

# Coverage and costs of childhood immunizations in Cameroon

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**Objective** To quantify the association between household-level and provider-level determinants and childhood immunization rates in Cameroon while also calculating the cost of childhood immunizations.

**Methods** This study uses multilevel regression analysis to calculate these relationships. The 1998 Cameroon Demographic and Health Survey and the 2000 Multiple Indicator Cluster Survey are the main sources of household-level data. These surveys are supplemented by data from a 2002 survey of health facilities conducted in three provinces. At the national level, immunization financing data were collected from the Ministry of Health and donors that support the national Expanded Programme on Immunization.

**Findings** The 1998 survey found that nationally 37% of children were fully immunized; the 2000 survey found that nationally 34% were fully immunized. These results are strongly correlated with both the mother's level of education and the household's economic status. Multilevel logistic regression shows that maternal education level is a stronger predictor of positive immunization status than is relative economic status. Children of mothers with secondary education or higher education were 3 times more likely to be fully vaccinated than children whose mothers had not completed primary education. At the health-facility level, both having an immunization plan and regular supervisory visits from someone at the health-district level are strongly positively associated with immunization rates. The cost of routine vaccinations for each fully immunized child is US\$ 12.73 when donors' contributions are included but not the costs of immunization campaigns.

**Conclusion** Studies conducted in the 1980s and 1990s found that costs per fully immunized child varied from US\$ 2.19 to US\$ 26.59 (not adjusted for inflation) in a range of low-income and middle-income countries. The relatively low rates of immunization coverage in Cameroon, and the strong influence of the household's socioeconomic status — particularly the mother's level of education — on immunization rates suggest that the effectiveness of the Cameroon programme could be increased by promoting immunization and directing such programmes towards households with limited resources.

**Keywords** Immunization/utilization/economics; Immunization programs/economics; Child; Costs and cost analysis; Health care surveys; Socioeconomic factors; Regression analysis; Logistic models; Cameroon (*source: MeSH, NLM*).

**Mots clés** Immunisation/économie/utilisation; Programmes de vaccination/économie; Enfant; Coût et analyse coût; Enquête système de santé; Facteurs socio-économiques; Analyse régression; Modèle logistique; Cameroun (*source: MeSH, INSERM*).

**Palabras clave** Inmunización/economía/utilización; Programas de inmunización/economía; Niño; Costos y análisis de costo; Encuestas de atención de la salud; Factores socioeconómicos; Análisis de regresión; Modelos logísticos; Camerún (*fuentes: DeCS, BIREME*).

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Voir page 673 le résumé en français. En la página 673 figura un resumen en español.

يمكن الاطلاع على الملخص بالعربية في صفحة 674.

## Introduction

Cameroon's national Expanded Programme on Immunization (EPI) was implemented in 1981. Under this programme, childhood immunizations included three doses of diphtheria–pertussis–tetanus (DPT) vaccine, three doses of the polio vaccine, and one dose each of bacille Calmette–Guérin (BCG) vaccine and the measles vaccine; coverage increased steadily between 1980 and 1990 (Fig. 1 and Fig. 2). At the beginning of the 1980s

coverage for these routine immunizations was low, ranging from 5% for three doses of DPT to 16% for measles vaccine. By 1989, coverage was above 55% for all of the recommended childhood immunizations in Cameroon. However, after 1990 rates of coverage began to decline. Cameroon's economic crisis, beginning in late 1980s, and currency devaluation in 1994 contributed to difficulties in paying for vaccines. Shortages of vaccine supply and disruptions to the cold chain adversely affected coverage rates.

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Since 1995 rates of coverage for all of the major childhood vaccines have recovered, but they remain well below Cameroon's target of 80% of eligible children. Childhood vaccines are now funded with assistance from UNICEF, the Japanese International Cooperation Agency and the Global Alliance for Vaccines and Immunization. Polio and measles vaccines are distributed through campaigns that target children at home and in other settings; all vaccines are provided at public and nongovernmental health centres. Although private providers generally charge for immunizations, the recommended childhood immunizations are provided free of charge in public facilities.

In Cameroon strategies to provide immunizations and the distribution of supplies are coordinated across the public, private and nongovernmental sectors. The country's 10 provinces are divided into health districts, which in turn are divided into health areas. Each health area has a lead health facility, which is generally public but can also be private. This facility coordinates the distribution of vaccines and supplies and reports coverage rates for all facilities — public and private — within the health area. As a result, both the cost and coverage calculations in this article refer to all childhood immunizations in Cameroon regardless of source.

## Methods

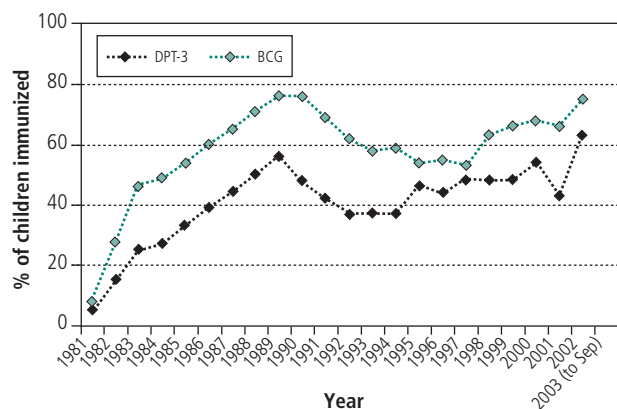
### Data

The 1998 Cameroon Demographic and Health Survey and the 2000 Multiple Indicator Cluster Survey are the main sources for household-level data (1, 2). (For further information on the 1998 survey see <http://www.measuredhs.com>.) These surveys provide information on a child's immunization status and personal characteristics as well as on the household's socioeconomic status and the occupations and educational attainment of the parents. The sample size from the 1998 survey is 2123 children aged younger than 3 years; for the 2000 survey it is 3582 children aged younger than 5 years. For both data sets, we constructed quintiles of household economic status using principal components analysis to create an asset index.

We also surveyed 80 health facilities in 51 health districts in three provinces of Cameroon. The health districts were randomly chosen from the same clusters as those used for both the 1998 and 2000 surveys, so data from the health-facility survey correspond to the same geographical areas and statistical clusters as the data from the household surveys. An independent consulting agency, IRESOCO, collected the data from the health facilities and health districts.

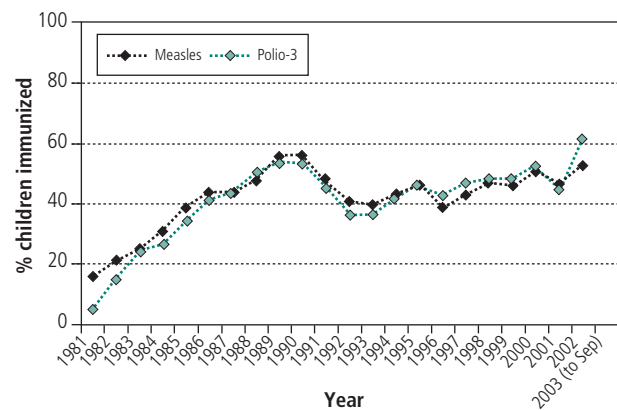
At the national level and provincial level, we collected data on immunization financing from the Ministry of Health and the donors and nongovernmental organizations (NGOs) that support the national EPI. These sources included WHO, UNICEF, Rotary International, Gesellschaft für Technische Zusammenarbeit (GTZ, or Society for Technological Cooperation), the Japanese International Cooperation Agency (JICA) and Coopération Française (French Cooperation). We also collected data on financing from the Global Alliance for Vaccines and Immunization, the European Union and international and local NGOs supporting the programme, including the International Red Cross, CARE International, Catholic Relief Services, the Cameroon National Association for Family Welfare and the Association pour le Développement Harmonieux de la Mère et de l'Enfant. We were not able to obtain actual expenditures from the Ministry of Health, and so instead used budgeted expenditures.

Fig. 1. Changes in coverage among children aged 12–23 months in Cameroon immunized with three doses of diphtheria–pertussis–tetanus (DPT-3) and bacille Calmette–Guérin (BCG), 1981–2003



Source: Ministry of Health, Cameroon, except 1991 and 1998 (1) and 2000 (2). WHO 04.119

Fig. 2. Changes in coverage among children aged 12–23 months in Cameroon immunized with measles vaccine and three doses of polio vaccine (Polio-3), 1981–2003



Source: Ministry of Health, Cameroon, except 1991 and 1998 (1) and 2000 (2). WHO 04.120

### Data analysis

We defined complete immunization status for children using these data based on a child receiving each of the immunizations in the Cameroon national EPI immunization schedule. This schedule is as follows: at birth children should receive BCG and the first dose of polio vaccine; by 6 weeks the child should receive the first dose of DPT and the second dose of polio vaccine; by 10 weeks the child should receive the second dose of DPT and the third dose of polio vaccine; by 14 weeks, the third dose of DPT should be given; and by 9 months, measles vaccine should be given. The programme also recommends that an additional dose of polio vaccine should be given by the time the child is 14 weeks of age.

Determination of children's immunization status was based on data from the 1998 and 2000 surveys. We used multivariate logistic regression analyses to simultaneously measure the relationships between different levels of determinants — individual, household, facility and health district — and children's immunization status. In this type of analysis, the data for household-level and regional-level variables are likely to be correlated

across observations since individuals in the same households and regions share values for these variables (3, 4). To correct for this clustering effect, we applied the Huber–White “sandwich” variance estimator; this calculates the variance of the regression coefficients as the sum of the scores within clusters and then calculates the sum of the cluster-scores across clusters. The form of correlation within clusters does not affect the results; the method therefore corrects for clusters that have subclusters within them, as is the case in our study.

To measure a household’s economic status, we used principal components analysis to create an asset index from the variables available in the household surveys. We then divided households into quintiles of relative economic status, with the first quintile containing the poorest households and the fifth quintile containing the wealthiest households. The variables used to construct the asset index included household possessions, such as radios, televisions, refrigerators and telephones, and the type of facilities providing water, sewerage and electricity. Principal components analysis allows variables that are collinear to be grouped together to form a composite index capable of representing the group of variables itself (5).

## Results

### EPI financing

Total funding for Cameroon’s EPI in fiscal year 2002 (July 2001–June 2002) was US\$ 9 million (Table 1). Of this, 36% came from the Ministry of Health’s budget. Government spending on EPI has been primarily on capital and equipment costs, including the costs of the buildings and space allocated for immunization services, and the cost of vehicles used for immunization activities. In addition to capital and equipment costs, the government also supports recurring costs, including personnel and overhead. The Ministry’s financial plan, prepared in October 2003, anticipates that all vaccines will be purchased by donors.

WHO has provided both financial and technical assistance to EPI, has been active in surveillance activities and has provided personnel and vehicles for this work. UNICEF primarily contributes to EPI by purchasing vaccines and financing some of the operating costs. Rotary International has been an active member of the polio eradication campaign in Cameroon. GTZ has contributed to the cold chain in 16 health districts by purchasing refrigerators, cold boxes and vaccine carriers. The

Japanese International Cooperation Agency primarily provides financial support for the procurement of vaccines, vehicles and cold-chain equipment, including refrigerators. Additionally, EPI also receives technical and financial support from the Coopération Française and the European Union. Other contributors to the programme include the Global Alliance for Vaccines and Immunization and the European Union; European Union funding for routine immunization activities is contained within the Ministry of Health’s budget.

Other international and local NGOs also support the programme, including the International Red Cross, CARE International, Catholic Relief Services, the Cameroon National Association for Family Welfare, and Association pour le Développement Harmonieux de la Mère et de l’Enfant.

### Costs per fully immunized child

Based on the budget of the Ministry of Health for the EPI programme and the contributions of donors to the programme, we determined a cost per fully immunized child after first calculating the number of immunizations administered. We included the costs of the routine EPI but not the costs of national immunization days and measles immunization campaigns, since both types of campaigns vaccinate children across a wider age range than the routine EPI. These special programmes vaccinate children regardless of prior immunization status, targeting children aged younger than 5 years for vaccination against polio and children aged from 9 months to 15 years for vaccination against measles. In the case of polio campaigns, children can be immunized multiple times up to the age of 5 years. The national immunization days also immunize children multiple times and administer the tetanus vaccine to pregnant women.

Based on an estimate of 548 000 births annually and an infant mortality rate of 95/1000 live births (6), we calculated that the average population aged younger than 1 year in Cameroon from July 2001 to June 2002 was 521 970. We multiplied this base number by the coverage rates for each vaccine taken from the 2000 survey (Table 1), resulting in a total of 2 573 312 separate immunizations for children aged younger than 1 year during this one-year period. Dividing the cost of the routine EPI programme (US\$ 4 095 614) by this number and multiplying by the eight vaccines necessary for full immunization yields an average cost of US\$ 12.73 per fully immunized child. (The average cost per vaccine administered

Table 1. Funding for Cameroon’s national Expanded Programme on Immunization (EPI), fiscal year 2001–02, in thousands of US\$

Source of funding	Programme			Total
	National immunization days	Measles campaigns	Routine EPI	
Ministry of Health	560	263	2435	3258
UNICEF	450	1500	287	2237
WHO	259	773	499	1531
Rotary International	17	0	0	17
Japanese International Cooperation Agency	276	0	276	552
GTZ <sup>a</sup>	10	0	0	10
Global Alliance for Vaccines and Immunization		0	581	581
European Union	380	0	0	380
Others	20	403	17	440

<sup>a</sup> Gesellschaft für Technische Zusammenarbeit (Society for Technical Cooperation).

Sources: Ministry of Health, Cameroon; Structured interviews with donor organizations.

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is US\$ 1.59 but there are clear differences in both the base cost and the administration of different childhood vaccines. The oral polio vaccine, for example, does not require reconstitution or injection.)

### Determinants of immunization coverage: health-district and health-facility levels

Our survey of 51 health districts in the centre, far north, and south-west provinces identified an average of 1.7 health facilities per district, or 1.2 health facilities per 100 000 people. We calculated coverage rates based on a health district's catchment size and the reported number of immunizations administered. In the Centre province these rates ranged from 32% for measles to 51% for BCG. In the far north, the rates ranged from 29% for two doses of polio vaccine to 43% for BCG. In the south-west province the calculated coverage rates were higher, ranging from a low of 45% for two doses of DPT to a high of 62% for BCG. The coverage rates found in our study are consistently 15–20 percentage points lower than the equivalent rates calculated from the 2000 survey in the three provinces chosen for the study. The possible reasons for this differential include the relatively small (and nonrepresentative) sample size of the 2000 survey at the provincial level or a secular decline in overall immunization rates in the three provinces from 2000 to 2002.

Of the 33 health facilities sampled in the centre province, more than 50% had a continuous supply of BCG and DPT vaccines, and more than 75% had the polio and measles vaccines in stock continuously. In the far north province, less than 50% of facilities had continuous supplies of BCG and polio but almost 80% had supplies of DPT and measles vaccine. The facilities in the south-west province were the best supplied: 58% had continuous supplies of DPT; 79% had supplies of BCG; and 90% had a continuous stock of polio and measles vaccines during the year prior to the survey.

### Determinants of immunization coverage: household level

Nationwide, the highest coverage rates are for BCG and one dose of polio vaccine; both of these are normally administered at birth. The 2000 survey found a coverage rate of 75% for BCG and 77% for one dose of polio vaccine; the 1998 survey found a coverage rate of 71% for BCG and 75% for one dose of polio vaccine (Table 2). However, the 2000 survey found that only 34% of children had been fully immunized, compared to 37% in the 1998 survey.

These results are strongly correlated with how many years of education the child's mother had and the family's economic status. In the 2000 survey, 77% of children whose mothers had completed secondary education or higher education had been immunized against measles (compared with only 53% of children whose mothers had not completed primary school; and 48% of children whose mothers had completed secondary education or higher education were completely immunized (compared with 21% of children whose mothers had not completed primary school) (Table 3). The survey in 2000 also found that 54% of children in the fifth quintile (the households that were wealthiest) had been fully vaccinated compared with 22% in the first quintile (the poorest households).

### Multilevel analysis

The multilevel logistic regression analysis combined data from the survey in 2000 with data from our health-facility survey,

which included data from the health-facility level and health-district level. For this analysis, we used a subset of 1648 children from the data set of the 2000 survey who live in the clusters in the centre, far north and south-west provinces where we conducted the health-facility and health-district surveys. The results show that maternal education is a stronger predictor of a child's vaccination status than economic status (Appendix 1). Controlling for the effects of other observable factors, children of mothers who completed secondary education or higher education are 3.5 times more likely to receive BCG, 2.1 times more likely to be immunized against measles and 3 times more likely to be completely vaccinated than are children whose mothers have not completed primary school.

Other important variables that correlated with immunization outcomes include whether a child has an immunization card (odds ratio (OR) = 7.0 for measles immunization; OR = 24.8 for complete immunization); whether the health facility has regular monthly supervision visits from someone at the health-district level (OR = 1.6 for measles immunization and 1.7 for complete immunization); whether the facility has an immunization plan of action (OR = 1.2 for measles immunization and 1.7 for complete immunization); and the ratio of health centres to population within the district (OR = 0.85 for measles immunization and 0.87 for complete immunization for each additional 1000 population per facility).

## Discussion

### Determinants of coverage of childhood immunization

Only a limited number of studies have analysed in depth the relationship between immunization coverage rates and household-level and individual-level determinants. In Bangladesh, the mother's level of education, the sex of the child, region of residence, economic status of the household and proximity to a health facility have all been shown to be significantly positively related to the immunization status of the child (7, 8). In Ghana, full childhood immunization has been shown to be significantly associated with town of residence, higher levels of paternal and maternal education, economic status and type of prenatal care (9, 10). Within Cameroon, a study conducted in 1982 found that in the capital city Yaoundé, children who

Table 2. National coverage rates (%) of childhood vaccinations in Cameroon for children aged < 1 year from the 2000 Multiple Indicator Cluster Survey and the 1998 Cameroon Demographic and Health Survey

Vaccine	2000 Survey	1998 Survey
BCG <sup>a</sup>	75	71
Polio vaccine, dose 1	77	75
DPT <sup>b</sup> , dose 1	66	69
Polio vaccine, dose 2	67	63
DPT, dose 2	53	59
Polio vaccine, dose 3	47	42
DPT, dose 3	43	48
Measles vaccine	65	56
<b>Fully immunized</b>	<b>34</b>	<b>37</b>

<sup>a</sup> BCG = bacille Calmette–Guérin.

<sup>b</sup> DPT = diphtheria–pertussis–tetanus.



Table 3. Children's immunization status in Cameroon by mother's level of education, from the 2000 Multiple Indicator Cluster Survey and the 1998 Cameroon Demographic and Health Survey

Mother's level of education	2000 Survey			1998 Survey		
	No. of women	% of children vaccinated against measles	% of children fully immunized	No. of women	% of children vaccinated against measles	% of children fully immunized
Less than primary school	961	53	21	438	36	24
Primary school	1137	66	34	603	62	39
Secondary education <sup>a</sup>	840	77	48	473	75	52
Higher education				12	83	67
<b>Total</b>	<b>2938</b>	<b>65</b>	<b>34</b>	<b>1526</b>	<b>56</b>	<b>37</b>

<sup>a</sup> In the 2000 survey, data on secondary education and higher education were combined.

lived in low-quality housing and whose mothers were poorly educated were significantly less likely to be vaccinated than other children (11).

In Cameroon whether a child is immunized is strongly correlated with both the mother's level of education and the household's economic status. The multilevel logistic regression analysis showed that maternal level of education is a more important predictor of child immunization than household economic status. Children whose mothers have completed secondary school are 3 times more likely to be fully immunized than children whose mothers have not completed primary school ( $P < 0.001$ ). This result is compatible with studies showing that a mother's level of education is a more accurate predictor of a child's nutritional status than economic status in a range of countries (12).

In our study economic status is measured by proxy as a composite of household assets so it is likely that the mother's level of education characterizes household socioeconomic status more accurately than the variable for economic status that results from principal components analysis. The two variables are statistically highly correlated ( $P = 0.45$ ). However, the fact that full immunization rates are just 48% for children of even the most well educated mothers (and 54% for those living in the wealthiest households) suggests that there are important supply-side constraints to increasing coverage rates (Table 3).

The regression analysis also points out clearly that supervisory visits are important to health facilities and facility-level planning. Controlling for other factors, health districts that had monthly supervisory visits have full immunization rates that are 1.7 times higher ( $P < 0.001$ ) and measles immunization rates that are 1.6 times higher ( $P < 0.01$ ) than districts without regular supervision. At the facility level, the presence of an immunization plan of action is associated with an odds ratio of 1.74 for full childhood immunization ( $P < 0.01$ ). These findings provide strong evidence of the importance of monitoring and planning for immunization programmes.

However, the availability of vaccines (defined as the continuous availability of all childhood vaccines in the one-month period prior to the health-facility survey) has no statistically significant association with child immunization outcomes. Although a lack of vaccines can adversely affect demand, such a shortage may also be an indication of high demand. Whether the child has a vaccination card is also highly correlated with actual immunization status. These results are difficult to interpret because having an immunization card is clearly subject to endogeneity

(reverse causality): children who have been immunized are more likely to have cards. Nonetheless, the strong association between cards and immunization status is a further indication of the importance of health system factors in immunization outcomes.

### Costs of immunization delivery

Due to the variety of inputs into expanded programmes for immunization, interstudy variability, and the generally limited availability of cost data, determining the cost-effectiveness of immunization programmes remains a challenge (13). A 1982 study commissioned by WHO found that the average costs per fully immunized child were US\$ 2.86 in Indonesia, US\$ 4.97 in the Philippines and US\$ 10.73 in Thailand (14). In public health facilities in India in 1985, the cost of fully immunizing a child was estimated to be US\$ 4.09 (15). None of these studies included costs to the Ministry of Health to manage or support the programme. A review of 30 EPI cost-effectiveness studies conducted during the 1980s found an average cost of US\$ 5.00–10.00 per fully immunized child (16–18). When all donor contributions, vaccines, syringes, cold-chain equipment, vehicles and local training costs are included, the average cost across a range of EPI programmes in the 1980s was US\$ 13.00 per fully immunized child. The World Bank, in a 1993 report, estimated that immunizations through EPI cost US\$ 14.20 per disability-adjusted life year (DALY) prevented, making immunizations through EPI one of the most cost-effective public health interventions (19).

More recently, research has continued to document the cost-effectiveness of immunization programmes. An in-depth study of the costs of immunization programmes in Morocco, Bangladesh and Côte d'Ivoire in the late 1990s found that the cost per fully immunized child was less than US\$ 25.00 in each of these countries (20). Separately, a wide-ranging review of the costs of immunization programmes in 17 low-income and middle-income countries in the 1980s and 1990s found that the cost of fully immunizing a child ranged from US\$ 4.39–59.90 (21). The costs per child fully immunized through routine services (which are comparable to the estimates from our study) ranged from US\$ 2.19 to US\$ 26.59 (21). These cost estimates are not corrected for inflation, possible changes in immunization schedules or for the variable cost of inputs and across countries.

In addition to comparing the cost-effectiveness of childhood immunizations to other public health interventions, there is also a growing amount of literature concerned with the relative cost-effectiveness of different approaches to immunizing

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children. In the 1993 World Bank report mentioned above, costs were lower when vaccinations were delivered through fixed facilities (US\$ 11.74 per fully immunized child on average) and higher when they were offered through campaigns (US\$ 15.62 on average) (19). However, a study in Zambia that modelled the cost effectiveness of three different strategies to deliver measles immunizations found campaigns to be cheaper than fixed delivery. Compared to delivering the single recommended measles dose at the age of 9 months, adding a facility-based second dose to be given at the age of 18 months resulted in estimated incremental costs of US\$ 366 per life saved, while adding a second dose through campaigns and other supplementary activities cost US\$ 127 per life saved (22).

Although immunizations are a highly cost-effective public health initiative, the cost of EPI is relatively expensive in comparison to overall health expenditures in Cameroon and other low-income countries. Total health expenditures in Cameroon, excluding donors' contributions, were estimated to be US\$ 24.00 per capita in 2001, of which US\$ 5.93 was publicly funded and US\$ 18.07 was privately funded (23). Against this background, the cost of US\$ 12.73 per fully immunized child represents a significant expense, helping to explain the continued importance of donor assistance for immunizations and other public health priorities.

The strong statistical effects of a household's socioeconomic status and especially the mother's level of education

point to a need for additional targeted outreach to low-income and poorly educated households in Cameroon. In particular, the large drop-off in coverage rates from early immunizations to those later in the schedule (particularly for the third dose of DPT and polio vaccine) indicates that there is a need for more support for poorly-educated mothers to encourage them to return for follow-up immunizations. These findings underline the need for effective dissemination of information and social mobilization efforts to accompany and support immunization delivery. At the facility level, the significance of supervision points to the fact that resources within the health system can be more effectively utilized. The results of this study strongly suggest that improving management at the health-facility level, through the development of a health plan and the implementation of regular supervisory visits, can increase effectiveness and ultimately lower the costs of immunization delivery. ■

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**Conflicts of interest:** none declared.

## Résumé

### Couverture et coût de la vaccination des enfants au Cameroun

**Objectif** Mesurer l'association entre les déterminants liés aux ménages et aux prestataires de soins et les taux de vaccination des enfants au Cameroun, et calculer en même temps le coût de la vaccination.

**Méthodes** La présente étude utilise une analyse de régression à plusieurs niveaux pour calculer ces relations. Les données concernant les ménages sont essentiellement tirées de l'enquête démographique et sanitaire menée au Cameroun en 1998 et d'une enquête par sondage en grappes avec indicateurs multiples réalisée en 2000. Ces données sont complétées par les résultats d'une enquête sur les établissements de soins réalisée dans trois provinces en 2002. Au niveau national, les données sur le financement de la vaccination ont été recueillies auprès du ministère de la santé et des donateurs qui soutiennent le Programme élargi de vaccination national.

**Résultats** L'enquête de 1998 avait trouvé au niveau national 37 % d'enfants entièrement vaccinés ; lors de l'enquête de 2000, cette proportion était de 34 %. Ces résultats sont fortement corrélés avec le niveau d'études de la mère et la situation socio-économique du ménage. Une analyse de régression logistique à plusieurs niveaux montre que le niveau d'études de la mère est un facteur prédictif plus puissant que la situation économique en ce qui concerne le

statut vaccinal. Les enfants dont la mère avait suivi des études secondaires ou supérieures avaient trois fois plus de chances d'avoir reçu tous leurs vaccins que ceux dont la mère n'avait pas achevé ses études primaires. Au niveau des établissements de soins, le fait d'avoir un plan de vaccination et de recevoir régulièrement la visite d'un représentant du service de santé de district présentait une forte association positive avec les taux de vaccination. Le coût des vaccinations de routine pour chaque enfant entièrement vacciné était de US\$ 12,73 lorsqu'on incluait les contributions des donateurs mais non le coût des campagnes de vaccination.

**Conclusion** Les études réalisées pendant les années 1980 et 1990 ont montré que les coûts par enfant entièrement vacciné allaient de US\$ 2,19 à US\$ 26,59 (valeurs non corrigées de l'inflation) dans divers pays à revenu faible ou intermédiaire. Les taux relativement faibles de couverture vaccinale au Cameroun et l'influence déterminante du niveau socio-économique du ménage, et en particulier du niveau d'études de la mère, sur les taux de vaccination indiquent que l'efficacité du programme camerounais pourrait être améliorée grâce à une promotion de la vaccination et à un ciblage des programmes sur les ménages ne disposant que de ressources limitées.

## Resumen

### Cobertura y costo de la inmunización infantil en el Camerún

**Objetivo** Cuantificar la relación existente entre diversos determinantes asociados al hogar y el proveedor y las tasas de inmunización infantil en el Camerún, y calcular paralelamente el costo de las vacunaciones en la niñez.

**Métodos** Se ha usado el análisis de regresión multinivel para

calcular las citadas relaciones. La Encuesta de Demografía y Salud del Camerún de 1998 y la Encuesta a base de Indicadores Múltiples de 2000 son las fuentes principales de los datos sobre las unidades familiares. Estas encuestas se han complementado con los datos de una encuesta de los establecimientos de salud

realizada en 2002 en tres provincias. A nivel nacional, los datos sobre la financiación de las vacunaciones proceden del Ministerio de Salud y de los donantes que apoyan el Programa Ampliado de Inmunización nacional.

**Resultados** La encuesta de 1998 reveló que, a nivel nacional, un 37% de los niños habían recibido todas las vacunas previstas; la encuesta de 2000 reveló un porcentaje del 34% a nivel nacional. Estos resultados están estrechamente correlacionados tanto con el nivel de instrucción de la madre como con la situación económica del hogar. La regresión logística multinivel muestra que el nivel de educación de la madre es más fiable que la situación económica relativa como factor predictivo de una correcta vacunación. Los hijos de las mujeres con estudios secundarios o superiores tenían tres veces más probabilidades de haber recibido todas las vacunas que los niños cuyas madres no habían terminado los estudios primarios. A nivel de los establecimientos de salud, tanto la existencia de un plan de inmunización como la realización

de visitas regulares de supervisión por alguna persona en el nivel de salud de distrito son factores relacionados muy positivamente con las tasas de inmunización. El costo de la vacunación sistemática por niño totalmente vacunado es de US\$ 12,73 si se incluyen las contribuciones de los donantes pero no los costos de las campañas de inmunización.

**Conclusión** En diversos estudios llevados a cabo en los años ochenta y noventa se observó que los costos por niño totalmente vacunado oscilaban entre US\$ 2,19 y US\$ 26,59 (sin corregir en función de la inflación) en una serie de países de ingresos bajos y medios. Las tasas relativamente bajas de cobertura inmunitaria que tiene el Camerún y la gran influencia de la situación socioeconómica del hogar -en particular el nivel de educación de la madre- en las tasas de inmunización llevan a pensar que la eficacia del programa del Camerún podría ser mayor si se promoviera la inmunización y si los programas se focalizaran en los hogares con recursos limitados.

## ملخص

### تكاليف ونطاق التغطية التمنيعية للأطفال في الكاميرون

مؤشر الوضع الاقتصادي النسبي. وكان احتمال التمنيع الكامل للأطفال الأمهات الحاصلات على تعليم متوسط أو عال ثلاثة أضعاف ما عليه في حالة الأمهات اللاتي لم يستكملن التعليم الأساسي. وعلى مستوى المرفق الصحي، توافق وجود خطة تمنيع وزيارات إشرافية منتظمة من قبل أحد العاملين في مستوى المنطقة الصحية مع معدلات تمنيع إيجابية قوية في كلتا الحالتين. وتبلغ تكلفة إعطاء اللقاحات الروتينية لكل طفل تم تمنيعه بالكامل نحو ١٢,٧٣ دولاراً أمريكياً عند تضمين مساهمات المانحين مع استبعاد تكاليف حملات التمنيع.

**الخلاصة:** توصلت الدراسات التي أجريت في ثمانينات وتسعينات القرن العشرين إلى أن تكلفة التمنيع الكامل للطفل تتراوح ما بين ٢,١٩ و ٢٦,٥٩ دولاراً أمريكياً (لم يتم تعديلها وفقاً للتضخم) في مجموعة من البلدان ذات الدخل المنخفض والمتوسطة. ومن ثَمَّ فإنَّ المعدلات المنخفضة نسبياً للتغطية التمنيعية في الكاميرون، والتأثير القوي للوضع الاقتصادي والاجتماعي للأسرة، ولاسيما مستوى تعليم الأم، على معدلات التمنيع، تشير إلى إمكانية زيادة فعالية برنامج الكاميرون من خلال تعزيز أنشطة التمنيع وتوجيه مثل هذه البرامج نحو الأسر المحدودة الموارد.

**الهدف:** قياس مدى الاقتران بين العوامل المحددة لمستوى الأسرة ومستوى مقدم الخدمة، وبين معدلات تمنيع الأطفال في الكاميرون، وفي نفس الوقت حساب تكلفة تمنيع الأطفال.

**الطريقة:** تستخدم هذه الدراسة تحليل التحوف المتعدد المستويات لاحتساب هذه العلاقات. ويعتبر المسح الصحي والديمغرافي للكاميرون لعام ١٩٩٨، والمسح العنقودي المتعدد المؤشرات لعام ٢٠٠٠ المصدرين الأساسيين للمعطيات على مستوى الأسرة. وقد تم استكمال هذه المسوحات بالمعطيات الناتجة عن مسح المرافق الصحية الذي أُجري في ثلاث مقاطعات في عام ٢٠٠٢. وعلى المستوى الوطني، تم تجميع المعطيات الخاصة بتمويل التمنيع من وزارة الصحة والجهات المانحة التي تدعم البرنامج الوطني الموسع للتمنيع.

**الموجودات:** كشف المسح الذي أُجري عام ١٩٩٨ عن تمنيع ٣٧٪ من الأطفال تمينياً كاملاً على المستوى الوطني، كما أظهر المسح الذي أُجري في عام ٢٠٠٠ أن ٣٤٪ من الأطفال تم تمنيعهم تمينياً كاملاً على المستوى الوطني. وهذه النتائج ترتبط ارتباطاً قوياً بكل من مستوى تعليم الأم والوضع الاقتصادي للأسرة. كما أظهر تحليل التحوف اللوجستي المتعدد المستويات أن مستوى تعليم الأم يعتبر مؤشراً للتنبؤ بالوضع التمنيعي الإيجابي أقوى من

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Appendix 1. Results of multilevel regression analysis of data from sample of 1648 children aged younger than 5 years living in the far north, centre and south-west provinces of Cameroon (Results reported as odds ratios)

Independent variables	Variable mean	Dependent variables <sup>a</sup>								
		BCG <sup>b</sup> (71%)	Polio, vaccine, dose 1 (74%)	DPT <sup>c</sup> , dose 1 (68%)	Polio, vaccine, dose 2 (64%)	DPT, dose 2 (48%)	Polio vaccine, dose 3 (43%)	DPT, dose 3 (39%)	Measles vaccine (63%)	Fully immunized (32%)
<b>Household-level and child-level</b>										
Mother's education (primary vs none)	0.36	1.81 <sup>d</sup>	1.1	1.73	1.06	1.25	0.92	1.36	1.62	1.90 <sup>d</sup>
Mother's education (secondary vs none)	0.26	3.50 <sup>e</sup>	2.00 <sup>f</sup>	3.80 <sup>e</sup>	2.44 <sup>e</sup>	2.12 <sup>d</sup>	1.61	2.59 <sup>d</sup>	2.14 <sup>f</sup>	3.01 <sup>e</sup>
Mother's total number of children	2.20	0.98	1.08	0.81 <sup>d</sup>	1.06	0.81 <sup>d</sup>	1.04	0.85	0.91	0.85
Economic level <sup>g</sup> (second quintile vs poorest)	0.20	1.65 <sup>f</sup>	2.26 <sup>e</sup>	1.02	1.46 <sup>f</sup>	1.58	1.57 <sup>f</sup>	1.42	1.67 <sup>f</sup>	1.27
Economic level (third quintile vs poorest)	0.21	0.83	1.95 <sup>d</sup>	1.25	1.93 <sup>e</sup>	1.43	1.26	1.49	1.05	1.51
Economic level (fourth quintile vs poorest)	0.20	1.5	1.49	1.29	1.02	1.29	1.08	1.29	2.08 <sup>f</sup>	1.04
Economic level (fifth quintile vs poorest)	0.23	1.84	1.33	1.11	1.42	1.58	1.55	1.76	2.83 <sup>d</sup>	2.33 <sup>f</sup>
Boy (vs girl)	0.54	0.88	1.34 <sup>d</sup>	1.50 <sup>e</sup>	1.50 <sup>e</sup>	1.46 <sup>d</sup>	1.46 <sup>e</sup>	1.43 <sup>d</sup>	1.25	1.26
Age of the child in years	1.97	1.05 <sup>d</sup>	1.13 <sup>e</sup>	1.04 <sup>f</sup>	1.14 <sup>e</sup>	1.03 <sup>f</sup>	1.07 <sup>e</sup>	1.03 <sup>d</sup>	1.12 <sup>e</sup>	1.08 <sup>d</sup>
Child has vaccination card	0.35	12.97 <sup>e</sup>	9.40 <sup>e</sup>	10.53 <sup>e</sup>	6.36	12.84 <sup>e</sup>	9.80 <sup>e</sup>	23.13 <sup>e</sup>	6.99 <sup>e</sup>	24.8 <sup>e</sup>
<b>Health-facility level</b>										
Vaccines available	0.73	0.81	1.47	1.05	1.16	1.17	0.98	0.86	0.99	0.91
Has an immunization action plan	0.55	1.09	1.2	1	1.54 <sup>f</sup>	1.37	1.66 <sup>e</sup>	2.00 <sup>d</sup>	1.19	1.74 <sup>d</sup>
No. of immunization personnel	4.94	1.01	0.98	1.04	1.04	1.04	1.07 <sup>d</sup>	1.10 <sup>e</sup>	1.03	1.04
<b>Health-district level</b>										
Ratio of health centres to 1000 population	0.12	0.82 <sup>f</sup>	1.08	0.94	0.95	1.01	0.78 <sup>e</sup>	1.03	0.85 <sup>d</sup>	0.87 <sup>d</sup>
Monthly supervision visits (yes/no)	0.45	1.55 <sup>f</sup>	1.18	1.43	1.71 <sup>e</sup>	1.31	1.49 <sup>e</sup>	1.70 <sup>d</sup>	1.60 <sup>f</sup>	1.70 <sup>e</sup>
<b>Province level</b>										
Far north vs Centre	0.41	1.08	2.72 <sup>e</sup>	1.14	2.14 <sup>d</sup>	1.03	1.16	1.23	1.51	1.07
South-west vs Centre	0.31	1.18	1.79	1.1	1.47	1.09	1.53	0.89	2.44 <sup>d</sup>	1.71 <sup>f</sup>

<sup>a</sup> Figures in parentheses are the mean rate of coverage within the sample.

<sup>b</sup> BCG = bacille Calmette–Guérin.

<sup>c</sup> DPT = diphtheria–pertussis–tetanus.

<sup>d</sup>  $P < 0.01$ .

<sup>e</sup>  $P < 0.001$ .

<sup>f</sup>  $P < 0.1$ .

<sup>g</sup> In the comparison of economic status, the first quintile represents those households that are the poorest and the fifth quintile represents those that are the wealthiest.