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Household experience and costs of seeking measles vaccination in rural Guinea-Bissau

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Abstract

OBJECTIVES Children younger than 12 months of age are eligible for childhood vaccines through the public health system in Guinea-Bissau. To limit open vial wastage, a restrictive vial opening policy has been implemented; 10-dose measles vaccine vials are only opened if six or more children aged 9–11 months are present at the vaccination post. Consequently, mothers who bring their child for measles vaccination can be told to return another day. We aimed to describe the household experience and estimate household costs of seeking measles vaccination in rural Guinea-Bissau.

METHODS Within a national sample of village clusters under demographic surveillance, we interviewed mothers of children aged 9–21 months about their experience with seeking measles vaccination. From information about time and money spent, we calculated household costs of seeking measles vaccination.

RESULTS We interviewed mothers of 1308 children of whom 1043 (80%) had sought measles vaccination at least once. Measles vaccination coverage was 70% (910/1308). Coverage decreased with increasing distance to the health centre. On average, mothers who had taken their child for vaccination took their child 1.4 times. Mean costs of achieving 70% coverage were 2.04 USD (SD 3.86) per child taken for vaccination. Half of the mothers spent more than 2 h seeking vaccination and 11% spent money on transportation.

CONCLUSIONS We found several indications of missed opportunities for measles vaccination resulting in suboptimal coverage. The household costs comprised 3.3% of the average monthly income and should be taken into account when assessing the costs of delivering vaccinations.

keywords measles vaccine, Guinea-Bissau, household costs, missed opportunities

Introduction

In low-income countries, WHO recommends Bacille Calmette-Guerin (BCG) vaccine at birth followed by three doses of pentavalent vaccine (diphtheria-tetanus-pertussis-hepatitis B-*Haemophilus influenza*e type b) and oral polio vaccine (OPV) at 6, 10 and 14 weeks of age. The first dose of measles vaccine (MV) is recommended at 9 months of age [1]. In Guinea-Bissau in West Africa, routine vaccinations are provided free of charge at health centres and through outreach services.

Although measles mortality has dropped by an estimated 75% between 2001 and 2014 [2] , measles was still the leading cause of vaccine-preventable deaths in children in 2016 [3]. The World Health Assembly has committed to increase MV coverage to at least 90% nationally and regional measles elimination goals have been set. In 2020, measles elimination should be achieved in at least five WHO regions [2]. However, with an MV coverage of 69% in 2014 in Guinea-Bissau [4], the national MV coverage goal of 90% is far from within reach. In Guinea-Bissau, here are two major barriers at the health centre for getting vaccinated. First, targets for low vaccine wastage have entailed a restriction on opening of multidose vials of live vaccines. The lyophilised live MV comes in 10-dose vials, which have to be used within 6 h after diluting the vaccine. Focus on vaccine wastage has increased; while the MV target wastage rate in Guinea-Bissau was 15% in 2010, it was 11% in 2014 [5]. Consequently, a MV vial is not opened unless a

sufficient number of children due to be vaccinated are present [6]. Also, the performance evaluation of the Guinean vaccination programme is based on vaccination coverage at 12 months of age. The WHO/UNICEF Joint Reporting Form instructs the Ministry of Health to report vaccination coverage among infants [7], and thus, vaccination of children older than 12 months does not count in the statistics [6]. As a result, the Expanded Programme of Immunization (EPI) in Guinea-Bissau has increasingly focused on infants and children older than 12 months are no longer entitled to vaccines [6].

Consequently, a MV vial is not opened unless at least six 9- to 11-month-old children are present to receive MV [6]. This implies that mothers can take their children for vaccination several times before succeeding in having their child vaccinated, and for some mothers, this delay entails that her child becomes too old to receive MV [6]. The costs incurred by the household of seeking vaccinations could be substantial as mothers often have long distances to the health centre, long waiting times and due to the restrictive vial opening policy may be told to return another day.

Household costs of seeking routine vaccination has to our knowledge not been studied in a low-income setting. We describe the experience with seeking MV and estimate household costs of seeking MV under the restrictive MV policy in Guinea-Bissau.

Methods

The Bandim Health Project (BHP) follows 182 clusters of approximately 100 women of fertile age and their under-five children in a health and demographic surveillance system in rural Guinea-Bissau. The clusters are visited every 6 months by BHP mobile teams, registering new pregnancies and children and collecting information aimed at assessing the health of children under survey, including vaccination status. Information on vaccinations is obtained from the child's health card. A nurse accompanies the mobile teams and offers routine vaccines to children with missing vaccinations. Global Positioning System (GPS) coordinates of the villages and the closest health centre have been collected.

In 2011, the BHP initiated a cluster-randomised trial (MVEPI) to evaluate the effects of the restrictive MV policy. Villages were cluster-randomised to follow the national MV policy; MV between 9 and 11 months of age and only if 6 or more eligible children were present (the control arm) or to receive MV if the child was unvaccinated and between 9 and 35 months of age regardless of number of children present (the intervention arm). The trial outcome measures are mortality, morbidity and growth. We took advantage of the trial set-up to collect information on experiences with seeking MV among all children being screened for enrolment.

Data collection

Data collection for this study took place between February 2013 and September 2014 in the regions where the MVEPI trial was implemented, that is Oio, Gabu, Bafata, Quinara, Tombali, Bijagos Islands (Bubaque/Bolama). No MV shortages occurred during this period [8]. The heavy rains from June to November damage the already poorly conditioned roads in Guinea-Bissau, increasing transportation time, or even making access to some villages impossible. To ensure that the seasonal variation in transportation time was captured, all villages were visited at least twice, once during the rainy season and once during the dry season.

We interviewed all mothers/guardians of children aged 9–14 months in their home. Children in this age group were too young to have received MV at the previous visit to the village 6 months earlier. We specified that we were interested in obtaining information about the vaccine 'given in the back' (only MV is administered at this site in Guinea-Bissau) to avoid confusion with other vaccines. We asked the mother how many times she had sought MV, transportation costs and time spent on seeking MV. If the mother was not present at the first visit, another interview was attempted at the next visit 6 months later, when the child was 15–21 months old.

Children enrolled in the MVEPI control arm were interviewed again at the subsequent visit 6 months later as they may have sought vaccination at the health centre.

Data analyses

Measles vaccine coverage was assessed among children screened for enrolment in MVEPI and whose health card was inspected on the day of the interview or at a subsequent visit. We calculated MV coverage as the proportion of children already vaccinated according to the vaccination card. Some mothers reported taking their child zero times for MV, although the child was already measles-vaccinated due to outreach. We re-coded these mothers to have gone once for vaccination (n = 128). For the analyses of transportation time and costs, it was assumed that these mothers did not go to the health facility and thus incurred no costs.

Costs of transportation were recorded in West-African Francs (CFA) and converted to US dollars using the 2013 average exchange rate of one USD to 478.7 CFA (www.oanda.com). Time spent seeking vaccination was

recorded as hours from leaving home until returning home.

Coverage of other vaccines by 12 months of age was assessed for children screened for enrolment in MVEPI with a health card seen between 12 and 23 months of age. A child was considered otherwise fully vaccinated if he/she had received one dose of BCG, three doses of pentavalent vaccine and three doses of OPV by 12 months of age. We also assessed coverage of the third dose of pentavalent vaccine as this vaccine has no vial opening restriction. We calculated the distance from the GPS mapped village centre to the nearest health centre.

We calculated the costs of seeking MV for each child individually. The costs of time spent on seeking vaccination, were valued according to the average salary across all sectors in the economy. Based on data on yearly earnings from 36 countries, Knight *et al.*[9] constructed a regression model with GNI per capita as the independent variable. For Guinea-Bissau, this model estimated average monthly earnings as 61 USD in 2011. We converted this to 0.35 USD per hour, assuming 176 working hours per month (22 working days*8 h a day). Costs of seeking vaccination for each child was estimated by multiplying number of hours spent on seeking MV by the average hourly earning, adding costs of transportation, if any, and multiplying by the number of times vaccination was sought.

Results

Study population

A total of 2298 children aged 9–21 were eligible for screening for enrolment in MVEPI and therefore eligible for interview on experiences with MV. Of these, 1503 mothers were present for interview (65%). In 32% of visits, the mother was not present, and for 3% of the visits, the field assistant provided no reason for not interviewing.

We included 1308 children with seen health cards and complete information on number of times MV was sought (Figure 1). Of the responses with complete information, 70% (910/1308) were measles vaccinated. A total of 1043 (80%) of children were taken for MV at least once.

Factors associated with seeking measles vaccination

Twenty-nine percentage (95% CI: 25-33%) (142/490) of children aged 9-11 months had not been taken for MV, 55% (51–59%) (270/490) were taken for MV once, and 16% (13-19%) (78/490) were taken twice or more for MV (range; 2–4 times) (Figure 2). Coverage was 59% (55–63%) (287/490).

Among children aged 12–21 months, 67% (64–70%) (548/818) were taken for MV once and 18% (15–21%) (147/818) twice or more (range; 2–6 times). Coverage in children 12–21 months was 76% (73–79%) (623/818).

Among measles-unvaccinated children, 34% (29–39%) (135/398) of mothers had attempted to get their child vaccinated (Figure 2); the proportion was higher in children who were 12 months or older (Figure S1). 9% (6–12%) of children not yet MV had been taken for MV 3–6 times (Figure 2). The number of times varied by region (Figure S2). The proportion of children taken for MV increased with age (Figure 3). Thus, 35% (27–43%) (53/150) of <10-month-old children were not taken for MV yet, while the proportion was 11% (6–16%) among children aged 14–21 months (Figure 3).

Coverage was lower, and children were taken fewer times for MV among those living >5 km from a health centre than among children living within a 2 km radius ($P < 0.01$) (Figure S3). Thus, 76% (73–80%) (441/580) of mothers living >5 km away took their child for vaccination and coverage was 65% (61–69%). In comparison, 83% (80–87%) (363/437) living ≤2 km away were taken for MV with a coverage of 75% (71–79%) (Figure S3).

Overall, 80% (78–82%) (1043/1308) of the interviewed mothers took their child for MV at least once; excluding children who were vaccinated by outreach ($n = 128$) the proportion was 77% (75–80%) (916/1180).

Costs of seeking vaccination under the national measles vaccine policy

Of 910 children (86% (84–88%), 782 already measles vaccinated had been taken for MV at least once. This was 134/398 (34% (29–39%)) among children not measles vaccinated. Thus, a total of 916 children were taken for MV. Among mothers who took their child for MV, 99/916 (11% (9–13%)) spent money on transportation (Table 1); on average 1.05 USD (SD 1.14). A larger proportion of mothers in Quinara and Tombali spent money on transport relative to other regions. Time spent on seeking vaccination was missing in 5% of the interviews (43/916); 44% (380/873) of mothers spent ≤2 h (range 0–2 h) and 5% (44/873) spent more than 8 h (range 9–36 h) (Table 2). The regional variation was substantial with 68% (61–75%) (91/183) of mothers in Gabu spending ≤2 h (range; 0–2 h) vs. 19% (12–26%) (25/132) in Tombali.

The majority of measles-unvaccinated children (96% (381/398)) were enrolled in the MVEPI study and 32%

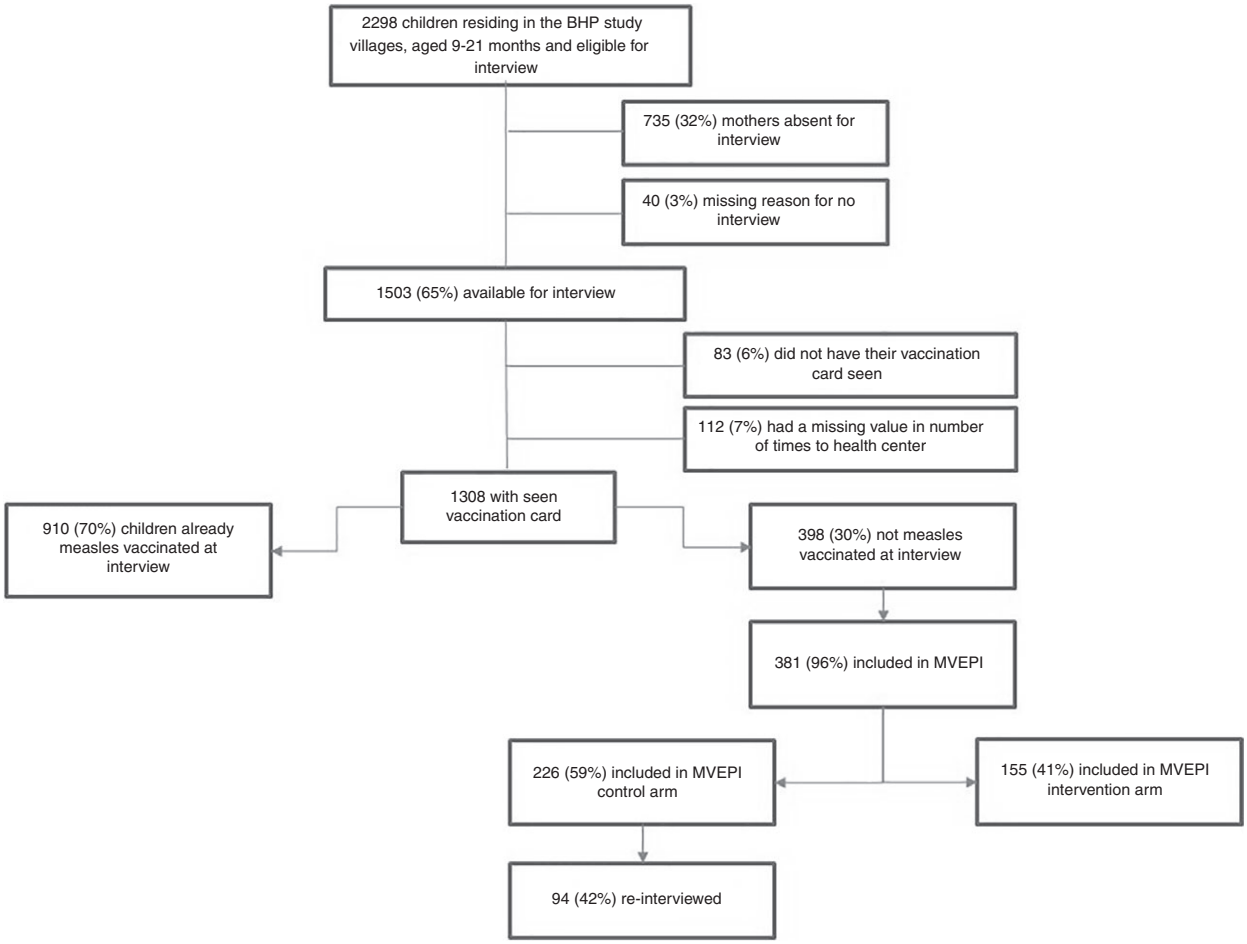

Figure 1 Interview participant flow.

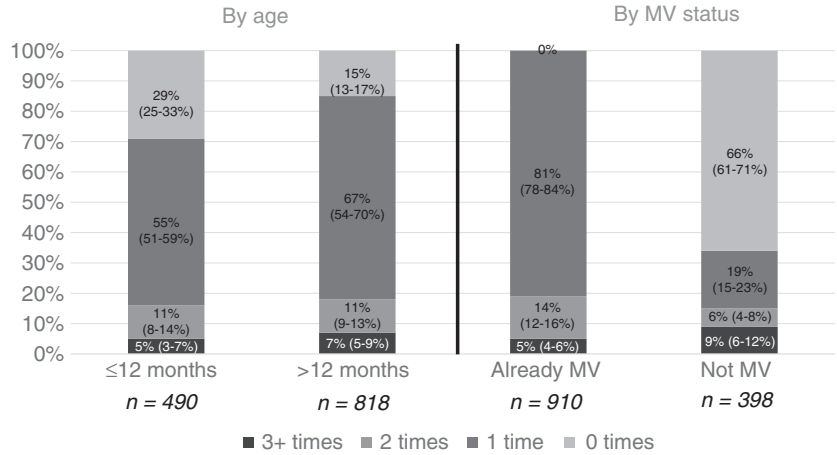

Figure 2 Number of times the mother went to the health centre for vaccination by age of child and by MV status, overall.

(121/381) of these reported having sought MV; 66/121 (55%) mothers said they were told to come back another day or that not enough children were present to open a vial; 226/381 children were enrolled in the control arm of MVEPI and had not yet been vaccinated at the interview day. We re-interviewed 96/226 (42%) at the

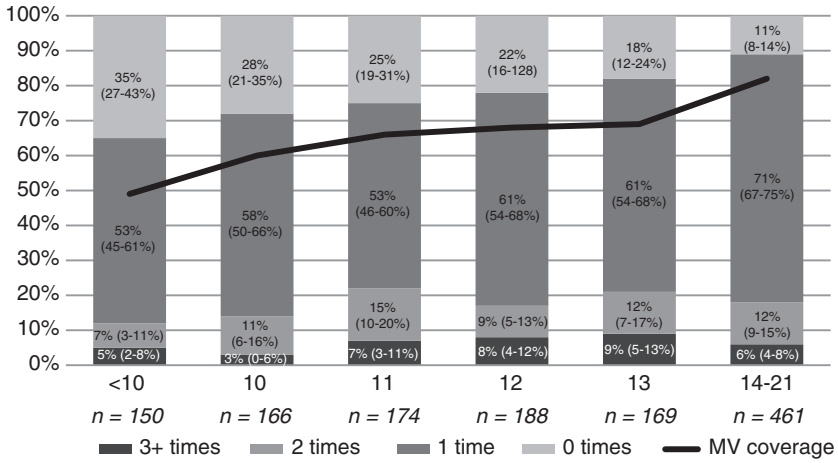

Figure 3 Number of times the mother took her child for vaccination, by child's age (months) at interview.

Table 1 Transport costs for seeking measles vaccination (2013 USD)

	Oio (n = 39)	Gabu (n = 268)	Bafata (n = 201)	Quinara (n = 210)	Tombali (n = 138)	Bijagos (n = 60)	Total (n = 916)
Number of mothers who paid for transport (n (%(95% CI))	1 (3 (−2 to 8))	4 (2 (0–4))	30 (15 (10–20))	41 (20 (15–25))	23 (17 (11–23))	0 (0)	99 (11 (9–13))
Mean costs of transport (SD)*	1.26	2.78 (1.74)	1.27 (0.70)	1.60 (1.36)	1.08 (0.90)	N/A	1.05 (1.14)

*Among those who paid for transport.

subsequent visit 6 months later. MV coverage at the second interview was 77% (74/96), but 88% said they took their child for MV.

The mean cost was 1.33 USD (SD 1.43) per time a child was taken for MV (Table 2). On average, mothers took their children for MV 1.40 times – thus, 0.4 times (equivalent to 0.53 USD) per child could have been avoided if the staff provided MV at every opportunity. The average costs of seeking vaccination among mothers who took their children for MV more than once was 4.51 USD (SD 6.83) (distribution of costs in Figure S4). The mean cost incurred by the mothers, and hence, the mean cost of attaining a total coverage of 70% was 2.04 USD (SD 3.86) per child taken for vaccination. Strikingly, two mothers living in Tombali and Quinara spent USD 41.7 and USD 83.5, respectively, on taking their child for MV. The high costs were due to long transportation time (24 and 36 h) and high transportation costs (USD 2 and USD 8). Both took their child for MV four times.

According to our estimates, taking a child for MV accounts for 3.3% of the estimated average monthly income of 61 USD in Guinea-Bissau. Further, the costs of seeking MV was equivalent to 19.4% of the annual expenditure on health per capita of 10.5 USD in 2013 [10].

Other vaccinations and missed opportunities for measles vaccination

Among the 1308 children, 1124 (86%) had their vaccination card inspected between 12 and 23 months of age (Table 2). A significantly higher proportion of children taken for MV were otherwise fully vaccinated by 12 months (89% (808/906)) than children who were not taken for MV (69% (150/218)) ($p < 0.01$). Similarly, coverage of the third pentavalent vaccine dose was 77% (168/218) among children not taken for MV yet and 96% (873/906) among children taken for MV. In addition, 35% (77/218) of children not yet taken for MV had received a delayed pentavalent vaccine between 9 months and age of health card inspection. Further, 3% (27/803) of measles-vaccinated children received a delayed pentavalent vaccine between 9 months of age and date of measles vaccination, while 29% (92/321) of measles-unvaccinated children received a delayed pentavalent vaccine between 9 months and date of health card inspection (Table 3).

Discussion

Measles vaccination coverage was 70%. Thirty-four percentage of children not measles-vaccinated had been

Table 2 Time spent on seeking vaccination*

	Oio (n = 38)	Gabu (n = 259)	Bafata (n = 183)	Quinara (n = 202)	Tombali (n = 132)	Bijagos (n = 59)	Total (n = 873)
Mean hours (SD)	3.86 (2.08)	2.26 (1.58)	3.10 (2.67)	4.97 (4.00)	4.77 (3.35)	2.88 (2.04)	3.55 (3.06)
Number of mothers spending ≤2 h (n(%(95% CI)))	9 (24 (10 to 38))	176 (68(62–74))	91 (50 (43–57))	51 (25 (19–31))	25 (19 (12–26))	28 (47 (34–60))	380 (44 (41–47))
Number of mothers spending 2–8 h (n(%(95% CI)))	27 (71 (57 to 85))	80 (31 (25–37))	85 (46 (39–53))	130 (64 (57–71))	96 (73 (65–81))	31 (53 (40–66))	449 (51 (48–54))
Number of mothers spending 9–36 h (n(%(95% CI)))	2 (5 (−2 to 12))	3 (1 (0–2))	7 (4 (1–7))	21 (10 (6–14))	11 (8 (3–13))	–	44 (5 (4–6))
Mean costs of going once (2013 USD (SD))	1.33 (0.86)	0.80 (0.77)	1.17 (1.26)	1.97 (1.98)	1.76 (1.50)	0.98 (0.71)	1.33 (1.43)
Mean cost per child taken for MV (mean cost of achieving 70% coverage) (2013 USD (SD))	1.67 (1.30)	1.03 (1.11)	1.80 (2.71)	3.31 (6.31)	2.64 (4.16)	1.72 (2.58)	2.04 (3.86)

*Among all interviewed who reported having gone to HC at least once (missing = 43).

Table 3 Other vaccinations among children interviewed with seen vaccination card between 12 and 23 months of age

	MV seeking		MV status	
	Took their child for MV (n = 906)	Did not take their child for MV (n = 218)	Already measles vaccinated (n = 803)	Not yet measles vaccinated (n = 321)
Otherwise fully vaccinated (received BCG, 3× pentavalent, 3× OPV)	89% (95% CI:87–91%) (n = 808)	69% (95% CI: 63–75%) (n = 150)	90% (95% CI:87–93%) (n = 725)	71% (95% CI:66–76%) (n = 229)
Had received penta3	96% (95% CI:95–97%) (n = 873)	77% (95% CI: 71–83%) (n = 168)	97% (95% CI: 95–99%) (n = 782)	80% (95% CI:76–84%) (n = 255)
Received delayed pentavalent vaccine after 9 months of age*	18% (95% CI:16.21%) (n = 167)	35% (95% CI:29–41%) (n = 77)	3% (95% CI:1–5%) (n = 27)	29% (95% CI:24–34%) (n = 92)

*For children already measles vaccinated, we report the proportion receiving pentavalent vaccine between 9 months and date of MV.

taken for MV once or more (range 1–6 times) without succeeding. Nineteen percentage of children already measles-vaccinated had been taken for MV twice or more (range 2–5 times). There were also missed MV opportunities not captured by our data: 35% of the mothers who reported not having taken their child for MV had received a delayed pentavalent vaccine after 9 months of age.

On average mothers took their child for MV 1.4 times; half of the mothers spent more than 2 h (range 2.5–36 h) with 5% spending more than 8 h seeking MV and 11% spent money on transportation.

The household costs of achieving a 70% MV coverage in rural Guinea-Bissau was 2.04 USD per child taken for MV, equivalent to 3.3% of the estimated average monthly income and 19.4% of annual expenditure on health per capita.

We have found no other study assessing and quantifying household costs and experiences of seeking routine MV in a low-income setting. Our estimates rely on a large sample of 1308 children embedded in the routine data collection of the BHP enabling us to follow children over time and providing extra information on reasons for not receiving MV at the health centre.

During village visits, the BHP teams see the vaccination card of approximately 70% of the children <2 years [6]. In the present study, 65% of the mothers of children eligible for interview were present. As some mothers work away from home and may not have time to take their children for vaccination, it could be speculated that the number of times a child was taken for MV was overestimated. However, we are more likely to have underestimated the number of times; in a study from 1998 in Guinea-Bissau, mother's recall of the child being measles-vaccinated was an accurate marker of measles vaccination status, although mothers' recall slightly underestimated coverage [11]. This is also supported by 128 mothers who reported not having taken their child for MV even though the child had received MV; and 35% of the mothers who had not taken their child for MV, received a delayed pentavalent vaccine after 9 months of age, indicating that they had taken their child for vaccination.

Although the low MV coverage in Guinea-Bissau is likely to be a consequence of the restrictive MV policy, health-seeking behaviour also plays a role: coverage of the third dose of pentavalent vaccine was higher among children taken for MV than in children not taken for MV. This may reflect that mothers who did not take their child for MV were less likely to take their child for vaccination in general. Several factors have been associated with completeness and timeliness of vaccinations in low-income countries [12]: Among others, out-of-hospital births, no reminder about the next vaccination visit, low socio-economic status, several children in the household and mothers working outside the home [12] play a role. Despite barriers to seek vaccination, our results show that many mothers took their child for MV without succeeding and some instead received a missing pentavalent vaccine.

We found a measles vaccination coverage of 59% among 9- to 11-month-old children for whom we saw the vaccination card. Thus, we may have overestimated measles vaccination coverage as children without a vaccination card or who travel and therefore do not have their card inspected, may have lower coverage [6].

We did not assess the household costs of vaccination for other vaccines; we would expect that the costs of seeking vaccines in multidose vials which can be used over 4 weeks (e.g. pentavalent and OPV) or single-dose vials (rotavirus and pneumococcal vaccines) to correspond to the cost of a single visit, while the household costs of obtaining other lyophilised vaccines (BCG and yellow fever) would be higher as these are also subject to restrictions on vial opening.

We observed that measles vaccination coverage decreased with distance to the health centre. Nonetheless, 76% of interviewed caretakers living >5 km from the health centre took their child for MV. However, coverage was only 65%, indicating that health centre policy plays a role in vaccination success. Among children included in the MVEPI control arm, we found that at least 55% of missed opportunities could be directly related to restrictive MV policy (the mother reported being told to come back another day). As there were no MV shortages during the data collection period [8] and 96% of children taken for MV were vaccinated with pentavalent vaccine, it seems unlikely that vaccination practices or health worker unavailability explains the low coverage.

Missed opportunities due to restrictive vial opening have also been seen in Turkey where one reason for not vaccinating children was that there were no open vials at the village health centres [13]. In an older literature review on missed opportunities for vaccination, BCG and MV vials were less frequently opened compared with Diphtheria-Tetanus-Pertussis (DTP) and OPV due to fear of vaccine wastage[14].

In general, there are two strategies to reduce open vial wastage of lyophilised vaccines; reduce vial size or increase number of participants in vaccination sessions [15]. The cost per MV dose varies substantially by vial size. In 2013 the price per dose in a 10-dose MV vial was 0.24 USD [16]. Prices for single-dose vials have not been quoted by UNICEF since 2003, where a single-dose vial was 0.77 USD [16]. Hence, the cost of vaccinating children is less if more than three doses are used from

each 10-dose MV vial, than using only single-dose vials. In a simulation study of MV vial size in Niger, reducing vial size from 10 dose to single dose increased the costs per dose as well as the total volume of vials and cold chain; increasing costs of vaccine administration and waste disposal, which far outweighed the costs saved from decrease in wasted doses [17]. Thus, if coverage is to be increased, the restrictive vial opening policy must be abolished. Even if a 10-dose vial was used only for one child, the cost of measles vaccinating a child is still only slightly more expensive than one dose of pentavalent vaccine, which is between 1.85 and 2.11 USD in a 10-dose vial [18]. In addition to protecting against measles infection, MV also has a profound impact on survival, reducing child mortality by up to 50% in vaccinated compared to MV-unvaccinated children [19]. This is far more than can be explained by prevention of measles deaths [20–22], indicating that MV has beneficial non-specific effects on the immune system [19] in addition to its measles-preventive effects.

Increasing session sizes is the current policy to reduce open vial wastage in Guinea-Bissau. However, as the present study shows, this policy affects vaccination coverage and shifts the cost burden to households. Some innovative actions are being developed to increase session sizes. In a randomized controlled trial from Zimbabwe, vaccination coverage was significantly higher among mothers who received a reminder to get their child vaccinated than among mothers who did not receive any reminders [23]. Further, introducing a second dose of routine MV as recommended by the WHO [24] could increase overall MV coverage and reduce open vial wastage as more doses would be required in each session.

While proper monitoring of wastage and reasons for wastage are essential for an efficient delivery of vaccines, it is imperative that wastage targets do not compromise coverage. The WHO and Gavi provide recommended wastage targets when applying for vaccine support, but it is the country itself which defines wastage targets suitable for its setting [25]. Although Gavi has a 40% indicative maximum wastage target for MV, Guinea-Bissau has specified its wastage targets of 11–15% for MV [5]. These very low wastage targets are also specified for other African countries [26] and may indicate that restrictions on vial opening take place in several other countries as well. It is not Gavi/WHO policy to restrict measles vial opening or limiting the age criteria [24]. Although vaccination of children older than 12 months is seen as wastage, as only coverage of children <12 months of age is reported to WHO/UNICEF [7], we found that some children still receive MV after 12 months. However, the vaccination coverage rate is lower than among children younger than 12 months and enforcing a restrictive vial opening policy is therefore the main reason for the many missed opportunities among children taken for MV.

Conclusions

The restrictive MV vial opening policy and restrictive MV age policy affect coverage and result in costs for mothers in rural Guinea-Bissau. Household costs of seeking MV constituted 3.3% of the estimated average monthly income and 19.4% of the average per capita health expenditure and should be taken into account when assessing the costs of delivering vaccines. A quarter of children older than 12 months were measles-unvaccinated. To increase MV coverage, it is imperative that both the restrictive vial policy and the restrictive age policy are abandoned. Taking the low cost of MV and the marked beneficial effects associated with MV into consideration, we recommend that a 10-dose MV be reclassified as a '1+ dose vial', which is opened for a single child, irrespective of age, but which can be extended to vaccinate up to 10 children.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Number of times the mother went for vaccination according to vaccination status, children >12 months of age.

Figure S2. Number of times the mother went to the health centre for vaccination for children, by age at interview and region.

Figure S3. Number of times vaccination was sought according to distance to nearest health centre.

Figure S4. Frequency distribution of costs of seeking measles vaccination (2013 USD) (n = 872).

Figure S5. Frequency distribution of number of times a child was taken for MV (n = 1308).

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