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# Is hygiene promotion cost-effective? A case study in Burkina Faso

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**Summary**

OBJECTIVES To estimate the incremental cost-effectiveness of a large-scale urban hygiene promotion programme in terms of reducing the incidence of childhood diarrhoeal disease in Bobo-Dioulasso, Burkina Faso.

METHODS Total and incremental costs of the programme were estimated retrospectively from the perspectives of the provider, from the households who change their behaviour as a result of the programme and from society (the sum of the two). The programme effects were derived from an intervention study that estimated the impact on handwashing with soap after handling child stools through a time-series method of observing 37 319 mothers. Using data from the literature, the associated reductions in childhood morbidity and mortality were estimated. The direct medical savings and indirect savings of caregiver time and lost productivity associated with child death were estimated from interviews with households and health workers. The cost and outcome data were combined to provide an estimate of the cost per mother who starts handwashing with soap as a result of the programme and the cost per case of childhood diarrhoea averted.

RESULTS The total provider cost (including start-up and 3-year running costs) was $302 507. Core programme activities accounted for 31% of the cost, administration 40%. The total cost to the 7286 households associated with changing behaviour during the 3 years of programme implementation was $160 125 ($7.3 per year per household). An estimated 8638 cases of diarrhoea, 864 outpatient consultations, 324 hospital referrals and 105 deaths were averted by the programme during this time. Savings to the provider from reduced treatment costs were estimated at $10 716 and savings to the households from averted treatment cost were $9136, resulting in a total saving to society of $19 852, increasing to $393 967 if indirect savings are included. The incremental provider cost per case of diarrhoea averted was $33.8. The incremental cost to society was $51.3 falling to $7.9 if indirect savings are included. If the programme were to be replicated elsewhere, savings in the international research input and start-up costs could reduce provider costs to $26.9 per case of diarrhoea averted. The annual cost of the programme represents 0.001% of the national health budget for Burkina Faso. The direct annual cost of implementing the programme at the household level represents 1.3% of annual household income.

CONCLUSION Hygiene promotion reduces the occurrence of childhood diarrhoea in Burkina Faso at less than 1% of the Ministry of Health budget and less than 2% of the household budget, and could be widely replicated at lower cost.

**keywords** diarrhoeal disease, hygiene promotion, cost-effectiveness analysis

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## Introduction

Diarrhoeal diseases are responsible for between two and three million deaths and over a billion episodes each year worldwide, mainly in children in developing countries (Bern *et al.* 1992). Diarrhoeal disease control programmes have been set up in most countries over the past three decades. These have focused on the promotion of oral rehydration, breast-feeding and hygiene. Over the same period major investments in water and sanitation infrastructure have taken place, sometimes accompanied by hygiene education (DFID 1999).

A series of reviews by Feachem *et al.* in the 1980s suggested that the promotion of personal hygiene was likely to be one of the most effective and cost-effective interventions for the prevention of diarrhoeal disease (Feachem 1984, 1986). Since then evidence for the effectiveness of hygiene promotion has mounted (Han & Hlaing 1989; Wilson *et al.* 1991; Haggerty *et al.* 1994; Shahid *et al.* 1996; Peterson *et al.* 1998), but little evidence for cost-effectiveness has so far been offered. Policy makers need this information to determine whether hygiene promotion should be a priority for health care spending.

Following a quantitative and qualitative study of childhood diarrhoea in the intervention area (Curtis *et al.* 1993, 1995; Kanki *et al.* 1994; Traoré *et al.* 1994) a hygiene promotion programme was set up and implemented in Bobo-Dioulasso by the Ministry of Health of Burkina Faso and funded by UNICEF from 1994 to 1998. The programme was designed to increase handwashing with soap after handling child stools and using a latrine, as well as to increase stool disposal in a latrine, and was tested through a time-series method of observing 37 319 mothers.

This paper presents an incremental cost-effectiveness analysis of this programme as compared with the status quo, i.e. what would have happened to the targeted households had there been no intervention. Issues of affordability and the cost implications of replication are also explored.

## Methods

### Study site

The site of the intervention was Bobo-Dioulasso, a city of a third of a million people in Burkina Faso, West Africa (INSD 1998). There are 26 health facilities within the medical sector, 13 of which are public and include mother and child health clinics and dispensaries (Curtis 1998). There is a national public hospital in Bobo-Dioulasso that includes a paediatric service with 138 beds (Curtis 1998). However, despite their availability, modern health services are not fully used, a major barrier being the high cost of medicines, which results in frequent preference of self treatment with traditional remedies or consultation with a traditional healer (Sauerborn *et al.* 1989).

### Intervention

Against this background, and following a detailed period of formative research into hygiene practices within the home, it was decided to try to change behaviour at the household level, to avoid the risk of diarrhoeal disease incidence in children. Based on preliminary research, the principal carers of young children were targeted through a programme of hygiene promotion. These included mothers, maids, and subsequently primary school children who were also keen to participate. The study design and intervention are described fully elsewhere (Curtis *et al.* 2001). The programme was designed to be replicable and sustainable in the urban Burkina setting and had five main elements. Monthly house-to-house visits were conducted by community volunteers who had received training in communication and hygiene. Health staff were trained to add participatory discussions related to hygiene to their normal programme of health centre talks. A theatre group created a play which was performed weekly, and a set of 12 radio spots were broadcast on three local radio stations. Furthermore, teachers were trained and a curriculum devised for six hygiene lessons in primary schools, and schools received a starter box of soap and buckets to encourage children to wash their hands.

### Analysis of costs

A detailed cost-effectiveness study was planned as a part of the hygiene promotion intervention. The primary goal was to measure the incremental cost-effectiveness of the programme from the perspective of society, which included costs to the provider, the agencies responsible for programme set-up and implementation[1], and to the households who changed their behaviour as a result of the programme. The total and average costs to the provider were evaluated for the three phases of the programme and were collated in June/July 1999. The evaluation of the costs of the qualitative and quantitative research period was based on a condensed package of research activities that

[1] We consider the provider to be the Ministries of Health and Education, through whom the activities are delivered and would ordinarily be financed, although as this was an original research project, UNICEF was the main provider of funds with technical assistance from the London School of Hygiene and Tropical Medicine.

would take place during a 6-month period. Costs to the household and the benefits of the programme were evaluated solely over the implementation period (1995–1998). Table 1 provides an overview of the framework for the cost-effectiveness analysis. Costs are divided into start-up and running costs. The start-up costs refer to the first two phases of the programme (the initial research and pilot study). The annual running costs include the costs of programme implementation alone.

An economic analysis of costs was carried out. This involves the valuation of all resources used in the programme, including the opportunity cost of volunteer time and donated inputs, valued at their current market value. Provider costs were classified as recurrent items, including personnel, training, office supplies and transport and capital items such as vehicles, equipment and building. Financial cost data were obtained from project expenditure records. Resources were also classified by type of programme activity (i.e. communication channels) including resources invested in administration, research and publicity to promote the programme. Where inputs were shared between activities, allocation of costs was based on interviews with members of the project team.

The household costs were identified as the cost of additional soap and water and jug (for pouring) during handwashing estimated during visits to households with the programme field workers (Table 2).

Costs were calculated in the Burkinabé currency: CFA Franc (FCFA). Cost data are presented in US dollars calculated according to the average exchange rate between 1995 and 1998 (550 FCFA to $1.00). Costs of capital items were annualized over their expected useful life at 7% discount rate (Drummond *et al.* 1997). All costs are presented in 1999 constant prices.

### Analysis of consequences

*Effectiveness*

Effectiveness was defined in terms of the change in behaviour in targeted mothers and the impact on health outcome as defined in Table 1. In the evaluation phase of the programme, behaviour change was monitored in mothers with children aged ≤36 months only. Behaviour change was defined for the cost-effectiveness analysis in terms of the increase in the number of mothers washing their hands with soap. This was monitored by structured

**Table 1** Framework for the cost-effectiveness analysis

| | | Description | Method of estimation |
|---|---|---|---|
| Costs | | | |
| Provider costs | Direct | Start-up and running costs | Expenditure records |
| | Indirect | Work time lost by volunteers, teachers and health agents | Interviews with relevant staff; market minimum wage |
| Household costs | Direct | Purchase of soap, water and plastic jug | Interviews with households |
| Consequences | | | |
| Process outcome | | Number of mothers who start washing hands with soap after contact with stools as a result of the programme | Curtis *et al.* (2001) |
| Health outcome | | Cases of diarrhoea, consultations, hospitalizations and deaths averted | Interviews with health workers; Soton (1994); Bern *et al.* (1992); Traoré (1994) |
| Savings | | | |
| Provider savings | Direct | Treatment costs to provider (the cost of the consultation and stool exam minus the fee; the costs of three nights in hospital minus the fee) | Welta *et al.* (1999) |
| Household savings | Direct | Reduced household expenditure in treatment and consultation/hospitalization fees | Health centre and hospital costs: interviews with health workers who defined the typical treatment path and cost of drugs prescribed; traditional practitioner costs: interviews with households. |
| | | Funeral costs | Interviews with households |
| | Indirect | Lost income from caregiver days | Interviews with households used to estimate time spent and average monthly income |
| | | Productivity loss from child death | Human capital approach assuming annual market minimum wage rate: US$300 |
| Savings to society | Direct | Direct provider and community savings | Sum of provider and household savings |
| | Indirect | Indirect household saving | |

**Table 2** Inputs into the evaluation of the household cost of responding to programme messages (from survey of mothers)

| Inputs | Values | Method of estimation |
|---|---|---|
| No. of people per household | 7 | INSD* |
| No. of balls of soap used per week | 1.4 | Mother's estimate |
| No. of litres of water required per handwashing | 0.3 | Observation of handwashing in selected households measured using graduated jug |
| No. of time hands washed per day (per household) | 11 | Mother's and other family members' estimate |
| Proportion of soap use for handwashing as compared with other uses (%) | 10 | Mother's and other family members' estimate |
| | Unit cost (US$1999) | |
| A ball of soap | $0.5 | Market |
| A litre of water | $0.002 | Water bills |
| Jug for pouring water | $0.8 | Mother's estimate |
| Construction of a latrine | $54.5 | School project |

* Institut National de la Statistique et de la Demographie.

observation just before the programme (in 1995) and 3 years later (1998). Changes in the prevalence of the target practices amongst the target population were assumed to be caused by the programme. Because of uncertainty regarding the combined impact of stool disposal in a latrine and handwashing with soap on diarrhoeal disease incidence, any health impact from increased stool disposal in a latrine was not considered in the cost-effectiveness analysis.

The impact of the programme on child health was defined as the number of cases of diarrhoea averted. The number of outpatient medical consultations or inpatient admissions deferred, and the number of diarrhoea-related deaths in children $\leq$36 months reduced, were also estimated. The estimated impact of handwashing with soap on diarrhoea rates was derived from the literature. Six studies were considered (Black *et al.* 1981; Khan 1982; Torun 1982; Han & Hlaing 1989; Shahid *et al.* 1996; Barros *et al.* 1999) offering an estimate of the average reduction in diarrhoea incidence of 42%.

*Resource use consequences*

To calculate total resource use consequences, the average household and provider costs of an episode of diarrhoea were estimated based on interviews with a convenience sample of eight households, and eight health workers, complemented by a review of the literature. It was assumed that 10% of children with diarrhoea consult with a health agent, 10% with a traditional practitioner. The assumption that 3.7% of children with diarrhoeal disease require hospital admission was taken from a study in Burkina Faso (Soton 1994). Based on a cross-country review study (Bern *et al.* 1992) it was assumed that 1.21% of childhood diarrhoea cases result in death.

The provider makes direct savings from the reduction in resources required for the management and treatment of diarrhoea cases in a health centre or hospital, estimated as the cost averted from providing the service, taken from a study by Welta *et al.* (1999), minus the fees charged to the patient. At the household level, direct savings include the deferred costs of drugs and medical supplies, the consultation fee (with a public health agent and/or a traditional practitioner), hospital fees, and eventually funeral costs. The cost of household travel to and from the health care provider was not included as, in the sample interviewed, all women travelled to the facility by foot[2]. Indirect savings to the household were identified as lost income associated with spent caregiver days with a sick child and as the lost productivity associated with a premature child death, to give an indication of future programme benefits. Lost productivity was evaluated using the human capital approach, which uses earnings data as the measure of productivity loss[3] (MacLaughlin 1971; Mushkin 1978; Drummond *et al.* 1997).

### Sensitivity analysis

One-way sensitivity analyses were conducted to test the robustness of the results to parameter uncertainty (for

[2] The opportunity cost of the time spent travelling to the facility was included in the indirect costs of lost caregiver days spent with a sick child.

[3] The calculation is based on a child born in 1995, with an assumed average life expectancy of 47 years, working life of 29 years and working year of 11 months, with an average monthly income equivalent to the market minimum wage (US$27). A discount rate of 3% (Gold *et al.* 1996) was used to provide a present value estimate of lost productivity.

**Table 3** Parameters considered for sensitivity analysis of programme costs and effects

| Parameters considered | Baseline estimate | Range | Justification of range |
|---|---|---|---|
| Percentage soap use for hand washing by households | 10 | 5–50 | Best guess |
| No. of episodes of diarrhoea/child/year before the start of the programme | 2.78 | 1.6–9.9 | Bern *et al.* (1992) |
| Change in the efficacy of handwashing with soap in preventing diarrhoeal disease (%) | 42 | 14–89 | Upper and lower limits from identified literature |
| Proportion of children under 36 months in total population (%) | 11.7 | 5.9–17.6 | 50% above and below baseline |
| Probabilities | | | |
| A child with diarrhoea has a consultation with a health worker | 0.1 | 0.025–0.5 | Best guess |
| A child with diarrhoea has a consultation with a traditional practitioner | 0.1 | 0.025–0.5 | |
| A child with diarrhoea is admitted to hospital | 0.037 | 0.01–0.05 | Bern *et al.* (1992) |
| Childhood diarrhoea leads to death | 0.0121 | 0.003–0.04 | Bern *et al.* (1992) |

baseline values, ranges and justification, see Table 3) (Drummond *et al.* 1997). The impact on the incremental cost to the provider and to society per case of diarrhoea averted is presented. The cost implications for the provider of replicating the programme elsewhere with a population of similar size is considered in terms of reduced start-up costs, research costs and variations in personnel costs.

## Results

### Total programme costs

The economic cost of the programme to the provider was $302 507 covering the full period of start-up and implementation as set out in Table 4. Start-up costs amounted to $36 307, representing 12% of the total cost. The annual programme running cost amounted to $88 733. Personnel represented 47% of the total cost, communication 10%, equipment 7% and transport 7%. The opportunity cost of volunteers', teachers' and health workers' time amounted to $10 508[4], or 8% of the total personnel costs. Table 5 indicates the breakdown of costs by programme activity for the 3 years during which the programme was operational. The core programme activities (house-to-house visits, group discussions, hygiene promotion in schools, street theatre and radio 'spots') together represent only 31% of total provider costs, while the support activities (administration, research and publicity) account for the remaining 69%. Forty per cent of resources were used for administrative purposes and 28% funded the research input into the programme.

For all the households who began washing their hands with soap, the total cost of associated supplies for the full programme (pilot year plus 3-year implementation) amounted to $160 125 or an average of $7.3 per household per year. The total cost of the programme to society amounted to $462 632 (start-up plus 3 years of implementation), an average of $142 108 per year.

### Total consequences

*Effectiveness*

A total of 37 319 mothers were specifically targeted by the programme. Washing hands with soap, observed after handling child stools, rose from 12.7% to 31.3%: an 18.5% rate of behaviour change (Curtis *et al.* 2001). Hence, an estimated 6916 mothers changed their behaviour as a result of the programme. The programme resulted in the prevention of an estimated 8638 cases of diarrhoea, 864 outpatient consultations with health agents, 324 hospital referrals and 105 deaths. The calculations and supporting assumptions are provided in Appendix 1.

*Resource use consequences*

It is estimated that patients cover 48% of the costs of providing a health centre consultation and 52% of the costs of providing a hospital consultation. The remainder of the cost is borne by the provider (Ministry of Health). The cost to the provider of a consultation with a traditional practitioner is assumed to be zero. Savings to the provider were estimated at $4.2 per health centre consultation averted and $7.3 per averted hospitalization. At the household level, treatment costs were estimated at $4.6 per

[4] There were 108 volunteers valued at $0.34 per day, based on the average monthly market minimum wage (1 day per month and 11-month year); 436 teachers valued at $0.66 per hour for 15 h per year each; 34 health staff valued at $0.57 per hour for an average of 2 h per month and an 11-month year.

**Table 4** Total provider costs by resource input in US$1999

| | Start-up cost | Average running cost/year | Total (start-up plus 3-year running costs) | |
|---|---|---|---|---|
| | | | Cost | Percentage of total |
| Recurrent costs | | | | |
| Personnel | 18 653 | 41 357 | 142 723 | 47.2 |
| Training | 791 | 3181 | 10 334 | 3.4 |
| Supplies | 714 | 5253 | 16 474 | 5.4 |
| Communication | 1788 | 7154 | 29 322 | 9.7 |
| Transport | 7861 | 5926 | 19 567 | 6.5 |
| Follow-up-evaluation | 647 | 3393 | 10 825 | 3.6 |
| Utilities | 2488 | 5300 | 18 387 | 6.1 |
| Sub total | 32 943 | 71 563 | 247 632 | 81.9 |
| Capital costs | | | | |
| Construction | 3364 | 4314 | 16 305 | 5.4 |
| Vehicle | 0 | 5543 | 16 630 | 5.5 |
| Equipment | 0 | 7313 | 21 940 | 7.3 |
| Sub total | 3364 | 17 170 | 54 874 | 18.1 |
| Total provider | 36 307 | 88 733 | 302 507 | 100.0 |

**Table 5** Provider costs per programme activity (excluding start-up costs) for the 3 years of programme implementation, in US$1999

| | Unit | No. | Total cost | Percentage of total |
|---|---|---|---|---|
| Core Activities | | | | |
| House-to-house visits | | NA | 17 856 | 7 |
| Discussion in health clinics | No. of participating health centres | 8 | 13 685 | 5 |
| Hygiene lessons in schools | No. of schools | 64 | 27 553 | 10 |
| Street theatre | No. of plays presented | 82 | 14 110 | 5 |
| Radio 'spots' | No. of broadcasts | 1920 | 8735 | 3 |
| Total core activities | | | 81 939 | 31 |
| Other Activities | | | | |
| Administration | – | | 106 899 | 40 |
| Research | – | | 75 626 | 28 |
| Publicity | – | | 1736 | 1 |
| Total other activities | | | 184 260 | 69 |
| Total | | | 266 199 | 100 |

NA: not available.

health centre consultation, $0.8 per consultation with a traditional practitioner and $7.8 per hospital admission. The cost of funeral for a child death was estimated at $18.1. In terms of indirect savings, it was estimated that mothers spend an average of two working days with their sick child at an estimated total cost of $0.9 in foregone income.

The total direct saving to the provider from the programme between 1995 and 1998 was $10 716 of which 66% was associated with inpatient care and 34% with outpatient consultations. For the 7286 households, the direct saving was $9136 of which 44% was associated with outpatient consultations (in the formal sector) and 28% with inpatient care (Table 6), a saving per household of $3 per year. The indirect saving to these households from fewer lost caregiver days was $10 954 and $383 013 from lost productivity associated with a child death. The direct saving to society was $19 892 and the total saving was $413 819. The net cost to the provider was $291 791. The net cost to society was $442 780, falling to $68 665 if indirect savings ($413 819) are included.

**Table 6** Total savings between 1995 and 1997 (incl.) to the provider and to the household in US$1999

| Savings | Saving per case | Total cases | Total savings | Percentage of direct savings |
|---|---|---|---|---|
| Provider direct (A) | | | 10 716 | |
| Consultation | 4.2 | 864 | 3635 | 66 |
| Hospitalization | 21.9 | 324 | 7081 | 34 |
| Total provider (A) | | | 10 716 | 100 |
| Households direct (B) | | | 9136 | |
| Consultation; health worker | 4.6 | 864 | 4011 | 44 |
| Consultation; traditional practitioner | 0.8 | 864 | 707 | 8 |
| Hospitalization | 7.8 | 324 | 2518 | 28 |
| Funeral costs | 18.1 | 105 | 1900 | 21 |
| Households indirect (B′) | | | 10 954 | |
| Lost income from caregiver days | 1.3 | 8638 | 10 954 | |
| Total households (B + B′) | | | 20 101 | |
| Society direct (A + B) | | | 19 852 | |
| Society indirect (B′) | | | 393 967 | |
| Households indirect | 1.3 | 8638 | 10 954 | |
| Productivity loss from child death | 3647.7 | 105 | 383 013 | |
| Total society (A + B + B′) | | | 413 819 | |

Figures are rounded to the nearest decimal place, so totals do not add up exactly in the Table.

**Table 7** Cost-effectiveness ratios in US$1999. Figures in brackets include indirect savings

| Perspective | Total cost | Savings | Net cost | Effect | Cost-effectiveness ratio |
|---|---|---|---|---|---|
| Provider | | | | | |
| Increase in handwashing | 302 507 | 10 716 | 291 791 | 6916 | 42 |
| Diarrhoea cases averted | | | | 8638 | 34 |
| Consultations deferred | | | | 864 | 338 |
| Hospitalizations deferred | | | | 324 | 902 |
| Deaths deferred | | | | 105 | 2792 |
| Households | | | | | |
| Increase in handwashing | 160 125 | 9136 | 150 989 (−242 978) | 6916 | 22 (−35) |
| Diarrhoea cases averted | | | | 8638 | 17 (−28) |
| Consultations deferred | | | | 864 | 174 (−281) |
| Hospitalizations deferred | | | | 324 | 466 (−751) |
| Deaths deferred | | | | 105 | 1445 (−2325) |
| Society | | | | | |
| Increase in handwashing | 462 632 | 19 852 (413 819) | 442 780 (68 665) | 6916 | 64 |
| Diarrhoea cases averted | | | | 8638 | 51 (8) |
| Consultations deferred | | | | 864 | 513 (74) |
| Hospitalizations deferred | | | | 324 | 1368 (212) |
| Deaths deferred | | | | 105 | 4236 (657) |

### Cost-effectiveness ratios

The cost per mother converting to handwashing after contact with child stools was $42.2 from a provider perspective and $64.0 from a societal perspective. The cost per case of diarrhoea averted was $33.8 from a provider perspective. The cost per case of diarrhoea averted was

**Table 8** Sensitivity of results to changes in assumptions. Provider and societal cost per diarrhoea case averted in US$ (value in brackets includes indirect savings)

| Parameters considered | Lower limit provider | Upper limit societal | Provider | Societal |
|---|---|---|---|---|
| Percentage soap use for hand washing by households | 34 | 46 (3) | 34 | 90 (47) |
| No. of episodes of diarrhoea/child/year before the start of the programme | 9 | 13 (−31) | 60 | 91 (48) |
| Change in the efficacy of handwashing with soap in preventing diarrhoeal disease (%) | 15 | 23 (−20) | 104 | 158 (115) |
| Proportion of children under 36 in total population (%) | 22 | 40 (−4) | 67 | 84 (42) |
| Probabilities | | | | |
| A child with diarrhoea has a consultation with a health worker | 32 | 48 (8) | 34 | 52 (8) |
| A child with diarrhoea has a consultation with a traditional practitioner | 34 | 51 (8) | 34 | 51 (8) |
| A child with diarrhoea is admitted to hospital | 34 | 52 (8) | 35 | 52 (8) |
| Childhood diarrhoea leads to death | 34 | 51 (41) | 34 | 51 (−94) |

$51.3 from a societal perspective, falling to $7.9 if indirect savings are taken into account (Table 7).

### Sensitivity analyses

The societal cost per diarrhoea case averted was especially sensitive to the estimated number of diarrhoea cases per child per year prior to the start of the programme and the estimated efficacy of handwashing with soap in preventing diarrhoeal disease, as indicated in Table 8. In the case of variations in the former parameter, the societal cost per case ranges from $13 to $91 [–$31 (a net saving) to +$48, if indirect savings are included]. In the case of variations in the latter parameter, the societal cost per case ranges from $23 to $158 [–$20 (a net saving) to +$115 if indirect savings are included]. The results were also sensitive to an increase in the percentage soap use by households to the upper limit, the societal cost per case of diarrhoea averted increasing to $90 ($47 if indirect savings are included). The results were robust to changes in other parameters tested.

The programme was experimental and as such spent substantial sums on research both prior to and during programme implementation. Were the programme to be replicated in another region of Burkina Faso, international technical assistance during the formative research period could be economized, and the pilot study would not be necessary, leading to savings in start-up costs by up to 38%, a fall from $36 307 to $22 466. Research costs accounted for 28% of total programme running costs, of which 13% were for monitoring and evaluation, and 72% an international research input. While monitoring and evaluation are essential to the success of a programme, savings could be made on international research costs (e.g. through implementation by a local counterpart), enabling a reduction in total provider costs to $232 268 ($69 934 yearly running cost). At an equivalent level of programme impact, the cost to the provider per case of diarrhoea averted would then fall from $33.8 to $26.9 (Table 8).

Personnel represents a significant proportion of total cost of this programme (47.2%), and it is likely that personnel costs will increase in accordance with the income level of the country selected for replication. However, the impact on cost-effectiveness of an increase in personnel costs by factors 1.5 and 2, and a reduction by 50%, is actually negligible, suggesting that, other things being equal, the programme would be equally cost-effective in settings with higher or lower labour costs.

## Discussion

The hygiene promotion programme successfully reduced diarrhoeal disease incidence at the incremental cost to the provider of $33.6 per diarrhoea case averted compared with the status quo and $51.8 to society (falling to $7.9 if indirect savings are included). Allowing for variation in parameters for which there was the greatest uncertainty, the range for provider costs per case of diarrhoea averted was $9–$104 and between –$31 (a net saving) and $158 for the societal cost (including indirect costs). While the impact on results of variations in the estimated relationship between handwashing and the reduction in the risk of diarrhoea was substantial, a number of factors suggest that the baseline value is more likely to have been underestimated than overestimated. The impact of increased stool disposal on diarrhoeal incidence was not taken into account and the programme's impact on the hygiene behaviour of other family members, husbands, maids, primary school children was not evaluated which means our measure of effectiveness is an underestimate of the true programme impact on diarrhoeal disease incidence. Hence,

the cost-effectiveness ratio is more likely to be at the lower, rather than upper, end of the range.

As the programme is both more costly and more effective than the status quo under most assumptions, the cost-effectiveness ratio's acceptability should be determined based on the degree of resource constraints, or available budget (Drummond *et al.* 1997). The average annual total provider cost represents 0.001% of the average annual national health budget between 1995 and 1998 (estimated at US$ 50.5 million[5]). The direct annual cost of implementing the programme at the household level represents 1.3% of the estimated average yearly household income.

Substantial savings could be made in terms of start-up and research costs were the programme to be replicated, which would improve cost-effectiveness by a third or more. With administration representing 40% of total provider cost, the overall cost-effectiveness could have been improved through more efficient programme administration. However, with such difficulties tending to be the norm in externally funded projects, it may be unrealistic to expect greater efficiency in a replicated programme.

Other things being equal, the results indicate that the programme will be more cost-effective in settings with a high incidence of childhood diarrhoeal disease. A potential increase in costs of transport and communication are likely if the programme is to be extended to rural areas, however, this may also be offset by a higher rate of childhood diarrhoeal disease.

The findings may have been subject to various sources of error. In particular, a small convenience sample of eight households and eight household health workers was selected for interview concerning costs. However, the sensitivity analysis indicated that results were robust to changes in key parameters derived from the interview with health workers. On the other hand, the findings were sensitive to the proportion of soap used for handwashing estimated by households.

This study considers both direct and indirect savings, in order to estimate the net programme cost to the provider and to society and the respective cost-effectiveness ratios. When the indirect savings of the programme are included, it seems that the programme's cost-effectiveness increases substantially. However, the evaluation of lost productivity from a child death requires the evaluation of a human life in monetary terms, which decision makers may find difficult or unethical (Weinstein 1980). Also the approach used to evaluate healthy time (future productivity) using the market wage rate (the human capital approach) does not reflect imperfections in the labour market (for example, if the marginal productivity of a worker may not be accurately reflected by the wage). In developing countries where the pool of unemployed and underemployed is large, coping mechanisms are often set up in households whereby healthy members replace sick members temporarily, making the estimation of production losses difficult (Mushkin 1978). Decision makers, who may be more concerned with the immediate impact of a programme, will find the 'direct' cost-effectiveness ratio of more relevance to immediate policy. However, to provide a comprehensive vision of the benefits of the programme, beyond the present, it is useful to consider the benefits in terms of future productivity from an averted child death, discounted to a present value, according to the social rate of time preference.

Further research is required to improve understanding of the nature of the relationship between specific hygiene behaviour and health and the impact of more than one type of behaviour (i.e. hand washing and disposal of stools in a latrine) on health, as the impact on cost-effectiveness is significant. Future studies of interventions targeting diarrhoeal disease need to ensure close documentation of resource use and costs as well as health impact to both assess their efficiency and affordability in resource-poor settings. Whilst our results suggest that hygiene promotion may be an excellent 'buy' for health providers, further data are still needed in different settings and for competing interventions.

[5] 27 750 million FCFA source: Ministry of Health.

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## Appendix 1 Calculation of programme effectiveness

The number of target mothers was estimated at 37 319, with 6916 (18.5%) changing their behaviour (washing hands) during the 3 years of the programme (between 1995 and 1998). Each mother is assumed to have 1.07 children under 3 years of age.

Therefore, there are 7398 children affected by the programme over these 3 years. Assuming an initial incidence of 2.78 episodes per year, the calculation of programme effectiveness is as follows:

No. of cases of diarrhoea averted = (Average no. of episodes of diarrhoea per child per year) × (Percentage reduction in diarrhoea incidence from handwashing with soap) × (No. of children under 36 months per household) × (Number of households changing behaviour)

No. of cases averted / year = $2.78 \times 0.42 \times 1.07 \times 6916 = 8638$

No. of consultations averted = (No. of cases of diarrhoea averted) × (Probability of going to dispensary)

No. of consultations averted = $8638 \times 0.1 = 864$

No. of hospitalizations averted = (No. of cases of diarrhoea averted) × (Probability of being admitted to hospital for a child with diarrhoea)

No. of hospitalizations averted = $8638 \times 0.037 = 324$

No. of deaths averted = (No. of cases of diarrhoea averted) × (Probability of death for a child with diarrhoea)

No. of deaths averted = $8638 \times 0.0121 = 105$