Does scale matter? The costs of HIV-prevention interventions for commercial sex workers in India

Lorna Guinness,[1] Lilani Kumaranayake,[1] Bhuvaneswari Rajaraman,[2] Girija Sankaranarayanan,[3] Gangadhar Vannela,[4] P. Raghupathi,[5] & Alex George[4]

Objective To explore how the scale of a project affects both the total costs and average costs of HIV prevention in India.
Methods Economic cost data and measures of scale (coverage and service volume indicators for number of cases of sexually transmitted infections (STIs) referred, number of STIs treated, condoms distributed and contacts made with target groups) were collected from 17 interventions run by nongovernmental organizations aimed at commercial sex workers in southern India. Non-parametric methods and regression analyses were used to look at the relationship between total costs, unit costs and scale.
Findings Coverage varied from 250 to 2008 sex workers. Annual costs ranged from US$ 11 274 to US$ 52 793. The median cost per sex worker reached was US$ 19.21 (range = US$ 10.00–51.00). The scale variables explain more than 50% of the variation in unit costs for all of the unit cost measures except cost per contact. Total costs and unit costs have non-linear relationships to scale.
Conclusion Average costs vary with the scale of the project. Estimates of resource requirements based on a constant average cost could underestimate or overestimate total costs. The results highlight the importance of improving scale-specific cost information for planning.

Keywords HIV infections/prevention and control/economics; Prostitution; Sexually transmitted diseases/therapy; Contact tracing/economics; Condoms/economics; Costs and cost analysis; India (*source: MeSH, NLM*).

Mots clés Infection à VIH/prévention et contrôle/économie; Prostitution; Maladies sexuellement transmissibles/thérapeutique; Recherche sujet contact/économie; Condom/économie; Coût et analyse coût; Inde (*source: MeSH, INSERM*).

Palabras clave Infecciones por VIH/prevención y control/economía; Prostitución Enfermedades sexualmente transmisibles/terapia; Trazado de contacto/economía; Condones/economía; Costos y análisis de costo; India (*fuente: DeCS, BIREME*).

الكلمات المفتاحية: العدوى بفيروس العوز المناعي البشري، الوقاية من العدوى بفيروس العوز المناعي البشري ومكافحتها، معالجة العدوى بفيروس العوز المناعي البشري، اقتفاء المخالطين، اقتصاديات اقتفاء المخالطين، العوازل الذكرية، اقتصاديات العوازل الذكرية، التكاليف وتحليل التكاليف، الهند. (**المصدر:** رؤوس الموضوعات الطبية، المكتب الإقليمي لشرق المتوسط)

Bulletin of the World Health Organization 2005;83:747-755.

Voir page 754 le résumé en français. En la página 754 figura un resumen en español. يمكن الاطلاع على الملخص بالعربية في صفحة 754.

Introduction

UNAIDS has highlighted the urgent need to scale-up prevention programmes as global funding for treatment and care for people living with AIDS increases. The understanding of the resource requirements needed to expand these activities has improved at the global level as a result of costings made by UNAIDS and the Commission on Macroeconomics and Health (1–3). However, these estimates still lack standardized datasets on cost structures for particular interventions at different scales of activity and in different environments. Improving the understanding of resource requirements is critical to identifying the cost implications of efforts to expand ongoing prevention services included in the work of the Global Fund to Fight AIDS, Tuberculosis and Malaria; the World Bank's Multi-Country HIV/AIDS Program for Africa; and the World Health Organization's 3 by 5 initiative.

Economic theory hypothesizes that as scale increases, total costs increase at a changing rate, giving rise to the classic U-shaped average cost curve. This curve results from certain inputs varying with the level of output (such as the cost of condoms or drugs) and, in the short run, other costs remaining fixed (such as overheads and building costs). As the scale increases, fixed costs are shared over an increasing number of outputs until they reach the limit of their capacity. This sharing of fixed costs leads to non-linearities in the relationship between total costs and scale. Evidence from other health services supports the theory of non-linearities and suggests that costs vary with scale as well as with a number of other contextual, organizational and intervention-specific factors (4–12).

In India, where an estimated 5.1 million people are living with HIV or AIDS (13), the National AIDS Control Programme, under the direction of the National AIDS Control

[1] Department of Public Health and Policy, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, England. Correspondence should be sent to Dr Guinness at this address (email:lorna.guinness@lshtm.ac.uk).
[2] Indian Institute of Technology (Madras), India.
[3] Emory University, Atlanta, GA, USA.
[4] Centre for Health and Social Sector Studies, Hyderabad, Andhra Pradesh, India.
[5] University of Hyderabad, Andhra Pradesh, India.

Ref. No. **04-017459**
(*Submitted: 13 August 2004 – Final revised version received: 10 December 2004 – Accepted: 10 January 2005*)

Organization, has contracted with nongovernmental organizations (NGOs) to target HIV prevention towards higher-risk groups (14–17, and National AIDS Control Organization, unpublished guidelines, 2000). Data on the costs of these initiatives are scarce (18, and D Wilson. Review of the Healthy Highways Project, unpublished report, 1999; V Gonzales et al. Midterm evaluation of West Bengal Sexual Health Project, unpublished report, 1999); there is little information to draw on from elsewhere (4, 19, 20); and there is limited evidence on how total costs change as activities expand (21).

In analysing the costs of 17 HIV-prevention interventions targeted at commercial sex workers in southern India, this paper explores how scale affects site-specific total costs and average costs of HIV prevention. It is the first paper to present cost data collected from multiple sites for a single HIV-prevention intervention. The analysis addresses previous problems of methodological and definitional differences and variations in input valuation, which researchers often face when using cost information from different studies (4, 20, 22), by using a standardized method across the sites. It is therefore able to explore how costs vary with scale.

Methods

Sample selection

A case-study approach was used to enable in-depth insights as well as collection of full economic costs. Seventeen NGOs were selected from the 259 targeted interventions identified in a census survey of interventions in Andhra Pradesh and Tamil Nadu (Table 1, available only on the web at http://www.who.int/bulletin). Both states had contracted with NGOs on a large scale (i.e., for more than 50 interventions). Interventions were purposively sampled according to their capacity, the funding agency, their geographical location, experience in implementing HIV interventions and willingness to participate. Only interventions aimed at commercial sex workers were selected in order to control for differences in intervention activities, epidemiology and target populations. Similarities in intervention design were further ensured by the National AIDS Control Organization's prescription of key components: information and education on behavioural change, condom distribution, peer education, management of sexually transmitted infections (STIs), and creating an enabling environment for the intervention (23, 24, and National AIDS Control Organization, unpublished guidelines, 2000).

Data collection

Economic data on providers' costs were collected for the financial year 2001–2002; data included information on costs incurred at the intervention-level and funding-agency level. Economic costs include all inputs involved in the intervention and value them at their opportunity cost (including inputs that are donated or subsidized). This provides a standardized method for data collection, enabling valid cost comparisons across the interventions. The ingredients approach to costing was used as far as possible (see, for example, (5)).

Measuring scale

Scale is defined from an economic perspective – that is, it is the extent or level of activity at which an intervention is operating (25, 26). *Coverage*, which is measured by the number of people reached, reflects scale as defined by national policy. Another six indicators reflect different aspects of the *volume* of services delivered: number of commercial sex workers referred for STI treatment, number of STIs treated, number of condoms distributed, number of first contacts made with members of the target group, total number of contacts made with members of the target group and total number of contacts with the members of the community. All scale measures were obtained from NGO's routine monitoring systems.

Input identification

Inputs were identified by reviewing project documentation, by interviewing project personnel and by ascertaining local market prices (Appendix 1, available only on the web at http://www.who.int/bulletin). They were classified as fixed or variable, according to standard economic definitions (5). Where quantities were not available, expenditures were used to represent input levels. Because methods of STI management varied, this was considered an input category in itself. Funding agency-level inputs were allocated to the interventions using direct allocation methods (27).

Cost valuation

All costs were valued at local market prices. Peer educators' time and costs were ascertained through a simple bidding game that generated values which were then validated in interviews with outreach staff. Condoms distributed free of charge were valued at the price of the lowest cost alternative in the market – that is, a subsidized socially marketed condom. Because there were

Table 3. **Characteristics of 17 HIV-prevention interventions run by selected nongovernmental organizations (NGOs) and targeted at sex workers, Tamil Nadu and Andhra Pradesh, India. Values are numbers (%), unless otherwise indicated**

Characteristics of the interventions[a]	Distribution
Intervention design	
STI treatment	
Referral	15 (88)
NGO's own clinic	2 (12)
Context	
Tamil Nadu	8 (47)
Andhra Pradesh	9 (53)
Median % (range) literacy	73 (59–85)
Median (range) length of time project under way (years)	6 (3–13)
Capacity	
Certified to receive foreign funds	
No certificate	3 (17.6)
Certified	14 (82.4)
Median No. (range) of staff working on HIV (n = 16)	39.3 (4.9–95.3)
Median (range) annual expenditure (US$ '000) (n = 14)	51.6 (5.3–1 088.3)
Financing	
Funding agency	
A	9 (52.9)
B	2 (11.8)
C	2 (11.8)
D	4 (23.5)
Median (range) HIV project budget (US$ '000) (n = 15)	15.5 (4.8–27.2)

[a] n = 17 unless otherwise specified.

no data on revenues, the net cost of condom sales (i.e., the cost of condom procurement minus revenue from sales) was assumed to be 0. Annualized economic costs were calculated using a standard discount rate of 3% (see, for example, (27)). Capital items were assumed to have a life of between 3 and 10 years, depending on the item. All costs were converted to constant 2002–03 Indian rupees, using the GDP (Gross Domestic Product) deflator, and then converted to US dollars (US$ 1.00 = 42 rupees) (28).

Analysis

Scale, total costs, cost structures and unit costs (total costs divided by a scale variable) were compared across the interventions. Due to the small sample size, non-parametric methods were used to look at the relationship between scale and the two cost variables: total costs and unit costs. The cost variables were regressed on scale, comparing linear and quadratic equation forms.

Non-parametric methods were also used to look at whether scale, total costs and unit costs are affected by factors including the state where the intervention took place, the funding agency, the method of STI management, district literacy levels, length of time the project has been under way, the intervention's budget and the NGO's capacity. Two tests were used: the median test for categorical explanatory variables (reported as Pearson's χ^2) and Spearman's rank–order correlation coefficient (r_s) test for independence of samples for the continuous explanatory variables (see, for example, (29)). The null hypothesis for each test was that there was no relationship between scale variables or cost variables and the explanatory variable.

Sensitivity analysis

Due to the retrospective nature of the study, several constraints were faced in data collection: some data were missing; there were inaccuracies in the data; and sometimes prices had to be used in place of cost. One-way sensitivity analysis was used to account for these limitations by manually changing values in the costing spreadsheets (Table 2, available at http://www.who.int/bulletin) and generating ranges of total costs and unit costs for each intervention. The non-parametric tests and regressions were then run again to explore whether relationships still held when extreme values were used.

Findings

NGO characteristics

Characteristics of the selected NGOs are described in Table 3. Of the sample, 8 were in Tamil Nadu and 9 were in Andhra Pradesh. Four different funding agencies were represented in the sample. District literacy rates ranged from 60% to 85%. The NGOs' total annual expenditures ranged from US$ 5324 to US$ 1.1 million, with the proportion of staff working on HIV representing between 5% and 95% of all staff. Three NGOs were not certified to receive foreign funds. The length of time the intervention had been under way varied from 3 to 13 years. Two of the interventions provided STI services at their own clinics; 12 NGOs referred people for treatment but subsidized their treatment; and 3 made referrals only.

Total costs and cost profiles

Total costs and their breakdown are described in Table 4. The median total cost was US$ 19 958 (range = US$ 11 274–52 793).

Table 4. **Total costs and cost profiles of 17 HIV-prevention interventions run by selected nongovernmental organizations (NGOs) and targeted at sex workers, Tamil Nadu and Andhra Pradesh, India**[a]

Cost category	Costs (US$ '000)[b]					
	Median		Minimum		Maximum	
Fixed personnel	3.63	(15.7)[c]	1.08	(6.5)	8.27	(22.6)
Training	0.12	(0.6)	0		1.70	(3.2)
Monitoring	0.55	(1.9)	0.03	(0.2)	0.92	(3.6)
Building and office costs	2.57	(12.7)	0.46	(3.6)	5.29	(26.1)
Vehicles	0.07	(0.4)	0	(0)	2.37	(10.4)
Total fixed	6.80	(34.1)	1.71	(13.5)	16.10	(40.6)
Variable personnel	4.62	(19.7)	1.28	(10.4)	6.49	(28.9)
Peer educators	2.16	(9.9)	0.34	(1.2)	12.83	(34.9)
Information, education and communication materials	0.38	(1.3)	0.01	(0.1)	2.21	(12.8)
STI treatment[d]	0.71	(3.3)	0	(0)	2.33	(10.7)
Condoms	0.85	(3.8)	0.01	(0.1)	7.37	(18.8)
Meetings	0.72	(3.5)	0.08	(0.4)	2.32	(8.8)
Transport	1.36	(4.6)	0.15	(1.2)	2.45	(9.3)
Other	0.40	(1.3)	0	(0)	1.62	(5.3)
Total variable	10.88	(53.2)	4.48	(39.7)	34.19	(70.7)
Total NGO	17.04	(88.5)	6.78	(60.1)	50.28	(95.3)
Agency	2.51	(11.5)	1.53	(4.7)	4.50	(39.9)
Total	19.96	(100.0)	11.27	(100.0)	52.79	(100.0)

[a] The minimum number of commercial sex workers reached by an intervention was 250; the median was 1047; the maximum was 2008.
[b] Costs are in 2002–03 prices.
[c] Values in parentheses are the median, minimum and maximum values for the percentages of total costs in each cost category.
[d] STI = sexually transmitted infection.

Table 5. **Coverage, volume per commercial sex worker reached and non-parametric tests for factors influencing scale variables for the 17 HIV-prevention interventions run by selected nongovernmental organizations (NGOs) and targeted at commercial sex workers, Tamil Nadu and Andhra Pradesh, India**

Intervention characteristic	Unit[a]	Sample size	Relationship with coverage (Spearman's r_s)[b]
Sex workers reached by the intervention (n = 17)	1 047 (250–2008)	17	1.000
People referred to health-care providers by the project for consultation on STI[c] (n = 17)	0.37[d] (0.09–2.20)	17	0.3235
People treated for STIs by the project or as a result of the project's referrals or subsidies (n = 15)	0.32[d] (0.11–0.71)	14	0.6205[e]
Condoms distributed for free and through NGO sales (n = 17)	101.10[d] (11.41–1001)	17	0.2304
First-time project contacts with members of the target group (n = 14)	0.71[d] (0.20–1.49)	15	0.4500[f]
Contacts with members of the target group (first and repeat) (n = 11)	3.43[d] (1.68–9.22)	11	0.2091
Contacts with members of the target group plus contacts with the broader community (first and repeat) (n = 11)	3.83[d] (2.30–10.19)	11	0.3455
Budget		17	0.7527[e]
Project age		17	0.2034
NGO expenditure		14	0.0549
HIV staff share		16	0.1321
Literacy		17	-0.5817[e]
			Pearson's χ^2
State		17	1.8862
Funding agency		17	4.9554[e]
Certified to receive foreign funds		17	0.1365
STI service provision		17	0.0048

[a] Values in this column are median (range).
[b] Values in this column measure the strength of the relationship between the variables: the closer r_s is to + /-1.0, the stronger the relationship between the two continuous variables; the higher the absolute value of χ^2, the stronger the correlation between the continuous and the categorical variables.
[c] STI = sexually transmitted infection.
[d] Value is per person reached.
[e] $P < 0.05$.
[f] $P < 0.01$

The levels at which costs are incurred and the cost profiles also vary. The median value of the proportion of costs incurred at the agency level (11.5%) hides a wide variation across NGOs, from 5% to 39.9%.

Variable costs range from 40% to 71% of total costs, with a median value of 53.2%. Personnel (staff time) costs are the largest portion of variable costs and range from 10% to 29%. On average the cost of peer education is the next largest part of variable costs (9.9%). The cost of peer educators also has the largest variation in relative contribution to the intervention. Although peer educators could be a substitute for or a complement to staff, no relationship, on average, is observed between the cost of peer educators and staff costs (r_s = 0.1368; probability t < 1 = 0.6764).

The cost of STI treatment appears to vary with the different methods of management; the proportion of costs attributable to STI treatment was highest at the two sites that provided clinic services. This relationship is not significant (Pearson's χ^2 = 1.6410; probability t < 1 = 0.2) indicating that other factors influence this part of the cost ratio, e.g. the share of peer-educator costs is low where the share of STI treatment costs is high. There is a wide variation in the relative costs of condoms, from 0.1% to 19% of total costs.

Profiles of fixed costs also show variability, ranging from 13.5% to 41% of total costs. Personnel and building costs (including rent and maintenance and all expenses associated with running an office) are the most important fixed costs, with median values of 16% and 12%, respectively. Although training costs appear to be low, the majority of these costs are incurred at the agency level, comprising between 6% and 28% of agency costs.

Scale of the interventions

In terms of coverage, interventions reached from 250 to 2008 commercial sex workers (Table 5), and non-parametric tests show that there are significant relationships between coverage and funding agency, budget (positive) and literacy rate (negative). Because coverage levels vary across the interventions, comparisons of service volume were made by first dividing the volume descriptors by coverage, thus revealing large variations in service volume. Although a relationship between volume and coverage was expected, no significant relationship was observed, except in the case of number of STIs treated.

Average costs of the interventions

Unit costs of the intervention are described in Table 6. The cost per person reached ranges from US$ 9.86 to US$ 50.70. The median value is US$ 19.20. Variation is also evident in the cost per unit of volume of services, e.g. the median cost per STI treated is US$ 62.50 (range = US$ 13.90–141.20) and the cost per first contact with the target group is US$ 26.30 (range = US$ 13.88–59.80).

Table 6. **Relationship between total costs, unit costs and scale for 17 HIV-prevention interventions run by selected nongovernmental organizations (NGOs) and targeted at commercial sex workers, Tamil Nadu and Andhra Pradesh, India**

Measure of scale	Total costs[a]	Unit costs (US$ '000)[b]	
		Median (range)	Spearman's rho (r_s)
Coverage (n = 17)	0.7990[c]	19.21 (9.86–50.70)	-0.5221[c]
Sexually transmitted infections referred (n = 17)	0.4828[c]	49.82 (16.47–167.48)	-0.8750[c]
Sexually transmitted infections treated (n = 14)	0.5017[d]	62.49 (13.91–141.19)	-0.7987[c]
Condoms distributed (n = 17)	0.4804[d]	0.22 (0.05–1.28)	-0.9216[c]
First contacts with target group (n = 15)	0.4500[d]	26.29 (13.88–59.81)	-0.7964[c]
All contacts with target group (n = 11)	0.4273	4.97 (1.74–11.27)	-0.7182[c]
All contacts (n = 11)	0.5545[d]	4.68 (1.57–8.46)	-0.5000
Median total cost (range) in US$ '000s	19.96 (11.27–52.79)		

[a] Values in this column measure the strength of the relationship between unit cost and the respective unit of scale: the closer r_s is to + /-1.0, the stronger the relationship between the two continuous variables.
[b] Values are constant 2002–03 prices.
[c] $P < 0.05$.
[d] $P < 0.01$

Analysis of cost variation

Total cost had statistically significant and positive relationships with both coverage and all but one of the indicators of volume (all contacts with the target group) (Table 6). Fig. 1 shows how total costs increase with coverage and suggests that total costs do not increase linearly. The quadratic model has a higher R^2 (measure of "goodness of fit" of the regression) than the linear form, supporting the hypothesis. The quadratic relationship between total costs and scale also applies to the volume indicators except condoms distributed, all contacts with target groups and all contacts. The regressions imply that there is a positive linear relationship between condoms and total costs. However, neither the linear model nor the quadratic model is a good fit for the relationships between the contact variables (F is not significant and $R^2 < 0.1$).

The null hypothesis (that there is no relationship between unit cost and measures of scale) can also be rejected. The results of the non-parametric tests of cost per unit of scale against the respective scale unit are all negative and, with the exception of all contacts, statistically significant (Table 6). The scale variables explain more than 70% of the variation in unit costs for all measures of unit costs except cost per sex worker reached and cost per contact. The influence of the factors, described in Table 3, on unit costs was also tested using non-parametric methods (see Appendix 2 and Appendix 3, available only on the web at http://www.who.int/bulletin). We could not reject the null hypothesis of no relationship except for a negative relationship between budget and the cost per condom distributed, a positive relationship between the length of time the project had been under way and the cost per sex worker referred for STI treatment or the cost per STI treated, a positive relationship between the price of field workers and the cost per contact, and a positive relationship between the price of peer educators and the cost per STI referred.

The regressions of unit costs against scale suggested non-linear relationships except in the case of all contacts (Fig. 2). In looking at the fitted regression line of cost per sex worker reached against coverage, we observed a fitted line resembling

Fig. 1. **Regression: a) Linear and b) quadratic forms of total costs against scale of HIV-prevention interventions targeted at commercial sex workers (CSWs).** (Values are for 2002–03 prices; additional statistical information is available at the following URL: http://www.who.int/bulletin)

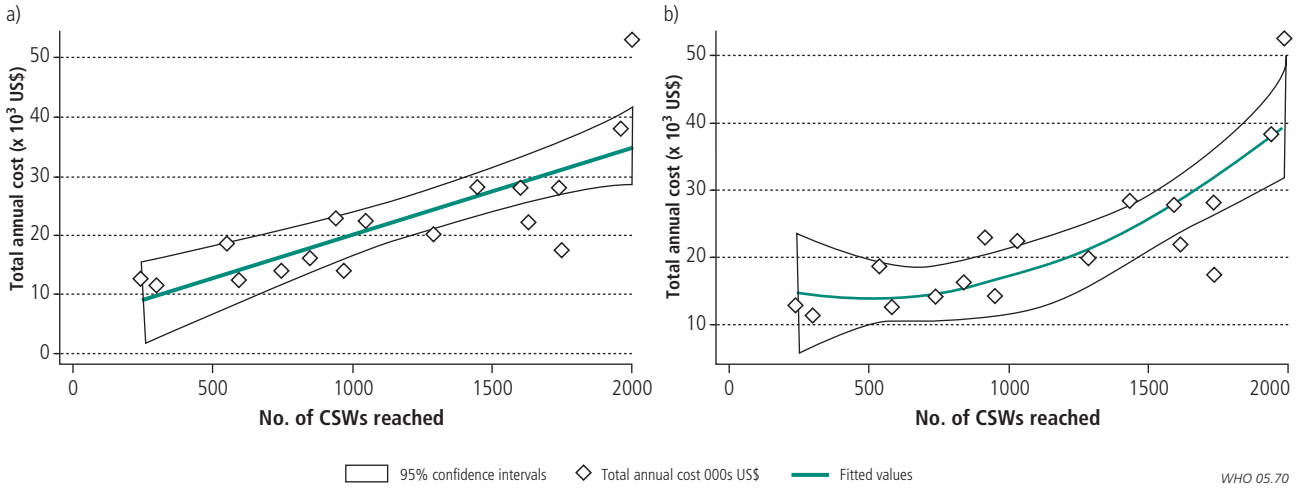
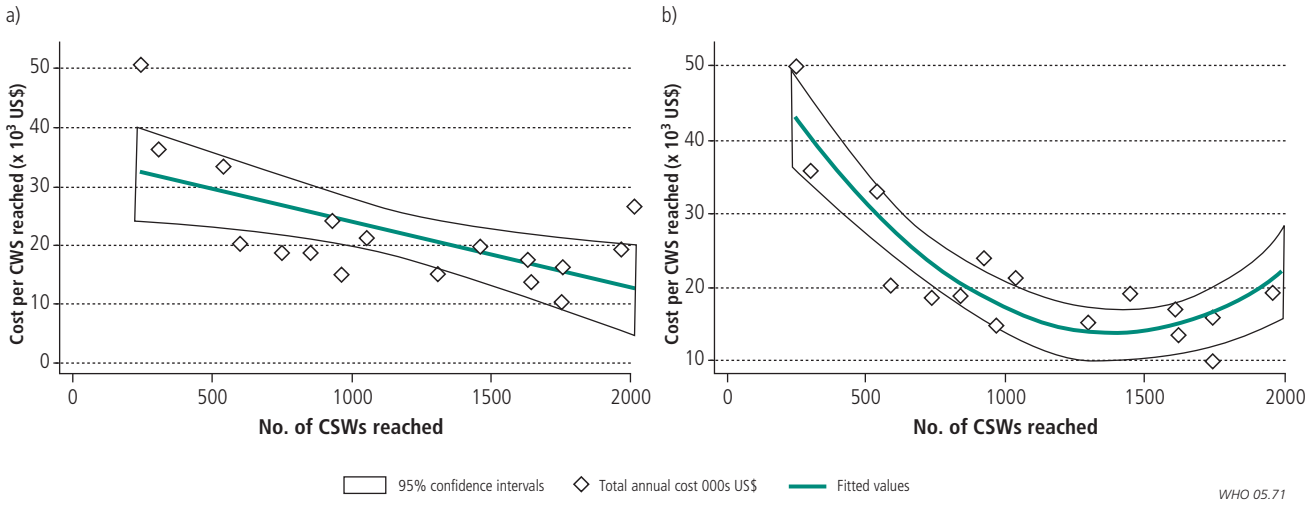


Fig. 2. **Fitted regression: a) Linear and b) quadratic forms of costs per unit of scale for the HIV-prevention interventions targeted at commercial sex workers (CSWs).** (Values are 2002–03 prices; additional statistical information is available at the following URL: http://www.who.int/bulletin)



a classic U-shaped average cost curve in which there is a cost-minimizing level of coverage in the range of 1000–1700 sex workers reached.

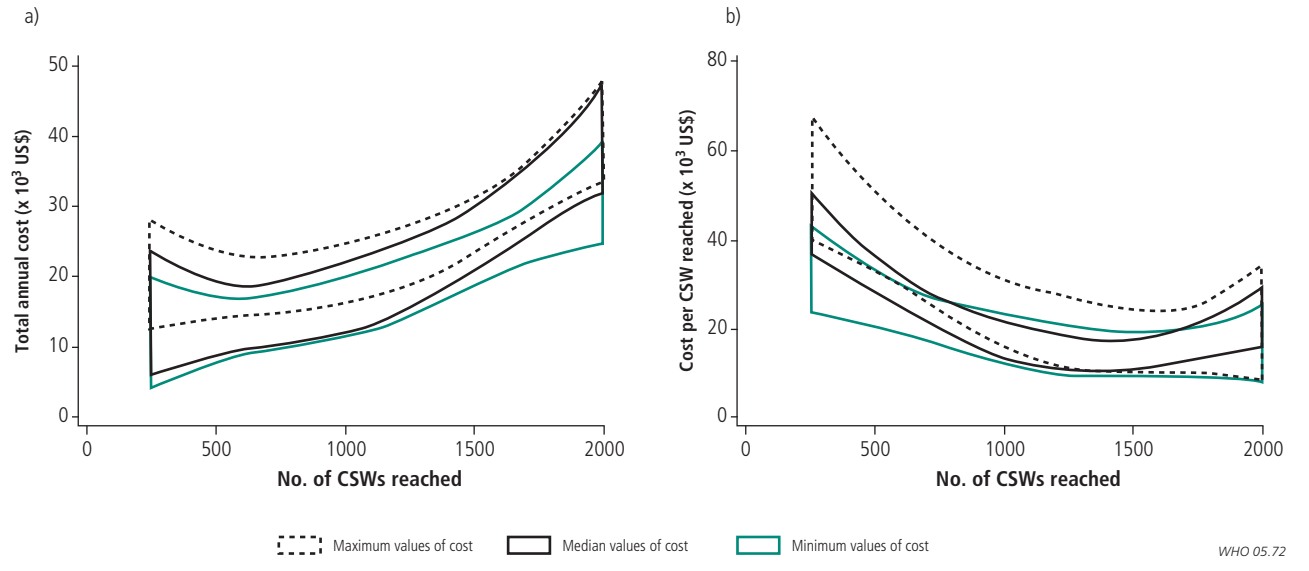
The sensitivity analysis generated ranges for the total costs between 10% and 40% of the value in the original analysis. Similarly, the range of unit costs was between 10% and 43% of the original values. The best-fit regression models for cost per person reached (Fig. 3) and cost per measure of volume held when they were run again with these extreme values.

Discussion

The cost analysis of targeted HIV-prevention interventions presented here explores how costs vary across similar interventions, with a particular focus on how costs vary according to the scale of the intervention. Differences were found in the scale, total costs, cost structures and average costs. Both total costs and average costs were found to have significant relationships with the scale variables. These relationships were not linear. Despite the large contribution of variable costs to the cost structure, average costs vary with scale: a point where average costs begin to rise is reached at relatively low levels of coverage.

This analysis is limited by being retrospective and by its use of routine monitoring systems not specifically designed for cost analyses. In some cases, inputs and values to the project were estimated based on interviews rather than records. Outputs were taken from routine monitoring systems, and these can be subject to errors. Financial data were used as a proxy for the economic costs of transport and monitoring owing to a lack of records. The small sample, compounded by the diversity in the organizations' characteristics, limits our ability to allow confident inference from the non-parametric and regression analyses. Therefore, interpretations of the results should be made with caution. In addition, it is not possible to determine

Fig. 3. **Sensitivity analysis plots of quadratic relationship between coverage of commercial sex workers (CSWs) and a) total costs and b) cost per person reached.** (Additional statistical information is available at the following URL: http://www.who.int/bulletin)



the strength of the relationships of scale with the other dimensions because multivariate analysis would be required. In spite of these problems, the one-way sensitivity analysis showed the results to be quite robust. Although there may also be bias resulting from the necessary sampling criteria of "agreement to participate", the direction of this bias is ambiguous, i.e. those agreeing to participate are likely to be better at reporting and this may or may not imply that the sample has average costs that are consistently lower or higher.

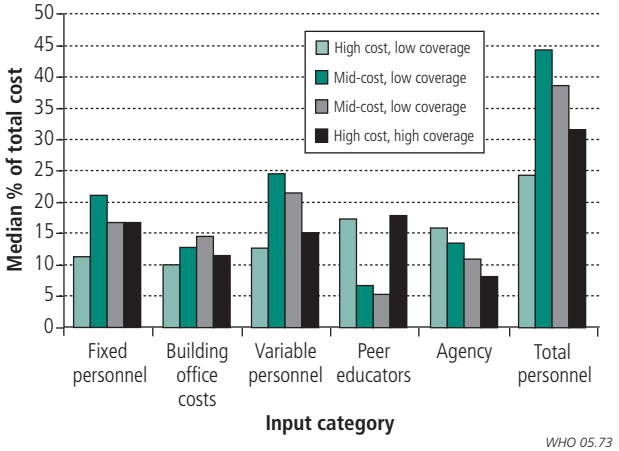
Variations in scale may arise from the length of time the intervention has been under way, the "reachability" and size of the target group as well as the targets set by the contracting agent. Coverage varied according to the funding agency and the budget. Because annual budgets depend on achievements made during the previous year and, at the time of the study, there was limited information on the size of the target populations, it is likely that coverage reflects the ability to negotiate targets rather than the actual size of the population. This may also apply to differences in volume with respect to coverage: for one funding agency, STI targets and budgets were set according to the agreed coverage of targets. However, these measures also confirm the degree of variation in technical efficiency (cost per unit of output) across apparently similar interventions.

As with scale, total costs are likely to be driven by budgets and targets set by the organizations. Further analysis finds that of the factors shown in Table 3, only "funding agency" had a significant relationship with total cost (Pearson's $\chi^2 = 13.4321$; probability $t < 1 = 0.004$). A wide range of factors has also been found to influence average costs including scale, intervention design, context, capacity, project age, inefficiencies and prices (5–8, 10–12, 19, 30–33). In order to facilitate the comparisons between costs and scale of operation, the sampling procedure controls for epidemiology, intervention design and context as far as possible. Inevitably, as the sample is taken from an active programme, these factors vary across the interventions. For example, two of the 17 interventions provided STI services within their own clinics. Other interventions referred people for treatment and, except for three interventions, provided a subsidy to the provider. Although this may limit the comparability of the interventions, it reflects the reality of scaling-up in which there will always be variation in the design of the intervention.

The context of the interventions also varied. The interventions examined took place in two different states and were funded by four different organizations. Despite these differences, the analysis found that these contextual factors and intervention characteristics had no influence on unit costs (see Appendix 2 and Appendix 3) nor did the non-parametric tests allow us to reject the hypothesis that there is no relationship between prices and average costs (Appendix 3). It was not possible to identify inefficiencies associated with different levels of performance in quantifiable form.

The analysis confirms that scale is a key factor in influencing the unit cost, resulting in a U-shaped average cost curve. Due to the limitations of the data, the cost function is not derived from a production function but is descriptive. This makes it more difficult to identify the causes of change in average cost and to explain the relationship between costs and scale. Fig. 4 (available only on the web at http://www.who.int/bulletin) looks at the relationship between cost structure and coverage. Fig. 4 shows that the percentage

Fig. 4. **Relationship between cost structure and coverage of the interventions**



WHO 05.73

of costs spent at the funding agency-level falls as coverage increases, but no other trends are discernable, emphasizing the context-specific nature of costs and the need for further research into the economics of the design and implementation of HIV prevention services.

The changing nature of the average cost has important implications for planning the resources needed for scaling-up interventions. Contrary to expectations that the high proportion of variable costs would lead to constant average costs and the resource estimation techniques that assume this, average costs fall and then rise again as coverage increases. Estimates of resource requirements that are based on a constant average cost would therefore significantly underestimate or overestimate the total costs. The results of this study, derived from a unique set of data on the costs of HIV prevention services across multiple sites, highlight the importance of using scale-specific cost information in order to identify the optimal size of an intervention and to improve estimates of resource requirements. ■

Acknowledgements

We thank Dr Kara Hanson and two anonymous reviewers for their invaluable comments, Professor V R Muraleedharan, Indian Institute of Technology (Madras) and Professor Charles Normand for their continued support, as well as all the participating NGOs and their funding agencies for their extensive cooperation.

Funding: This research was funded by the Wellcome Trust, United Kingdom. Lorna Guinness is a Wellcome Trust Research Fellow at the London School of Hygiene and Tropical Medicine and also a member of the Health Economics and Financing Programme, which receives funds from the Department For International Development of the United Kingdom (DFID). Lilani Kumaranayake is a member of the Department for International Development of the United Kingdom-funded Tuberculosis and AIDS/STI Knowledge Programmes at the London School of Hygiene and Tropical Medicine. DFID supports policies, programmes and projects to promote international development. The views and opinions expressed are those of the authors alone.

Competing interests: none declared.

Résumé

Coûts des interventions visant à prévenir la transmission du VIH chez les travailleurs du sexe indiens : influence de l'échelle du projet

Objectif Étudier l'impact de l'échelle d'un projet sur les coûts totaux et moyens de la prévention de la transmission du VIH en Inde.

Méthodes Pour 17 interventions gérées par des organisations non gouvernementales et visant les professionnels du sexe du sud de l'Inde, on a recueilli des données relatives aux coûts et des mesures de l'échelle du projet [couverture et indicateurs du volume de services correspondant aux nombres de cas d'infections sexuellement transmissibles (IST) adressés, d'IST traitées, de préservatifs distribués et de contacts noués avec les groupes cibles]. La relation entre coûts totaux, coûts unitaires et échelle du projet a été analysée par des méthodes non paramétriques et des analyses par régression.

Résultats La couverture des interventions allait de 250 à 2 008 professionnels du sexe. Les coûts annuels se situaient entre US $ 11 274 et US $ 52 793. Le coût médian par travailleur du sexe atteignait US $ 19,21 (plage de variation : US $ 10,00 à 51,00). Les variables d'échelle permettaient de justifier plus de 50 % de la variation des coûts unitaires pour l'ensemble des mesures de coût unitaire, excepté le coût par contact. Les coûts totaux et les coûts unitaires sont reliés à l'échelle par une relation non linéaire.

Conclusion Les coûts moyens varient avec l'échelle du projet. Les estimations des besoins en ressources se fondant sur un coût moyen constant pourraient donc conduire à une sous-estimation ou à une surestimation des coûts totaux. Les résultats de l'étude font ressortir l'importance pour la planification d'une meilleure information sur les coûts dépendant de l'échelle du projet.

Resumen

La escala, ¿un factor importante? Costo de las intervenciones de prevención de la infección por VIH entre los profesionales del sexo en la India

Objetivo Estudiar cómo influye la escala de un proyecto tanto en los costos totales como en los costos medios de la prevención de la infección por VIH en la India.

Métodos A partir de 17 intervenciones emprendidas por organizaciones no gubernamentales entre profesionales del sexo en el sur de la India, se reunieron datos sobre los costos económicos e indicadores de la escala de la intervención (cobertura y volumen de servicios para el número de casos de infecciones de transmisión sexual (ITS) remitidos, número de ITS tratadas, número de preservativos distribuidos y contactos habidos con los grupos destinatarios). La relación entre los costos totales, los costos unitarios y la escala se determinó mediante métodos no paramétricos y análisis de regresión.

Resultados La cobertura varió entre 250 y 2 008 profesionales del sexo. Los costos anuales oscilaron entre US$ 11 274 y US$ 52 793. La mediana del costo por profesional del sexo alcanzado fue de US$ 19,21 (intervalo: US$ 10,00 - 51,00). Las variables indicativas de la escala explican más del 50% de la variación de los costos unitarios para todas las medidas del costo unitario, exceptuando el costo por contacto. Los costos totales y los costos unitarios están relacionados de manera no lineal con la escala.

Conclusión Los costos medios varían con la escala del proyecto. Las estimaciones de las necesidades de recursos basadas en un costo medio constante tienden a subestimar o sobrestimar los costos totales. Los resultados destacan la importancia de mejorar la información sobre los costos en función de la escala a efectos de planificación.

ملخص

هل لسلالم القياس أهمية
تكاليف تداخلات وقاية المومسات من فيروس العوز المناعي البشري في الهند

الملخص: للتعرف على مدى تأثير سلالم القياس لمشروع ما على كل من التكاليف الكلية والتكاليف الوسطية للعدوى بفيروس العوز المناعي البشري في الهند.

الطرق: تم جمع معطيات حول التكاليف الاقتصادية ومقاييس سلالم القياس (مدى التغطية ومؤشرات مقادير الخدمات لعدد من حالات العدوى المنتقلة جنسياً التي تم تحويلها، وعدد حالات العدوى المنتقلة جنسياً التي تم معالجتها، وعدد من العوازل الذكرية التي تم توزيعها وعدد المخالطات) لدى المجموعات المستهدَفة من 17 من التداخلات التي قامت بها منظمات غير حكومية والتي استهدفت المومسات في جنوب الهند. وقد استخدم كل من الطرق غير المعلمية والتحليل التحوفي لدراسة العلاقة بين التكاليف الإجمالية وتكاليف الوحدة وسلم القياس.

الموجودات: تراوح مدى التغطية بين 250 و 2008 من المومسات، وتراوحت التكاليف السنوية من 274 11 دولاراً أمريكياً إلى 793 52 دولاراً أمريكياً وقد بلغت التكلفة الوسطية لكل مومس 19.21 دولاراً أمريكياً (بمدى يتراوح بين 10 و51 دولاراً أمريكياً). وتفسر المتغيرات في سلم القياس أكثر من نصف التفاوت في تكاليف الوحدة لجميع مقاييس تكاليف الوحدات باستثناء تكاليف المخالطة الواحدة. ولم يكن بين التكاليف الإجمالية وتكاليف الوحدات علاقة خطية مع سلم القياس.

الاستنتاج: تختلف التكاليف الوسطية باختلاف سلم القياس المتبع في المشروع، ويمكن أن تؤدّي تقديرات المتطلبات المُسْنَدة على التكاليف الوسطية الثابتة إلى الإقلال من أو الإفراط في تقدير التكاليف. إن النتائج توضح أهمية تحسين المعلومات اللازمة للتخطيط الخاص بتكاليف كل سلم قياس على حدة.

References

1. Schwartlander B, Stover J, Walker N, Bollinger L, Gutierrez JP, McGreevey W, et al. Resource needs for HIV/AIDS. Science 2001;292: 2434-6.
2. Commission on Macroeconomics and Health. Macroeconomics and health: investing in health for economic development. Geneva: World Health Organization; 2001.
3. UNAIDS. Report on the global AIDS epidemic. Geneva: UNAIDS; 2004.
4. Creese A, Floyd K, Alban A, Guinness L. Cost effectiveness of HIV/AIDS interventions in Africa: a review of the evidence. Lancet 2002; 359:1635-42.5.
5. Creese A, Parker D. Cost analysis in primary health care: a training manual for programme managers. Geneva: World Health Organization; 1994.
6. Gilson L. Value for money? The efficiency of primary health units in Tanzania [thesis]. London: University of London, Faculty of Medicine; 1992.
7. Mansley EC, Dunet DO, May DS, Chattopadhyaj SK, McKenna MTM. Variation in average costs among federally sponsored state-organized cancer detection programs: economies of scale? Med Decis Making 2002;22 Suppl 5:S67-79.
8. Over M. The effect of scale on cost projections for a primary health care programme in a developing country. Soc Sci Med 1986;22: 351-60.
9. Robertson RL, Davis JH, Jobe K. Service volume and other factors affecting the costs of immunizations in the Gambia. Bull World Health Organ 1984;62:729-36.
10. Robertson RL, Hall AJ, Crivelli PE, Lowe Y, Inskip HM, Snow SK. Cost-effectiveness of immunizations: the Gambia revisited. Health Policy Plan 1992;7:111-22.
11. Stallworthy G, Meekers D. An analysis of unit costs in selected condom social marketing programmes 1990–1996. Proceedings of XII International Conference on AIDS. Geneva: Congrex; 1998 (Abstract No. 467/44240).
12. Grieve R, Dundas R, Beech R, Wolfe C. The development and use of a method to compare the costs of acute stroke across Europe. Age Ageing 2001;30:67-72.
13. UNAIDS. Table of country-specific HIV/AIDS estimates and data, end 2003. In: 2004 report on the global AIDS epidemic. Geneva: UNAIDS; 2004.
14. Ramasundaram S, Allaudin K, Charles B, Gopal K, Krishnamurthy P, Poornalingam R, et al. HIV/AIDS control in India –lessons learned from Tamil Nadu. Geneva: Commission on Macroeconomics and Health; 2001 (Working paper No. WG5:25). (Also available from http://www.cmhealth.org/docs/wg5_paper25.pdf.)
15. Ramasundaram S. Can India avoid being devastated by HIV? Yes, by scaling up local prevention efforts targeted at the most vulnerable groups. BMJ 2002;324:182-3.
16. National AIDS Control Organization. Combating HIV/AIDS in India, 1999-2000. New Delhi: Ministry of Health and Family Welfare, National AIDS Control Organization, Government of India; 2000.
17. World Bank Nutrition and Population Sector Unit, South Asia Region. Project appraisal document on a proposed credit in the amount of SDR 140.82 million to India for a second national HIV/AIDS control project. Washington, DC: World Bank; 1999. p. 31-4.
18. National AIDS Control Organization, UNAIDS. Costing of focused interventions among different sub-populations. Delhi: UNAIDS, South Asia; 2001.
19. Kumaranayake L, Watts C. Economic costs of HIV/AIDS prevention activities in sub-Saharan Africa. AIDS 2000;14 Suppl 3: S239-52.
20. Walker D. Cost and cost-effectiveness of HIV/AIDS prevention strategies in developing countries: is there an evidence base? Health Policy Plan 2003; 18:4-17.
21. Kumaranayake L, Watts C. HIV/AIDS prevention and care interventions in sub-Saharan Africa: an econometric analysis of the costs of scaling-up. S Afr J Econ 2000;68:1012-33.
22. Soderlund N, Lavis J, Broomberg J, Mills A. The costs of HIV prevention strategies in developing countries. Bull World Health Organ 1993;71:595-604.
23. Jana S, Bandyopadhyay N, Mukherjee S, Dutta N, Basu I, Saha A. STD/HIV intervention with sex workers in West Bengal, India. AIDS 1998;12:101-8.24.
24. Jenkins C. Female sex worker HIV prevention projects: lessons learnt from Papua New Guinea, India and Bangladesh. Geneva: UNAIDS; 2000.
25. Kumaranayake L, Watts C. Costs of scaling HIV program activities to a national level for sub-Saharan Africa: methods and estimates.:Washington, DC: AIDS Campaign Team for Africa (ACTafrica), World Bank; 2000.
26. De Jong J. Making an impact in HIV and AIDS: NGO experiences of scaling up. London: ITDG; 2001.
27. Drummond M, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. Oxford: Oxford Medical Publications; 1997.
28. Reserve Bank of India. Handbook of statistics for India. New Delhi: Reserve Bank of India; 2003 (Also available from http://www.rbi.org.in/index.dll/7?OpenSection?fromdate=06/07/2003&todate=06/07/2003&s1secid=1001&s2secid=1001).
29. Pett M. Nonparametric statistics for health care research: statistics for small samples and unusual distributions. London: Sage; 1997.
30. Fiedler J, Day L. A Cost analysis of family planning in Bangladesh. Int J Health Plann Manage1997;12:251-77.
31. Barnum H, Kutzin J. Public hospitals in developing countries: resource use, costs and financing. Baltimore, MD: Johns Hopkins University Press; 1993.
32. Berman P. Cost analysis as a management tool for improving the efficiency of primary care: some examples from Java. Int J Health Plann Manage 1986; 1:275-88.