Vaccine 33S (2015) A66–A71

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Determinants of routine immunization costing in Benin and Ghana in 2011

Césaire Damien Ahanhanzo[a], Xiao Xian Huang[a,*], Jean-Bernard Le Gargasson[a], Justin Sossou[b], Frank Nyonator[c], Anais Colombini[a], Bradford D. Gessner[a]

[a] Agence de Médecine Préventive (AMP), Ferney-Voltaire, France
[b] Ministry of Health of Benin, Cotonou, Benin
[c] Ministry of Health of Ghana, Accra, Ghana

ARTICLE INFO

Keywords:
Benin
Cost
Economics
Ghana
Immunization
Vaccine

ABSTRACT

Background: Existing tools to evaluate costs do not always capture the heterogeneity of costs at the facility level. This study seeks to address this issue through an analysis of determinants of health facility immunization costs.
Methods: A statistical analysis on facility routine delivery and vaccine costs was conducted using ordinary least squares regression. Explanatory variables included the number of doses administered; proportion of time spent by facility staff on immunization; average staff wage; whether the health facility had enough staff; presence of cold chain equipment; distance to a vaccine collection point; and, facility ownership. Data were drawn from representative samples of primary care facilities in Benin and Ghana (46 and 50 facilities, respectively) collected as part of the EPIC studies.
Results: Weighted average RI immunization facility cost was US$ 16,459 in Ghana and US$ 14,994 in Benin. The regression found total doses administered to be positively and significantly associated with facility cost in both countries. A 10% increase in doses resulted in a 4% increase in cost in Ghana, and a 7.5% increase in Benin. In Ghana, the proportion of immunization time, presence of cold chain, and sufficiency of staff were positively and significantly associated with total cost. In Benin, facility cost was negatively and significantly related to distance to the vaccine collection point. In the pooled sample, facilities in capital cities were associated with significantly higher costs.
Conclusions: This study provides evidence on the importance of the level of scale in determining facility immunization cost, as well as the role of availability of health workers and time they spend on immunization in Ghana and Benin. This type of analysis can provide insights into the costs of scaling up immunization services, and can assist with development of more efficient immunization strategies.

1. Background

Like most Sub-Saharan African countries, Benin and Ghana have improved immunization performance during the past decade. According to the 2011 Ghana Multiple Indicators Cluster Survey, coverage of pentavalent vaccine (DTP–HepB–Hib) was 92.1%, while measles, yellow fever and neonatal tetanus immunization coverage were lower at 88.5%, 88.3% and 70.3%, respectively [1]. In Benin, a 2007 EPI Review found 81% administrative coverage for the pentavalent vaccine compared to 67% obtained through surveys [2]. Both countries have introduced new vaccines with GAVI support (pneumococcal, rotavirus or measles second dose) (Table 1).

Existing tools to assess routine immunization (RI) costs (such as the comprehensive multi-year plan) do not capture heterogeneity in facility costs. This is an important limitation as previous studies have demonstrated wide variation in facility cost that would contribute to national program costs and performance [3 ref: Walker]. The current manuscript seeks to address this issue by analyzing determinants of RI costs at facility level. Results from this type of analysis can support development of more targeted interventions to improve immunization program efficiency.

2. Methods

2.1. Data collection

The current evaluation is based on a representative, stratified random sample of 50 facilities in Ghana and 46 facilities in Benin.

* Corresponding author. Tel.: +33 4 5040 0535.
E-mail addresses: xxhuang@aamp.org, huang.xiaoxian@gmail.com (X.X. Huang).

http://dx.doi.org/10.1016/j.vaccine.2014.12.069
0264-410X/

Table 1
Routine childhood immunization vaccine schedule and age of administration in Benin and Ghana.

	Ghana	Benin
Traditional and underused vaccines (routine immunization cost analysis)		
Bacillus Calmette-Guérin (BCG)	Birth	Birth
Oral poliovirus (OPV)	Birth, 6, 10 and 14 weeks	Birth, 6, 10 and 14 weeks
Diphtheria–tetanus–pertussis–hepatitis B–*Haemophilus influenzae* type b	6, 10 and 14 Weeks	6, 10 and 14 Weeks
Measles	9 Months	9 Months
Yellow-fever	9 Months	9 Months
New vaccines (NUVI analysis)		
Pneumococcal conjugate* (13-valent)	6 Weeks, 10 weeks, 14 weeks (introduced April 2012)	6 Weeks, 10 weeks, 14 weeks (introduced July 2011)
Rotavirus*	2, 6 and 10 Weeks (introduced April 2012)	Not introduced
Measles second dose*	18 Months (introduced February 2012)	Not introduced

* Not included in facility routine immunization costs in 2011.

In Ghana, districts were classified according to urban and rural location, number of pentavalent doses administered in 2011, and population density. Four rural districts (high and low number of doses administered by high and low population density) and two urban districts (high and low doses administered) were selected. Facility types included reproductive and child health (RCH) units of district hospitals; health centers (HC); community health planning and services facilities (CHPS); and clinics. CHPSs serve as first-line health facilities providing direct interventions as well as outreach services to mostly rural communities. Many CHPSs tend to require more manpower and fuel per vaccinated child than other health facilities. While costs may be higher, they tend to deliver fewer vaccine doses than other facilities, and have higher unit costs [4 ref: Le Gargasson et al. in this Supplement].

In Benin, eight districts were selected based on population density, pentavalent doses administered and geographic zone. Within the 14 total selected districts, immunization facilities associated with immunization programs were stratified by type (district hospital, health center, clinic, community health center); ownership (non-governmental or government); and rural versus urban location. The average urban health facility covered a total population of approximately 20 to 40 thousand versus 8 to 15 thousand for the average rural health facility. Table 2 describes the sample of health facilities included in this analysis.

Forty percent of health facilities in the Ghana sample were CHPSs, while an equivalent type of health facility did not exist in the Benin sample (Appendix 1). This difference in health structure composition and distribution limits direct comparison of costs between Ghana and Benin. Benin had a higher average number of doses delivered per facility, and did not use volunteers to conduct RI activities (Tables 3 and 4).

Data were collected using standardized, pre-tested questionnaires. Total RI facility economic costs were estimated based on input quantities and prices as per a common methodological approach developed for the EPIC studies and global costing guidelines [6,7]. Vaccines administered were collected from facility monitoring records. Economic costs of inputs were allocated to the different immunization activities (cf. Appendix 2 for definitions) based on factors in the common approach. A fully immunized child (FIC) was defined as children receiving the third dose of pentavalent (DTP–hepatitis B–Hib) vaccine derived from facility immunization records. Weighted average costs were estimated using facility sampling weights.

In Ghana, the study protocol was submitted to the Ghana Health Service Ethical Review Committee and the study was authorized in December 2012. In Benin, the study was exempted from an Internal Review Board (IRB) process. Standard confidentiality procedures were implemented to protect the identity of study informants including password-protected computer entry.

2.2. Strategy for the treatment of joint cost

In most of the surveyed health facilities, resources were shared between different vaccination delivery strategies (facility-based or outreach), and between vaccination and other health services. For personnel, paid labor was estimated based on the percent of total working time spent on a range of immunization activities, such as record-keeping, vaccine administration, outreach, program management, among others. Vaccine costs were allocated to outreach or facility-based service delivery based on the number of doses administered within each strategy. For transportation and vehicle costs, the number of kilometers obtained from vehicle log books or estimated response was used to determine share of costs. Costs for overhead, utilities and communication were estimated based on the total facility or administration expenses for these items, multiplied by the ratio of the number of patients receiving the third DTP dose and the sum of outpatient visits and inpatient admissions. In Ghana, the daily allowance for national immunization days was used to estimate volunteer labor costs.

2.3. Cost determinants model

According to economic theory, costs are a function of quantities, prices, quality, and other environmental factors [8–10]. For this study, facility immunization RI cost is represented in the following reduced form equation:

$$\log(CQ_i) = \beta_0 + \beta_1 \times \log(\text{Doses}_i) + \beta_2 \times \log(\text{Time}_i) + \beta_3 \times \log(P_i) + \beta_4 \times Z_i.$$

In this linear model, CQ_i is the total facility immunization cost (including vaccine cost); Doses_i represents the total doses administered to RI (quantity measure); Time_i reflects the proportion of time spent on immunization by facility staff; P_i is the average wage of staff (proxy price measure); and Z_i reflects other environmental and quality factors that could influence cost. One measure of quality was based on answer to the question "Do you have enough staff to perform routine immunization well?" Other variables included type and ownership of the health facility, location of the facility, whether cold chain equipment was present in a facility, distance of the facility (km) to the nearest vaccine collection point, and existence of volunteers.

Variables in the regression equations were transformed into logs base 10. The coefficients on the explanatory variables can be interpreted as the effect a particular variable would have on total facility cost. Alternative model specifications were conducted for this analysis to examine the effects of different control variables in the regression. Ordinary least squares (OLS) regressions were