Estimating the global costs of vitamin A capsule supplementation: A review of the literature

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Abstract

Background. *Vitamin A supplementation reduces child mortality. It is estimated that 500 million vitamin A capsules are distributed annually. Policy recommendations have assumed that the supplementation programs offer a proven technology at a relatively low cost of around US$0.10 per capsule.*

Objectives. *To review data on costs of vitamin A supplementation to analyze the key factors that determine program costs, and to attempt to model these costs as a function of per capita income figures.*

Methods. *Using data from detailed cost studies in seven countries, this study generated comparable cost categories for analysis, and then used the correlation between national incomes and wage rates to postulate a simple model where costs of vitamin A supplementation are regressed on per capita incomes.*

Results. *Costs vary substantially by country and depend principally on the cost of labor, which is highly correlated with per capita income. Two other factors driving costs are whether the program is implemented in conjunction with other health programs, such as National Immunization Days (which lowers costs), and coverage in rural areas (which increases costs). Labor accounts for 70% of total costs, both for paid staff and for volunteers, while the capsules account for less than 5%. Marketing, training, and administration account for the remaining 25%.*

Conclusions. *Total costs are lowest (roughly US$0.50 per capsule) in Africa, where wages and incomes are lowest, US$1 in developing countries in Asia, and US$1.50 in Latin America. Overall, this study derives a much higher global estimate of costs of around US$1 per capsule.*

Key words: Micronutrient interventions, vitamin A capsule supplementation cost studies

Introduction

Worldwide, between 100 and 140 million children between the ages of 6 and 59 months have vitamin A deficiency, which contributes both to blindness and to poor immune function, which in turn increases the severity of diarrhea and measles [1–4]. Every year 1.2 to 3.0 million children die from the effects of vitamin A deficiency [5]. Reducing vitamin A deficiency would greatly contribute to achieving Millennium Development Goal Four, "Reduction in child mortality," and its target of reducing by two-thirds the mortality rate among children under 5 years of age.

The problem of vitamin A deficiency in developing countries is inextricably linked to poverty. Low incomes constrain families' abilities to purchase the diverse foods they need for a nutritious and balanced diet with adequate amounts of vitamin A. Maternal vitamin A deficiency results in low concentrations of vitamin A in breastmilk, predisposing infants to deficiency. This is exacerbated by an inadequate dietary intake of vitamin A during the complementary feeding period. Finally, illness can worsen vitamin A status because of a reduced food intake from anorexia, malabsorption, and increased excretion in urine [6].

To redress vitamin A deficiency, megadose vitamin A capsules are administered twice yearly to preschool children in many developing countries, often in conjunction with the Expanded Program of Immunization (EPI). As noted by UNICEF:

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> The impact of vitamin A supplementation on reducing child mortality is comparable to—if not greater than—that of any single immunization against a childhood disease. Long known as a cause of blindness, vitamin A deficiency (VAD) has increasingly been recognized over the past decade as significantly heightening children's risk of dying from such common diseases as measles and diarrhea.[3]

There is, however, relatively limited evidence on the costs of vitamin A capsule supplementation programs and their coverage and effectiveness [7]. Policy recommendations to date have assumed that vitamin A supplementation programs offered a proven technology at relatively low cost, which has been based on an estimate (see, for example, Levin et al. [8]) of US$0.10 per capsule in the World Development Report *Investing in Health* [9]. This figure was based on the findings of three studies: a 1978 study in Haiti [10], with a reported cost of US$0.13 per capsule delivered, and 1975 studies in Indonesia and the Philippines, both reporting costs of US$0.10 per capsule [11]. The cost estimates derived from these three studies are discussed briefly in Appendix 1. Applying a 3% annual inflation factor to this estimate of US$0.10 (in 1978 prices) gives a cost of US$0.25 per capsule delivered expressed in 2004 prices, or US$0.50 per child for two capsules per year.

The present study updates these estimates by reviewing detailed country-level cost studies on vitamin A capsule supplementation programs in seven countries, and provides a comparative analysis of the key factors that affect program costs. A full understanding of program costs is crucial for both effective policymaking and efficient allocation of resources.

Our analysis shows that the costs of vitamin A capsule supplementation programs are determined primarily by labor costs incurred in the distribution of the capsules, which account for approximately 70% of total costs. The cost of the capsules themselves, which is 2 to 4 US cents (US$0.02 to 0.04) per capsule [12], represents only 5% of total program costs. The remaining 25% of costs are associated with promotional campaigns, training, and other expenses. Using the higher program costs documented in this paper, we estimate that the average global cost of distributing each capsule is approximately US$1, a figure four times that commonly used, although this average varies widely by region. In general, costs are lowest in low-income Africa and highest in Latin America.

Methods

To supplement and update previous findings, a search was conducted of PubMed, Cab-abstracts, and the Library of Congress for additional studies of the costs of vitamin A capsule programs. Unpublished reports were also solicited from donors and programs working on micronutrient interventions. Only two detailed cost studies, for Nepal [13] and the Philippines [14], were found in the published literature. In addition to these two published studies, six unpublished studies were also included.* Additional details are provided in Appendix 2.

Among these eight studies, detailed ex post cost analyses were available for five countries: Ghana (Rassas et al. 2003, unpublished), Guatemala (Phillips et al. 1994, unpublished), Nepal (Fiedler [13]), the Philippines (Fiedler et al. [14]; Capistrano et al. 1998, unpublished), and Zambia (Rassas et al. 2004, unpublished). Feasibility studies for proposed vitamin A capsule supplementation programs in both Peru (Ureta et al. 1998, unpublished) and South Africa (Hendricks et al., 1998, unpublished) included sufficiently in-depth and comprehensive data that could also be used.

Since this paper was written, another study focusing on Tanzania has been completed [15]. This study is, however, not included in the present analysis. Also, PATH Canada is attempting to collect more comprehensive and up-to-date information on costs of vitamin A interventions, including supplementation, using annual project accounts and questionnaires [16].

To compare costs across studies, outlays in local currency were converted into US dollars for the year in which the study was conducted. The exchange rate was taken from the World Development Indicators 2004, and costs were converted to 2004 US dollars by using the inflation adjustment factors published by the US Bureau of Labor Statistics.

To examine the studies according to type of cost, five broad cost categories were identified:

» *Capsules* (includes the cost of transporting the capsules).

* Capistrano M, Dado D, Maglalang H, Magpantay MV, Juban NR. Cost-effectiveness analysis of vitamin A intervention programs in the Philippines. Manila, 1998 (mimeograph).

Hendricks M, Saitowitz R, Fiedler J. An economic analysis of vitamin A interventions in South Africa. Washington, DC: OMNI Project, 1998.

Phillips M, Sanghvi T, Suarez R, McKigney J, Vargas V, Wickham C. The costs and effectiveness of three vitamin A interventions in Guatemala. Working Paper No. 2. Nutrition Cost-Effectiveness Studies. Washington, DC: International Science and Technology Institute, 1994.

Rassas B, Hottor JK, Anerkai OA, Kwame M, Agble R, Nyaku A. Cost analysis of the national vitamin A supplementation program in Ghana. Washington, DC: US Agency for International Development, 2003.

Rassas B, Nakamba P, Mwela C, Mutemwa R, Mulenga B, Siamusantu W, Taylor T. Cost analysis of the national vitamin A supplementation program in Zambia. Washington, DC: MOST Project, 2004.

Ureta N, Cabada RV, Campos M. Cost-effectiveness of vitamin A interventions in Peru. Final report. Washington, DC: OMNI Project, 1998.

» *Training* (includes the cost of initial training and refresher costs, but excludes labor).
» *Promotion* (includes radio and television advertisements, advertisements in cinemas, pamphlet distribution, audio cassettes played at village gatherings, and posting of signs, but excludes labor).
» *Personnel* (includes costs of field staff and the opportunity cost of the time of volunteers). Labor costs were divided into three components: (1) the cost of permanent and shared government staff who worked year-round and who dedicated time to plan, organize, and implement the vitamin A capsule program; (2) the cost of temporary paid labor hired for program-specific tasks (this included drivers, trainers, enumerators, communications specialists, monitors, and supervisors); and (3) an imputed cost of unpaid volunteer labor. Labor costs for additional workers hired to support the activities of full-time staff were classified as "program-specific" costs under component (2) and included activities such as technical assistance, awareness creation and social mobilization, national-level planning, and implementation.

  To impute a value of unpaid volunteer labor under component (3), an estimate of the number of days worked by volunteer per year was obtained; this was multiplied by a country-specific minimum wage rate to provide an economic value for their time.

  Under component (1), the number of days worked by full-time government workers exclusively on the vitamin A capsule program was multiplied by their daily salary rate equivalent to obtain the salary cost. Other personnel costs include salaries of administrative personnel and of staff responsible for promotional and educational campaigns. For the Philippines, we excluded the time spent on follow-up after the campaign from cost calculations to ensure comparability across studies.
» *Other* (includes expenses that do not fall explicitly into any of the other four categories: for example, vehicles, buildings, computers, paper, and other office expenses).

As will be shown, the cost of vitamin A capsule programs is largely a function of the expense of labor employed to distribute the capsules. Salaries and wage rates, in turn, are closely linked to per capita income [17]. These two relationships suggest that a simple model may be used to estimate the relationship between the cost of capsule distribution and per capita income, whereby the costs of vitamin A capsule adjusted to 2004 values are regressed on per capita incomes, using a semilogarithmic formulation. Data on per capita incomes were obtained from the World Development Indicators database [18].

Although wage rates would be a more appropriate variable to use as a proxy for labor costs than per capita income, data for several of the countries included in this study are not available in the international wage rate database developed by the International Labor Organization (ILO). Freeman et al. [17], using the ILO database of available countries, showed a strong correlation between wages and per capita income in all countries. They argued that "the principal forces that affect the occupational wage structure around the world are the level of gross domestic product per capita and unionization/wage-setting institutions" and recommended using per capita income as a proxy where wage rate data were not available. This is the approach taken here, although it should be noted that we are unable to capture the differential rates of change of wages of the three components of labor over time.

Results

Total costs and their distribution

The results of the cost studies for the seven countries are summarized in **table 1**, while **table 2** provides a disaggregation of these costs by the categories delineated above. The total cost per capsule delivered is lowest in Ghana (US$0.51) and Zambia (US$0.61) and highest in higher-income countries such as South Africa (US$2.27) and Peru (US$2.22). In general, costs are lower in Africa (except South Africa) than in Latin America.

The cost of the vitamin A capsule itself is low, representing an average of 4% of the total cost for all seven countries. The capsules cost US$0.02 each, and transportation costs to deliver the capsules to port range from US$0.02 to US$0.04, for an estimated cost of US$0.04 per capsule [19]. The estimated annual cost for buying and transporting the vitamin A capsules is thus relatively small—20 million dollars per year (4 cents × 500 million children per year) for the entire developing world.

Training activities averaged about 5% of total costs, but were somewhat higher in Nepal and Peru. Promotional costs averaged 12% of total costs, with higher than average costs in Nepal, the Philippines, and South Africa. For example, in Nepal, more than 25,000 leaflets are printed for each vitamin A capsule distribution campaign. International agencies sometimes support the development and broadcasting of vitamin A campaign radio spots, some of which are broadcast on radio channels with subnational (i.e., regional) coverage.

Personnel costs account for the lion's share of all costs; in all cases, field staff account for more than one-half of total costs, including the opportunity cost of the time of volunteers. Because 70% of the costs associated with distributing vitamin A capsules are related to personnel costs, countries with low wage rates and per capita incomes (e.g., Nepal) have lower costs than those with higher wage rates and per capita incomes (e.g., South Africa). Given the large share of personnel

TABLE 1. Summary of cost studies in seven countries

Study feature	Ghana[a]	Guatemala[b]	Nepal[c]	Peru[d]	Philippines[e]	South Africa[f]	Zambia[g]
Total cost in local currency reported in study	13,672,000,000	357,780	92,520,000	24,684,124.36	834,000,000	16,300,000	7,804,000.00
Local currency	Cedi	Quetzal	Rupee	Nuevo Sol	Peso	Rand	Kwacha
Exchange rate from local currency to US$	4,794.00	5.00	55.20	2.66	40.00	6.13	3.61
Total cost for evaluation year (US$)	2,851,898	71,556	1,725,000	9,273,052	20,850,000	2,664,009	2,163,107
Year study was evaluated	2000	1991	1996	1997	1998	1999	2004
Years elapsed from 2004 since study evaluation	4	13	8	7	6	5	0
Total cost (consumer price index inflation factor) (2004 US$)	3,215,506.02	105,686.84	2,185,178.39	11,435,723.48	24,961,982.02	3,095,137	2,163,107
Population dosed reported in study	3,175,806	42,680	1,330,366	3,121,830	6,500,000	680,000	1,768,000
Coverage at the time of evaluation (% of target population)	89%	45%	80%–85%	80%–94%	88%	58%–85%	88%
Estimated cost per capsule (2004 US$)	0.51	1.24	0.82	1.83*	1.92	2.27	0.61
Per capita gross national income (2004 US$)	380	2,190	250	2,360	1,170	3,630	400

* Costs were high for Peru due to a calculation using the door-to-door approach. Integration with the Expanded Program of Immunization and National Immunization Days would reduce costs.

a. Rassas B, Hottor JK, Anerkai OA, Kwame M, Agble R, Nyaku A. Cost analysis of the national vitamin A supplementation program in Ghana. Washington, DC: US Agency for International Development, 2003.

b. Phillips M, Sanghvi T, Suarez R, McKigney J, Vargas V, Wickham C. The costs and effectiveness of three vitamin A interventions in Guatemala. Working Paper No. 2. Nutrition Cost-Effectiveness Studies. Washington, DC: International Science and Technology Institute, 1994.

c. Fiedler [13].

d. Ureta N, Cabada RV, Campos M. Cost-effectiveness of vitamin A interventions in Peru. Final report. Washington, DC: OMNI Project, 1998.

e. Fieldler et al. [14] Capistrano M, Dado D, Maglalang H, Magpantay MV, Juban NR. Cost-effectiveness analysis of vitamin A intervention programs in the Philippines. Manila, 1998 (mimeograph).

f. Hendricks M, Saitowitz R, Fiedler J. An economic analysis of vitamin A interventions in South Africa. Washington, DC: OMNI Project, 1998.

g. Rassas B, Nakamba P, Mwela C, Mutemwa R, Mulenga B, Siamusantu W, Taylor T. Cost analysis of the national vitamin A supplementation program in Zambia. Washington, DC: MOST Project, 2004.

TABLE 2. Distribution of costs in the seven countries studied (percentage of total costs)

Component	Ghana	Guatemala	Nepal	Peru	Philippines	South Africa	Zambia	Simple average
Capsule	4	10	5	2	2	4	4	4
Training	4	2	10	12	2	1	5	5
Promotion	10	2	17	5	18	22	7	12
Personnel	67	80	60	76	71	68	65	70
Other	15	6	8	5	7	5	19	9

or labor costs, it is useful to examine its composition in greater detail (**table 3**).

The contribution of volunteer labor ranges from 20% of total costs in Ghana to 30% in Nepal. Volunteers account for 82% to 95% of the total number of workers, whereas the number of days worked per year per volunteer varies from 7 to 14. Even though paid labor represents only 10% of the total number of workers involved in capsule distribution, paid labor costs range from 20% to 40% of total program costs.

Factors affecting costs

Costs of integrated versus stand-alone programs

Total vitamin A capsule program costs are higher for stand-alone programs than those integrated with or "piggy-backed" on other health interventions such as National Immunization Days; for the latter, fixed costs, including personnel costs, can be shared between the two activities. **Table 4** presents the data from the Philippines study, which is the only study that directly compared the costs of stand-alone and piggy-backed programs.

In Ghana, Guatemala, and Nepal, the cost studies were based on twice-yearly stand-alone campaigns. In Zambia, the vitamin A capsule distribution program was integrated into two Child Health Weeks. The Peru and South Africa feasibility studies provided costs for both stand-alone and combined programs.

Rural versus urban costs

The difference between costs in rural versus urban areas is analyzed in the Philippines and Peru cost studies. The Philippines report estimates that the cost in rural areas (US$3.16 per capsule) is 3.7 times more than in urban areas (US$0.85 per capsule). More workers and more time are needed to reach dispersed rural populations. In Peru the differences were not as sharp as in the Philippines but were still important. For example, the cost per child in metropolitan Lima was $3.33, as compared with US$3.85 for the relatively less accessible jungle areas.

Direct financial outlays

The foregoing analysis has used estimates of "economic" costs, which are higher than "financial" costs or the direct expenditures that developing country governments incur. The lower the financial costs, the more likely it is that programs will be sustained. Because permanent government employees are paid on an annual basis and unpaid volunteers do not receive a

TABLE 4. Philippines: ratio of costs of stand-alone program to those of program integrated with National Immunization Days

Component	Ratio
Personnel	2.7
Supply and materials	1.4
Transportation	1.3
Snacks	1.2
Information and education communications	1.2
Other	1.1
Total cost	2.0

TABLE 3. Labor costs and number of volunteers and paid workers

Country[a]	Temporary paid labor ("program-specific costs")	Permanent salaried staff	Imputed value of volunteer labor	Total labor costs	No. of volunteers	No. of paid workers
	Labor costs for evaluation year—US$ (% of total costs)					
Ghana	199,633 (7)	1,140,759 (40)	570,380 (20)	1,910,772	65,182	8,346
Nepal	172,500 (10)	345,000 (20)	517,500 (30)	1,035,000	40,000	2,000
Philippines	1,876,500 (9)	8,340,000 (40)	4,587,000 (22)	14,803,500	900,000	200,000
Zambia	173,049 (8)	757,087 (35)	475,884 (22)	1,406,020	45,450	5,050

a. Guatemala, South Africa, and Peru were excluded because the studies did not mention the use of volunteer labor, which is assumed to be zero.

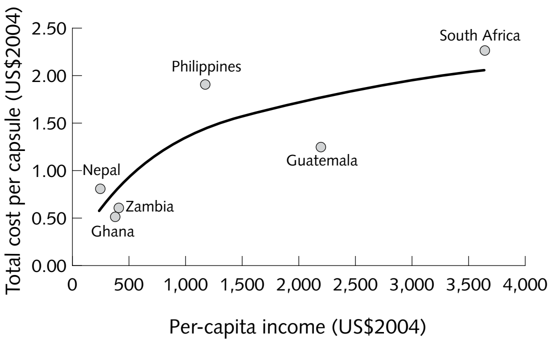

FIG. 1. Relationship between vitamin A delivery costs and national per capita income. The filled symbols show the plot of the cost of distribution of one capsule in 2004 US dollars versus per capita income in current US dollars in 2004. The solid line show the costs including the opportunity cost of volunteer labor valued at the minimum wage ($y = 0.5675 \text{ Ln}(x) - 2.591$, $R^2 = 0.73$). The per capita income in low-income countries with a high prevalence of vitamin A deficiency in Africa ranges from US$145 to US$392 in 2002, with an average of US$275. These countries include Ethiopia, Burundi, Sierra Leone, Eritrea, Malawi, Tanzania, Mozambique, Nigeria, Guinea Bissau, Chad, Rwanda, Madagascar, Burkina Faso, Niger, Mali, Sudan, Togo, Kenya, Central African Republic, São Tomé and Principe, Uganda, Gambia, and Zambia. The "fitted" cost of distribution per capsule is approximately US$0.53 at an income level of US$275, as estimated from the regression. In Asia, low-income countries include Nepal, Cambodia, Yemen, Vietnam, Bangladesh, Mongolia, Laos, India, Pakistan, China, Syria, Sri Lanka, Indonesia, and the Philippines. In these countries the average per capita income is $579, and the fitted cost of distribution per capsule is $0.98. In Latin America, low-income countries include Haiti, Nicaragua, Honduras, Guyana, Bolivia, Suriname, Ecuador, Guatemala, Paraguay, El Salvador, Jamaica, the Dominican Republic, Colombia, Peru, Saint Vincent Grenadines, Belize, and Panama. The average per capita income of these countries is US$1,307, and the fitted cost of distribution per capsule is approximately US$1.54. Countries are selected according to the low income classification of the World Bank (WDR 2004 Database: http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20420458~menuPK:64133156~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html). Low-income economies are those in which the 2002 gross national income per capita was $735 or less. Lower-middle-income economies are those in which the 2002 gross national income per capita was between $735 and $2,935. A simple average was used to compute the cost per capsule.

salary per se, these two categories are not included in the direct financial costs incurred by the governments under "program-specific" costs. Shared capital costs are also excluded. Direct financial outlays are described as "program-specific costs" in the studies and refer to costs incurred at the margin for items such as capsules; supplies; transportation; information, education, and communication; and hiring of temporary labor. In Zambia, 39% of total costs are considered program specific. The figure is 28% for Ghana.

International funding

International funding can be crucial in sustaining vitamin A capsule supplementation programs. **Table 5** shows that international funding as a percentage of total financial costs varies widely, from 10% in the Philippines to 95% in the Guatemala pilot program. International organizations play a vital role in both supplying vitamin A capsules and funding program components. Some large programs, such as that in Nepal, are heavily dependent on international funding.

Estimating costs for countries worldwide

Figure 1 shows the results of the regression relating costs of vitamin A capsules to per capita incomes. As per capita income increases, there is an increase in the cost of distributing supplements. As outlined in the note at the bottom of **figure 1**, the regression line provides approximate estimates for the costs of capsule distribution across regions: US$0.50 per capsule in low-income Africa, US$1 in Asia, and $US1.50 in Latin America. This result is consistent with the preliminary findings from the PATH Canada study for countries such as Uganda. For some countries the cost per capsule can be as high as US$3.50 [16].

Discussion

The cost per vitamin A capsule delivered ranges from US$0.45 to US$2.25 in the seven countries analyzed. The global per-capsule cost in low-income countries was estimated to be approximately US$1, expressed in 2004 prices, and is comparable to that estimated by Helen Keller International for Africa [20]. Also, although our analysis included a relatively small

TABLE 5. National versus international funding of vitamin A supplementation programs (%)

Funding source	Ghana	Nepal	Guatemala	Philippines	South Africa[a]	Peru
National	73	31	5	90	100%	50
International	27	69	95	10	0	50

a. Personal communication, John L. Fiedler.

number of case studies, the results from the PATH Canada study are similar to ours. This is a substantially higher estimate than the US$0.10 per capsule presented in the 1993 *World Development Report*, or US$0.25 expressed in 2004 prices. Our model predicts that vitamin A capsule costs are highest in Latin America (about $1.50 per capsule), followed by Asia (about $1.00 per capsule), and lowest in Africa (about $0.50 per capsule).

The cost of manufacturing and international shipment is only US$0.02 to US$0.04 per capsule; this represents less than 5% of the total costs. Approximately 70% of the total costs are related to labor for delivering the capsules to the target population. The remaining 25% of the costs are associated with administration, marketing, planning, organization, and training.

It may cost up to twice as much to deliver capsules to rural communities than to urban ones because of the greater time and transportation costs associated with delivery to dispersed rural populations. Stand-alone campaigns also cost significantly more than those integrated with National Immunization Days—twice as much in the one study (from the Philippines) that provided comparative estimates. International funding apparently plays a critical role in financing the vitamin A supplementation programs included in this analysis.

Both the data compared in these studies and the conclusions drawn from them must be treated with caution, and further research is warranted. First, different methods were used to tabulate costs in each of the studies, and the classification of costs into specific categories was subject to various interpretations. There is a need for standardization of cost categories, as PATH Canada is attempting to do by looking at as many as 25 micronutrient intervention projects. A template has been provided by the World Health Organization (WHO) that provides a standard listing of cost categories involved in any program [21]. Further, the issue of scale has not been addressed in this paper because of insufficient information. There are considerable differences between implementing pilot programs such as the one in Guatemala, with a target population of less than 40,000, and national programs such as that in the Philippines, where more than 3 million children received capsules. Finally, the greater cost of distributing capsules to widely dispersed rural populations is also not discussed in detail here, since data on comparative costs between urban and rural areas were available for only two case studies.

This paper contributes to the larger effort required to control vitamin A deficiency by demonstrating how highly diverse estimates of the per capsule costs of delivering vitamin A capsules can be explained by differences in labor costs and wage rates across countries. Vitamin A capsule distribution is a proven intervention that continues to save lives. Even though the costs estimated in this study are higher than those previously quoted, the benefit–cost ratios remain high. If costs are subject to inflation when cost estimates are updated, so also are estimates of benefits. Public health can be improved by an expansion of vitamin A capsule programs. Nevertheless, there is a continuing need to evaluate the comparative costs of various micronutrient strategies. Reducing micronutrient malnutrition is key to meeting specific Millennium Development Goals. It is very likely that target levels for future reductions in micronutrient malnutrition—and so also the Millennium Development Goals—will not be met without a significant increase in funding for micronutrient interventions. Securing the additional funding will require not only a thorough review and update of the comparative costs of supplementation, fortification, biofortification, nutrition education, and other public health interventions, but also an analysis of how the comparative advantages of these interventions can be exploited and programs coordinated. If supplements are more expensive to deliver in less densely populated rural areas, then strategies such as delivering biofortified crops that originate in rural areas may be highly complementary.

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Appendix 1. Studies from the 1970s

Estimates of the cost of vitamin A capsule supplementation presented by the World Bank [9] were based on two literature reviews, one conducted by Austin et al. [10] and the second by West and Sommer [11] as outlined in the table to the right. Because these studies did not contain the level of detail required for this paper, they were not included in the comparisons.

West and Sommer [11] cite studies from Indonesia and the Philippines from 1975. The studies were commissioned to evaluate the effectiveness and coverage of vitamin A capsule programs. In both studies, the cost data are sparse and do not include distribution costs. The reported costs were US$0.10 per capsule for both countries, including the costs of the capsule and those related to transportation but not the capital costs or costs for volunteer labor and personnel.

Source of vitamin A	Country and year	Cost per person (US$)	Reference
Sugar fortification	Guatemala 1976	0.07	Arroyave et al. 1979 [22]
Capsule	Haiti 1978	0.13–0.19	Austin et al. [10]
Capsule	Indonesia and Philippines 1975	0.10	West and Sommer [11]

Source: Jamison, DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, and Musgrove P, eds. 2006. *Disease Control Priorities in Developing Countries*, 2nd ed. New York: Oxford University Press.

The review by Austin et al. [10] discussed a study commissioned by Helen Keller International in Haiti in 1978, which was a detailed coverage study that did not include distribution costs. The costs ranged from US$0.13 to US$0.19, depending on the location of the community where the capsules were distributed.

*Appendix 2: Summary of Program Cost Studies**

Using schools and volunteers in Ghana**

At a cost of US$1.02 (2004), the Ghana vitamin A capsule supplementation was one of the most cost-effective of all the interventions reviewed. Although a stand-alone intervention, it uses an existing network of volunteers through the Ghana Education Service to distribute the capsules, thereby lowering its administrative costs. Teachers distribute capsules to students, who in turn distribute the capsules to preschool children (the child-to-child strategy), making it an efficient means of reaching children. Community-based volunteers, trained during the Guinea worm eradication program and active in other community health programs, also play a vital role on vitamin A distribution days. These volunteers are in direct contact with caregivers and children and work closely with health workers and other community leaders to mobilize beneficiaries, administer the vitamin A capsules, and maintain distribution records.

Using community health volunteers in Nepal***

The Nepal program uses an organized volunteer network of female community health volunteers to distribute vitamin A capsules over 2 days every 6 months. Minisurveys report high coverage levels of 85% of the target population. The success of the program is partly attributed to the 15 days of training on basic medical treatment, nutrition, and other health issues as well as on provision of the vitamin A capsules. The volunteers are associated with local health centers and are given preferential consideration in the hiring of maternal and child health workers. The incentive of getting a permanent job in the local health clinics makes the volunteer positions attractive, and the involvement of volunteers, in turn, helps to lower the costs of the vitamin A capsule program.

* Because the South Africa and Peru case studies were feasibility cost studies and not actual programs, they are not described here but are mentioned in the cost analysis section.

** Rassas B, Hottor JK, Anerkai OA, Kwame M, Agble R, Nyaku A. Cost analysis of the national vitamin A supplementation program in Ghana. Washington, DC: US Agency for International Development, 2003.

*** Fiedler [13].

Comparing stand-alone versus piggy-backed interventions in the Philippines*

The cost study of the Philippines is unique in its comparison of two interventions, a stand-alone intervention (Micronutrient Days) with a piggy-backed intervention (polio National Immunization Day). The Micronutrient Days cost twice as much as the supplementation campaign combined with the polio National Immunization Day. The vitamin A capsule program was implemented at the level of the health station in the *barangay* (the smallest administrative unit in the Philippines, representing an average of 2,500 inhabitants). A midwife and four health workers staff each clinic and set up four distribution centers that are managed by volunteers who distribute the vitamin A supplements. In operation since 1993, this program is the oldest reviewed in this study and has reached the largest number of children (approximately 6.5 million). However, volunteer fatigue has caused coverage rates to fall since the program started, from nearly 90% (1993) to 60% (1999). Better incentives for volunteers have been recommended.

Improving cost-effectiveness in Zambia**

The vitamin A capsule program in Zambia is similar to the Philippine program in that it has two components. One program is a stand-alone effort known as the Child Health Week, which includes health interventions such as deworming, immunization, and growth monitoring. The second program is integrated with polio National Immunization Days. Initially vitamin A capsule coverage was low, particularly in remote rural areas with poor physical infrastructure, but this improved after the Child Health Week program was promoted at the national level. The latter has increased awareness of the multiple role of the vitamin A capsule program, leading to a higher coverage among the target population.

* Fiedler et al. [14]; Capistrano M, Dado D, Maglalang H, Magpantay MV, Juban NR. Cost-effectiveness analysis of vitamin A intervention programs in the Philippines. Manila, 1998 (mimeograph).

** Rassas B, Nakamba P, Mwela C, Mutemwa R, Mulenga B, Siamusantu W, Taylor T. Cost analysis of the national vitamin A supplementation program in Zambia. Washington, DC: MOST Project, 2004.

Complementing sugar fortification in Guatemala*

The vitamin A capsule program in Guatemala (1991–1994) was part of a pilot project organized by a private nonprofit organization that was assisting the Ministry of Health to deliver basic health services in two municipalities. Several surveys had indicated that vitamin A deficiency was a problem among children, and thus the pilot program was started to provide vitamin A capsules to supplement the sugar fortification program that was not reaching all rural communities. The program used midwives and traditional birth attendants as well as community-level volunteers and promoters to distribute the capsules among the mainly rural and poor population. Involving local helpers who spoke the indigenous languages was a key factor in the program's success.

* Phillips M, Sanghvi T, Suarez R, McKigney J, Vargas V, Wickham C. The costs and effectiveness of three vitamin A interventions in Guatemala. Working Paper No. 2. Nutrition Cost-Effectiveness Studies. Washington, DC: International Science and Technology Institute, 1994.