Cost Effectiveness and Resource Allocation

Methodology

Programme costs in the economic evaluation of health interventions

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Abstract

Estimating the costs of health interventions is important to policy-makers for a number of reasons including the fact that the results can be used as a component in the assessment and improvement of their health system performance. Costs can, for example, be used to assess if scarce resources are being used efficiently or whether there is scope to reallocate them in a way that would lead to improvements in population health. As part of its WHO-CHOICE project, WHO has been developing a database on the overall costs of health interventions in different parts of the world as an input to discussions about priority setting.

Programme costs, defined as costs incurred at the administrative levels outside the point of delivery of health care to beneficiaries, may comprise an important component of total costs. Cost-effectiveness analysis has sometimes omitted them if the main focus has been on personal curative interventions or on the costs of making small changes within the existing administrative set-up. However, this is not appropriate for non-personal interventions where programme costs are likely to comprise a substantial proportion of total costs, or for sectoral analysis where questions of how best to reallocate all existing health resources, including administrative resources, are being considered.

This paper presents a first effort to systematically estimate programme costs for many health interventions in different regions of the world. The approach includes the quantification of resource inputs, choice of resource prices, and accounts for different levels of population coverage. By using an ingredients approach, and making tools available on the World Wide Web, analysts can adapt the programme costs reported here to their local settings. We report results for a selected number of health interventions and show that programme costs vary considerably across interventions and across regions, and that they can contribute substantially to the overall costs of interventions.

Introduction

Estimating the costs of health interventions is important to policy-makers for a number of reasons including the fact that the results can be used as a component in the assessment and improvement of the performance of their health systems. As part of its WHO-CHOICE cost-effectiveness work programme (go to http://www.who.int/evidence/cea for more details), WHO has undertaken an effort to assess the overall costs and effects of a wide variety of health interventions [1]. Single global estimates of intervention costs are not relevant to individual countries. On the other hand, very few countries are able to estimate

the costs of all possible interventions in their settings. WHO-CHOICE is, therefore, assessing the costs and effects of a range of interventions for 14 epidemiologic sub regions of the world. The provision of sub-regional estimates allows interventions to be classified into broad categories for decision-making that have broad validity across that set of countries – e.g. those that are very cost-effective, those that are cost-effective, and those that are cost-ineffective. Policy-makers can then ask if there are good reasons why very cost-effective interventions are not done in their setting, while at the same time cost-ineffective interventions are being done [2]. The results will be presented in a way that analysts from countries in each region will be able to judge the appropriateness of the findings for their country and adapt them to their own settings. In the future, WHO-CHOICE will provide technical assistance to selected countries interested in applying the tools of generalized cost-effectiveness analyses

Costs can be divided into 'patient costs' and non-patient or 'programme costs'. Patient costs refer to all costs at the point of delivery such as outpatient visits, bed days, drugs, or laboratory tests. Programme costs include costs incurred at the administrative levels of the district, provincial or central-levels, i.e. the costs incurred at a level other than the delivery point of an intervention to beneficiaries. The components include such items as administration, training or media campaigns[3]. It is not uncommon for analysts to ignore programme costs when performing CEA. For example, only one [4] out of nine studies examining the cost-effectiveness of tuberculosis treatment strategies clearly showed that programme costs had been incorporated [5]. That study estimated the average cost of different ways of directly observing tuberculosis treatment as a means of improving adherence. For the option of completely ambulatory short course chemotherapy with daily supervision, programme costs accounted for 33%, 16% and 34% of estimated total costs in Mozambique, Malawi and Tanzania in turn. These findings suggest that programme costs can be a substantial proportion of total costs, and that the proportion may well vary across settings. They also mean that using a simple rule of thumb in which programme costs are assumed to be a fixed percentage of patient costs may not always be appropriate – although probably preferable than ignoring this category of cost completely [6,7].

While most CEA guidelines recommend including all relevant costs that vary between programmes, studies may ignore them because they use an "incremental" approach to costing – comparing the introduction of a new technology against an existing intervention [8,9]. These studies are concerned with marginal changes in costs and effects; they assume that overhead items such as programme costs will remain approximately the same for each alternative being compared, and will not affect the choice between the given alternatives [8]. However, this is simply not appropriate when considering non-personal health interventions, such as mass media campaigns to encourage people to exercise more, where virtually the entire intervention consists of programme costs. Nor is it appropriate in many personal health interventions, such as the tuberculosis case described above, or when analysts are interested in answering the question of how best to use existing health resources to improve population health[10].

This paper presents the systematic method for estimating programme costs for health interventions across settings used for WHO-CHOICE. The method and the resulting estimates can be used for different purposes, e.g. cost-effectiveness analysis (CEA) and other types of costing exercises such as estimating the costs of scaling-up interventions as part of the activities of such bodies as the Global Fund to Fight AIDS, Tuberculosis and Malaria. The following section presents the methods for identifying, collecting and calculating programme costs, including consideration of the theoretical basis for calculating programme costs. The third section presents an application of the approach including programme cost estimates for a number of interventions. Conclusions are presented in the final section.

Methods

This section describes the methods used in calculating programme costs as part of WHO-CHOICE. The first part discusses the theoretical approach for defining relevant costs. The second and third parts document the methods used to determine the amount of resource use and their prices. The last part elucidates a means of accounting for different coverage levels of an intervention.

Conceptual Approach

Observed prices or charges do not necessarily reflect economic value. Generally, the economic definition of costs should be used in cost valuation, not the accounting (or financial) definition. This is based on the concept of 'opportunity cost', i.e. the value forgone by not utilizing the same resource in its next best alternative use [11,12]. The concept implies that all resources consumed by an intervention should be valued, not just those constituting a budgetary line item.

In collecting costs, several basic issues concerning the costing process arise. The following issues outline the approach used to determine costs.

Joint or overhead costs

Programme cost analysis to inform decisions at the sectoral level requires information on the costs of introducing each intervention singly and also in combination with

other related interventions. This requires identifying all resources involved to establish and run each intervention, including the necessary overheads.

The simplest way to identify intervention-specific overhead costs is to identify shared resources used by the different interventions and use joint costing rules or some basis of allocation related to the usage of the overhead item[8]. The percentage of time devoted to each individual intervention was used to allocate personnel costs and the share of equipment used. Similarly with buildings and vehicles, the proportion of intervention-specific utilization to total utilization was used [8,13]. This implies that the resources are divisible, or can be shared across interventions (e.g. it is feasible to use 0.2 vehicles for an individual intervention). This is appropriate since most resources can be shared across interventions and programmes, and particular types of personnel, transport, and buildings can be hired in the short term or rented out to other users. In theory, all costs related to a set of evaluated interventions could be allocated. However, WHO-CHOICE excludes two major types of 'ongoing' costs in this context. First, some of the costs of central administration are not included – those that are part of the overall planning and management of the health system that are unrelated to the development and implementation of particular interventions aimed at improving health. Second, the current level of education of health professionals is excluded; if the skills required to deliver an intervention are available in the country under study, training costs to develop those skills are not included in the programme costs since a reallocation of health system resources does not affect these costs.

Capacity utilization

The extent to which capital and labor are used can critically influences unit costs [5,8]. Capacity utilization is defined as the proportion of the total target workload time a resource is actually used; for example, a computer used 5 hours in a 10 hour work day has a capacity utilisation of 50%. In comparing the cost-effectiveness of interventions, it is important to ensure that the observed differences are due to the intrinsic characteristics of the intervention rather than the extent to which capital and labor have been utilized in the environment in which the interventions were evaluated. WHO-CHOICE seeks to inform policy-makers on the optimum mix of interventions if health resources could be reallocated. It is not useful to perform this analysis by analyzing some interventions that are delivered inefficiently and others delivered efficiently. Therefore, for this analysis we report the cost-effectiveness estimates of interventions that are done efficiently, using 80% capacity utilization as the norm. This is consistent with recommendations made in CEA guidelines and ensures the comparability of cost-effectiveness ratios across interventions and settings [8,9].

Ingredients approach

Rather than collecting data on total expenditures, the ingredients approach is used. The cost of any input to a production process is the product of the quantity used and the value (or price) of each unit. The ingredients approach is useful for many reasons, the most important are that it allows analysts and policy-makers to validate the assumptions used; judge whether the estimates presented can be applied to their settings; and, if necessary, change some of the parameters to replicate the analysis for their settings [3,13,14].

Classification of costs

Costs are classified according to three characteristics: phase of implementation of the intervention, organizational level where costs are incurred, and nature of costs. This can be classified in the following three categories, with primary classifications listed first:

• *Start-up* and *Post Start-up* costs: Programmes incur different types of costs in the start-up and post-implementation phases. The definition of the start-up period is the time between the decision to implement an intervention and starting its delivery to the first beneficiary. Quantities are reported for the total time of the start-up period. If the start-up period is 18 months, the quantities used for the entire time are reported. Post start-up programme costs for the full period of implementation of the intervention were based on an estimate of the annual cost required to run the intervention in a typical post start-up year when the programme is fully implemented.

• *Central* versus *Lower Levels* costs: Factor inputs are classified according to where in the administrative and organizational level of the health system they are used. In this analysis we collected cost data from three programme-cost levels: central, provincial and district levels, but the data can be easily adapted to the relevant administrative classification in different settings.

• *Recurrent* versus *Capital* costs: Factor inputs are further classified into recurrent and capital items. Following standard practice, capital costs are annualized over the useful life of the factor input, i.e. the 'equivalent annual costs' are calculated.

Discounting across time

For country-specific analysis, the local rate of return on long-term government bonds would ideally be used as the social discount rate for costs. For our purposes, to allow comparability across regions, a 3 % discount rate was used as recommended by most guidelines [8].

Total start-up costs of the programme were considered as a capital investment and annualized and discounted over the life of the programme. For country-specific analysis, the choice of the period over which start-up costs should be annualised would be made on a case by case basis, but to allow comparability for the sub regional analysis, 10 years was chosen as the useful life of a start-up period [3]. The sensitivity of the analysis to this assumption was explored in the individual intervention studies.

Data on quantities

In the period 2001–2, WHO-CHOICE invited regional expert teams representing countries from each of the 14 epidemiologic sub regions to gather the quantities of physical inputs (the ingredients) required for approximately 75 interventions using a standard tool (see Endnotes section, Note 1 for details of the data collection tools and procedures). Most of the ingredients were for specific interventions, but some were for generic cost components which could be used in a number of interventions – for example, the cost of training health workers on case management using different combinations of number of days, and number of participants.

The data they provided were compiled and compared to form the basis of a set of costing sheets for the different activities covered by programme costs. Next, a list of required activities and the intensity of each activity was compiled for each intervention. For example, media outreach was classified into four intensities: extensive (daily or more radio and television emissions), moderate (weekly emissions), minimal (monthly emissions or less), and printed material only (for programmes which have some information distribution requirements). Further activities included basic administration, monitoring, evaluation, and supervision, passage of legislation, training, and law enforcement. Other activities relevant only to one or a few programmes were entered separately. Training was divided into the costs involved in setting-up and running a specific training session, and the costs of overseeing and administering a training programme. The former costs are considered to vary with the number of trainees and length of training, while the latter were considered a fixed cost needed to run any training programme, no matter how many trainees or the length of training. The use of this standardized format ensures that different programmes are valued consistently based on the activities needed. This, in turn, ensures comparability of results.

Quantities were divided into fixed and variable costs. Fixed costs include those necessary to set up and run a programme no matter how many people are covered. Some examples of fixed cost include parts of the central administration, passage of legislation, and basic monitoring activities. Some examples of items that vary by the number of people covered include people delivering a service, the amount of storage space and shipment needed, supervision, and the production of printed information materials.

The required quantities of inputs were based on the estimates by the regional expert teams. However, because there was missing data for some interventions in some regions, the quantities for the variable and fixed cost functions were standardized across regions for most interventions (this was done except in cases where difference between regions is clearly justifiable, such as random breath testing of motor vehicle drivers where significantly different traffic patterns across regions would result in very different needs for enforcement). Because of different sizes of countries within the various regions, variable costs obviously varied by region (this builds in economies of scale, where fixed costs are spread over populations of different sizes).

The regional expert teams also estimated details such as the office supplies, equipment, and office space different staff members would consume in a year. Based on these assumptions, the quantities of utilities used and maintenance costs were also estimated (further details can be found at http://www.who.int/evidence/cea). Within the broad categories outlined in the conceptual approach section, inputs were classified in the manner reported in Table 1.

Data on prices

This analysis requires the unit prices used to reflect the economic cost of goods, and allow for inter-country comparison of costs of interventions. For this purpose, the world price level was chosen as the *numeraire* or price level [11], and a reference currency, i.e., the International Dollar (I$), was chosen for the presentation of the results at the international level. Costs in local country currency units were converted to international dollars using purchasing power parity (PPP) exchange rates. A PPP exchange rate is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market of a reference country, in this case the United States. An international dollar is, therefore, a hypothetical currency that is used as a means of translating and comparing costs from one country to the other. Because published estimates of PPPs do not cover all 192 countries that are members of WHO, the PPP exchange rates used in this analysis were developed by WHO and are available on the WHO-CHOICE website.

Prices for traded goods

Traded goods are commodities that are available on the international market, and all countries can purchase them at an international market price. Since the international

Table 1: Cost categories in programme cost sheet

	A. Recurrent cost
A.1 Personnel	Personnel time allocated to each intervention is netted out from time spent by those personnel in other interventions. Personnel time used in the start-up and post start-up periods is expressed in person-months.
A.2. Materials & Supplies	Materials and supplies in terms of the quantities used for the programme. Examples are office supplies that are used by the programme.
A.3. Media operating costs	Media inputs such as radio or television time, leaflets or posters are provided in terms of their unit of measurement (e.g. minutes for radio, or quarter page ads in newspapers).
A.4. Transport operating costs	Transport is measured in terms of total kilometers traveled per mean of transport.
A.5. Equipment operating cost	In cases when equipment is rented, the number of equipment and the duration of rental (in months) are reported.
A.6. Maintenance	Maintenance costs are listed as a percentage of annual costs.
A.7. Utilities	The amounts of utility items allocated to the programme are listed here. Examples of utility items are electricity, gas, and water. The allocation of the quantities used by the programme is based on the square meter surface area used by the programme, after applying any further allocation needed if the space is shared with other programmes.
A.8. Others	
A.8.1. Rented buildings	In case buildings are rented, both the total square meter surface area of the buildings and the duration of rental (in months) are used.
A.8.2. Per diems and travel allowances	The types of personnel who are entitled for per diems and travel are listed. The types reflect the activity they are involved in, e.g. trainers, trainees, support staff in meetings, participants of meetings, supervisors visiting health facilities etc. Reported by the number of days per type of personnel.
A.8.3. Miscellaneous items	Any other category of recurrent resources used that is not provided in the list are reported here by identifying the item and the quantities used.
B. Capital Costs	
B.1. Building	Space used by the programme are reported in terms of the total square meter surface area allocated to that programme, i.e., if the space used by the programme is shared with other activities, the share of the space used for the programme under study are estimated and the value are entered here.
B.2. Transport	The number of means of transport used by the programme is listed here. If they are only partly used, the estimated share of their use are entered.
B.3. Equipment and implements	The number of office equipment, storage and distribution, maintenance, cleaning and other capital equipment are reported here. If they are only partly used, appropriate allocation is made, using the same allocation factors used for building space.
B.4. Furniture	See point B.3 above.
B.5. Other capital costs	This section is used to report any other capital resources used by the programme.

market price reflects the opportunity cost of using a good to the country, it is used as the price for traded goods, adjusted to include cost, insurance and freight (c.i.f.) for imported goods and free on board (f.o.b.) for exported goods.

International prices were derived from price indexes compiled in WHO publications and catalogues of prices from firms and non-governmental organizations operating at an international level that excluded costs of shipment and taxes. These international values were placed in a common currency (year 2000 I$) using World Bank Gross Domestic Product (GDP) deflators, or, when GDP deflators were unavailable, Consumer Price Index deflators [15].

Generally, for small items that can be bought in bulk, the lowest internationally listed price was selected. This assumes the existence of a basic health infrastructure, enabling the purchase of items in bulk. For larger items, a middle level price was selected to represent a "typical" price. In some cases, the price range for a good was too big to justify the use of a mid-level price. For example, a given model of a four-wheel-drive vehicle can range in price from US$15,000 to US$25,000. Thus, for vehicle prices, generators, and other large cost items, the regional expert teams were asked to provide the local price of goods excluding taxes and subsidies.

The f.o.b. (free-on-board) price of exports includes the production cost, transport costs, local marketing costs and local port charges of the exporting country [16]. The c.i.f. (cost-insurance-freight) price excludes import duties and subsidies (transfer payments), and includes the selling price of the producing country, freight, insurance, and un-

Table 2: Mark-up of goods to account for the cost of transport

Country	CIF/FOB Ratio	Domestic Margin			
		50% Coverage	80% Coverage	95% Coverage	100% Coverage
Afghanistan	1.71	1.73	1.73	1.74	1.74
Brunei Darussalam	1.24	1.25	1.25	1.25	1.26
Burkina Faso	1.49	1.50	1.50	1.51	1.51
China	1.30	1.30	1.31	1.31	1.31
Denmark	1.16	1.16	1.16	1.17	1.17
India	1.24	1.24	1.24	1.24	1.25
Jordan	1.31	1.31	1.32	1.32	1.33
Mexico	1.27	1.27	1.27	1.27	1.27
Nicaragua	1.41	1.41	1.42	1.42	1.43
Russian Federation	1.26	1.27	1.27	1.28	1.29
Thailand	1.29	1.29	1.30	1.31	1.31
The former Yugoslav Republic of Macedonia	1.22	1.22	1.22	1.22	1.22
United Republic of Tanzania	1.42	1.43	1.43	1.44	1.44
United States of America	1.18	1.19	1.19	1.20	1.21

loading charges. If a country imports the good, the costs of local transport and distribution (termed 'domestic margin') were added to the c.i.f. price in order to approximate the local opportunity cost [16]. Methods for calculating c.i.f./f.o.b. adjustments are discussed in the section on coverage levels.

Prices for non-traded goods

Prices of non-traded goods like labour vary across regions. The regional expert teams provided local prices for non-traded goods for reference countries in their regions. Where possible, supplementary information from other sources on country-specific prices of non-traded goods, such as the International Labour Organization (ILO) database on occupational salaries, was also used to determine a typical cost for the region as a whole.

Coverage Levels

As coverage expands into remote areas, the marginal costs of providing an intervention to each additional person will generally increase [17–19]. To account for the increasing marginal costs of transportation to more remote areas, the following methods were used to adjust costs for different levels of population coverage. Transportation costs consist of the cost of transporting goods to a country (c.i.f./f.o.b.) and transporting goods within a country (the domestic margin).

Adjusting prices for traded goods

The calculation of the cost of transportation was based on the only available study showing the percentage change in the price of a traded good based on the distance it travels between countries, the transportation infrastructure and the average GDP per capita of a country, and other variables relating to the availability of seaports, neighbouring trade partners, etc. [20]. For purposes of calculating the c.i.f./f.o.b. mark-up of goods, an infrastructure index was calculated and applied using the price elasticity coefficients reported in Limão and Venables [21]. Table 2 illustrates the results of this analysis for selected countries in different regions with the c.i.f./f.o.b. mark-up ranging from 1.16 (16% increase in price) in Denmark to 1.71 in Afghanistan, with a median mark-up of 1.28.

The domestic margin was calculated based on a hexagon shaped regional distribution model [22]. Each hexagon was assumed to cover 80 square kilometres, approximating the area served by one health centre reflecting a circular area with a radius of 5 km [23]. The population of each hexagon was derived from Geographical Information System (GIS) data on the population density of a country. In this model, the population density of the most crowded 80 square kilometres is assumed to be at the centre of the country, with hexagons further from the centre having progressively lower population densities. Thus, in the case of Burkina Faso, 4% of the population is assumed to live in the central hexagon, while only 2% of the population is assumed to live in the adjacent hexagon.

Each country is also divided into provinces and districts based on the number of provinces and districts reported by WHO databases. In cases where the number of secondary or tertiary administrative units was not certain, an average was taken from the available sources. The average size of a province or district was calculated by dividing the total area of a country by the number of provinces or dis-

tricts, which were then incorporated into the hexagonal grid. A traded good was assumed to travel, on average, half the distance from the central hexagon to the centre of the most peripheral province, and then to the centre of a district. The Limão and Venables price elasticity for distance was then used with this calculated distance to derive the domestic margin. Since, in this model, the central areas are more crowded than outlying areas, a programme covering 50% of the population will have a proportionately lower mark-up than a programme covering 95% of the population. However, as shown in Table 2, the domestic margin is a minor cost compared to the cost of initially transporting a good to the country.

Impact on resource utilization

When an intervention covers a larger part of the population, the resources required to run the intervention also increase. As coverage goes up, certain cost parameter values were increased as follows:

• As indicated above, the hexagon shaped regional distribution model assumes a health centre for every 80 square kilometres of space. This implies that health centres may not always run at 80% capacity, since more remote areas may have a very low population density. Since costs of training of health care professionals are independent of population density, these costs – expressed as costs per capita – will increase as coverage levels increase

• The number of provinces covered increases as coverage expands. Under the assumptions listed above, one or two provinces may contain 50% or more of the population. Thus, as coverage expands, the number of provinces covered will increase, but each new province covered will have fewer people. Since there are fixed costs associated with running a programme at the province level, this produces diseconomies of scale.

• The distance travelled in a supervision visit increases. At the national level, this is calculated as the distance from the centre to the most remote province covered (the average distance would be half the distance from the center to the periphery; however, because supervision visits are assumed to be round trips, the full distance from the center to the periphery is used). The distance travelled for supervision visits within provinces is similarly calculated.

• Thus, the number of programme staff involved in supervision activities needs to increase both in proportion to the increased distances covered and to account for the increased number of provinces. Each province was assumed to need an equal number of supervision visits.

It is possible that salaries may be higher in very remote areas to give health personnel extra incentive to relocate to these areas. In the absence of data, this factor was not incorporated.

Organising and using the data

The predicted quantities of resources needed were multiplied by their respective prices to calculate the total programme costs for a ten-year period of implementation. These ten-year costs are calculated in year 2000 international dollars using a standard net present value formula [8].

Validation

Once the data had been collected and analysed, the accuracy of the data was verified. Where possible, previous costing or CE studies which included programme costs were used as a benchmark for comparison, but very few presented programme cost estimates using the ingredients approach (e.g. [24]). In addition, disease and public health experts or programme managers who are familiar with the particular interventions and settings for a number of diseases reviewed the final costing figures. In the cases where the estimates did not have face validity, controls were made to ensure that there had not been mistakes with coding, and discussions were held with the regional costing experts to confirm the basis of their quantity and price estimates.

Results

WHO-CHOICE has used the methods described above to produce a set of cost-effectiveness estimates, initially for 14 epidemiologic sub regions [25]. Table 3 reports the average annual programme cost per capita, and as a percentage of total intervention cost per capita, for selected interventions in these regions. Costs are presented in 2000 International dollars. The table shows that programme costs vary across interventions and across regions for a given intervention. For example, cost per capita of educating sex workers totals I$ 0.01 in SearB, whereas it amounts to $0.07 in AfrE. For a population of 100 million people, this would mean programme costs differ substantially – $1 million in the former and $7 million in the latter sub region. Variations are caused by differences in the number of sex workers and in the number of social workers required to train sex worker peer educators, and to differences in regional price levels of inputs. (Note also that a straight comparison of cost per capita across interventions is misleading in deciding whether an intervention is of low cost or more expensive at a population level, because there is wide variation in the target populations for each of these interventions.)

The importance of programme cost in comparison with patient cost also varies by intervention and by region. Obviously, non-personal interventions such as the introduction of random breath testing for drivers to reduce the

Table 3: Average annual program cost per capita for selected interventions in GBD regions* (2000 I $)

Disease / intervention	HIV/AIDS: Preventing Mother To Child Transmission		HIV/AIDS: Educating sex workers						Alcohol: Random breath testing of drivers**		Alcohol: Brief physician advice to reduce heavy alcohol use†	
Coverage level	Antenatal care coverage††		50%		80%		95%		95%		50%	
GBD2000 region‡	PC‡‡	PC as % of Total Costs	PC	PC as % of Total Costs	PC	PC as % of Total Costs	PC	PC as % of Total Costs	PC	PC as % of Total Costs	PC	PC as % of Total Costs
AfrD	$0.08	8%	$0.05	70%	$0.06	63%	$0.06	61%	$0.31	100%	$ 0.011	21%
AfrE	$0.15	10%	$0.07	74%	$0.09	69%	$0.10	67%	$0.42	100%	$ 0.012	8%
AmrA	$0.19	5%	$0.06	92%	$0.09	91%	$0.10	91%	$0.29	100%	$ 0.006	0%
AmrB	$0.05	5%	$0.02	84%	$0.03	78%	$0.03	76%	$0.28	100%	$ 0.007	2%
AmrD	$0.03	4%	$0.02	62%	$0.02	55%	$0.03	52%	$0.45	100%	$ 0.005	8%
EmrB	$0.11	9%	$0.08	96%	$0.09	96%	$0.09	96%	NA	N.A.	N.A.	N.A.
EmrD	$0.08	15%	$0.06	94%	$0.06	94%	$0.06	94%	NA	N.A.	N.A.	N.A.
EurA	$0.17	9%	$0.09	97%	$0.10	96%	$0.11	96%	$0.55	100%	$ 0.025	1%
EurB	$0.14	18%	$0.05	91%	$0.05	91%	$0.05	91%	$0.51	100%	$ 0.008	2%
EurC	$0.03	9%	$0.03	83%	$0.03	83%	$0.03	83%	$0.25	100%	$ 0.003	0%
SearB	$0.07	9%	$0.01	36%	$0.02	35%	$0.02	34%	$0.19	100%	$ 0.001	2%
SearD	$0.02	4%	$0.03	69%	$0.03	65%	$0.04	64%	$0.17	100%	$ 0.004	29%
WprA	$0.19	9%	$0.10	97%	$0.11	97%	$0.12	96%	$0.95	100%	$ 0.022	4%
WprB	$0.09	15%	$0.10	89%	$0.11	89%	$0.11	89%	$0.23	100%	$ 0.006	5%

* Costs are average annual discounted programme costs of implementing an intervention during 10 years ** Only relevant at 95% coverage † Only relevant at 50% coverage ††Current antenatal care coverage in GBD regions; defined as percentage of target population with at least one antenatal care visit during pregnancy ‡ AFR = Africa Region; AMR = Region of the Americas; EMR = Eastern Mediterranean Region; EUR = European Region; SEAR = South East Asian Region; WPR = Western Pacific Region. A sub regions have very low rates of adult and child mortality; B = low adult, low child; C = high adult, low child; D = high adult, high child; E = very high adult, high child mortality.

burden of motor vehicle accidents consists entirely of programme costs. On the other hand, the provision of brief physician advice to heavy alcohol users consists largely of patient costs, with programme costs ranging from less than 1% of total costs to almost 30%.

The tools used to estimate these results are available on the Internet at http://www.who.int/evidence/cea for use by local analysts. They include:

• a database of prices for traded goods,

• a database listing the reported useful life of capital goods,

• a workbook listing activities used in programme costs together with assumptions of quantities of resources used based on the data collected by WHO, and

• a costing tool CostIt© to calculate and present the final results of the costing exercise.

• a tool for uncertainty analysis MCLeague© to calculate uncertainty regions around cost-effectiveness ratios and present stochastic league tables.

All of the estimates presented could be modified by analysts to suit the particularities of their own setting. In adapting these tools, analysts have to assess if the assumptions outlined in this paper are appropriate for their own setting. The following list highlights some major considerations:

• Local analysts may wish to carry out the analysis using a capacity utilization rate other than 80% to better reflect their actual situation. However, one standard rate should be used for the evaluation of all interventions to ensure comparability. The CostIt© tool allows this to be done automatically.

• Local analyst may wish to use local prices rather than international prices as estimated by WHO-CHOICE. Analyst can also vary prices for non-traded goods according to the location within the country where they are incurred; for example, provincial staff may have lower salaries than staff in the capital city, or vice-versa.

• The spatial model for scaling-up can be revised to the geography of a particular country. For example, multiple points of entry for traded goods can be considered. Alternatively, local analysts may be able to gather data on the prices of goods in various parts of the country, or the costs of transportation, and thus not need to employ the model

as used by WHO-CHOICE. Further, the assumption that the number of provinces expands with increasing population coverage may not accurately reflect how a country implements health interventions, and analysts should adjust their assumptions accordingly. Finally, the coverage area of health centres can be determined locally.

Conclusion

Programme costs can constitute a substantial component of costs even for personal health interventions and should not be ignored in the economic evaluation of health interventions. This paper has presented a first effort to systematically analyze programme costs in different sub regions of the world. The use of a standardized methodology ensures comparability of cost estimates across interventions and settings.

In addition, this paper has introduced "ready-to-use" tools and programme cost estimates that are available on the World Wide Web. The programme cost estimates constitute an important part of WHO-CHOICE database on costs and effects of multiple interventions in various regions in the world exploring the question of whether resources are being used to achieve the maximum possible level of population health. Analysts may wish to adapt the regional estimates to their local setting to make the results more relevant for local decision makers. This paper has shown that, in this process, special attention should be paid to issues such as capacity utilization, prices of goods, and increasing marginal costs of delivering interventions into more remote areas.

As with any innovative work, there are some limitations to the approach that has been used, which offers possibilities of further development over time. For example, in the consultation process with regional expert teams to obtain input quantities and prices, considerable efforts were made to standardize reporting approaches. Nevertheless, reported quantities still showed considerable variation beyond that reasonably expected on the basis of regional differences, and it was necessary to return to the experts for clarification and to seek the input of external data sources and expert advice. Analysts wishing to adapt the results to their own settings should be aware that they would need to seek the advice of more than one expert in their own countries before adapting the quantities of inputs and unit prices reported here. WHO-CHOICE incorporates extensive efforts to develop methods for uncertainty analysis, to reflect uncertainty in the final cost and cost-effectiveness estimates. This is designed to help local policy makers decide the extent to which the results of the WHO-CHOICE analysis inform policy in their countries [26,27].

A key element in our approach is the specification of intervention cost functions at various coverage levels. Whereas other studies have estimated costs of scaling-up health services using a linear cost function, the present study includes non-linearities [28]. Economies of scale have been incorporated by allowing some costs to be fixed regardless of the size of the population reached – television broadcasts are a case in point. On the other hand, diseconomies of scale have been included by using higher prices (for transport costs) and higher quantities (for training and supervision) at higher coverage levels. This is an important step for showing the impact of higher coverage on costs and outcomes. However, further work is required to add non-spatial determinants of increasing costs relating to scaling-up.

Conflict of Interest

None.

Authors' contributions

BJ has day-to-day responsibility for the data management of programme costs, participated in the development of the methodology and drafted the manuscript. RB and RH participated in the development and coordination of the methodology. All authors read and approved the final manuscript.

Endnote section

Note 1

WHO-CHOICE instructed the costing experts on data gathering techniques. Each was given a standardised collecting tool and a guideline, and most attended a workshop detailing the methods to be used. The standardized data collection tool involved two Microsoft Excel spreadsheets. The first, the "general information" sheet, documents general health system parameters of a country. This sheet contains five tables, some for use in determining patient costs, some for use in determining programme costs. The second spreadsheet provided a template for recording the quantities of resource inputs for each intervention (see Table 1). A WHO-CHOICE team member made a follow-up visit to each country to determine the adequacy of the experts' techniques, answer questions, and provide further guidance. Responses were checked against those of other experts, as well as the literature, allowing outliers to be identified and the sources of any difference to be explored and corrected if necessary.

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