Economic Benefit-Cost Analysis of Select Secondary Prevention Interventions in LMIC

Rachel Nugent, Elizabeth Brouwer

Seattle, WA, USA

We present a quantitative economic benefit-cost analysis of 2 secondary prevention targets that are part of the World Health Organization's Global Monitoring Framework for noncommunicable diseases (NCD). These targets are expected to contribute to the achievement of the overall NCD target proposed for the Post-2015 Sustainable Development Goal Framework. We estimate that interventions would need to avert roughly 6 million to 7 million NCD deaths worldwide in 2030 to meet the target. We calculate that the combination of tobacco taxation that achieves 50% reduction in use and 70% coverage of high-risk populations with a multidrug regimen can provide one-half of that mortality reduction in 2030, at a benefit-cost ratio of 7:1, or U.S. $7 in benefits for each U.S. $1 in cost.

Success in lowering noncommunicable disease (NCD) mortality rates in high-income countries (HIC) has been dramatic. Much of the gains can be attributed to population- 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). This review argues that cost-effective NCD prevention and treatment solutions are ready to be scaled-up and implemented across the globe. These investments will improve in value as the epidemiological and demographic transitions progress and as developing countries establish greater health system capacity to provide NCD services and implement related policies.

We present a quantitative economic benefit-cost analysis of 2 secondary prevention targets that are part of the World Health Organization's (WHO) Global Monitoring Framework (GMF) for NCD [1]. These targets are expected to contribute to the achievement of the overall NCD target proposed for the Post-2015 Sustainable Development Goal Framework (Table 1) [2]. The proposed NCD target (#3.4) to reduce premature NCD mortality refers to the unconditional probability of dying between the ages of 30 and 70 years from CVD, cancer, diabetes, or chronic respiratory diseases. Most NCD deaths in HIC occur after 70 years of age, so we concentrate our interventions in developing countries, where 80% of NCD deaths occur, and among people under 70 years of age. We estimate that interventions would need to avert roughly 6 million to 7 million NCD deaths worldwide in 2030 to meet the target. We calculate that the 2 interventions presented and analyzed here can provide one-half of that mortality reduction in 2030:

1. Tobacco tax—Tax tobacco to achieve a 50% relative reduction in user prevalence.
2. Secondary prevention of CVD—70% coverage and 60% adherence to a multipill regimen for those at a high risk of a cardiovascular event.

METHODS

We draw from literature the health benefits and the intervention costs and make adjustments for population size, intervention coverage, and inflation as needed [3-8]. We considered the average age of premature death and the assumed life expectancy to move from deaths averted to disability-adjusted life years (DALY). Given that the age range we are considering is 30 to 70 years old, we assumed that the average age of death in our analysis would be the midpoint of 50 years old. If the premature death was averted and the subject lived to or past life expectancy of 70 years old, that person averted 20 DALY. We then applied a 3% and 5% discounting function to the projected future DALY averted before multiplying them by the monetary value.

Briefly, for converting DALY into a monetary value, we referred to the rule of thumb used in earlier Copenhagen Consensus papers and proposed by WHO [9]. It values a DALY at 1× the gross domestic product (GDP) per capita. The Copenhagen Consensus 2012 paper on chronic diseases set U.S. $1,000 as the average GDP per capita for LMIC based on World Bank Data [9]. We assumed each DALY was worth this amount, and then for sensitivity, we used U.S. $5,000.

To interpret the benefit-cost ratio (BCR), we use the following cutoffs: 15 or above was considered excellent; between 5 and 15 was considered good; between 1 and 5 was considered fair; and <1 was considered poor.

RESULTS

Tobacco taxation

We analyze the results of a tobacco tax that reduces consumption by 50%. We concentrate the tax in LMIC because many HIC have already implemented significant taxes on tobacco and achieved reductions in consumption. The agreed GMF target is a 30% relative reduction in the prevalence of tobacco use [1]. However, we calculate the

TABLE 1. Proposed SDG health and NCD goals: secondary prevention targets and indicators

Goal, Target, Indicator	Definition or Indicator	Rationale
Goal 3: Ensure healthy lives and promote well-being for all at all ages		
Proposed NCD target #3.4 and GMF target #1: By 2030, reduce by one-third premature mortality from NCD through prevention and treatment and promote mental health and well-being.	Refers to the unconditional probability of dying between ages 30 and 70 years from cardiovascular diseases, cancer, diabetes, or chronic respiratory diseases.	There is political agreement on the numerical part of the target from the WHO World Health Assembly. The target is felt to be sufficiently ambitious, realistic, and feasible.
GMF target: A 30% relative reduction in prevalence of current tobacco use in persons aged 15+ years.	Prevalence of current tobacco use among adolescents. Age-standardized prevalence of current tobacco use among persons aged 18+ years.	Each 10% increase in tobacco tax leads to at least a 4% reduction in demand, about one-half of which is from current consumption.
GMF target: A 25% relative reduction in the prevalence of raised blood pressure or contain the prevalence of raised blood pressure according to national circumstances.	Age-standardized prevalence of raised blood pressure among persons aged 18+ years (defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg).	High blood pressure is responsible for at least 50% of cardiovascular disease, particularly stroke and ischemic heart disease.

GMF, Global Monitoring Framework; NCD, noncommunicable disease; SDG, Sustainable Development Goal; WHO, World Health Organization. Reprinted, with permission, from WHO [2].

benefits and costs of a more ambitious target that would achieve a 50% relative reduction in user prevalence. This goal is achievable given evidence from effective policies for reducing tobacco usage in other countries. Jha and Peto [10] claim that a reduction of about one-third could be achieved by doubling the inflation-adjusted price of cigarettes.

Assuming a prevalence elasticity of demand of about −0.4 (one-half of the average price elasticity for tobacco products), a tax that increases tobacco prices about 125% would lead to about a 50% reduction in tobacco usage. We are assuming that reducing tobacco consumption in ages 30 to 70 translates directly to reduction in premature mortality. The effects of tobacco cessation depend on the age at quitting, the reduction in intensity of smoking if one does not quit, and other genetic and lifestyle factors [11]. We assume, however, that tobacco taxation will not only cause current smokers to quit, but also prevent initial uptake of smoking in young people.

It is difficult to estimate the cost of implementing policy reform, as countries vary widely in their ability to impose and enforce taxes; however, several studies have made an attempt. One estimate puts the average annual cost per capita to implement a revised tobacco tax system at U.S. $0.50. In this calculation, we considered the per capita population of LMIC as projected in 2030 [12].

Results are shown in Table 2.

Assuming 10 million tobacco-attributable deaths in 2030, an increase in the real price of cigarettes by more than 125% would avert up to 2.5 million deaths and 37 million DALY. At a cost of about $3.5 billion globally, approximately 10 DALY would be averted for each dollar spent in the base case, and 52 with a higher DALY valuation. This results in a good BCR.

Deviating from standard welfare economic practice, we also calculate the effects of applying the revenue from taxation to offset the costs. Standard practice considers the tax revenue to be a straightforward transfer from one group in society to another with no consequent welfare effects. However, because revenue is an important policy consideration, we calculate it here and show a BCR that reflects the net costs of implementing the tax. Using the 2030 LMIC projected population, we assumed 20% of men and 5% of women would be smokers based on current rates [13,14]. We then took the smoking population, adjusted to reflect an estimated 5% loss to smuggling and our assumed 50% decrease in usage, buying 12 packs/year per user at U.S. $1/pack [15]. If we assume that the tax increase is at least 75%, tax revenues in LMIC would exceed U.S. $2.5 billion. After subtracting estimated tax revenue from costs, we obtain a BCR of 48, or an excellent BCR. This is not the base case result that is shown in Table 2, and is provided only as an illustration of the additional government revenue to be gained from a tax policy.

Secondary prevention of cardiovascular disease

Second, we analyze the economic effects of increased drug coverage for high-risk heart disease patients. Secondary

TABLE 2. Selected interventions to achieve post-2015 NCD target: benefits and costs, BCR (3% discounting)

Target	Annual Costs (U.S. $ billions)	Annual Benefits (U.S. $ billions)*		BCR		Rating (DALY = 1,000)
		DALY = 1,000	DALY = 5,000	DALY = 1,000	DALY = 5,000	
Increase the price of tobacco by 125%	3.5	37.2	186	10	52	Good
Secondary prevention of CVD with multidrug (70% coverage)	3.8	13.1	66	3	17	Fair
Total	7.3	50.3	252	7	35	

BCR, benefit-cost ratio; CVD, cardiovascular disease(s); DALY, disability-adjusted life year(s); NCD, noncommunicable disease.
*3% discounting.

prevention for people at high risk of CVD, or who have already had a nonfatal coronary heart disease or cerebrovascular event, provides a multidrug regimen including aspirin, blood-pressure lowering drugs, and cholesterol-lowering drugs for long-term disease management. Such treatment can prevent approximately 20% of premature deaths in this population [6]. We assume that at least 70% of high-risk people have access to this regimen at an average annual cost of about $55 [10]. We applied the treatment and the costs to an estimated high-risk population of 100 million people globally. We obtain a BCR of 3, or a fair BCR.

DISCUSSION

We have identified 2 major opportunities for investment in secondary prevention interventions that address a large disease burden highly cost-effectively. Even valuing DALY at a conservative U.S. $1,000, the BCRs associated with investing in these opportunities are very positive. At a higher DALY valuation of U.S. $5,000, our combined BCR is 35. This suggests that our base results are conservative.

The opportunities identified do not explicitly address the strengthening of health system capacity, and for the sake of simplicity, we did not study other promising interventions. It will be important to ensure that implementation includes related investments in human resources and institutions, with "related" broadly defined.

SUMMARY

NCD are the largest cause of mortality both globally and in the majority of LMIC. NCD are expected to be central to the post-2015 health goals. In fact, it will not be possible to achieve the proposed Sustainable Development Goal #3 without reducing NCD mortality. The 2 interventions in our analysis have high estimated BCR and also address major NCD disease burden. For example, despite considerable cost of U.S. $3.85 billion per year, secondary prevention with the multidrug regime would avoid almost 900,000 fatal heart attacks and strokes a year.

REFERENCES

1. WHO. NCD Global Monitoring Framework. Geneva, Switzerland: World Health Organization; 2012.
2. WHO. Draft Comprehensive Global Monitoring Framework and Targets for the Prevention and Control of noncommunicable Diseases. Geneva, Switzerland: World Health Organization; 2013.
3. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380:2224–60.
4. Jamison DT, Breman J, Measham A, Alleyne G, Claeson M, Evans D, editors. Disease Control Priorities in Developing Countries. 2nd edition. Washington, DC: World Bank; 2006.
5. Yusuf S, Islam S, Chow CK, et al., for the PURE Study Investigators. 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 2011;378:1231–43.
6. Kotseva K, Wood D, De Backer G, et al., for the EUROASPIRE Study Group. Cardiovascular prevention guidelines in daily practice: a comparison of EUROASPIRE I, II, and III surveys in eight European countries. Lancet 2009;373:929–40.
7. Yusuf S. Two decades of progress in preventing vascular disease. Lancet 2002;360:2–3.
8. WHO. From Burden to 'Best Buys': Reducing the Economic Impact of Non-Communicable Diseases in Low- and Middle-Income Countries. Geneva, Switzerland: World Health Organization, World Economic Forum; 2011.
9. Jha P, Nugent R, Verguet S, Bloom D, Hum R. Chronic Disease Prevention and Control. In: Global Problems, Smart Solutions: Costs and Benefits. Cambridge: Cambridge University Press; 2013.
10. Jha P, Peto R. Global effects of smoking, of quitting, and of taxing tobacco. N Engl J Med 2014;370:60–8.
11. Kontis V, Mathers CD, Rehm J, et al. Contribution of six risk factors to achieving the 25 × 25 non-communicable disease mortality reduction target: a modelling study. Lancet 2014;384:427–37.
12. WHO. Global Health Estimates Summary Tables: Projection of Deaths by Cause, Age, and Sex. July 2013 edition. Geneva, Switzerland: World Health Organization; 2013.
13. WHO. World Health Organization: Prevalence of Tobacco Use Among Adults and Adolescents. Available at: http://gamapserver.who.int/gho/interactive_charts/tobacco/use/atlas.html; 2014. Accessed December 5, 2014.
14. WHO. WHO Report on the Global Tobacco Epidemic, 2013: Enforcing Bans on Tobacco Advertising, Promotion and Sponsorship. Geneva, Switzerland: World Health Organization; 2013.
15. Asaria P, Chisholm D, Mathers C, Ezzati M, Beaglehole R. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. Lancet 2007;370: 2044–53.