

Comparative costs and cost-effectiveness of behavioural interventions as part of HIV prevention strategies

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Background	Behavioural interventions have been widely integrated in HIV/AIDS social marketing prevention strategies and are considered valuable in settings with high levels of risk behaviours and low levels of HIV/AIDS awareness. Despite their widespread application, there is a lack of economic evaluations comparing different behaviour change communication methods. This paper analyses the costs to increase awareness and the cost-effectiveness to influence behaviour change for five interventions in Benin.
Methods	Cost and cost-effectiveness analyses used economic costs and primary effectiveness data drawn from surveys. Costs were collected for provider inputs required to implement the interventions in 2009 and analysed by 'person reached'. Cost-effectiveness was analysed by 'person reporting systematic condom use'. Sensitivity analyses were performed on all uncertain variables and major assumptions.
Results	Cost-per-person reached varies by method, with public outreach events the least costly (US\$2.29) and billboards the most costly (US\$25.07). Influence on reported behaviour was limited: only three of the five interventions were found to have a significant statistical correlation with reported condom use (i.e. magazines, radio broadcasts, public outreach events). Cost-effectiveness ratios per person reporting systematic condom use resulted in the following ranking: magazines, radio and public outreach events. Sensitivity analyses indicate rankings are insensitive to variation of key parameters although ratios must be interpreted with caution.
Conclusion	This analysis suggests that while individual interventions are an attractive use of resources to raise awareness, this may not translate into a cost-effective impact on behaviour change. The study found that the extensive reach of public outreach events did not seem to influence behaviour change as cost-effectively when compared with magazines or radio broadcasts. Behavioural interventions are context-specific and their effectiveness influenced by a multitude of factors. Further analyses using a quasi-experimental design would be useful to programme implementers and policy makers as they face decisions regarding which HIV prevention activities to prioritize.
Keywords	Cost-effectiveness analysis, HIV, prevention, behaviour change, Benin

KEY MESSAGES

- Behavioural interventions have been widely integrated in HIV/AIDS social marketing prevention strategies and are considered particularly valuable in settings with high levels of risk behaviours and low levels of HIV/AIDS awareness.
- While individual interventions may be an attractive use of resources in terms of raising awareness, this may not translate into a cost-effective impact on behaviour change.
- We found that the extensive reach of public outreach events did not seem to influence behaviour change as cost-effectively as did magazines or radio broadcasts.
- Behavioural interventions are context-specific and their effectiveness is influenced by a multitude of factors. Further analyses using a quasi-experimental design would be useful for programme implementers and policy makers facing decisions regarding which HIV prevention activities to prioritize.

Introduction

Strategies in health promotion and disease prevention have increasingly applied methods of social marketing, i.e. the adaptation of commercial concepts and techniques to increase the coverage of interventions and promote healthy behaviours in target populations (Kotler and Zaltman 1971; DFID 2003). In the context of HIV/AIDS prevention, social marketing has primarily focused on the procurement and distribution of subsidized products (e.g. condoms), the promotion and delivery of services (e.g. voluntary counselling and testing), and communication to address behavioural determinants and promote the practice of safer sexual behaviour (UNAIDS 1998; UNAIDS 2000; Bonell and Imrie 2001). These latter efforts are commonly referred to as information, education and communication (IEC) or behaviour change communication (BCC) and include a variety of methods such as mass media campaigns, peer education and community-based activities. Such behavioural interventions are an important component of national prevention strategies and are particularly useful in populations with low levels of HIV/AIDS awareness and high levels of risky behaviours.

The last decade has seen widespread integration of BCC interventions in HIV prevention (Karim *et al.* 1997; Pequegnat and Stover 2000). Despite this, systematic reviews indicate there is a relative lack of economic evaluations, especially those that compare the cost-effectiveness of individual components of BCC programmes and those occurring in low- and middle-income countries (Holtgrave *et al.* 1996; Walker 2003; Frick 2006; Hutchinson and Wheeler 2006). Findings from such analyses often provide critical input to policy makers and programme implementers, particularly in developing countries facing limited resources and decisions regarding what might be the most efficient mix of interventions from a portfolio of health interventions (Kahn and Marseille 2000).

When social marketing activities have been found to be cost-effective, in many cases this conclusion is based on measuring 'population reached' as the outcome measure (Piotrow *et al.* 1992; Watts *et al.* 2000; Robinson and Lewis 2003). In the HIV community, however, there is increasing concern about evaluations which only measure numbers reached or awareness raised, as opposed to behavioural or biological outcomes (Parkhurst *et al.* 2010). While cost per person reached is not a measurement of effectiveness, it does provide important information to health policy makers and

fundors regarding how costly an intervention is to reach one person or where to expect the highest burden of costs. Measuring cost-effectiveness of social marketing with regard to intended or actual behavioural intentions or outcomes can further provide a critically important metric to compare interventions and inform HIV prevention policy. Analyses from both Uganda (Kirby 2008) and Zimbabwe (Halperin 2011) have shown that strategic condom use with casual or commercial partners may have been an important contributor to reductions in national prevalence rates.

Study setting

AIDS has been classified as a priority disease for over two decades in Benin (INSAE and Macro International Inc. 2007). While HIV prevalence in Benin is relatively low (2.0%), trends show that over the last 10 years the percentage of infected adults has multiplied 12-fold (PNLS 2008a; UNAIDS 2010). Further, concentrated epidemics exist in specific high-risk populations, rising to 2.6% in truck drivers and 26.5% in sex workers across all of Benin (USAID 2008; UNAIDS 2010).

HIV/AIDS-related knowledge in Benin is mixed. Misconceptions regarding transmission modes are still widespread, with four out of five adults believing that AIDS can be transmitted by mosquito bites or supernatural means (INSAE and Macro International Inc. 2007). On the other hand, approximately three-quarters of men and women report knowing that condom use during each sexual relation is an effective means to reduce the risk of contracting the virus (INSAE and Macro International Inc. 2007). This knowledge, however, is not reflected in safer sexual behaviour as condom use remains low. Across the general population, only two out of 10 females and four out of 10 men report using a condom in 'high risk' sex, i.e. with extramarital or non-cohabiting partners (INSAE and Macro International Inc. 2007, p. 235).

Social marketing activities to educate and change behaviour have featured as a main component in Benin's National Framework to Fight HIV/AIDS (CNLS 2006). Over the 2007–2009 period the non-governmental organization (NGO) Population Services International (PSI) implemented a set of interventions across Benin under the responsibility of the Benin Ministry of Health and supported by the German Financial Cooperation. Interventions promoted safer sexual behaviour and the systematic use of condoms.

The objective of this study is to analyse and compare the costs and cost-effectiveness of each intervention to inform both programme implementers and policy makers on BCC interventions in the context of HIV-prevention in Benin and comparable settings.

Methods

A cost-effectiveness analysis was conducted for five social marketing behavioural interventions: peer education, radio broadcasts, magazines, public outreach events and billboards (described in Table 1).

Calculating costs

Cost-effectiveness was measured using an incremental approach from a service provider's perspective. Following standard and HIV-specific guidelines (UNAIDS 2000; Drummond *et al.* 2005), a full cost analysis estimated the economic costs of all provider inputs required to implement social marketing programmes with a behaviour change component. We report on economic costs in our analysis to allow for comparison across different interventions and different settings. Costs were divided into capital and recurrent costs for major categories, including personnel, service contracts, buildings, vehicles, and equipment and supplies. Implementation costs were collected for 2009, representing the most recently available and most comprehensive cost data. Start-up costs and capital costs paid

for in previous years were converted into 2009 prices using the average consumer price index for the year concerned (IMF 2010). Capital costs were annualized over their estimated lifetime at a discount rate of 4.75% (BCEAO 2007). The lifetime of vehicles and equipment was estimated based on the expertise of concerned staff and verified against standard costing guidelines. Recurrent costs were based on annual expenditures from 2009; given life effect was 1 year or less, discounting of costs was considered negligible and not analysed. All costs were converted from the Financial Community of Africa franc (CFA) into United States dollars (USD) at the official exchange rate averaged across 2009, when all major expenses were incurred, of 1 USD = 480.58 CFA (Oanda Corporation 2010).

Costs were collected from financial records and contract agreements of the organization with primary responsibility, PSI. Opportunity costs consisted of expatriate personnel and volunteers' next best use of time, derived from interviews with personnel and from reports estimating sex workers' earnings (PNLS 2006); full market price contractual rates, based on expertise of concerned staff; a share of overhead costs of implementing NGO partners, derived from specific line items in established contracts; donated equipment, based on equivalent market price of similar items; and annualisation of capital costs (UNAIDS 2000).

Intervention-specific costs were differentiated from shared overhead costs. Specific costs related to personnel, service contracts and some equipment; shared costs related to building and vehicle operation and maintenance, support staff and office supplies. Personnel costs were specified according to an 'activity approach', i.e. the proportion of total working time of PSI personnel dedicated to social marketing behavioural interventions focused on HIV prevention and the practice of safer sexual behaviour (UNAIDS 2000, p. 84). This proportion was ascertained through focused interviews conducted with department heads and other key staff members directly involved in implementation. Personnel were asked to recall activities of their last typical working week and to retrospectively estimate how they allocated their time across interventions. First, the percentage of time for all social marketing BCC activities was determined. Time was then distinguished from social marketing activities focused on other health areas, and lastly apportioned across the five specific interventions. Costs related to service contracts are based on agreements with three major entities: (i) radio stations for the translation and diffusion of messages and themed broadcasts, (ii) publishing agencies for the development of artistic work featured in magazines, billboard advertisements and the like, and (iii) NGO management fees and overheads to host public outreach events, supervise peer educators and ensure the running of radio broadcasts. Some equipment items were identified in financial records as specific to a certain intervention.

Shared overhead costs were allocated according to the average time dedicated to all social marketing behavioural interventions focused on HIV prevention and the practice of safer sexual behaviour. The average time across the total number of PSI personnel, 27.6%, was applied in distributing shared overheads.

Three assumptions for calculating costs were adopted. First, equivalent salaries for equally qualified local staff in place of expatriate volunteers were assumed throughout the analysis.

Table 1 Description of interventions

Intervention	Description
Peer education	One-to-one or small group discussions held 5–10 times a month led by one of 200 trained sex workers or youth peer educators to raise awareness on prevention and transmission of HIV and to encourage behaviour change.
Radio broadcasts	150 approximately 30-second messages on HIV prevention and transmission per month and a bi-weekly approximately 45-minute themed talk show ('Amour et Vie' or 'Love and Life') specifically targeting youth and covering a variety of sexual and reproductive health topics broadcasted by 10 contracted radio stations.
Magazines	A youth-oriented magazine issued on a bi-monthly average and of approximately 15 pages covering a variety of sexual and reproductive health topics including delaying the onset of sexual activity, fidelity, contraception and other means to prevent transmission, and communicating with partners and parents.
Public outreach events	Activities held in local communities and hosted by a network of 16 contracted non-governmental organizations to disseminate messages via theatrical sketches, condom use demonstrations and the projection of short videos. Messages raise awareness on prevention and transmission of HIV, promote safer sexual behaviour and address social norms.
Billboards	56 billboard sides featuring messages regarding the prevention of HIV and adverts for condoms displayed for a period of 6 months in major cities and along highways.

The second and third assumptions were adopted to more accurately attribute costs from service contracts. It was assumed that attributable costs from service contracts with radio stations were 25% of expenditure given that broadcasts covered one of four health issues (i.e. HIV/AIDS, reproductive health, malaria or diarrhoeal diseases). Similarly, 60% of contractual costs with NGOs were taken to reflect the portion of costs associated with BCC interventions as opposed to costs incurred for other activities (e.g. voluntary counselling and testing).

Total costs for each intervention were calculated. Costs were further calculated per person reached by each intervention. This process measurement of 'intervention reach' was derived from cost data and survey questions asking if, over the last 12 months, respondents heard messages communicating means to prevent HIV, immediately followed by an open-ended question asking where they last heard such messages.

Calculating cost-effectiveness

This study analysed effectiveness by the number of persons reporting systematic use of condoms. These data are drawn from surveys and evaluations conducted by PSI with support from a local research agency over the period March to May 2009, approximately 28 months after social marketing behavioural interventions commenced and thus allowing for sufficient time for BCC measures to take effect. As reported elsewhere (PSI 2009a; PSI 2009b; PSI 2009c), these surveys collected information regarding sexual activity, knowledge and attitudes about HIV/AIDS, and exposure to the five methods of behavioural interventions. In total, 5451 respondents (936 sex workers, 1125 truck drivers and 3390 youth) were randomly selected across all zones of intervention, i.e. 29 communes in 7 of 12 departments across Benin. Sample size was calculated to maintain a power of 0.80 ($\alpha=0.05$). Selection criteria included female sex workers aged 15–29 who engaged in sex for remuneration during the last 30 days, and truck drivers aged 15 years or more, and youths aged 15–24 years who had at least one casual partner over the study period.

Measurement of effectiveness was derived from a survey question asking about systematic condom use. The definition of systematic was derived from national surveys and defined by the sexual routine of specific target groups, viz. for sex workers, the use of condoms with all partners over the last 7 days; for truck drivers, the use of condoms with casual partners and paid sex workers over the last 30 days; and for youth, the use of condoms with all casual partners over the last 12 months (PNLS 2009a; PNLS 2009b). Responses were then cross-tabulated against variables of exposure to interventions in order to analyse effect size between receipt of messages and behaviour. Three variables of exposure indicated a high, medium or null/low level of exposure to each of the five interventions. Levels were determined through a count of responses to 10 pairs of questions asking about the receipt and source of specific messages. Null/low exposure represented a count of 0 or 1; medium exposure counts of 2–3; and high exposure counts 4 and above. Approximately 25% of respondents showed high levels, 50% medium levels and 25% null/low levels of exposure (PSI 2009a; PSI 2009b; PSI 2009c). Effect size between exposure and behaviour was determined through

inter-quartile odds ratios (OR) comparing systematic condom use between the 25% with high exposure against the 25% with low/null exposure. The model assumed potential behaviour effects were limited to the sub-group of highly exposed individuals.

To calculate the absolute numbers of effects by each intervention, previously reported survey percentages were applied to the total target population size, recently estimated in national reports (PNLS 2008a; PNLS 2008b; PNLS 2008c).

Cost-effectiveness ratios were calculated for cost per (highly exposed) person with self-reported behaviour of systematic condom usage, per intervention. Incremental cost-effectiveness ratios (ICERs) were then compared to assess relative cost-effectiveness.

Sensitivity analyses

Uncertain variables and major assumptions of the cost-effectiveness model were subjected to univariate and multivariate sensitivity analyses to test the robustness of the model. Table 6 lists base case, upper and lower limits, and sources of values. Sensitivity analyses varied uncertain effects variables, notably survey results measuring percentages of persons reached and reporting behaviour. It further tested sensitivity to costs variables including the exchange rate, discount rate, lifetime of vehicles and attribution of overheads. Sensitivity analyses were additionally conducted for major assumptions, i.e. volunteers' next best use of time, attributable costs of service contracts, and limiting behaviour effects to the sub-group of highly exposed individuals. Finally, an alternative scenario tested the cost-effectiveness of interventions across settings, varying percentages of condom use reported across sub-Saharan Africa.

The study obtained ethical approval from the Benin Ministry of Health (Ministre de la Santé) and ethics committee (Comité d'éthique de la Faculté des Sciences de Cotonou) and the London School of Hygiene and Tropical Medicine (LSHTM).

Results

Costs

Across all five social marketing behavioural interventions, annual economic costs amounted to \$794 274 in 2009 USD. Table 2 shows a breakdown of costs across major capital and recurrent cost categories. Personnel costs are the strongest cost driver, representing take-home salary (i.e. net wage) and additional benefits which amounted to \$507 819 or 63.9% of total economic costs. Fifty-two per cent went to 29 PSI technical staff and volunteers, 3.5% to 18 PSI support staff (e.g. administration and finance, information technology, drivers, etc.), and 8.4% to contracted staff and volunteers from 16 NGOs.

The second strongest cost driver is recurrent contracted services, amounting to \$65 375 and representing 8.2% of total costs. Service contracts with radio stations for the translation and diffusion of messages and themed broadcasts represented 3.2%, publishing agencies for the development of artistic work featured in magazines, billboard advertisements and the like represented 2.4%, and management fees with NGOs were 1.5%.

Table 2 Total annual costs for all social marketing behavioural interventions (2009 USD)

Cost category	Economic costs	% total	Public outreach events	Peer education	Radio broadcasts	Magazine	Billboards
Capital							
Service contracts	26 540	3.3%	4 015	3 916	10 177	4 517	3 916
Buildings	21 648	2.7%	4 386	6 464	5 349	3 804	1 645
Vehicles	30 540	3.8%	14 529	5 996	4 962	3 528	1 526
Equipment	15 272	1.9%	9 896	2 013	1 666	1 185	512
Sub-total	94 000	11.8%	32 825	18 389	22 154	13 033	7 599
Recurrent							
Personnel	507 819	63.9%	113 843	153 735	120 396	87 254	32 591
Technical staff and volunteers	413 321	52.0%					
Support staff	27 491	3.5%					
Contracted NGO staff	67 006	8.4%					
Service contracts	65 375	8.2%	10 466	1 763	28 928	4 999	19 219
Radio stations	25 776	3.2%					
Publishing agencies	19 219	2.4%					
NGOs	12 096	1.5%					
Misc	8 284	1.0%					
Building operation and maintenance	27 564	3.5%	5 585	8 231	6 811	4 843	2 095
Vehicle operation and maintenance	43 661	5.5%	14 517	10 914	9 031	6 422	2 778
Supplies	55 855	7.0%	10 547	6 097	7 854	29 805	1 552
Printing materials	25 594	3.2%					
General office supplies	13 244	1.7%					
Prizes	8 424	1.1%					
T-shirts, hats and misc	8 594	1.1%					
Sub-total	700 274	88.2%	154 958	180 740	173 019	133 322	58 234
TOTAL	794 274	100%	187 783	199 129	195 173	146 355	65 834

The remaining 1.0% refers to contracts with individual parties to conduct training or host public outreach events.

Supplies are the third most expensive cost category amounting to \$55 855 or 7.0% of total costs. The most costly items are the printing of materials for magazines and flyers (3.2%), general office supplies (1.7%), prizes given at public outreach events (1.1%) and t-shirts, hats and other such promotional material (1.1%).

Table 2 summarizes capital and recurrent costs across interventions. The costliest intervention is peer education (\$199 129), followed closely by radio broadcasts (\$195 173) and public outreach events (\$187 783).

Table 3 shows the cost per person reached by each intervention. The reach of methods varied widely, with billboards reaching the least number of persons (2626) and public outreach events the most (82 005). As such, public outreach events were found to be the least expensive method in terms of raising awareness (\$2.29 per person) and billboards the most expensive (\$25.07 per person).

Cost-effectiveness of exposure on condom use

Calculation of inter-quartile odds ratios (OR) in Table 4 indicates the likelihood of reporting systematic condom use by respondents

Table 3 Costs per process measure 'persons reached'

Intervention	Costs	Effects	Cost per person
Billboards	\$65 834	2 626	\$25.07
Peer education	\$199 129	5 112	\$38.95
Magazines	\$146 355	8 070	\$18.14
Radio broadcasts	\$195 173	43 338	\$4.50
Public outreach events	\$187 783	82 005	\$2.29

Table 4 Impact of exposure on the odds of reporting systematic use of a condom (high vs null exposure)

Intervention	Odds ratio	95% CI	P-value
Billboards	0.95	0.70, 1.30	Not significant
Peer education	1.22	0.93, 1.61	Not significant
Radio broadcasts	1.40	1.16, 1.69	$P < 0.001$
Public outreach events	1.51	1.20, 1.88	$P < 0.000$
Magazines	1.86	1.32, 2.62	$P < 0.000$

Table 5 Costs and cost-effectiveness (persons reporting systematic condom use, interventions with significant odds ratios)

Intervention	Costs	Effects	Cost per person	Incremental		
				Costs	Effects	Ratios
Public outreach events	\$187 783	6 034	\$31.12	\$187 783	6 034	\$31.12
Magazines	\$146 355	6 582	\$22.24	−\$41 429	548	−\$75.57
Radio broadcasts	\$195 173	7 785	\$25.07	\$48 818	1 203	\$40.60

with high against low/null levels of exposure. Results suggest that high exposure to magazines (OR = 1.86), radio broadcasts (OR = 1.51) and public outreach events (OR = 1.40) is associated with reported desired behaviour, while exposure to billboards or peer educators does not show any significant association.

Table 5 shows the cost per person reporting systematic condom use for the three interventions with significant ORs. The ORs should be interpreted cautiously as they represent a statistical correlation but not a causal relationship. Comparing against Table 3, significantly more costs must be expended per person reporting desired behaviour than receipt of messages; this is especially true for public outreach events, which sees a 13-fold increase in cost per person (\$2.29 to \$31.12).

Table 5 presents ICERs for interventions on reported systematic use of condoms. While behavioural messages communicated through radio broadcasts, magazines and public outreach events are similarly effective (6034 to 7785 persons), variations in costs suggest that, in the context of this study, magazines influence individual behaviour more cost-effectively than public outreach events as more people report desired behaviour for less cost.

Sensitivity analyses

Sensitivity analyses were performed for all uncertain variables and major assumptions. Table 6 lists values and sources for base case and upper and lower bounds. The most sensitive assumption of this model refers to the limitation of behaviour effects to those individuals highly exposed to interventions, approximately 25% of respondents. Sensitivity analyses tested the model across the lower to upper 95% confidence intervals. Results showed sensitivities in cost per person reporting systematic condom use at an average of 1.4 times lower when moving from the lower to upper bounds but no changes in comparative cost-effectiveness across the interventions. Additionally, given the wide variation in reported condom use by men and women in surveys across 25 sub-Saharan African countries (Salem and Gardner 2004), effects were further extrapolated to 70% (Figure 1) to reflect applicability of this model in other settings. Results showed a 5.5 fold average decrease in cost per person when moving from the base case of 12.8% to 70% reporting systematic condom use.

Sensitivity analyses also tested the percentage of relevant costs of service contracts with both radio stations and NGOs. Overall ICER rankings were not affected, although cost per person reporting behaviour was more sensitive for contracts with NGOs. This was particularly evident for public outreach events, which saw a decrease of \$3.32 at the lower bound and an increase of \$3.34 at the upper bound.

Variables in one-way analyses demonstrating some cost per person sensitivities were additionally analysed in two-way analyses. The relevant percentage of contract costs with NGOs

were varied across lower to upper bounds while simultaneously varying the allocation of personnel time to social marketing BCC activities. At the point where personnel time was at its highest and NGO costs at its lowest, cost per person decreased by \$2.17 for public outreach events and slightly increased for magazines and radio broadcasts by \$0.41 and \$0.68, respectively. Results showed no change in relative cost-effectiveness across the interventions.

Discussion

Findings indicate that the cost per person reached varies greatly by method of communication (from \$2.29 to \$25.07). It further suggests that the process measure of 'persons reached' is not indicative of an intervention's cost-effectiveness in terms of reported behavioural outcomes.

In this study, public outreach events were found to reach the most individuals with behaviour change communications for the least cost per person but were not found to be cost-effective when measured against reported condom use. This corresponds to reports by Bollinger *et al.* (2004) and Bollinger (2008) which had found only a moderate impact on condom use resulting from community mobilization activities relative to other interventions such as mass media. Such findings, however, should be interpreted with caution and in the context of the implementation setting (e.g. considering how it may interact with other prevention activities). In this study's setting, the extensive coverage of public outreach interventions—reaching more than 30 times the number of people reached by billboards and nearly twice that of radio broadcasts—indicate they may still be a worthwhile investment, but this conclusion would further rely on an assessment of the need for awareness raising in a population and an understanding for how such knowledge may 'prepare' for behavioural or other structural interventions to take effect.

Findings from this study also shared some similarities with other recent cost-effectiveness analyses. Studies done by Keating *et al.* (2006) and Van Rossem and Meekers (2007) also show a high reach of radio broadcasts and an associated effect on reported condom use. These findings can further be explained by high levels of households in Benin possessing a radio (76.2%) and high frequencies of listening to the radio at least once a week (57.4% of females and 84.6% of males) (INSAE and Macro International Inc. 2007). In contrast, results from this study on the cost-effectiveness of peer education diverge from recently available evidence (Speizer *et al.* 2001; Hutton *et al.* 2003; Bollinger *et al.* 2004; Bollinger 2008). This analysis failed to find peer education comparatively less costly in terms of the number of persons reached and did not find a significant association between participation in peer education

Table 6 Sensitivity analyses (impact on cost per person reporting systematic condom usage and cost-effectiveness)

Variable (Rationale)	Lower bound	Base case	Upper bound	Source of values	Impact on cost per person with behaviour: increase (or decrease) from base case			Impact on cost-effectiveness
					Public outreach events	Magazines	Radio broadcasts	
Exchange rate (Uncertain)		\$480.58	\$512.68	Highest observed value Average for year	(\$1.83)	(\$1.26)	(\$1.37)	No change
	\$452.12			Lowest observed value	\$3.82	\$2.63	\$2.86	
Discount rate (Uncertain)		3.75%	6.00%	WHO (2003) BCEAO (2007) WHO (2003)	\$0.29	\$0.08	\$0.11	No change
	3.00%				(\$0.09)	(\$0.02)	(\$0.04)	
Lifetime of vehicles (cars, motorcycles) (Uncertain)		6 : 4	7 : 5	Expertise of concerned staff	No change			No change
	5 : 3							
Allocation of personnel time (Uncertain variable)		27.6%	40.2%	Top 25% of observed values Average % time Bottom 25% of observed values	\$1.16	\$0.96	\$1.30	No change
	13.4%				(\$1.31)	(\$1.08)	(\$1.47)	
Allocation of service contracts with radio stations (Assumption)	10%	25%	40%	Expertise of concerned staff	\$0.02	No change	\$1.80	No change
					(\$0.01)	No change	(\$1.80)	
Allocation of service contracts with NGOs (Assumption)		60%	90%	Expertise of concerned staff	\$3.34	\$0.54	\$0.61	No change
	30%				(\$3.32)	(\$0.55)	(\$0.61)	
% of target population reporting systematic condom use		12.8%	14.9% / 70%	95% confidence limit / Cleland & Ali (2006) Survey results 95% confidence limit	(\$4.76) / (\$25.42)	(\$3.01) / (\$18.16)	(\$3.40) / (\$20.48)	No change but degree of dominance decreases
	10.7%				\$6.85	\$4.14	\$4.67	
Multivariate sensitivity analyses:								
Highest allocation of personnel time + Lowest allocation of service contracts with NGOs	40.2% of personnel time and 30% of contracts with NGOs	Expertise of concerned staff	of (\$2.17)	\$0.41	\$0.68	No change		

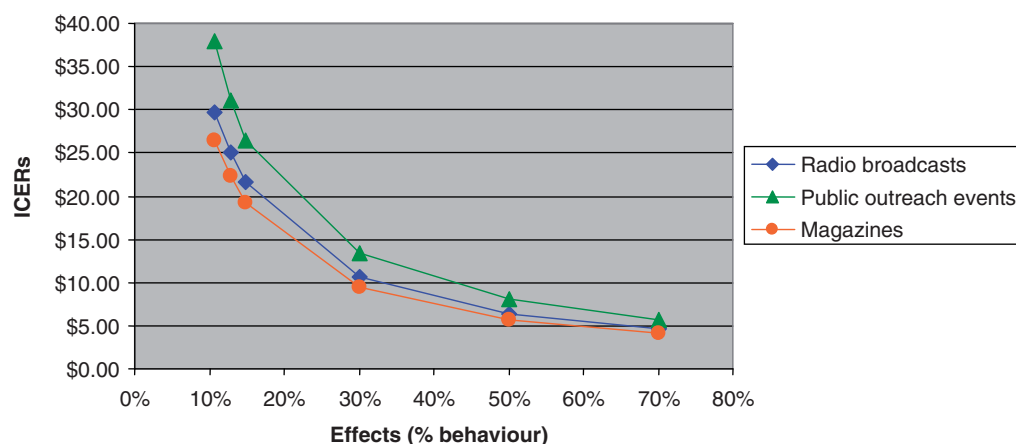


Figure 1 Sensitivity analysis (% systematic condom usage). *Note:* Incremental cost-effectiveness ratios (ICERS) for percentage of target population reporting systematic condom use, varied across lower bound (95% confidence interval), base case, upper bound (95% confidence limit) and highest percentage reported from a sub-Saharan African country.

sessions and reported systematic condom use. It would be useful to explore the cost-effectiveness of peer education across specific target populations, particularly as other studies have found a significant effect on sexually active youths (Speizer *et al.* 2001) and sex workers (Hutton *et al.* 2003; Bollinger *et al.* 2004).

The cost analysis also provides important information to health policy makers and funders who need to know where to expect the highest burden of costs. Information on cost-drivers of interventions as a group particularly points to personnel (63.9% of total costs). The other major cost driver relates to service contracts, particularly those with local NGOs (8.2% of total costs). While contracting out services is argued to increase geographical equity of interventions through closer links to communities, it is unclear if this is more efficient than if the primary implementer undertook the activities.

Two limitations of cost-effectiveness analyses of this nature merit further discussion. The first caveat refers to the inability to make a strong causal inference between specific behavioural interventions and changes in condom use. As the original programme design lacked a control group, baseline or other features of quasi-experimental research, we relied on calculating the statistical correlation between exposure to the various interventions and reported behaviour. Cost-effectiveness analyses often face challenges in estimating the effects of social interventions that can be attributed to communication alone. This applies in particular to those interventions with wide coverage such as mass media where randomized control groups are difficult to design or often not desired given ethical considerations in withholding health information (Kincaid and Do 2006). A similar challenge is the difficulty in knowing the length of the interval between intervention and actual behaviour change. Our study has thus identified costs 'per annum' of various BCC interventions and presented relative cost-effectiveness in terms of self-reported behaviour change over the same time period for all interventions.

The second caveat is the use of self-reported behaviour change as an outcome indicator. The self-reported nature of the indicator is, however, a constraint externally imposed given that the behaviour in question concerns sexual practices. While it does introduce potential biases (e.g. respondent bias) or confounders (e.g. level of

education or previous HIV/AIDS knowledge) which we were not able to control for, it is reasonable to assume that the *comparative* cost-effectiveness across different interventions that address the same overall target group will be less affected than the interpretation of the *absolute* cost-effectiveness of various interventions, given that any errors would most likely affect the findings of all interventions in the same direction. The other issue concerns the validity of behaviour change as an outcome indicator. While biological measures are often considered the most valid measures, they do not appropriately link back to interventions whose main objective is to change behaviour. It should be noted that such a limitation is not unique to our study but a methodological challenge for evaluations of interventions that are structural or social in nature (Rao Gupta *et al.* 2008; Auerbach *et al.* 2011).

The analysis was also limited in interpreting its results, as relative cost-effectiveness was calculated against all three target population groups and was not disaggregated. However, given that only three of the five interventions appeared to be significantly associated with the behavioural effect and that one of the three was directed to youths only, such detailed analysis would not have provided further insight for this particular analysis, but it should be incorporated into the design of future interventions.

Despite these limitations, this study provides new information regarding the comparative costs and cost-effectiveness of several BCC methods. It offers new information on cost drivers which is particularly important for health policy makers, implementers and funding agencies who may wish to know where to expect the highest burden of costs across a group of interventions and within one intervention. It also provides new insights regarding the comparative cost-effectiveness across behavioural interventions, which, if interpreted within a broader understanding of the multiple interacting determinants of behaviour change, can help to guide intervention choices particularly in contexts with high levels of risk behaviours and low levels of HIV/AIDS awareness. Additional research using a quasi-experimental design to evaluate cost-effectiveness by specific target groups in combination with other interventions may be useful to programme implementers and policy makers as they continue to prioritize interventions.

This study cannot and does not intend to recommend which intervention is more effective than another at reducing HIV risk. Recent literature (The aids2031 Consortium 2010) has also discussed the importance of combining biological, behavioural and structural interventions in order to achieve significant and lasting HIV prevention outcomes. HIV prevention interventions should be seen as context specific and complementary, where each intervention contributes to overall efforts in preventing the spread of HIV/AIDS whether through increasing awareness of transmission modes or encouraging the practice of safer sexual behaviour or the provision of antiretroviral treatment. Countries need to select a mix of behavioural as well as biomedical and structural actions that would best address the epidemic and needs of those most at risk in their setting. Cost-effectiveness analyses, such as this one, can help inform the components of that mix.

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Conflict of interest

JH and JP have no conflict of interest. CZ, MN and LF are members of staff of PSI. DHM is a member of staff of the Health, Education and Social Protection Division of KfW. The views expressed herein are those of the authors and do not necessarily reflect those held by PSI or KfW.

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