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A cost benefit analysis of elimination of kala-azar in Indian subcontinent: an example of Nepal

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Abstract

Background & objectives: Visceral leishmaniasis, locally known as kala-azar (KA) has been considered as a major public health problem in Bangladesh, India and Nepal that affects 100,000 people per year with 147 million people at risk. Elimination of infectious disease is an ultimate goal of the public health system, therefore, the efforts have recently gained momentum from various organizations and governments to expand KA interventions in the endemic countries. The paper aims to estimate discounted net benefits and internal rate of return (IRR) to evaluate the economic feasibility for elimination of KA by utilizing available secondary information.

Methods: Cross-sectional data were collected from different sources to estimate societal costs of and benefits from KA interventions with a 13-year project period. Total costs are estimated based on the unit cost of inputs used for interventions. The benefits are derived from productivity change and resources saved due to reduction of KA incidence. Net benefits and IRRs are estimated based on standard procedures used in the field of economics, subsequently the sensitivity analysis is conducted.

Results: A total discounted net benefit of KA intervention is Nepalese Rupees (NRs) 65,287 million with 35% IRR. The result suggests that for every rupee invested in KA intervention at present will yield NRs 71 in future. The regional benefits from the interventions will be greater than the sum of benefits gained by the individual country due to its nature of public goods.

Conclusion: Elimination of KA is a good investment opportunity for the Government and international partners involved in the health sector.

Key words Discount rate; internal rate of return; intervention; kala-azar; net benefits; societal benefits; societal costs; Nepal

Introduction

Visceral leishmaniasis, locally known as kala-azar (KA), is one of the most neglected tropical diseases, despite its serious consequences, if untreated, it results in a high mortality, with estimates ranging from 80 to 100%[1]. The disease has been considered as a major public health problem in the Indian subcontinent: Bangladesh, India and Nepal that affects 100,000 people per year with 147 million people at risk[2].

Elimination of infectious disease is an ultimate goal of the public health system, and therefore, the efforts have recently gained momentum from various organizations such as WHO/TDR, WHO-SEARO, World Bank, UNICEF, GTZ, Bill and Melinda Gates Foundation, Drugs for Neglected Diseases *initiative* (DND*i*) and the Governments of Bangladesh, India and Nepal to eliminate KA by 2015. They have targeted elimination of KA to reduce annual incidence to less than one case per 10,000 population at the district or subdistrict levels in the endemic countries[2].

Biological and technical feasibility, political commitments and economic feasibility are the primary criteria for elimination of the disease[3]. Biological and technical feasibility mainly includes burden of disease, improvement of case management technologies, and preventive measures. Recently developed serological diagnostic tools (dipstick rK39), new drugs (miltefosine, paromomycin), personal protection (long-lasting insecticidal nets), vector control (insecticide spraying) and new evidence in transmission cycle (no intermediate host for transmission of KA) have confirmed the biological and technical feasibility to eliminate KA[3]. Sustained political and financial commitment is necessary to expand the interventions and to sustain its implementation. The health ministers of these countries have signed a memorandum of understanding on 18 May 2005 for its elimination through inter-country cooperation[2]. In this particular situation, economic feasibility is the most effective means of communicating the value of 'elimination of KA' and can provide powerful tool to organize and mobilize the resources necessary to expand the KA intervention. It provides pieces of information about how scarce resources can be used to derive the greatest possible net societal benefits[4].

In the literature on economic evaluation of control or elimination of the disease, cost benefit analysis (CBA) or cost-effectiveness analysis (CEA) are the most popular methods that compare the costs and consequences of an intervention to assess whether it is worth undertaking from the economic perspective. CBA is most appropriate among the methods of economic evaluation for health interventions because of its theoretical foundation in welfare economics[5]. CBA is an economic tool for comparing desirables and undesirable impact of health interventions that suggests in making purchasing decision[6]. A handful of literature is found on CBA of health interventions, and further some studies suffer major weakness in estimating the costs and benefits of the interventions[5]. From an extensive search of the literature, many of the published papers have dedicated substantial effort on CEA for disease control[7–10].

The paper contributes to the aforementioned literature with comparison of the societal discounted costs and benefits of the KA interventions in Indian subcontinent with an example of Nepal by utilizing available secondary information. The paper aims to estimate discounted net benefits and internal rate of return (IRR) to evaluate the economic feasibility of KA interventions. The study has particular relevance in support of current interventions throughout south Asian countries, which are designed for elimination of KA. The results demonstrate quite strongly that KA is an appropriate target for an elimination intervention.

Methods

Research design: The study has used descriptive and comparative economic evaluation design. Cross-sectional data were collected from different sources and triangulated to estimate societal costs of and benefits from KA interventions with a 13-year project horizon: 2003 through 2015.

Conceptual framework: The health production function is conceived of as having the following sequence: inputs → process → consequences (outputs/outcomes) for an intervention of KA control. The health production function shows a technical relation between inputs and outputs. KA related health programmes including treatment procedures, guidelines, rules and regulations facilitate in the health production process and ensure the technical relationships between health inputs and outputs. We assume that the curative and preventive interventions are concurrently implemented to control KA.

Costs are values of resources or inputs used to produce a set of health care services to control KA. The resources used in KA interventions are personnel, equipments, infrastructure, drugs, vehicle, building, patients' time, etc. The intervention has also produced undesirable impacts, for example, environmental impact of insecticide spraying, toxicity of drugs, painful diagnostic test, that are also included as costs of interventions. Cost of each intervention was calculated using the ingredients approach. Estimates for cost inputs were obtained through reviews of published and unpublished literature. The costing perspective included costs to both the provider and the consumer. Direct cost for treatment and indirect cost of the time taken by the consumers to seek health care services are also included in estimating total cost of interventions. Therefore, costs of interventions can be broadly classified into four categories: curative, preventive, household direct expenses and household time loss.

The benefits of the interventions are desirable impacts that include productivity gains due to cases prevented and reduction of morbidity (disability) and mortality, additional utility or satisfaction due to better quality of life, costs saved on curative treatment, poverty reduction, improvement of educational quality for children and household economies[11]. People will be healthy and able to work more hours, thereby contributing to the overall labour productivity in the society. Similarly, costs of KA care by service providers and households can be saved after the reduction of KA incidence. We measure benefits through two components only: productivity change and resources saved. The conceptual framework for CBA is illustrated in Fig. 1.

Study setting and incidence: In Nepal, KA is confined to 12 districts of *Terai* belt bordering the state of Bihar, India and about eight million people are at

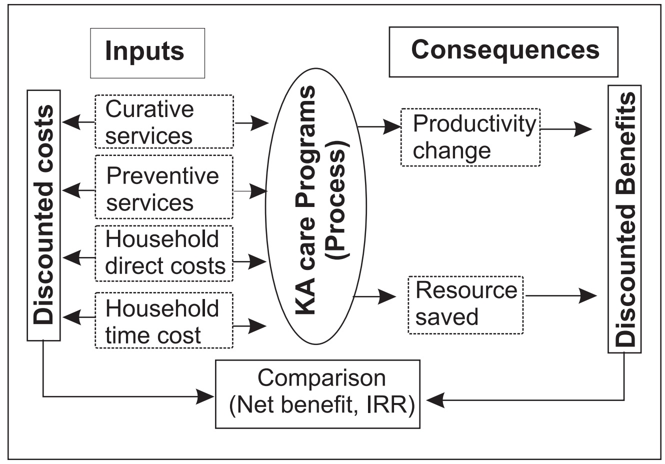

Fig. 1: Conceptual framework for cost benefit analysis (CBA) of kala-azar

risk. KA cases were first recorded in 1980 with <1 case/10,000 population with a case fatality rate of 5.88%. Since 1980 to 2006, a total of 28,424 cases and 582 deaths have been reported from this disease[12]. In Nepal, reported incidence rates have varied from about 4–5 cases/10,000 population since 2000 (Fig. 2).

Existing policy for KA intervention: KA intervention aims at reducing KA morbidity and preventing mortality by applying the primary health care approach, including active community participation. The hospitals of endemic districts are using rK39 dipstick for diagnosis of KA. Sodium antimony gluconate (SAG) is the first line drug for treatment. The second line drug is amphotericin B. New oral drug,

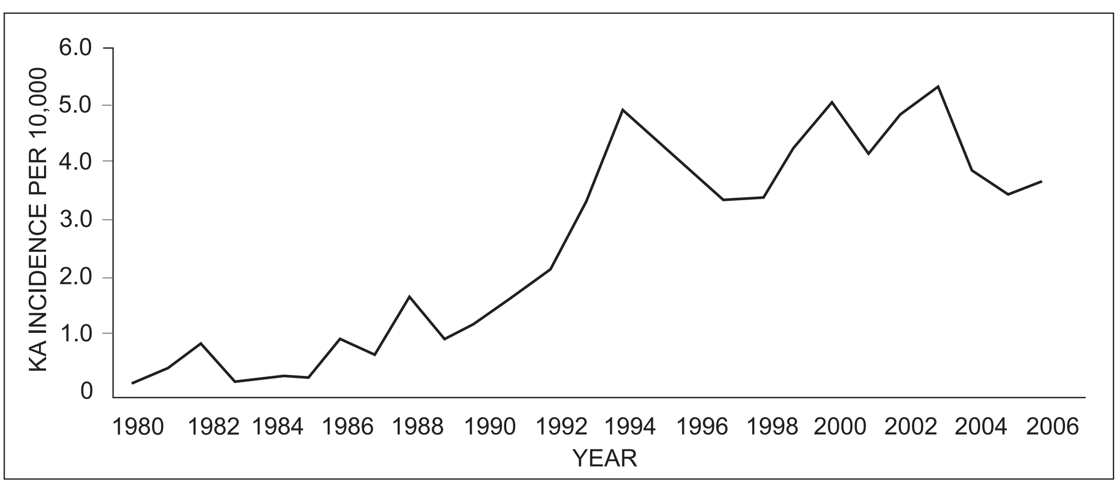

Fig. 2: Incidence of KA in Nepal from 1980 to 2006

miltefosine that is easy to administer at the community-level has recently been introduced. In the preventive side, indoor residual spraying (IRS) in two cycles in a year is used for vector control. Diagnostic and treatment services are provided free of cost at public hospitals. KA elimination intervention is a regional collaborative partnership among Nepal, India and Bangladesh. The common consensus has been built to apply oral drugs (miltefosine) and rK39 diagnostic tools for the elimination program[12,13].

Strategies of KA elimination in Nepal

- Early diagnosis, prompt and complete treatment of KA cases through strengthening of referral system at the peripheral health institutions
- Early detection and timely containment of KA epidemics
- Establishment of appropriate laboratory diagnostic facilities
- Protection of at-risk population (highly selective) with IRS
- Promotion of health education for community awareness of KA, so that early diagnosis is made and timely treatment is given
- Regular supply of drugs and logistic
- Capacity building of health personnel on KA control and management
- Conducting field research on the epidemiology of KA, vector bionomics and the effectiveness of different anti-KA drugs

Cost estimation: Costs of interventions are the values of inputs used to control KA for a year. The information was used to plan maximum intervention coverage with the resources available. The costs of interventions were estimated from societal perspectives. Cost of curative services includes salary, allowances, first line and second line treatment (SAG or amphotericin B), equipments, capital costs, utilities, maintenance, administrative cost, training, diagnostic cost, and others. Post-kala-azar dermal leishmaniasis (PKDL) cases have not been found yet in Nepal. Therefore, consequences of PKDL are not included in the cost of case management. Unit cost of per KA case management for recovery was estimated through step down method. This unit cost includes cost of inpatient and outpatient services. A KA patient in Nepal requires Nepalese Rupees (NRs) 31,223 on an average to obtain curative services from the hospital[14].

The expenses involved for preventive services are salaries, per diem expenses for field work, vehicle repairs and depreciation, fuel, insecticides, spraying equipments, maps and stationery goods, monitoring and supervision, training, etc. Some other costs are incurred during the spraying campaigns, for example, time and help of the house owner, possible damage to food and furniture, etc. Unit cost of IRS was estimated using ingredient method. The unit cost of IRS per household for one time spraying is NRs 85.11 that include recurrent and capital costs[15].

KA treatment and diagnosis services are provided free of cost to the patients. However, the patients have to pay for obtaining services like transportation, food, and associated medical cost. These costs are direct cost of treatment. Regarding the distribution of the total direct cost of an episode of KA treatment: medical costs constitute the largest share at 66.5%, followed by food, travel and other costs, at 22.6, 8.9 and 1.9%, respectively. The average total direct cost of KA treatment is NRs 7076[10]. The opportunity costs of the household, the workdays lost (which comprised the total hospitalized days, bed rest at home during symptomatic periods, and recovery time) were multiplied by the prevailing market wage rates for conversion into monetary terms. The average total opportunity cost for the household is thus, NRs 11,000[10].

Cases of KA with intervention are based on actual reported data[12] for 2003 to 2006 and estimated for 2007 to 2015; we assumed that in the interventions, KA cases would reduce linearly to reach one case per 10,000 population by 2015. Estimation of KA cases and risk population for 2007 to 2015 has been adjusted with existing population growth rate of endemic districts[16]. Available information suggested that IRS covers 15% of total risk population of the endemic districts[12].

The sum of costs of all inputs gives the total cost of the interventions, as illustrated in the conceptual framework. By utilizing the information mentioned above, total number of served individuals in a year multiplied by the unit cost of the services provides total cost of each component of the interventions. Following formula is employed to estimate the total cost of KA interventions:

$$TC = (\alpha_1 + \alpha_2 + \alpha_3)\,Y + \alpha_4\,X$$

Where, TC = Total cost; α_1 = Unit cost of KA case management; α_2 = Average direct cost of treatment; α_3 = Average indirect (resource) cost of treatment; α_4 = Unit cost of IRS; X = IRS covered population; Y = Total KA cases in a year.

Benefit estimation: The interventions support to increase KA case prevented and to reduce the morbidity (disability) and mortality. This consequently increases the labour availability in KA endemic districts. The formula for the number of cases of KA prevented for a given year is calculated as follows:

Cases of KA prevented = (Cases of KA without interventions – Cases of KA with interventions)

Method of estimation of KA cases with intervention has already been mentioned in the earlier section, however, the estimation of KA cases without intervention is determined by many factors, for example, vector density, densities of *Phlebotomus argentipes* (Diptera: Psychodidae), disease transmission, population growth rate, existing effectiveness of IRS, current incidence rate, climate and environmental factors, household behaviour among others. The incidence of KA without interventions can be estimated, as a rule of thumb, by utilizing the effectiveness of IRS and reported KA cases, however, reported data are grossly under reported. For example, estimated annual incidence of KA per 10,000 population with adjustment of under reported cases was 9 (where reported cases are 4 or 5/10,000) for Nepal and average annual incidence for all three countries is 22.3[17]. In Bihar, average incidence of KA cases was 5.7 per 1000 population based on reported data and overall magnitude of unreported KA cases was higher by the factor 4.17[18]. Similarly, the recent data suggest that KA infection prevalence rate is 9% with a range of 5 to 15% in Nepal[19]. In addition, some of KA patients of Nepal are found to have consulted health facilities in India for treatment. Again, if there is no intervention, new foci of KA will arise. Sandfly feeding behaviour results in increased transmission rate[20]. IRS has covered 15% of risk population and its average effectiveness is only 21% in Nepal, based on reported data[21]. The odds ratio of houses not sprayed with DDT in the past six months with reference to sprayed households is 3.4 in India[22]; however, such information is not available in Nepal. During the 1960s and 1970s KA ceased to be a public health problem which was mainly attributed to countrywide malaria eradication activities with insecticide spraying. As per existing national IRS policy, only those villages have been sprayed, where KA cases were recorded in the previous year. Hence, with observations of available epidemiological data of KA and past experiences, we assume that in the absence of KA interventions, average incidence rate of KA would be 20: 1000 per year during project horizon 2003 to 2015.

In the absence of KA interventions, the effective labour force (economically active population as suggested by population monograph[16]) in the KA endemic areas can be broken down into infected and non-infected individuals in the given year, similar to that in other literatures[23–24]. The effective labour force (E) in the KA endemic areas $E = (1 - z)\,L + z\,(1 - k)\,L$, where $(1 - z)\,L$ is the labour supply of non-infected workers and $z\,(1 - k)\,L$ is the labour supply of infected workers. z is the proportion of labour force (L) that is infected in the given year. k is fraction of work year lost per KA-stricken workers ranging a value between 0 and 1.

In the presence of KA intervention, the effective labour force (E_c) can similarly written as $E_c = (1-z_c) L + z_c (1-k)L$, where z_c is the fraction of labour force infected with KA in the given year. With KA intervention, z_c is progressively lower than z. The incremental labour input available as a result of KA intervention is given by (E_c-E) or $k(z-z_c)L$, where $(z-z_c) L$ is simply the number of KA cases prevented due to KA interventions in the productive segment of the population. Therefore, $k(z-z_c)L$ gives us the additional productive labour input available as a result of reducing incidence of KA. Note that KA is a fatal disease, therefore, k can be assigned a value of 1. The percentage change in labour force as a result of reducing incidence of KA multiplied by labour elasticity gives the proportionate change in value added due to labour effect of the interventions[11]. Again, number of cases prevented due to the interventions and unit costs gives an estimate of the amount of money needed to allocate for curative services, thus, direct and indirect costs of households that will be saved.

For the estimation of benefit gains, the following formula has been used:

$$TB = \eta\varepsilon(\mu) + \Omega$$

Where TB = Total benefits, η = Proportionate change in labour force as a result of reduced incidence of KA; ε = Elasticity of labour with respect to output for Nepal[25] (using Cobb Douglas production technology) suggests that a 1% increase in the number of workers will increase output by 0.54%; μ = Per capita income from household survey (Nepal living standard survey[26]) data of the endemic districts for 2003. Real gross domestic product (GDP) per capita income that has increased by 1.6% per year[27] is used for estimation of per capita income for 2004 to 2015; Ω = Total cost saving due to KA cases prevented.

$$\Omega = (\alpha_1 + \alpha_2)\,\tau$$

Where, τ = Total KA cases prevented.

Total population at risk, effective labour force and per capita income of the districts are given in Table 1. All required data from different sources are entered into the Microsoft Excel and costs and consequences of interventions are estimated based on standard procedures used in the field of economics, subsequently the sensitivity analysis is conducted. In turn, we estimated the net present value (NPV) by utilizing social rate of discount using standard formula[28].

$$V = \sum_{t=0}^{n} (B_t - C_t)/(1+r)^t$$

Where, t indicates project horizon; B_t represents total societal benefits; C_t is total societal costs. V is equal to NPV and r is social discount rate (10%). If

Table 1. Population, effective labour force and per capita income of KA endemic districts for 2003

KA endemic districts	Effective labour force	Total population at risk	Population growth rate	Per capita income (NRs)
Jhapa	400479	688109	0.015	17377
Morang	490754	843220	0.022	15540
Sunsari	364118	625633	0.030	11897
Saptari	331904	570282	0.020	13550
Siraha	333136	572399	0.022	15049
Udayapur	167435	287689	0.026	19299
Dhanusha	390734	671364	0.021	15007
Mahottari	322126	553481	0.023	16728
Sarlahi	369978	635701	0.026	17745
Rautahat	317267	545132	0.028	16346
Bara	325417	559135	0.030	12108
Parsa	289381	497219	0.029	12285

NPV is greater than zero that ensures economic feasibility to eliminate KA and if it is less than zero, KA is not the potential candidate for elimination. By setting *V* at zero, then estimating *r* by interactions, *r* gives an estimate equal to IRR.

Results

Effects of interventions: Table 2 exhibits the number of cases prevented due to interventions of KA in a year. Total cases with intervention for 2003 to 2006 were based on reported data. The result demonstrates that not more than 316 cases should occur in Nepal to meet the target of elimination of KA by 2015.

Costs of interventions: Preventive intervention and curative intervention share 50 and 31% cost out of discounted total societal cost respectively (Fig. 3). The public sector alone has contributed 81% of total cost (NRs 749 million). The households have contributed in terms of direct and indirect costs of obtaining services of KA by 19%. The share of indirect cost or opportunity cost is higher than the direct cost because KA care is provided free of cost at the public hospitals.

Figure 4 illustrated that all cost curves have negative slope meaning that additional cost of each component of interventions is going down over the year, however, the curve of curative cost is steeper than others. In the initial year, the curative cost is higher than preventive cost. Additional preventive discounted cost will be reduced only by 57% but additional discounted curative cost will be reduced by >90% in the end of project period. At least NRs 28 million discounted costs per year will be needed to maintain the incidence rate of KA below 1:10,000 after 2015.

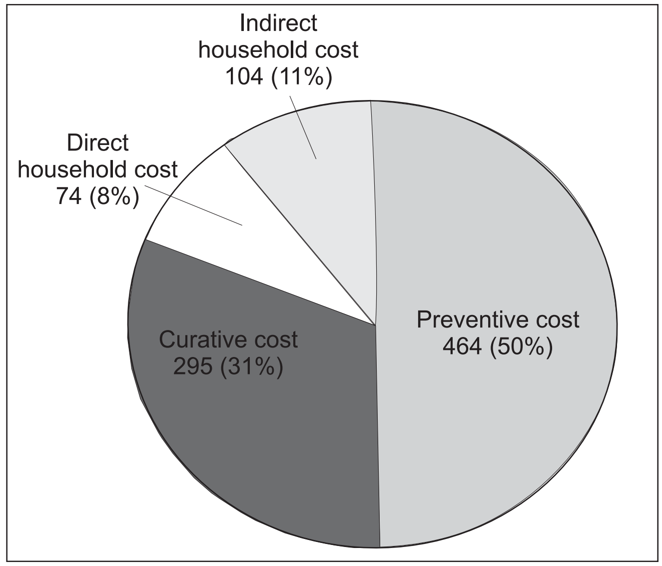

Fig. 3: Cost components of interventions in million NRs

Benefits from interventions: The benefits from the KA interventions are categorized into three components: productivity gains, saving of service obtain-

Table 2. Total KA cases prevented during the project time

Year	IRS covered population	Total prevented cases	Cases with interventions	Total cases without interventions
2003	1115261	91374	2222	93596
2004	1141723	92981	1889	94869
2005	1173780	94987	1605	96593
2006	1201622	97473	1365	98838
2007	1230144	99714	1160	100874
2008	1259366	102016	986	103001
2009	1289303	104377	838	105215
2010	1319974	106800	712	107512
2011	1351397	109285	605	109890
2012	1383592	111832	515	112347
2013	1416578	114444	437	114882
2014	1450375	117122	372	117493
2015	1485003	120161	316	120477

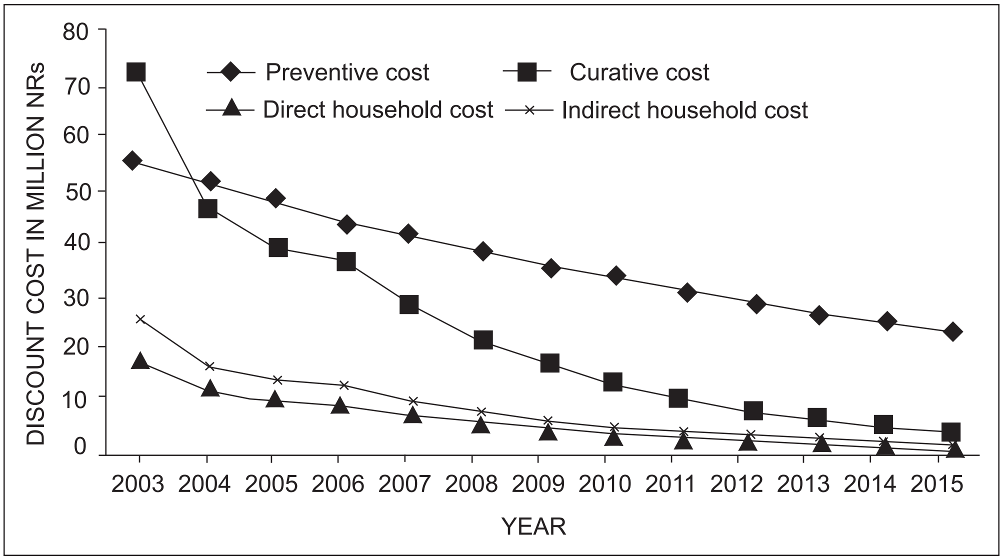

Fig. 4: Discounted cost curves

ing cost borne by the household and saving of curative cost subsidized by the government (Fig. 5). The diagram reveals that the society gains additional production in term of money due to reduction of KA that is 40% out of total discounted benefits. The government will save a large amount of money (NRs 24,812 million) that is 37% of total discounted benefits.

The results show that additional benefits through cost saving will be declining throughout the project period (Fig. 6). Additional discounted benefit from the productivity change will be increasing over the years.

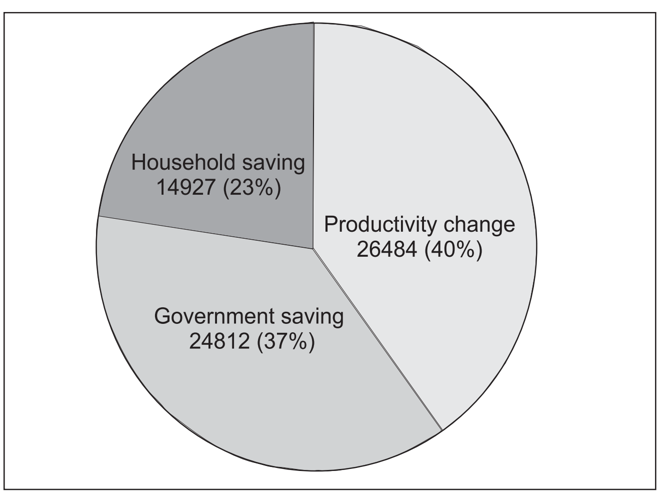

Fig. 5: Benefit components of interventions in million NRs

Benefit-cost analysis: The summary results in Table 3 exhibit that the mean of discounted net benefits is around NRs 5022 million or USD 67.18 million (NRs 74.75: USD 1 for 2003). The standard deviations suggest the risks about the cost and benefits. The results show that obtaining discounted benefits are at more risk than the discounted costs for interventions. Total discounted net benefit is quite high, NRs 65,286 million with 35% IRR. The ratio of discounted benefits and costs is 71:1. This means that if we invest one Rupee in interventions of KA will yield NRs 71 in reference period.

Sensitivity analysis: Sensitivity analysis helps to build confidence in the model by accommodating for the uncertainties that are often associated with parameters. The analysis encompasses several techniques[29].

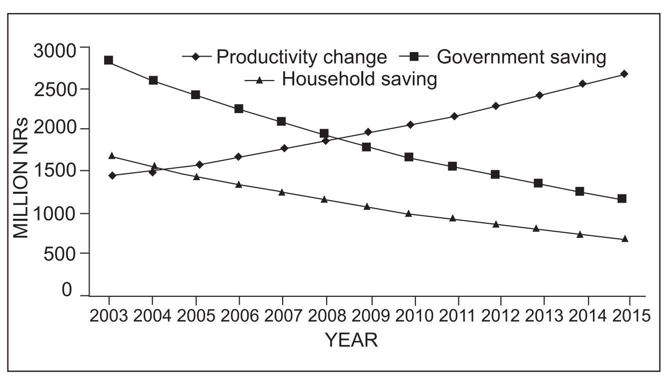

Fig. 6: Discounted benefit curves

Table 3. Summary results of costs and benefits of KA intervention (in million NRs)

Summary results	Discounted costs	Discounted benefits	Discounted net benefits
Mean	72.09	5094.13	5022.04
Standard error	11.40	129.26	117.94
Median	60.45	4943.17	4882.71
Standard deviation	41.09	466.06	425.25
Sample variance	1688.21	217211.86	180841.02
Kurtosis	0.44	–0.31	–0.36
Skewness	0.99	0.89	0.88
Range	136.34	1406.70	1273.66
Minimum	27.88	4640.60	4609.42
Maximum	164.22	6047.30	5883.08
Sum	937.11	66223.69	65286.57

Sensitivity analysis is used to identify the range of plausible estimates for the economic consequences of the KA epidemic and change in parameters. We used the practical methods of handling uncertainty by using point estimates for each parameter, and conducting a sensitivity analysis by varying these estimates to test the robustness of the conclusions of the analysis. We take the form of a max-min analysis where all variables are given their extreme "optimistic" and "pessimistic" values to elicit a best and worst case scenario. The ranges of values of the parameters with some descriptions are presented in Table 4.

The usefulness of CBA depends largely on addressing the presence of uncertainty in the analysis. The sensitivity analysis suggests the wide variation of costs and benefits of KA interventions when the parameters have different values. Under these circumstances as described in Table 4, both IRRs and societal net benefits (at 10% discount rate) are largely fluctuated, however, total societal costs are loosely stable (Fig. 7). The effectiveness of the interventions determines the amount of societal benefits. The results suggest that IRRs and discounted net societal benefits vary from 29 to 43% and NRs 29,967 to 164,712 millions respectively (Figs. 7 and 8). Obviously, if we increase (or decrease) the social discount rate, societal net benefits will decrease (or increase) linearly, therefore, that is not shown in the diagram.

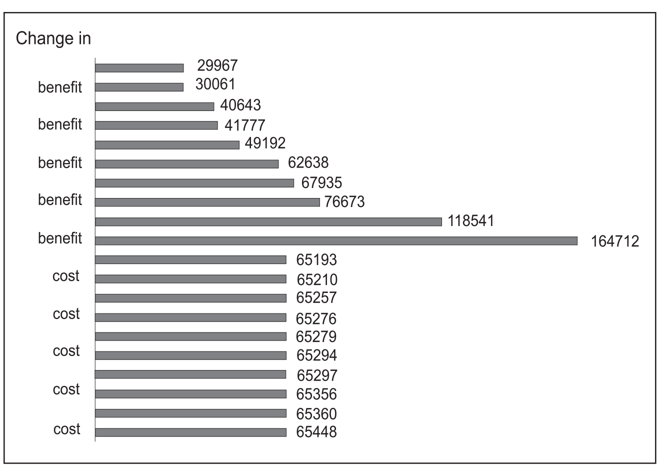

Fig. 7: Discounted benefits from sensitivity analysis (in million NRs)

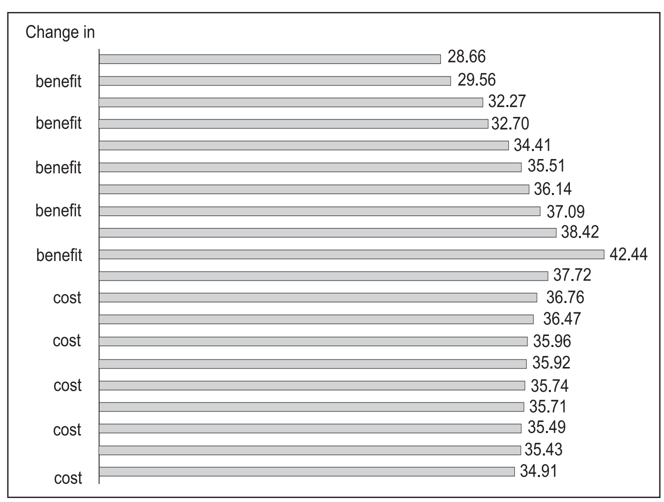

Fig. 8: IRRs from sensitivity analysis (in %)

Table 4. Sensitivity analysis for discounted costs and benefits

Parameters	Range of values	Descriptions of optimistic and pessimistic values of the parameters
Unit cost for KA case management	10% increase to 25% decrease	Prices of resources, for example salary of health professional will increase over the time, therefore, it is assumed that of the health expenditure has been increased by 10% each year. However, introducing new drugs, such as miltefosine and diagnostic tools are likely to reduce curative cost and length of stay in the hospitals, hence unit cost of care will be reduced by about 25%.
Average direct costs of households	10% increase to 10% decrease	Costs of medicine, transportation, food and accommodation are generally increasing over the years. Nevertheless, the improvement of access to KA care services can reduce the direct cost of treatment.
Average indirect costs of households	10% increase to 10% decrease	Opportunity cost is increasing with increasing per capita income and socioeconomic development in the society. However, due to the improvement in KA case management and access to services, loss of time can be reduced in future.
Unit cost of IRS per person	10% increase to 15% decrease	Cost of IRS will increase due to the increase in cost of capital, wage rate of staff, and among others. The costs will be decreased by 15% due to increasing awareness of the interventions, spillover effects of the interventions, self-motivation to control diseases among others.
Effectiveness of IRS	1 to 21%	The secondary source of information suggested that the effectiveness of IRS varies from 1 to 21%.
Elasticity of output with respect to labour	10% increase to 10% decrease	KA disproportionately falls into rural areas where agriculture is the primary occupation of people. The labour elasticity can be increased through improvement in agriculture production and agribusiness, but it can be reduced due to disguised unemployment in the agriculture sector.
Change in per capita income	3.4% increase to 2% decrease	We have used two extreme values (the highest and the lowest growth rates) of real GDP per capita income in the last decade.
Unemployment rate	2.9% to fully unemployed (additional labour)	National unemployment rate is 2.9 and in the extreme case, additional labour due to KA case prevented will be fully unemployed.

Discussion

Prior to discussing the above results, we must highlight the study limitations. Firstly, not all costs and benefits can be estimated in terms of market prices and not all epidemiological data are available, and in such cases indirect simulation methods are used in which the treatment becomes somewhat arbitrary. Therefore, the value judgements are inevitable. Secondly, in a study of this type that involves synthesizing data from a number of secondary sources into an analytical framework, the parameters are subject to uncertainty in their estimated values. For example, unit costs may not vary at the individual patient level; but that may vary among different treatment centres. Similarly, there may be uncertainty associated with modelling process because we do not know the functional relationships between all parameters used in the model. For example, what will be the relationship between elasticity of labour and opportunity of cost of treatment of the patient? Thirdly, the externalities of costs (disease) and consequences of interventions will not be limited within the project period and within 12 endemic districts of Nepal. Therefore, this analysis provides a truncated view of the real implementation of the interventions. In spite of all the limitations and pitfalls associated with epidemiology, cost and consequences of the interventions, the process is still a more reasonable procedure for estimating net benefits and IRRs.

The economic evaluation of the health interventions with limited information is a challenging task. Almost 60% of CBA related studies, therefore, were found without estimating the benefits in monetary terms[5,30]. The paper has contributed in the literature in providing the methods of estimation with separate components of discounted societal costs and benefits of the KA intervention.

This paper has attempted to assess the economic evaluation of KA interventions by utilizing various sources of information. Despite the given assumptions and the exclusion of non-quantifiable benefits, KA is potential candidate for elimination, however, IRR for KA intervention is lower than chagas disease control[28], but almost similar to dracunculiasis eradication campaign[24]. Bassombrio *et al*[28] estimated benefits from the chagas disease control for a hundred years and ignored the opportunity cost of households, however, we have estimated benefits for a 13-years project duration including opportunity costs of households and with details of cost and benefit components. The sensitivity analysis shows that the intervention remains highly profitable. The discounted societal costs for interventions are more stable than the benefits. Thus, the successful implementation of the interventions is most important for producing higher benefits to the society. There is a growing consensus among concerned agencies and policy makers that new supporting institutions and policies are needed in order for endemic countries to capture the full benefits of health interventions and minimize the associated risks[4]. The argument for investment gets better when other economic benefits such as poverty reduction, improving economic welfare, and better household economy from the KA interventions, not reflected in natural units such as incidence, prevalence, disability adjusted life years (DALYs) are taken into account. Further, the results show a considerable amount of money required in maintaining the level of elimination, therefore, it requires CEA to reset the targeted incidence of elimination of KA in each district and to design the policy for getting more benefits within the given level of costs.

The elimination of KA is technically and politically feasible[3], nevertheless, they have merely power to mobilize the resources for intervention. Political commitment can help to mobilize the resources through collective action; however, there is lack of self-motivation. The economic evaluation serves as a strong motivator for mobilizing and generating the resources for interventions through self-motivation from local to central or regional levels, but without economic analysis, it is more difficult to expand the interventions for elimination of KA through development of a national agenda because KA is confined to certain areas of the country.

Multicentre studies in Indian subcontinent[17] have suggested similar strategies for elimination of KA for these countries. The financing and resource mobilizing strategies must be similar because “elimination of KA” is a joint product of these countries. Hence, the evidences produced in this paper will be useful to them for developing the financing strategies. “Elimination of KA” is a regional public good that has spillover effects, for example, Bhutan or non-KA endemic areas of the countries will get the benefits from the consequences of the interventions. The regional benefits from KA interventions, hence, will be greater than sum of benefits gained from the individual countries. On the other hand, the intervention is directly related to equity of health care financing because KA is a disease of the poor and benefits disproportionately contribute in favour of the poor people[10].

Conclusions

This paper has developed a framework for analyzing costs and economic consequences of KA by comparing with and without health interventions. Elimination of KA is a good investment opportunity or highly profitable investment for the governments and international partners who want to invest in health sector. The benefits from the interventions of KA are not limited to endemic countries, other countries will also benefit by keeping away from the future risk of KA. The produced evidences in this paper will be useful for policy makers, not only for Nepal, but also to its neighbour countries. The KA interventions are pro-poor financing because poor people will get greater benefits from this intervention. CBA may serve as a strong motivator to expand the interventions because the society can easily understand the consequences of a disease in tangible monetary term rather than in natural units such as incidence, prevalence, or DALYs of the disease.

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