

Household costs of seeking BCG vaccination in rural Guinea-Bissau

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1 **Introduction**

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

6 *Bacillus Calmette-Guérin* (BCG) vaccine is recommended to be given at birth in countries with high
7 tuberculosis burden¹. The vaccine is supplied in 20-dose vials, and like other live vaccines, once
8 reconstituted the vaccine must be used within 6 hours. The official wastage target for BCG was
9 25% in Guinea-Bissau in 2013-2017². In an attempt to reduce vaccine wastage, most health centres
10 only provide live vaccines on a specific week day. However, even on these days a vial is not opened
11 unless a sufficient number of infants (10 in Guinea-Bissau) are present for vaccination, causing
12 mothers to seek vaccination in vain³⁻⁵. Thus, BCG is often delayed in Guinea-Bissau⁴, and in other
13 low-income countries^{6,7}.

14 Delays in BCG vaccination are not monitored through administrative data, and the high BCG
15 coverage (88% globally in 2017⁸) reported at 12 months of age does not call for action. Despite
16 BCG being developed to protect against tuberculosis, increasing evidence supports that the vaccine
17 has beneficial non-specific effects (NSE)⁹, reducing mortality by more than can be explained by the
18 prevention of tuberculosis. Even small delays in BCG vaccination may be important for the benefits
19 of NSEs: In a meta-analysis of three randomised trials among low-weight infants in Guinea-Bissau
20 for whom vaccination is normally delayed, BCG-at-birth was associated with 38% (17-54%) lower
21 mortality within the neonatal period compared with infants with delayed vaccination¹⁰. The effect
22 was 45% (7-68%) within three days after vaccination¹⁰.

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

27 **Methods**

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

35 All mothers were asked whether their infant had received the BCG vaccine against tuberculosis
36 (explained as “the vaccine given in the arm that often makes a small scar”), and date of BCG was
37 obtained from the infant’s vaccination card. Mothers of infants born in a health facility were asked
38 whether their infant had received BCG at birth. The interview was terminated for infants vaccinated

39 at birth at a health facility. However, some mothers stated that their infant received BCG vaccine at
40 birth, although the date of BCG vaccination was registered to be later. Since very few infants are
41 hospitalised longer than 7 days after birth, infants stated to be BCG-vaccinated at birth in a health
42 facility and with a registered date of BCG vaccination within 7 days after birth were classified as
43 brought for vaccination 0 times. Infants stated to be BCG-vaccinated at birth in a health facility and
44 with a date of BCG vaccination after 7 days after birth were assumed to have been brought for BCG
45 vaccination once.

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

55 All costs were collected in West-African Francs (CFA), and converted into US dollars (USD) using
56 the 2016 average exchange rate of 594 CFA to 1 USD. The value of time spent seeking BCG
57 vaccination was calculated based on an estimated average monthly earning of 61 USD (2011,
58 Guinea-Bissau) by Knight et al¹¹. Using World Bank Consumer Price Index¹² this corresponded to
59 an average monthly earning of 69.94 USD in 2016. We assumed 176 working hours per month as in
60 a previous study³, resulting in a value of 0.36 USD per hour of a mother's time. We calculated the
61 costs of seeking BCG vaccine per infant among those who were stated not to be BCG vaccinated at
62 birth, by multiplying the value of the mother's time by time spent seeking vaccination and adding
63 transportation costs. If the mother had sought BCG vaccination for her infant more than once, the
64 cost of seeking BCG was multiplied by the number of times. We calculated an average cost of
65 seeking BCG vaccination per infant among children who had been brought for vaccination.

66 **Results**

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

75 Among the 2271 infants where information was obtained, 1850 (81%) were BCG vaccinated at time
76 of interview. On average mothers had sought BCG vaccination 1.17 times; 1.26 times among BCG-
77 vaccinated infants and 0.82 times among infants who had not yet been vaccinated (Excluding

78 children who had not been brought for vaccination, mothers of unvaccinated children on average
79 sought BCG vaccination 1.97 times). Among the 1753 infants for whom BCG vaccination had been
80 sought, a median of two hours was spent away from home (Range: 0-14 hours) (Table 1), but 11
81 (0.1%) mothers had spent more than 24 hours away from home. 315 (16%) of the infants' mother
82 paid for transport to the health facility. Among these, the median transport cost was 0.84 USD
83 (Range: 0.17-11.78) (Table 1). The average total cost of seeking BCG vaccination was 1.89 USD
84 per infant among those who had sought BCG vaccination. The total cost of seeking BCG
85 vaccination differed according to birth location: The average cost of seeking BCG for infants born
86 at home was 1.93 USD. The average cost for infants born in health facilities was 1.71 USD (Table
87 1). When stratifying by BCG vaccination status at time of interview the average cost of seeking
88 BCG vaccination among infants BCG-vaccinated was 1.89 USD. Among the BCG-unvaccinated
89 infants, 169 (42%) had been brought for BCG vaccination at an average cost of 2.83 USD (Table 2).
90 The older the infant, the more likely the mother was to have sought BCG vaccination several times
91 (Figure 1).

92 Among BCG-unvaccinated infants at time of interview, mothers to a subset of infants (275) were
93 asked for reasons for the infant not being vaccinated. The majority of these, 205 (75%) knew that
94 vaccines were recommended at birth, and 53 (19%) had sought vaccination. Of these, 42 (79%)
95 were told to return another day since no BCG vaccine vial was opened. Among the 222 infants who
96 had not been brought for vaccination, mothers gave several reasons for not seeking BCG
97 vaccination: distance (116 (52%)), lack of money (124 (56%)) and waiting for vaccination outreach
98 (116 (52%)).

99 **Discussion**

100 Utilising the HDSS setup in rural Guinea-Bissau, we were able to assess household costs of seeking
101 BCG vaccination. We found that mothers on average brought their infant for BCG vaccination 1.26
102 times before obtaining the vaccine and that average household cost of seeking BCG vaccination was
103 1.89 USD per BCG-vaccinated infant. At the time of interview, 42% of unvaccinated infants had
104 been brought for BCG vaccination with an average household cost of 2.83 USD. This is equivalent
105 to the UNICEF price ranges of 1.36-3.24 USD per vial of BCG in 2016¹³. Mothers seeking BCG
106 vaccination, spent an average of 2 hours (Range: 0-14 hours) on obtaining the vaccine for their
107 infant, with 0.1% of mothers spending more than 24 hours. The average household costs of seeking
108 BCG vaccination was almost 1 USD higher among children brought for BCG vaccination without
109 obtaining the BCG vaccine (2.83 USD) than for children, who were successfully BCG vaccinated
110 (1.89 USD). This was mainly because children not succeeding in obtaining BCG, despite seeking
111 BCG vaccination, were brought for vaccination 1.97 times compared with 1.26 times for children,
112 who were successfully BCG vaccinated.

113 Most mothers in rural Guinea-Bissau are not aware of which vaccines are recommended at which
114 age. BCG and oral polio vaccine are scheduled at birth and further vaccines are scheduled after 6
115 weeks of age, and only BCG and yellow fever vaccine are administered in the arm. Thus, mothers
116 were told that we were asking about "the vaccine against tuberculosis given in the left arm and that
117 often leaves a small scar". Mothers do not take their infant for a specific vaccine and we were

118 therefore not able to disentangle the costs of bringing the infant for BCG vaccination from the costs
119 of bringing the infant for other vaccines. Aside from vaccination contacts, the mothers were asked if
120 they had taken their infant for consultations. All reported health contacts (seeking vaccination or
121 consultation) prior to date of BCG were counted as possible opportunities for BCG vaccination.
122 Outreach vaccination is part of the national vaccination programme and was conducted in some
123 villages during the study period. We were not able to account for outreach vaccination, although
124 mothers of infants vaccinated during outreach vaccination most likely would report to have spent
125 little time and no money on seeking vaccination.

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

131 To our knowledge, no other study has assessed the household costs of seeking BCG vaccination.
132 We have previously assessed the household costs of seeking measles vaccination in Guinea-Bissau,
133 and found that mothers on average took their children for vaccination 1.4 times with an average cost
134 of 2.04 USD³. We found that mothers of BCG-vaccinated children on average took their infants for
135 vaccination 1.26 times with an average cost of 1.89 USD. We did not assign a cost to the
136 vaccination opportunity at the time of birth for children born in health facilities. 79% of mothers of
137 unvaccinated infants who had sought BCG vaccination were told to return another day. One could
138 speculate that seeking BCG vaccination in vain may affect subsequent behaviour. Hence, the time
139 and money spent may prevent the mother from seeking vaccination again, or may even prevent
140 other mothers from seeking BCG vaccination for their infant, but these potential wider
141 consequences were not assessed in our study.

142 **Conclusion**

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

147 **Competing interests:** None

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158

159

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

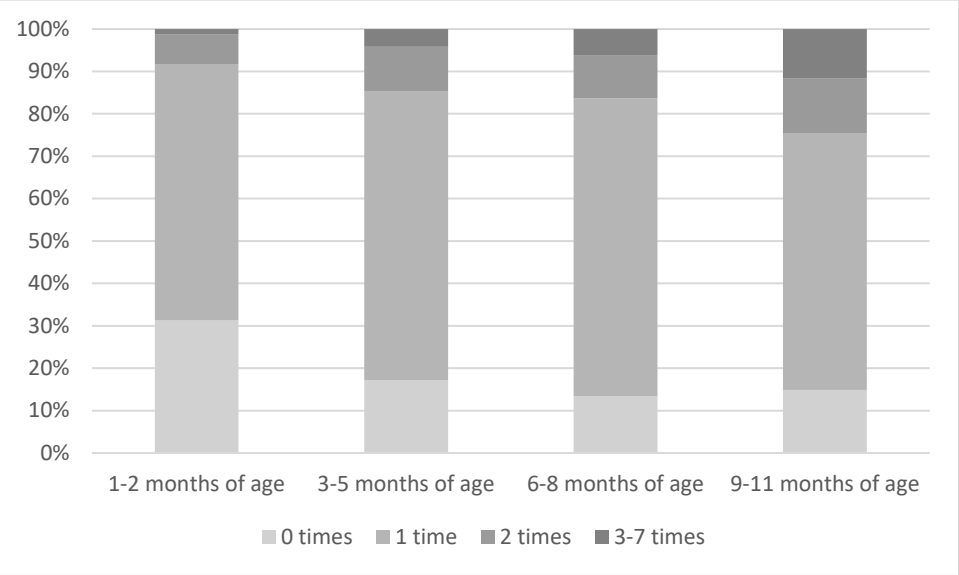


Table 1. BCG vaccination opportunities and costs of seeking BCG vaccination according to birth location

	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 (hours)	Number of mothers who paid for transport	Transport costs of seeking BCG vaccination (USD)	Average costs of seeking BCG vaccination (USD) ²
Birth place	n	n (%)	n (%)	n (%)	Mean (sd)	Median (Range ¹)	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)

¹ With exception of 11 mothers, who reported to have spent more than 24 hours seeking BCG vaccination per time

² 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 (hours)	Number of mothers who paid for transport	Transport costs of seeking BCG vaccination (USD)	Average costs of seeking BCG vaccination ² (USD)
	n	n (%)	n (%)	Mean (sd)	Median (Range ¹)	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)

¹ With exception of 11 mothers, who reported to have spent more than 24 hours seeking BCG vaccination per time

² 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)