



## Short communication

## Household costs of seeking BCG vaccination in rural Guinea-Bissau

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## ABSTRACT

In Guinea-Bissau, a vial of BCG vaccine is often not opened unless 10 infants are present for vaccination, with the aim of reducing vaccine wastage. This causes delays in vaccination, as previously demonstrated in Guinea-Bissau and other low-income countries. Reducing wastage of BCG vaccine to save money may deprive infants of important health benefits and transfer costs from the vaccination programme to mothers.

Using the Bandim Health Project's rural Health and Demographic Surveillance System, we interviewed mothers of infants aged 1–11 months about household costs of seeking BCG vaccination.

On average mothers took their infant for BCG vaccination 1.26 times before obtaining the vaccine. For mothers who had sought BCG vaccine for their infants the average cost was 1.89 USD for each BCG-vaccinated infant. Among BCG-unvaccinated infants at the time of interview, 42% had brought their infant for BCG vaccination in vain at an average cost of 2.83 USD.

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## 1. Introduction

Investments in vaccination programme strengthening are justified by their impact on target infections, commonly measured by vaccination coverage as proxy, and decisions are supported by cost-effectiveness assessments. A way to increase the efficiency of vaccination programmes is by reducing costs, for example by reducing vaccine wastage.

Bacillus Calmette-Guérin (BCG) vaccine is recommended to be given at birth in countries with high tuberculosis burden [1]. The vaccine is supplied in 20-dose vials, and like other live vaccines, once reconstituted the vaccine must be used within 6 h. The official wastage target for BCG was 25% in Guinea-Bissau in 2013–2017 [2]. In an attempt to reduce vaccine wastage, most health centres only provide live vaccines on a specific week day. However, even on these days a vial is not opened unless a sufficient number of infants (10 in Guinea-Bissau) are present for vaccination, causing mothers to seek vaccination in vain [3–5]. Thus, BCG is often

delayed in Guinea-Bissau [4], and in other low-income countries [6,7].

Delays in BCG vaccination are not monitored through administrative data, and the high BCG coverage (88% globally in 2017 [8]) reported at 12 months of age does not call for action. Despite BCG being developed to protect against tuberculosis, increasing evidence supports that the vaccine has beneficial non-specific effects (NSE) [9], reducing mortality by more than can be explained by the prevention of tuberculosis. Even small delays in BCG vaccination may be important for the benefits of NSEs: In a meta-analysis of three randomised trials among low-weight infants in Guinea-Bissau for whom vaccination is normally delayed, BCG-at-birth was associated with 38% (17–54%) lower mortality within the neonatal period compared with infants with delayed vaccination [10]. The effect was 45% (7–68%) within three days after vaccination [10].

Thus, reducing wastage of BCG vaccine to save costs may deprive infants of important health benefits and also transfer costs from the vaccination programme to mothers. The objectives of this study were to determine the average number of times a mother sought BCG vaccination for her infant and to estimate the household costs of seeking BCG vaccination in rural Guinea-Bissau.

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## 2. Methods

The Bandim Health Project runs a Health and Demographic Surveillance System (HDSS) in rural Guinea-Bissau where women and children are followed through biannual household visits. Between May 24, 2014 and December 29, 2016, we interviewed mothers of infants living in seven regions (Oio, Gabu, Bafata, Quinara, Tombali, Bolama and Bijagos). Mothers of infants registered prior to birth were interviewed at the first visit after the neonatal period. If the mother and infant were not present or the infant had not yet been BCG vaccinated, the mother was (re-)interviewed at the next visit if the infant was still below one year of age.

All mothers were asked whether their infant had received the BCG vaccine against tuberculosis (explained as “the vaccine given in the arm that often makes a small scar”), and date of BCG was obtained from the infant’s vaccination card. Mothers of infants born in a health facility were asked whether their infant had received BCG at birth. The interview was terminated for infants vaccinated at birth at a health facility. However, some mothers stated that their infant received BCG vaccine at birth, although the date of BCG vaccination was registered to be later. Since very few infants are hospitalised longer than 7 days after birth, infants stated to be BCG-vaccinated at birth in a health facility and with a registered date of BCG vaccination within 7 days after birth were classified as brought for vaccination 0 times. Infants stated to be BCG-vaccinated at birth in a health facility and with a date of BCG vaccination after 7 days after birth were assumed to have been brought for BCG vaccination once.

All mothers were asked if and how many times they had sought BCG vaccination. We asked for details on time spent seeking BCG vaccination (from leaving the house to returning home). We asked for number hours up to 24 h, and categorised mothers who had used more than 24 h in one group (>24 h). To provide a realistic picture of the time most mothers use to seek BCG vaccination, these mothers were excluded in the reported range of transportation time, but contributed to the median estimate and were classified as having spent 24 h. We furthermore asked for money spent on transportation. To evaluate if there were other missed opportunities of BCG vaccination, we asked whether the mother had brought her infant for other vaccinations or consultations prior to obtaining BCG.

All costs were collected in West-African Francs (CFA), and converted into US dollars (USD) using the 2016 average exchange rate of 594 CFA to 1 USD. The value of time spent seeking BCG vaccination was calculated based on an estimated average monthly earning of 61 USD (2011, Guinea-Bissau) by Knight et al. [11]. Using World Bank Consumer Price Index [12] this corresponded to an average monthly earning of 69.94 USD in 2016. We assumed 176 working hours per month as in a previous study [3], resulting in a value of 0.36 USD per hour of a mother’s time. We calculated

the costs of seeking BCG vaccine per infant among those who were stated not to be BCG vaccinated at birth, by multiplying the value of the mother’s time by time spent seeking vaccination and adding transportation costs. If the mother had sought BCG vaccination for her infant more than once, the cost of seeking BCG was multiplied by the number of times. We calculated an average cost of seeking BCG vaccination per infant among children who had been brought for vaccination.

## 3. Results

We interviewed 2203 mothers of 2271 infants aged 1–11 months. Among these 1480 (65%) were born at home, 780 (34%) were born in health facilities, and 11 infants had missing information on place of birth. For infants born in health facilities, mothers stated that 287 (37%) were BCG vaccinated at birth with 96 (12%) having received BCG vaccine at birth, and 175 (22%) having received BCG before 7 days of age. These infants were counted as BCG vaccinated with 0 times seeking the vaccine. Among infants stated to be BCG-vaccinated at birth, the date of BCG according to the vaccination card was more than 7 days after birth for 112 infants (39%), and these infants were recoded to have been brought for BCG vaccination once.

Among the 2271 infants where information was obtained, 1850 (81%) were BCG vaccinated at time of interview. On average mothers had sought BCG vaccination 1.17 times; 1.26 times among BCG-vaccinated infants and 0.82 times among infants who had not yet been vaccinated (Excluding children who had not been brought for vaccination, mothers of unvaccinated children on average sought BCG vaccination 1.97 times). Among the 1753 infants for whom BCG vaccination had been sought, a median of two hours was spent away from home (Range: 0–14 h) (Table 1), but 11 (0.1%) mothers had spent more than 24 h away from home. 315 (16%) of the infants’ mothers paid for transport to the health facility. Among these, the median transport cost was 0.84 USD (Range: 0.17–11.78) (Table 1). The average total cost of seeking BCG vaccination was 1.89 USD per infant among those who had sought BCG vaccination. The total cost of seeking BCG vaccination differed according to birth location: The average cost of seeking BCG for infants born at home was 1.93 USD. The average cost for infants born in health facilities was 1.71 USD (Table 1). When stratifying by BCG vaccination status at time of interview the average cost of seeking BCG vaccination among BCG-vaccinated infants was 1.89 USD. Among the BCG-unvaccinated infants, 169 (42%) had been brought for BCG vaccination at an average cost of 2.83 USD (Table 2). The older the infant, the more likely the mother was to have sought BCG vaccination several times (Fig. 1).

Among BCG-unvaccinated infants at the time of interview, mothers to a subset of infants (275) were asked for reasons for the infant not being vaccinated. The majority of these, 205 (75%)

**Table 1**  
BCG vaccination opportunities and costs of seeking BCG vaccination according to birth location.

	Total number of mothers present for interview	Infants stated to be vaccinated at the health facility at birth	Infants with BCG at time of interview	Infants brought for BCG vaccination at least once	Number of possible BCG vaccination contacts	Time spent on seeking BCG vaccination (h)	Number of mothers who paid for transport	Transport costs of seeking BCG vaccination (USD)	Average costs of seeking BCG vaccination (USD) <sup>2</sup>
Birth place	n	n (%)	n (%)	n (%)	Mean (sd)	Median (Range) <sup>1</sup>	n (%)	Median (Range)	Mean (sd)
All	2271	286 (13%)	1850 (81%)	1753 (88%)	1.17 (0.82)	2 (0–14)	315 (16%)	0.84 (0.17–11.78)	1.89 (2.67)
Home	1481	0	1150 (78%)	1278 (86%)	1.13 (0.80)	2 (0–14)	234 (16%)	0.84 (0.17–11.78)	1.93 (2.76)
Health facility	779	286 (37%)	690 (89%)	464 (94%)	1.28 (0.86)	2 (0–12)	79 (16%)	0.84 (0.17–3.37)	1.71 (2.13)

<sup>1</sup> With exception of 11 mothers, who reported to have spent more than 24 h seeking BCG vaccination per time.

<sup>2</sup> Among children for whom BCG vaccination was sought (excluding infants who received BCG at birth in a health facility and children who had not been brought for BCG vaccination).

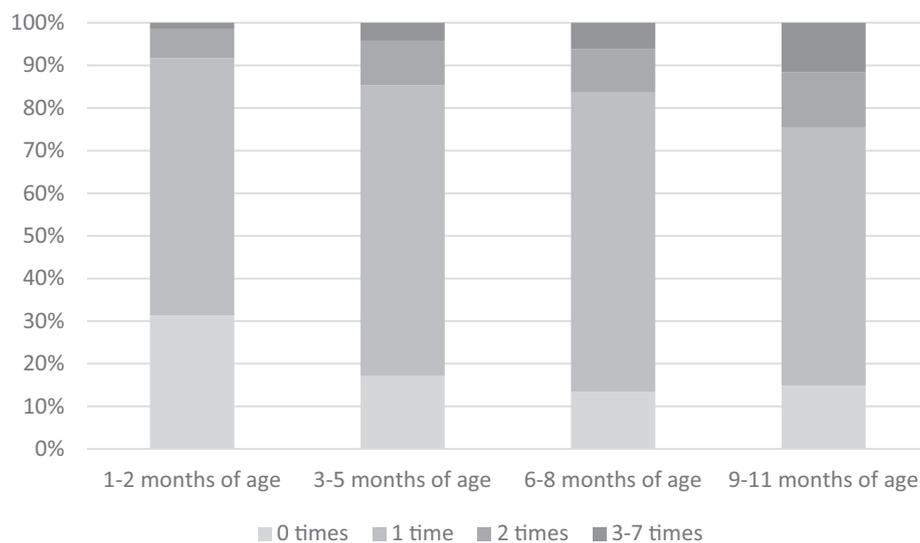
**Table 2**

BCG vaccination opportunities and costs of seeking BCG vaccination according to BCG vaccination status at time of interview.

	Total number of mothers present for interview	Infants stated to be vaccinated at the health facility at birth	Infants brought for BCG vaccination at least once	Number of possible BCG vaccination contacts	Time spent on seeking BCG vaccination (h)	Number of mothers who paid for transport	Transport costs of seeking BCG vaccination (USD)	Average costs of seeking BCG vaccination <sup>2</sup> (USD)
	n	n (%)	n (%)	Mean (sd)	Median (Range <sup>1</sup> )	n (%)	Median (Range)	Mean (sd)
BCG vaccinated prior to interview	1850	266 (14%)	1584 (100%)	1.26 (0.67)	2 (0–14)	290 (18%)	0.84 (0.17–11.78)	1.89 (2.67)
Not BCG vaccinated prior to interview	421	20 (5%)	169 (42%)	0.82 (1.18)	1 (0–11)	25 (6%)	1.01 (0.34–3.37)	2.83 (4.51)

<sup>1</sup> With exception of 11 mothers, who reported to have spent more than 24 h seeking BCG vaccination per time.

<sup>2</sup> Among children for whom BCG vaccination was sought (excluding infants who received BCG at birth in a health facility and children who had not been brought for BCG vaccination).



**Fig. 1.** Number of times a mother brought her infant for BCG vaccination according to the infant's age at time of visit.

knew that vaccines were recommended at birth, and 53 (19%) had sought vaccination. Of these, 42 (79%) were told to return another day since no BCG vaccine vial was opened. Among the 222 infants who had not been brought for vaccination, mothers gave several reasons for not seeking BCG vaccination: distance (116 (52%)), lack of money (124 (56%)) and waiting for vaccination outreach (116 (52%)).

#### 4. Discussion

Utilising the HDSS setup in rural Guinea-Bissau, we were able to assess household costs of seeking BCG vaccination. We found that mothers on average brought their infant for BCG vaccination 1.26 times before obtaining the vaccine and that average household cost of seeking BCG vaccination was 1.89 USD per BCG-vaccinated infant. At the time of interview, 42% of unvaccinated infants had been brought for BCG vaccination with an average household cost of 2.83 USD. This is equivalent to the UNICEF price ranges of 1.36–3.24 USD per vial of BCG in 2016 [13]. Mothers seeking BCG vaccination, spent an average of 2 h (Range: 0–14 h) on obtaining the vaccine for their infant, with 0.1% of mothers spending more than 24 h. The average household costs of seeking BCG vaccination was almost 1 USD higher among children brought for BCG vaccination without obtaining the BCG vaccine (2.83 USD) than for children,

who were successfully BCG vaccinated (1.89 USD). This was because children not succeeding in obtaining BCG, despite seeking BCG vaccination, were brought for vaccination 1.97 times compared with 1.26 times for children, who were successfully BCG vaccinated.

Most mothers in rural Guinea-Bissau are not aware of which vaccines are recommended at which age. BCG and oral polio vaccine are scheduled at birth and further vaccines are scheduled after 6 weeks of age, and only BCG and yellow fever vaccine are administered in the arm. Thus, mothers were told that we were asking about “the vaccine against tuberculosis given in the left arm and that often leaves a small scar”. Mothers do not take their infant for a specific vaccine and we were therefore not able to disentangle the costs of bringing the infant for BCG vaccination from the costs of bringing the infant for other vaccines. Aside from vaccination contacts, the mothers were asked if they had taken their infant for consultations. All reported health contacts (seeking vaccination or consultation) prior to date of BCG were counted as possible opportunities for BCG vaccination. Outreach vaccination is part of the national vaccination programme and was conducted in some villages during the study period. We were not able to account for outreach vaccination, although mothers of infants vaccinated during outreach vaccination most likely would report to have spent little time and no money on seeking vaccination.

In a country like Guinea-Bissau with few national registries and large informal sector, it is difficult to assign a value to mothers' time. We used estimates of average monthly earning to calculate the value of an hour of a mother's time. However, this estimate contains much uncertainty, and is likely to differ significantly between urban and rural women. In absence of better estimates, we assumed that the monthly earning on average was representable for the mothers in rural Guinea-Bissau.

To our knowledge, no other study has assessed the household costs of seeking BCG vaccination. We have previously assessed the household costs of seeking measles vaccination in Guinea-Bissau, and found that mothers on average took their children for vaccination 1.4 times with an average cost of 2.04 USD [3]. We found that mothers of BCG-vaccinated children on average took their infants for vaccination 1.26 times with an average cost of 1.89 USD. We did not assign a cost to the vaccination opportunity at the time of birth for children born in health facilities. 79% of mothers of unvaccinated infants who had sought BCG vaccination were told to return another day. One could speculate that seeking BCG vaccination in vain may affect subsequent behaviour. Hence, the time and money spent may prevent the mother from seeking vaccination again, or may even prevent other mothers from seeking BCG vaccination for their infant, but these potential wider consequences were not assessed in our study.

## 5. Conclusion

Not opening a vial of BCG vaccine to save costs not only delays BCG vaccination, but also increases household costs and time spent on seeking BCG vaccination. To avoid that mothers seek BCG vaccination in vain, BCG vaccination should be provided at the first health-facility contact, opening a vial of BCG vaccine even for a single unvaccinated infant.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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