-2015, cancer is a high priority for Bangladesh because of its economic impact, meaning that most (66%) cancer patients are of the age (30-65 years) to constitute the workforce of the nation (DGHS 2008). There is no national cancer registry in Bangladesh although information is reported from specialty institutions and public

health hospitals and outpatient facilities. It is estimated that there are approximately 200,000 new cases of cancer per year. (MIS 2009). However, overall population projections estimated that cancer was the main cause in 7.5% of deaths in Bangladesh in 2005 and in 2008, 70.7% of cancer deaths occur in men and 27.3% occur in women (DGHS 2008; MIS 2009). However, cancer deaths are projected to constitute 12.7% of deaths by 2030 (DGHS 2008). Age standardized death rates per 100,000 show that Mouth and Oropharynx cancers were projected to be the leading cause of cancer deaths in Bangladesh in 2005 for both genders (27 per 100,000 for men and 22.5 per 100,000 for women). Among women, cervix uteri cancer (21 per 100,000) was second and breast cancer (16 per 100,000) was third (DGHS 2008). More recently in 2012, there were an estimated 11,956 new cases and 6,582 deaths due to cervical cancer.

### Primary prevention of cervical cancer

The government cancer control strategy calls for prevention of cervical cancer through vaccination. The vaccine for Human Papillomavirus (HPV) was originally tested in Bangladesh by BSMMU. The cervical cancer vaccine Cervarix™ by GlaxoSmithKline was launched in Bangladesh on 9 February 2009. To date, a version of the HPV vaccine is not included in the national immunization strategy.

Previous analysis of developing countries concluded that HPV vaccination of preadolescent girls could potentially reduce the morbidity and mortality associated with cervical cancer, under assumptions of sustained, high vaccine efficacy and reasonable uptake (Denny et al.) Previous Gavi sponsored full country demonstration programmes in Mozambique and Uganda failed to appropriately account for the feasibility and sustainability of the demonstration model (Gavi 2015)

In line with the national cancer control strategy, in September 2014 Bangladesh applied to be a Gavi HPV Full Country Evaluation Programme. Countries successfully able to reach the adolescent population, who are not part of the more infant and child focused EPI program, in their demonstration programme subsequently will be able to roll out HPV vaccine across the country with the support of Gavi. In 2016 Bangladesh will implement a Gavi supported demonstration project of the HPV vaccine, Cervarix, in a single district. The test is expected to commence in April and targets some 33,500 girls with two doses of the vaccine between April 2016-April 2017.

### Secondary prevention of cervical cancer

Low cost, low technology interventions are needed to bring cervical cancer screening to women in low resource settings. One such technique is Visual Inspection of the cervix with Acetic Acid (VIA). A systematic review of the accuracy of using VIA as the screening mechanism for precancerous and

cancerous cervical lesions concluded that VIA is a simple, low-cost, and efficient alternative to cytologic testing in low-resource settings (Sauvaget et al 2011). Most importantly the study found that region, capacity of screener, or size of the study population did not modify VIA accuracy.

Previous implementation of VIA took place during a pilot screening program from 2004-2007. The public sector operated the programme in 16 of the 64 districts, scaling up to 44 districts by the end of the programme. Evaluation of the pilot programme showed that VIA can be successfully implemented by physicians, nurses, and paramedical workers, even though the level of resources is poor, and women and their families are often unaware of the disease and its consequences (Ahmed et al. 2008). The study also noted the need to strengthen the links between diagnostic screening and treatment as well as challenges with the false positive rate of VIA.

However, in a resource poor setting a combination of vaccination in youth and even one to three time follow up screening of the older at risk female population can have a large impact on reducing the risk of cervical cancer. A study by Sharma et al (2011) demonstrated that HPV vaccination of preadolescent girls combined with screening of older women reduced the risk of cervical cancer by more than 50% in Thailand.

Acceptability of pelvic exam screening is an area of consideration with introducing a new program as greater than 90% of adult women in Bangladesh reported never having undergone such screening in a 2008 study (Gakidou et al. 2008)

### Issue #3: Hypertension

In a groundbreaking change, non-communicable diseases and some risk factors were included in the Bangladesh Health & Demographic Survey of 2011. Previously, there had been no nationally representative sample of hypertension in Bangladesh-just a plethora of smaller, earlier studies. The BDHS 2011 results presented a population laden with a high burden of hypertension in which an estimated one in three women (35%) and one in five (19%) men > 35 years are hypertensive. Further there is expected variation by age group. Variation also exists by urban versus rural residence: 40% versus 29% for women; 25% versus 18% for men (BDHS 2011). Pre-hypertension rates were also found to be very high in the population.

Prior research on hypertension and its risk factors in Bangladesh had revealed a diverse array of populations, and methodologies were employed to necessarily distinguish between high blood pressure readings and a diagnosis of hypertension. A non-systematic review was conducted by Zaman

and Rouf (1999) that included three articles each of which employed a non-standard definition of hypertension; included populations were only based in Dhaka and had a chronological range of 1979-1994. Because of heterogeneity and a lack of appropriate categorization in the primary studies, the review was inconclusive on the prevalence of hypertension in Bangladesh and recommended that a large-scale hypertension study should be undertaken. Studies with relatively small sample sizes (240 urban and rural) like the India-Bangladesh based study conducted by the Hypertension Study Group in 2001, found an overall hypertension rate of 65% in populations over 60 years of age; there have given way in recent years to more rigorously designed studies with sample sizes greater than 2,000 (Razzaque et al 2009; Sayeed et al 2002). There were no surprises in the later studies in that lack of physical activity, overweight, age and higher socio-economic status were positively associated with higher levels of hypertension and/or high blood pressure.

Although the WHO STEPS Methodology has been applied in numerous studies conducted in Bangladesh by BRAC, ICDDR,B and other agencies, Bangladesh did not report prevalence of raised blood pressure nor prevalence of known hypertension and its treatment in World Health Organization Regional Reports (WHO-SEARO 2007a). It is worth noting that although there is no representative sample of hypertension in Bangladesh, hypertensives attending clinics have been used to test interventions for tobacco cessation and to capture the clustering of metabolic factors (Ahmed, Choudhury S, & Zaman MM 2007; Siddique et al 2008)

Previously the 2006 Bangladesh Urban Health Survey looked at hypertension (using a single reading of blood pressure and self-reported medication use for hypertension in adults over 35 years) in slum and non-slum areas of the six largest City Corporations in Bangladesh (Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet). The survey found that 25% of slum-dwelling women and 38% of non-slum women had hypertension. Men were found 18% hypertensive in the slums and 25% in the non-slum areas. Hypertension increased with age, wealth quintile, and education. Highlights are that 64% of non-slum women over the age of 60 had hypertension (versus 37.1% of slum women of the same age). For men, household wealth quintile held the greatest difference, so that the richest households in the non-slum areas reported 28.5% versus 6% for the lowest quintile in the non-slum areas. The extreme was greater in the slum areas where 31.2% of men in the highest quintile had hypertension versus 13% in the lowest. (NIPORT 2006). This seminal survey has not been similarly conducted.

The pharmaceutical industry is an important player in consideration for the development of hypertension interventions. The pharmaceutical sector in Bangladesh is thriving with approximately 224 licensed pharmaceutical factories in the country, six of which are owned by multinational

companies producing about 10.4% of local drug production. Eighty-five percent of the raw materials used in the local production of pharmaceuticals are imported and only 1.1% of locally produced drugs are exported. The Drug Control Ordinance of 1982 placed a ceiling on selling imported drugs in the local market in an effort to promote self-reliance in its pharmaceutical sector. At present, approximately 450 generic drugs, in 5,300 registered brands having 8,300 different presentations of dosage forms and strengths are manufactured in the sector. However, the local market is extremely concentrated with the top ten firms capturing about 70% of the market and only two companies, Beximco and Square holding 25% of the entire market (HLSP 2010). In Bangladesh, there are very low levels of collaboration between private firms and public sector institutions involved in Research and Development (R&D) of medical technology. Furthermore, the internal market is characterized by branded competition: each product is essentially a generic, competing on the basis of brand names. Since as early as the 1980', Bangladesh has had a national essential drugs policy and a list of essential drugs to be procured and used in the public health services. Most of the essential drugs are generics. At present drugs for treating non-communicable diseases are not included in the essential drugs list. However, technical assistance from WHO has developed a list of recommended products to be added to the essential drugs list (El-Saharty et al 2013).

Although the Health Population & Nutrition Sector Development Plan (HPNSDP) which runs from 2011-2016 includes strategies for non-communicable diseases including CVD, no specific mention is made of diagnosis and treating hypertension. Further, hypertension and other NCD risk factors continue to be excluded from the bi-annual Bangladesh Health and Demographic Survey. These items should be included in future national surveys (Bangladesh Ministry of Health 2012).

The most important aims for the adequate control of hypertension are daily compliance and long-term adherence to therapy (Mancia et al 2013). In general, previous studies in high income countries have found that patients with hypertension tend to take less than half of their prescribed medications (Viswanathan 2012). Previous research in South Asia including Bangladesh demonstrated that among elderly hypertensive patients taking medication, only 10% were well- controlled (Hypertension Study Group 2001). In a more recent study among the elderly people in the Matlab Health and Demographic Surveillance Area, prevalence of hypertension was found to be 50% among the elderly people of rural Bangladesh, but only 26% had control of their blood pressure (Khanam et al 2011). Further complicating the situation is that unlicensed providers diagnose upward of 40% of hypertension cases and are associated with higher rates of non-adherence to treatment, especially among the poorest (Khanam et al. 2014).

## Interventions to reduce NCD risks and burden

To reduce the burden of NCDs in Bangladesh, we propose three interventions be implemented by the GoB. We estimate the societal benefits and costs of those interventions in 5 years (2021) and 14 years (2030, when the SDGs expire).

- Increase tobacco taxation
- Vaccinate against HPV, and provide screening and treatment for cervical cancer
- Screen for and treat hypertension

We also discuss the problem of diabetes – a very serious health issue in Bangladesh, but one which does not have feasible solutions at present.

## Assumptions and Methods

We collected data from academic literature to estimate the benefit cost ratio (BCR) of our three chosen interventions. We follow the Copenhagen Consensus' standard guidelines and assumptions where applicable. The United Nations Development Project provided the current and projected demographic numbers (Bangladesh Government). We report all costs in Bangladeshi Taka, with the exchange rate of 77.63 Taka per 1 USD (Bangladesh Bureau of Statistics). All benefits are reported in disability-adjusted life-years (DALYs) and translated to Bangladeshi Taka at the rate of 95,864 taka per DALY averted (Bangladesh Bureau of Statistics). We apply discount rates of 0%, 3%, 5% and 10%. We consider two time frames by which we recommend the interventions be fully implemented. The first time frame reflects standard Copenhagen Consensus methodology and projects through 2021, five years in the future. We also examine costs and benefits through 2030, about 15 years into the future, in order to capture the benefits of our long-term interventions.

### Intervention #1: Tobacco Taxation

Increasing taxes on cigarettes is a proven technique for reducing smoking. We propose levying a uniform tax on all tobacco products that is adequately enforced. The current tax on tobacco products is approximately 35% of the retail price, although this tax varies by product and is not strictly enforced (Nargis 2014). We propose creating a well-enforced, uniform tobacco tax across all products, and raising that tax to 50% of the retail price by 2021, and to the WHO recommended level of 75% by year 2030.

To estimate benefits, we apply a -0.49 price elasticity to tax rates of 50% and 75%, which would result in a reduction in demand for tobacco products of 7.4% and 19.6% respectively (Nargis 2014). We then

use WHO predictions of tobacco mortality in Bangladesh to estimate the aggregate reduction in mortality from increased taxes and decreased tobacco consumption (WHO 2005). Each death averted was valued at 15 DALYs. On average, tobacco users die about 10 years earlier than their non-smoking counterparts, with other years of life discounted for tobacco-related illness.

We estimate costs to implement increased tobacco taxes with and without considering tax revenues. Asaria and Chisholm (2009) estimated that a revised tobacco tax would cost Bangladesh approximately 3.88 taka (\$0.05 USD) per capita per year, which we multiplied by the projected populations in 2021 and 2030 in Bangladesh. The cost of the tax would be offset by tax revenue on each tobacco product sold. For simplicity, we estimate that the average smoker in Bangladesh smokes about one pack of 10 cigarettes per day at 30 taka per pack (Nargis 2014). Tax revenue per pack in years 2021 and 2030 would be 15 and 22.5 taka respectively. This revenue is then multiplied by the estimated number of smokers, adjusting for population increase and reduction in demand due to the price increase.

Increasing tobacco tax, without considering tax revenue, would result in 12 taka in benefits for every 1 taka spent for the 50% tax rate in 2021; this increases to 32 taka in benefits for every 1 taka invested for a 75% tax rate in 2030. Incorporating the tax revenue dramatically increases the return on investment to 23:1 and 87:1 for years 2021 and 2030 respectively.

## Intervention #2: HPV Vaccination and Cervical Cancer Screening and Treatment

A combined strategy of HPV vaccination and cervical cancer screening, followed by treatment when appropriate, can reduce cervical cancer deaths by 44% (Levin 2015). There are currently about 10,000 cervical cancer deaths a year in Bangladesh, and this number is projected to reach 18,000 by 2030 (Bradford 2012). We propose a screening and treating program for cervical cancer using VIA.

We estimate costs of a screening and treating program for cervical cancer using VIA. In our analysis, we assume women aged 35-59 would be screened about every 5 years at a cost of \$5 USD (388.15 taka) per person (Bradford 2012, Levin 2015). We also propose that treatment options be available to those whose screenings detect irregularities. While treatment can run the gamut from cheap and simple to expensive and complex, we assume the average woman will need relatively low-cost and low-technology treatment such as LEEP. LEEP costs about \$70 USD (5,434 taka) per treatment (Levin 2015). Estimating about 24,300 and 31,000 cases detected in years 2021 and 2030 respectively, we assume the health system can reasonably treat 80% of the low-cost cases detected. We assume that 20 DALYs are averted for each cervical cancer death averted in Bangladesh, given a median age at death of 50 and a female life expectancy of about 70 (SEER 2014, Bangladesh Government). To

calculate benefits, we reduced the expected number of cancer deaths by 44% and monetized the corresponding DALYs averted.

HPV vaccination costs will likely be covered by GAVI, however we calculated the BCR both including and excluding costs of an expanded vaccination plan. Estimates from China indicate that each fully vaccinated girl would cost about \$46 USD (3,571 taka) including 2 vaccine doses, administration, and wastage. Given the strong vaccine delivery infrastructure in Bangladesh, we assume 100% coverage of 10-year old girls.

If we assume GAVI covers the immunization costs, investing in HPV vaccination and routine cervical screening programs would return 5.2 and 5.9 takas per 1 taka spent in years 2021 and 2030 respectively. These ratios decrease to approximately 2 taka in benefit per 1 taka spent when including vaccine costs.

### Intervention #3: Screening and Treatment for Hypertension

We assume a slightly conservative estimate of hypertension prevalence in our analysis, assuming that about 20% of adults over 25 either have hypertension or are at high risk of cardiovascular disease due to multiple risk factors. Women in our analysis have a slightly higher prevalence of hypertension, although they are also more likely to keep their disease under control and adhere to their medications. We also assume that successful adherence to a hypertension management program will avert an average 3 DALYs per person (Robberstad 2007). This average is taken over all patients, some of whom will avert major health events such as AMIs or strokes, others of whom will see only small health benefits. Our analysis assumes we can reach about 60% of the high-risk hypertensive population who are not already controlling their condition, and that about 75% of those reached will successfully manage their disease.

Hypertension, or raised blood pressure levels, is a primary risk factor for a host of other serious conditions, including heart disease, diabetes, and stroke. It can be diagnosed and managed inexpensively, however, with daily adherence to common anti-hypertensive medication. This type of secondary prevention is essential to prevent disease and potentially fatal events. We examine a scenario in which the Bangladesh healthcare system reaches at least 60% of adults at high risk for cardiovascular disease with uncontrolled hypertension and with approximately 75% adherence rates.

To evaluate benefits, we estimated how many people would manage their hypertension successfully if we achieved our assumptions. Hypertension prevalence estimates for Bangladesh vary by source, between 9-25% for men and 14-32% for women (Rahman 2015, 2010 Bangladesh NCD Risk Factor

Survey, Koly 2015, Khanam 2014). We stratify on gender as three significant factors vary by gender: prevalence, current hypertension management, and medication adherence. For this analysis we assume 19.4% prevalence overall, with 16.4% in men and 21.8% in women. We also assume 70% of this population is not successfully managing their condition (72% for men, 66% for women) (Rahman 2015). For each person that successfully managed their hypertension, we assume they averted an average of 3 DALYs (Robberstad 2007).

The “WHO Brief on Global Hypertension” estimated hypertension control could be implemented for \$1 per capita in low-income countries in 2013. This translates into \$13 per treated person per year. (We also make a sensitivity analysis of \$60 per treated person, which produces benefit-cost ratios at just below 4.)

With the above assumptions, we find Bangladesh will see 17.8 taka in benefits for every 1 taka invested. Stratified by gender, we find that treating women results in a slightly higher BCR than men, at 18.3 and 17.1 respectively.

## Diabetes

Much has been written about the high rates of diabetes in Bangladesh. The 2011 Bangladesh Health and Demographic Survey discovered that 11% of men and women over age 35 have diabetes and an addition 25% can be categorized as having prediabetes. An overwhelming majority of public sector and non-governmental organization funds and activities relate to maternal and child health, overlooking this enormous problem among adults and older women. Further, almost 60 percent of women and 65 percent of men with diabetes are unaware that their fasting plasma glucose levels exceed normal standards (BDHS 2011). Further urban women were found to be twice as likely as rural woman (17 versus 9 percent) to be diabetic: however, the absolute number of diabetics and pre-diabetics in the rural areas cannot be ignored.

Bangladesh is also experiencing an increase in overweight and obesity (BMI over 25) among women of childbearing age (15-49). The increase in BMI over 25 went from 12 percent in 2007 to 17 percent in 2011. No similar sample was taken from older women or men at any age. However, the implications are grave given that being overweight increases the risk of multiple non-communicable diseases including Type II Diabetes, hypertension and heart disease (BDHS 2011). Given the emphasis on maternal health, the engagement of this population with the community health clinics provides an opportunity for the development of counseling mechanisms toward curbing the risk of diabetes through weight loss and increased physical activity.

If left untreated or poorly managed the cost of diabetes care is high. While flag ship programs exist in Dhaka through well-respected and long-established organizations like BIRDEM, current outreach and education efforts in rural areas are insufficient to meet the needs of the vast diabetic and pre-diabetic population, especially in the rural areas. Further, diabetes screening and management are not cost effective or simple to implement. Thus, while awareness building and effective prevention strategies through behavior change communication, especially for the 25% of the population who are pre-diabetic, are essential to reduce the growth in future burden of disease, the Government of Bangladesh and all health, science and economic stakeholders must lobby the international development community including government and foundational type organizations to take on the challenge of developing and testing of low cost, low technology innovations to screen, diagnose, and manage diabetes that can be rolled out to community health clinics and delivered by community health workers across Bangladesh and other low resource settings. The time for action on diabetes and pre-diabetes is now. (Saharty et al. 2013).

## Conclusion

Bangladesh is suffering from soaring chronic non-communicable disease rates and, to date, has not successfully implemented prevention and control programs and policies at national scale. Compelled by the country's strong surveillance and research capabilities, and with support from the huge network of BRAC health care providers, Bangladesh is in a good position to implement three proven interventions that will prevent thousands of premature deaths and provide net economic benefits within 6 years.

There is no doubt that Bangladesh like other parts of the world, is suffering from an increase in obesity leading to higher rates of diabetes. This disease will likely be the biggest killer in the country in the next years. However, in this work we have decided to focus our interests in other important NCDs also affecting the population of Bangladesh for which we feel there is a need to approach its control by other measures than those used for the combat of diabetes. Smoking continues to be another one of the biggest factors in adult mortality in the world and measures towards its control by taxing the product and restricting its areas for use have clearly shown their impact in other parts of the world. At the same time with the possibility of vaccinating young girls against papilloma viruses we have now a way for preventing cervical cancer in a way that is cost effective especially in countries where services are still few and restricted for the appropriate treatment of this disease. The highly efficient health infrastructure present in today's Bangladesh is an asset that few low income countries have to tackle these complex diseases, its use will depend on the best approach on how to use it as its population grows older and faces other challenges for survival.

## References

- [Ahmed T](#), [Ashrafunnessa](#), [Rahman J](#) (2008) Development of a visual inspection programme for cervical cancer prevention in Bangladesh. *Reprod Health Matters*. 16(32):78-85
- Bangladesh Bureau of Statistics (2011) Report on Sample Vital Registration System 2010. Dhaka.
- Bangladesh Ministry of Health (2012) Bangladesh NCD Risk Factor Survey 2010 Fact Sheet.
- Bradford, Leslie S., Bimalangshu R. Dey, Syed Md Akram Hussain, Sultana Razia Begum, Farhat Hussain, Sharmina Hoque, and Annekathryn Goodman. "Development of a cervical cancer screening program in a slum setting using visual inspection with acetic acid: feasibility and cost." (2012).
- Denny L, Herrero R, Levin C, Kim JJ ( 2015) Cervical Cancer, Chapter 4, Volume 4 of Disease Control Priorities, 3rd Edition, World Bank, Washington, DC.
- El-Saharty S, Ahsan KZ, Koehlmoos TLP, Engelgau MM (2013) Tackling Noncommunicable Diseases in Bangladesh: Now is the Time. World Bank: Washington, DC.
- Gakidou, E., S. Nordhagen, and Z. Obermeyer (2008) Coverage of Cervical Cancer Screening in 57 Countries: Low Average Levels and Large Inequalities. *PLoS Medicine* 5 (6): e132
- Gavi Full Country Evaluations Team (2015) Human Papillomavirus Vaccine: Lessons Learned from the 2014 Gavi Full Country Evaluations. Seattle, WA: IHME.
- HLSP/Mott McDonald Ltd. 2010. "Bangladesh Health Sector Profile." Draft report for the World Bank in collaboration with Government of Bangladesh and World Health Organization, Dhaka.
- Hypertension Study Group (2001) Prevalence, awareness, treatment and control of hypertension among elderly in Bangladesh and India: a multicentre study. *Bull World Health Organ*, 79: 490500.
- International Agency for Research on Cancer (IARC) (2012) 'Bangladesh' GLOBOCAN 2012 Estimated Cancer Incidence, Mortality and Prevalence Worldwide in 2012.
- Khanam MA, Lindeboom W, Koehlmoos TLP, Alam DS, Niessen L, Milton AH (2014) Hypertension: Adherence to treatment in rural Bangladesh- findings from a population based study. *Global Health Action* , 7: 25028
- Khanam MA, Qiu C, Lindeboom W, Streatfield PK, Kabir ZN, Wahlin A (2011) The metabolic syndrome: prevalence, associated factors, and impact on survival among older persons in rural Bangladesh. *PLoS One*; 6: e20259.
- Larson CP, Koehlmoos TP, Sack DA (2012) Scaling up zinc treatment of childhood diarrhoea in Bangladesh: theoretical and practical considerations guiding the SUZY Project. *Health Policy & Planning*. 27(2):102-14.
- Levin, Carol E., Monisha Sharma, Zachary Olson, Stéphane Verguet, Ju-Fang Shi, Shao-Ming Wang, You-Lin Qiao, Dean T. Jamison, and Jane J. Kim. "An extended cost-effectiveness analysis of publicly financed HPV vaccination to prevent cervical cancer in China." *Vaccine* 33, no. 24 (2015): 2830-2841.

Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, et al. (2013) ESH/ESC guidelines for the management of arterial hypertension: The Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Eur Heart J*, 34: 2159-219.

Mirelman, Andrew, Tracey Pérez Koehlmoos, and Louis W. Niessen. "Risk-attributable burden of chronic diseases and cost of prevention in Bangladesh." *Global heart* 7, no. 1 (2012): 61-66.

Nargis, Nigar, Ummul H. Ruthbah, AKM Ghulam Hussain, Geoffrey T. Fong, Iftekharul Huq, and S. M. Ashiquzzaman. (2013) "The price sensitivity of cigarette consumption in Bangladesh: evidence from the International Tobacco Control (ITC) Bangladesh Wave 1 (2009) and Wave 2 (2010) surveys." *Tobacco control: tobaccocontrol-2012*.

National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International (2013) Bangladesh Demographic and Health Survey (BDHS) 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International.

Robberstad, Bjarne, Yusuf Hemed, and Ole F. Norheim. "Cost-effectiveness of medical interventions to prevent cardiovascular disease in a sub-Saharan African country—the case of Tanzania." *Cost effectiveness and resource allocation* 5, no. 1 (2007): 1.

Sauvaget C, Fayette JM, Muwonge R, Wesley R, Sankaranarayanan R (2011) Accuracy of visual inspection with acetic acid for cervical cancer screening. *Int J Gynaecol Obstet*, 113(1):14-24.

Sharma MJ, Ortendahl E, van der Ham S S, Kim JJ. (2011) Cost-Effectiveness of Human Papillomavirus Vaccination and Cervical Cancer Screening in Thailand. *British Journal of Obstetrics and Gynaecology* 119 (2): 166–76.

Viswanathan M, Golin CE, Jones CD, Ashok M, Blalock SJ, Wines RC, et al. (2012) Interventions to improve adherence to self-administered medications for chronic diseases in the United States: a systematic review. *Ann Intern Med*, 157: 785-95.

World Health Organization (2008) Disease and Injury Regional Estimate: Cause-Specific Mortality: Regional Estimates for 2008.

World Health Organization (2012) NCD Global Monitoring Framework. Geneva, Switzerland: World Health Organization.

World Health Organization (2014) Bangladesh. Non-Communicable Disease Country Profile.

Yusuf S (2002) Two decades of progress in preventing vascular disease. *Lancet*, 360:2–3.

Yusuf S, Islam S, Chow CK, et al., for the PURE Study Investigators. (2012) Use of secondary prevention drugs for cardiovascular disease in the community in high-income, middle-income, and low-income countries (the PURE Study): a prospective epidemiological survey. *Lancet* (2012) 378:1231–43.

## Appendix

### Appendix 1: Benefit Cost Ratios in 2021 and 2030 using discount rates of 0%, 3%, 5%, 10%. Benefits and Costs in millions

#### 2021

Intervention	No discount Rate			3% Discount Rate		5% Discount Rate		10% Discount Rate	
	Benefit	Cost	BCR	Benefit	BCR	Benefit	BCR	Benefit	BCR
Tobacco tax									
With tax revenue		337	23.3	6,252	18.5	5,436	16.1	3,983	11.8
Without tax revenue	7,855	661	9.5		9.5		8.2		6.0
HPV vaccine and cervical cancer									
With GAVI funding	11,963	2,279	2.2	4,927	2.2	2,809	1.2	757	0.3
Without GAVI funding		7,706	1.6		0.6		0.4		0.1
Hypertension management									
Total	1,349,188	75,778	17.8	1,224,684	17.8	1,152,052	17.8	999,786	17.8
Men	471,085	27,577	17.1	427,613	17.1	402,253	17.1	349,087	17.1
Women	849,354	46,449	18.3	770,975	18.3	725,250	18.3	629,395	18.3

2030

Intervention	No discount Rate			3% Discount Rate		5% Discount Rate		10% Discount Rate	
	Benefit	Cost	BCR	Benefit	BCR	Benefit	BCR	Benefit	BCR
Tobacco tax									
With tax revenue	23,384	268	87.3	18,611	69.5	16,181	60.4	11,857	44.3
Without tax revenue		737	31.7		25.2		21.9		16.1
HPV vaccine and cervical cancer									
With GAVI funding	15,185	2,565	5.9	6,254	2.4	3,566	1.4	961	0.4
Without GAVI funding		8,623	1.8		0.7		0.4		0.1
Hypertension management									
Total	3,939,146	221,246	17.8	3,142,667	17.8	2,738,304	17.8	2,021,304	17.8
Men	1,375,400	80,515	17.1	1,097,300	17.1	956,112	17.1	705,763	17.1
Women	2,479,809	135,615	18.3	1,978,401	18.3	1,723,843	18.3	1,272,471	18.3



Bangladesh, like most nations, faces a large number of challenges. What should be the top priorities for policy makers, international donors, NGOs and businesses? With limited resources and time, it is crucial that focus is informed by what will do the most good for each taka spent. The Bangladesh Priorities project, a collaboration between Copenhagen Consensus and BRAC, works with stakeholders across Bangladesh to find, analyze, rank and disseminate the best solutions for the country. We engage Bangladeshis from all parts of society, through readers of newspapers, along with NGOs, decision makers, sector experts and businesses to propose the best solutions. We have commissioned some of the best economists from Bangladesh and the world to calculate the social, environmental and economic costs and benefits of these proposals. This research will help set priorities for the country through a nationwide conversation about what the smart - and not-so-smart - solutions are for Bangladesh's future.

# SMARTER SOLUTIONS FOR BANGLADESH

For more information visit [www.Bangladesh-Priorities.com](http://www.Bangladesh-Priorities.com)

## C O P E N H A G E N C O N S E N S U S C E N T E R

Copenhagen Consensus Center is a think tank that investigates and publishes the best policies and investment opportunities based on social good (measured in dollars, but also incorporating e.g. welfare, health and environmental protection) for every dollar spent. The Copenhagen Consensus was conceived to address a fundamental, but overlooked topic in international development: In a world with limited budgets and attention spans, we need to find effective ways to do the most good for the most people. The Copenhagen Consensus works with 300+ of the world's top economists including 7 Nobel Laureates to prioritize solutions to the world's biggest problems, on the basis of data and cost-benefit analysis.