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REVIEW

Risk-Attributable Burden of Chronic Diseases and Cost of Prevention in Bangladesh

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To address the increasing burden from noncommunicable diseases (NCD) in Bangladesh, new epidemiologic and economic information for risk factors are needed. This work quantified the attributable risk from specific NCD risk factors and undertook a costing exercise for prevention of NCD risk factors. We used available data for Bangladesh and implemented an iterative questionnaire process with local experts to calculate risk factor population attributable fractions and establish resource requirements for NCD prevention. The burden analysis showed that myocardial infarction and stroke occurrence can be greatly reduced by risk factor control. From the costing, we found that $3.95 USD per capita is needed for a prevention program, which is 26% of the total expenditure on health. These estimates should facilitate advocacy for setting expenditure targets and identifying financing mechanisms to address NCD. The information supports the scaling-up of NCD prevention strategies in Bangladesh and serves as a model for work in developing country settings.

NONCOMMUNICABLE DISEASES AND RISK FACTORS IN BANGLADESH

Addressing the noncommunicable disease (NCD) burden is proving to be an important and increasingly acknowledged issue on the global health agenda. The momentum for global efforts to address prevention and control of the burden from NCD has been high in recent years leading to a culmination at the United Nations' High-Level Meeting of September 19–20, 2011, when national governments confirmed the need for an action agenda. In low-resource countries, the fight against rising levels of NCD has only begun. In most of these settings, global health support efforts have been focused on communicable diseases, and building capacity for intervention strategies and surveillance for NCD is novel.

This special issue of *Global Heart* highlights important efforts that are taking place worldwide to support the planning and implementation process in countries for NCD control efforts. The initial results presented in this work demonstrate a process for collecting and using the best available country-specific data sources and input from country-level experts to estimate epidemiological burden and the costs for intervention strategies. This work focuses on Bangladesh, where the advancing epidemiologic transition from communicable diseases to NCD is underway and is projected to accelerate over the next two decades [1].

Resources for NCD are limited in any setting, and the most economically viable solutions for disease control are through primary prevention, i.e., reductions of NCD risk factor levels leading to reduced disease incidence. Here, we define a risk factor as an underlying cause of the disease that often is part of a complex pathway of multiple individual risk factors leading to the onset of disease [2]. Many risk factors for NCD are modifiable, and reduction of major risk factors could lead to a reduction in disease incidence of up to 50% [3].

An agenda addressing NCD risk factors requires information about the risk factors' epidemiology

and distributions in the country. Likewise, cost estimates of primary prevention efforts are important and provide a key step to mobilize local and international political and financial support. There are strong economic arguments to address the NCD burden in developing countries where a sizable burden occurs in younger, working-age populations, which reduces labor productivity and leads to negative economic impacts for households [4,5]. For Bangladesh, research on the economics of NCD has been largely lacking [6].

Several efforts to estimate the burden of risk factors in the Bangladeshi population have been undertaken. In 2002, a stepwise approach to surveillance survey (STEPS) conducted by the World Health Organization (WHO) suggested that preventable risk factors, including tobacco, unhealthy diets, physical inactivity, and alcohol, are becoming an increasing problem in the country [7]. A separate survey using the STEPS methodology in the subdistrict of Matlab in 2005 cast further light on the characteristics of households and individuals that were likely to have NCD risk factors. The results showed that there were high levels of many risk factors and that their distribution across characteristics such as age, sex, and socioeconomic status were varying [8]. Countrywide, evidence suggests that there are high rates of any tobacco use, particularly among men (men: rural: 52%, urban: 41%; women: rural: 29%, urban: 17%); moderate rates of fruit and vegetable consumption among adults (vegetables: 3.2 servings daily; fruit: 1.7 servings daily); and high rates of physical inactivity among adults, particularly women (men: 35%; women: 64%) [9–11].

The consequences of neglecting to address NCD risk factors now are high. If current trends of NCD-related risk factors in Bangladesh are maintained, then many deaths will occur in the future that could have been prevented. A recent household survey in Bangladesh estimated that tobacco-related illnesses were responsible for 16% of all deaths in the country [9,12]. Further case–control studies have shown that strong linkages between tobacco smoking and cardiovascular disease (CVD) exist in Bangladesh and that smokeless tobacco can have devastating effects [13].

Currently in Bangladesh, several efforts adapt existing health services to address the NCD burden [12]. As a comprehensive approach to addressing risk factors, though, these efforts focus on information gathering and ad hoc intervention programs with passive case finding. For the country to take steps to address NCD risk factors, information from many sources needs to be collated, synthesized, and made available to decision makers. This paper provides some initial results from ongoing work that focuses on accessing multiple sources of information within Bangladesh to estimate the epidemiologic burden and the costs of NCD risk factor intervention strategies.
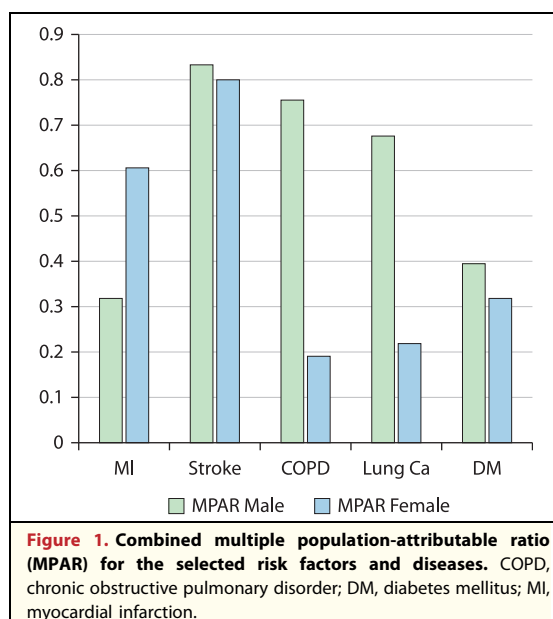
ESTIMATING THE RISK FACTOR– ATTRIBUTABLE BURDEN

To estimate the risk factor burden, we used the epidemiologic concept of population-attributable fraction (PAF) to prioritize specific risk factors in prevention and control programs. The PAF is defined as the amount of disease incidence that is attributed to a specific risk factor or the amount of potential decrease in disease incidence that can be expected if that risk factor were completely eliminated [14,15]. A secondary parameter to the PAF is the multiple population-attributable ratio (MPAR), which combines the PAF multiplicatively to give the total amount of disease incidence that would be averted if all the risk factors were eliminated [15,16]. Clustering of risk factors or joint occurrence in single individuals is shown to be potentially important in older and less-educated populations in Bangladesh but has not yet taken into account in this analysis [17].

Risk factors for this exercise were chosen based on strength of evidence and importance for addressing the NCD burden in Bangladesh. The five selected risk factors were a combination of behavioral and biologic risk factors using standard definitions set out by WHO [18]. The risk factors chosen were hypertension, elevated cholesterol, smoking, body mass index (BMI), and inactivity (see Box). On the disease side, five NCD that are prevalent in Bangladesh and associated with the risk factors were selected for the analysis. These included two forms of CVD, including myocardial

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NCD risk factor definitions

- Hypertension: systolic blood pressure >140 mm Hg or diastolic blood pressure <90 mm Hg.
- Elevated cholesterol: >200 mg/dl.
- Smoking: daily and nondaily user of cigarettes.
- BMI: overweight (25.0–29.9) or obese (>30.0).
- Inactivity: prevalence of nonengagement in moderate physical activity.

Figure 1. Combined multiple population-attributable ratio (MPAR) for the selected risk factors and diseases. COPD, chronic obstructive pulmonary disorder; DM, diabetes mellitus; MI, myocardial infarction.

infarction (MI) and stroke; chronic obstructive pulmonary disorder (COPD); lung cancer; and diabetes mellitus (DM).

The data for all risk factors except elevated cholesterol are preliminary data from the latest WHO STEPS report for Bangladesh (to be released in 2012), which recorded prevalence data on risk factors in the adult population over 25 years old. Because cholesterol information was not available from the STEPS report, elevated cholesterol prevalence was reported from a rural survey from 1996 [19]. Relative risk information for each risk factor and its associated diseases are difficult to obtain for a low-income setting such as Bangladesh, or even the South East Asia region. We assumed that relative risks are maintained across different countries and regions and used previous estimates from sources using relative risks for the same risk factors, which has been previously justified [20,21].
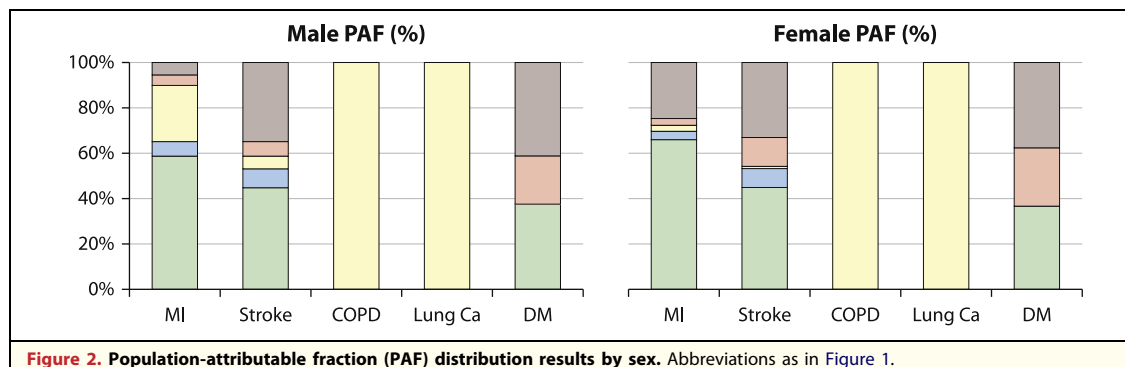
The results for the MPAR calculations broken down by sex are shown in Figure 1. For both sexes,

the largest reduction in disease comes from addressing the risk factors associated with stroke. For men, there is also a high level of COPD and lung cancer that is preventable, and significant proportions of DM and MI are also preventable. In women, the amount of preventable MI is higher than that for men, and the levels of COPD and lung cancer are quite a bit lower. Figure 2 shows the percentage of each portion of the preventable level of disease that is attributed to each risk factor. Because smoking is the sole factor associated with COPD and lung cancer, we see that the higher prevalence of smoking in men is what leads to the higher preventable levels. For MI, hypertension plays a major role for both sexes, followed by smoking for men and inactivity for women. Stroke shows similar trends, with an even greater contribution from inactivity and, especially for women, elevated BMI. The major risk factor contributions for DM result from hypertension, elevated BMI, and inactivity for both sexes. Overall, hypertension, smoking, and inactivity contributed the most as risk factors. Elevated cholesterol, alcohol consumption, and higher BMI showed less impact on the selected diseases.

These results show that, especially for men, known risk factors contribute to large proportions of disease occurrence. This is also true for women in the case of MI and stroke. The amount of available evidence on NCD is limited for Bangladesh. Our calculations show that some risk factors are more important than others are and that MI and stroke occurrence in both sexes, as well as smoking-related diseases in men, can be greatly reduced by risk factor control.

COSTING OF RISK FACTOR PREVENTION STRATEGIES

In addition to the burden estimation, we also conducted a costing exercise for risk factor prevention

Figure 2. Population-attributable fraction (PAF) distribution results by sex. Abbreviations as in Figure 1.

strategies for Bangladesh. We developed a generic framework for costing, based on the approaches by WHO, and used a country-specific validation process to obtain cost estimates [22,23]. We divided costs into two broad categories: patient costs, which include the unit prices of resources; and program costs, which include administrative, education, and training costs, among others. The costing took into account estimates for preventive interventions that specifically addressed elevated blood pressure and cholesterol. These include diagnostic testing and first- and second-line medications such as statins, diuretics, and beta-blockers for lowering cholesterol and blood pressure. Costing components addressed additional risk factors indirectly through programmatic costs established at the national, divisional, district, and community levels.

A self-administered questionnaire was developed for costing estimates, based on an earlier NCD-costing exercise done in China and a global maternal and child health–costing exercise [20,23]. To capture all of the appropriate cost drivers, the survey consisted of three types of questions: risk factor epidemiology; economic costs of the individual-based interventions; and questions on the functioning and size of CVD prevention programs. The questionnaires were pre-populated with the most recent global, publicly available information from databases such as WHO Global Infobase [24], WHO CHOICE costing database [25], and Management Sciences for Health drug price indicator database [26]. Minimum and maximum estimates were also requested for relevant parameters for inclusion in sensitivity analyses.

Once the available information was compiled in the questionnaire, it was circulated to country experts for a validation procedure. In this process, local qualified health economists and administrators (n = 5) were identified and contacted to either confirm that the information in the questionnaire was correct or to provide more accurate information.

The respondents provided new estimates of the costs from sources such as the existing Ministry of Health salary and benefit rates for health workers at various levels, previous or ongoing costing projects, and the market prices for drugs as reported by expert pharmacists. Validated epidemiology data for risk factor prevalence were based on a national population sample using the STEPS protocol, updating the WHO 2002 estimates for the year 2011. Standard case-management protocols were provided in the questionnaires for validation by the country experts as well. These provided another source of variation across countries and have implications for costs.

A costing model was developed in Microsoft Excel (Redmond, Washington) with Palisade's @Risk add-on (Ithaca, New York) for probabilistic analysis. The model used all of the validated country cost and epidemiologic information to generate the total cost of prevention and associated confidence intervals. The 2010 Bangladesh population estimate from the UN Population Division [27] was used to calculate a country total cost per capita for CVD risk factor prevention strategies. The preliminary results for both Bangladesh and the entire South East Asia region are available in Table 1. Overall, the validated costing estimates were higher than the pre-populated estimates for the South East Asia region. In Bangladesh, the validated estimate rose 28% during the country validation procedure to the final estimate of US$3.95 per capita (denoted: "Validated Total Cost per Capita of Prevention Strategies"). This estimate is around 26% of the total expenditure on health in the country and 79% of the government expenditure on health [28]. Relative to the average cost of prevention for the South East Asia region, the cost for prevention in Bangladesh represents a relatively affordable proposition. To account for levels of uncertainty in the evidence and outcomes, sensitivity analyses were also conducted using probabilistic techniques, though they are not presented here.

Table 1. Price tag for prevention in Bangladesh and SEAR

	2010 Population	Per capita total expenditure on health 2007 (US$)[a]	Per capita government expenditure on health 2007 (US$)[a]	Validated total cost per capita of prevention strategies	% of total expenditure	% of government expenditure
Bangladesh	164,424,000	15.00	5.00	3.95	26	79
SEAR	1611,408,000	41.00	15.00	27.19	66	181

Adapted, with permission, from WHO [28].
SEAR, South East Asia region.
[a] Average exchange rate.

The costing results show that from a financing perspective, meeting the needs of risk factor prevention requires an increase in resources from government, private sector, and external aid organizations. Further study on averted cost of illness and economic impact should also be conducted for conclusions about the cost-effectiveness of these programs. Another outcome of this work is the emphasis on the country-level validation process. The work involved bringing together relevant NCD stakeholders in the country and compiling risk factor epidemiologic and economic data that has been collected in different places and times. The use of such a validation process helped ensure that there was appropriate buy-in and input from experts in the country who are concurrently working on NCD.

DISCUSSION

Bangladesh, as a developing country, is moving forward with including noncommunicable diseases on its health agenda. Even though the country's large inequalities and rampant poverty represent a general case of issues facing developing settings, especially those in Southeast Asia, many of the solutions will have to account for the starkly different profiles of risk factors even within similar countries [17].

A limitation of our work is the lack of quality data. Data limitations made it difficult to model risks related to unhealthy diet and the lack of consumption of fruits and vegetables. Improved data is needed for program monitoring and predicting future burden. Further work to identify the major gaps in risk factor data in Bangladesh should follow in the steps of recent work in India, which takes into account country-specific risks [29].

Data on the epidemiology of diseases and risk factors could serve as important tools for establishing priorities for NCD prevention and management in the future. Specifically, more should be done to obtain basic indicators of disease prevalence and mortality. For risk factors, there is an urgent need to establish the prevalence of elevated cholesterol. More data is also needed on relative risks and degrees of risk factor clustering among the population. With this in mind, even in developed countries, some disease and risk factor information is difficult to obtain such as prevalence levels of pre-diabetes and causal linkages between salt intake and CVD.

For determining a cost of prevention, our work only uses information from the public sector and is limited by the lack of data from the private sector. Because the costs and coverage of the private sector is unknown, our cost estimates only represent a minimum of what is needed. Adding information for the private sector would provide a fuller picture of the costing landscape and, predictably, would increase the total prevention cost by a considerable amount.

Costing studies will also be vital to provide decision makers with estimates of the amount of resources required. Several costing components will continue to be difficult to measure in a lower-income country such as Bangladesh. These include the intensity and cost of providing community health workers at the neighborhood levels and the extent of facility- versus community-level care for selected interventions and the quality of care provided. Regardless, assumptions will need to be made to obtain an appropriate cost for program introduction and scale-up, and sensitivity analysis methodologies provide a solution to determining the levels of certainty around these estimates. New cost estimates have the potential to facilitate advocacy, set targets for appropriate expenditure on health, and help identify funding and financing mechanisms for neglected health issues [23]. With reliable cost estimates, a co-coordinating and negotiating national mechanism could provide strong leverage for a prevention program that includes both the private and public sector, is involved in price setting, and that contributes to adequate efforts for monitoring and evaluation.

The work that has been done for NCD in Bangladesh is beginning to shed new light on the scale of the problem. The country has inequalities in disease and risk factor distribution and health-seeking behavior between urban and rural populations and between groups of rich and poor [30]. Tackling this issue is vital to continue the fight against poverty in the country. We have shown that working at the country level through iterative processes with experts provides leverage for unifying the relevant actors and generating local capacity to produce country-specific information on disease burden and costs, information that demonstrates resource needs that can be used to support scaling up of NCD prevention strategies for the Bangladeshi people.

ACKNOWLEDGMENT

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