# Effects of community health interventions on under-5 mortality in rural Guinea-Bissau (EPICS): a cluster-randomised controlled trial

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## Summary

**Background** Evidence suggests that community-based interventions that promote improved home-based practices and care-seeking behaviour can have a large impact on maternal and child mortality in regions where rates are high. We aimed to assess whether an intervention package based on the WHO Integrated Management of Childhood Illness handbook and community mobilisation could reduce under-5 mortality in rural Guinea-Bissau, where the health service infrastructure is weak.

**Methods** We did a non-masked cluster-randomised controlled trial (EPICS) in the districts of Tombali and Quinara in Guinea-Bissau. Clusters of rural villages were stratified by ethnicity and distance from a regional health centre, and randomly assigned (1:1) to intervention or control using a computerised random number generator. Women were eligible if they lived in one of the clusters at baseline survey prior to randomisation and if they were aged 15–49 years or were primary caregivers of children younger than 5 years. Their children were eligible if they were younger than 5 years or were liveborn after intervention services could be implemented on July 1, 2008. In villages receiving the intervention, community health clubs were established, community health workers were trained in case management, and traditional birth attendants were trained to care for pregnant women and newborn babies, and promote facility-based delivery. Registered nurses supervised community health workers and offered mobile clinic services. Health centres were not improved. The control group received usual services. The primary outcome was the proportion of children dying under age 5 years, and was analysed in all eligible children up to final visits to villages between Jan 1 and March 31, 2011. This trial is registered with ISRCTN, number ISRCTN52433336.

**Findings** On Aug 30, 2007, we randomly assigned 146 clusters to intervention (73 clusters, 5669 women, and 4573 children) or control (73 clusters, 5840 women, and 4675 children). From randomisation until the end of the trial (last visit by June 30, 2011), the intervention clusters had 3093 livebirths and the control clusters had 3194. 6729 children in the intervention group and 6894 in the control group aged 0–5 years on July 1, 2008, or liveborn subsequently were analysed for mortality outcomes. 311 (4·6%) of 6729 children younger than 5 years died in the intervention group compared with 273 (4·0%) of 6894 in the control group (relative risk 1·16 [95% CI 0·99–1·37]).

**Interpretation** Our package of community-based interventions did not reduce under-5 mortality in rural Guinea-Bissau. The short timeframe and other trial limitations might have affected our results. Community-based health promotion and basic first-line services in fragile contexts with weak secondary health service infrastructure might be insufficient to reduce child deaths.

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## Introduction

In 2013, 6·3 million children worldwide died before their fifth birthday. Improved health systems and services, as well as high-quality community-based interventions, are necessary to reduce child and maternal mortality.[1–5] However, in some high-mortality regions, strengthening of health systems and services is difficult because of political instability, ethnic conflict, and other socioeconomic factors,[6,7] and community-based interventions remain crucial to the reduction of child and maternal mortality. Substantial evidence shows that community-based interventions promoting improved home-based practices and care-seeking behaviour can have a large impact on maternal and child mortality. These interventions include training of traditional birth attendants; introduction of one-to-one health education through community health workers, traditional birth attendants, and peers; and community mobilisation through participatory approaches, including women's discussion groups.[8–13] Studies[14–16] have shown reductions in child deaths through training of community health workers to treat childhood illness and through community mobilisation. However, these methods have not been consistently successful.

## Research in context

### Evidence before this study

We searched PubMed and the Cochrane Library, along with general search engines on the internet, for any articles published from Jan 1, 1990, to Dec 31, 2007, using the terms "community health promotion", "health clubs", "child mortality", "neonatal mortality", and "community health workers". We focused particularly on randomised controlled trials and other studies showing high-quality evidence. Most of the articles reviewed were in English. Some articles reported research, often done in south Asia, that examined effectiveness of specific components of the EPICS intervention, but we did not find reviews that addressed the whole package or that were related to west Africa.

### Added value of this study

EPICS is, as far as we are aware, the first randomised controlled trial to assess child mortality reduction with a comprehensive package of interventions—including community outreach, training of community health workers, and provision of first-line treatments for diseases that cause child deaths—in a very poor region of west Africa.

### Implications of all the available evidence

Our results, taken together with the existing evidence, suggest that provision of a package of primary care interventions through community health workers and outreach might not be adequate to reduce child mortality in west Africa. Our results support the view that an integrated approach, with functioning clinics to provide second-line treatments, might be required to substantially reduce child deaths in this context.

We developed a package of interventions based on the WHO Integrated Management of Childhood Illness (IMCI) handbook,[17] focusing on strategies for community mobilisation in remote and resource-constrained settings.[9,18] In particular, introduction of community health workers in India and community mobilisation work in Zimbabwe appeared to be technically effective, cost-effective, and organisationally feasible for the setting in Guinea-Bissau that we intended to work in.[9,18] Our package included a health promotion campaign and education through community health clubs; equipping and training of community health workers to diagnose and provide first-line treatment for children's diseases and to deliver preventive care for pregnant women and newborn babies; and improving outreach services.

Guinea-Bissau is a former Portuguese colony in west Africa with a population of approximately 1·6 million. A civil war from June, 1998, to May, 1999, devastated public services and fragmented efforts of non-governmental agencies and donors. The health service infrastructure is weak; in the rural districts of Tombali and Quinara, child mortality in the 5 years prior to the baseline interview was 135 per 1000 livebirths.[19] We aimed to assess whether a community-based intervention package in the absence of health system strengthening activities could generate a rapid and cost-effective reduction in under-5 mortality in these regions.

## Methods

### Study design

EPICS (Enabling Parents to Increase Child Survival) is a cluster-randomised controlled trial in geographical clusters covering villages in the rural districts of Tombali and Quinara in Guinea-Bissau. We chose a cluster-randomised design because the intervention was delivered at the cluster level (ie, individual villages or groups of villages), and thus individual randomisation was unfeasible.

Because no accurate maps of these two districts exist and the latest census data were from 1991, a research team visited every settlement in the region to collect information on village size and location. These data were used to identify clusters, which were formed either from villages with a population of 350 or more, or from groups of smaller villages. Clusters were separated by a minimum of 4 km to minimise contamination.

A baseline survey was done between March 1 and July 31, 2007. For operational convenience, 40–52 households closest to the central meeting point in the village were selected for inclusion in the trial. Once the central meeting point was determined, field workers mapped a minimum of 40 households, and up to 52 households if available. In villages with fewer than 40 households, fieldworkers continued mapping households in the most nearby village until they reached a minimum of 40 households but not more than 52 households.

Approval for the study was obtained from the Ministry of Health of Guinea-Bissau on June 13, 2007, and from the ethics committee of the London School of Hygiene & Tropical Medicine (UK; number 5173) on Oct 3, 2007. The detailed methods were described in the published protocol.[20]

### Participants

A woman was eligible for allocation if her main residence was in one of the clusters; if her reported age was 15–49 years or if she reported being a primary caregiver of a child younger than 5 years old in the baseline survey; if she was resident in one of the enumerated households per village; and if she was interviewed in the baseline survey. Children were eligible for allocation if they were younger than 5 years at randomisation, if they resided permanently with an eligible woman at the time of the baseline survey, and if their name was recorded during the baseline survey. A child was also eligible if he or she was born to an eligible woman after randomisation, or

was born after the baseline survey and before randomisation and was alive at the time of randomisation. Women and their children were only eligible for inclusion if they gave consent to be included in the trial.

Local leaders of each village were informed about the trial protocol in their local language and were then asked to seek consent from community members. Women who were asked to take part in and who gave oral consent to the quarterly enumeration were considered to have given their implied consent to the study. Women were informed that they could withdraw consent at any time during the trial. All oral consent and ethics approval were sought before randomisation. Oral consent at the village and household levels was obtained at the time of the baseline survey. Participants were informed about activities in both groups of the trial at the time we sought consent.

### Randomisation and masking

We stratified the clusters by ethnic origin (Balanta, non-Balanta, and mixed) and by distance from a regional health centre or hospital (within 3·5 h walking distance or further), which are both important risk factors for child mortality found in a baseline survey.[19] In August, 2007, after completion of the baseline survey, all clusters were randomly allocated by the trial statistician (VM) at the London School of Hygiene & Tropical Medicine within these six strata, to either the intervention group or the control group using a computerised random number generator. Because of the nature of the services provided, masking was not feasible after randomisation. Field data collection and statistical analysis were not masked; data entry was masked.

### Procedures

All women and children residing in clusters of the intervention group were registered, provided with identity cards, and offered access to the programme activities and community interventions, regardless of whether they were from one of the households selected for analysis in the trial. Community health clubs were organised and facilitated by trained health promoters. Health promoters were young men and women who had achieved a high level of educational qualification (equivalent to GCSE in the UK) and who underwent 3 weeks of training as part of the programme. There was a mixture of individuals from the regions that we worked in (this was a priority criterion in recruitment) and those from other regions (as we could not identify enough people with the necessary qualifications). We ensured that health promoters spoke the languages relevant to the communities they worked in (as well as Portuguese and Kriol). The clubs met approximately three times a month for the first 6 months and once a month, outside the rainy season, for the remainder of the trial. The clubs used participatory methods to address a range of topics on maternal and child health. Each club meeting focused on a different issue—eg, antenatal care, safe delivery, malaria, and diarrhoea. We used a variety of approaches that drew on visualisation methods associated with participatory appraisals (eg, mapping), as well as the use of cards with drawings during activities such as "block the route" or "two-pile sorting".[18]

Each village selected at least one community health worker (one per 20–50 households) who was trained to provide basic community case management according to the country-approved protocols at the time of project design, including standard oral rehydration salt solutions for diarrhoeal disease and co-trimoxazole for moderate acute respiratory infections in children aged 2–59 months. Community-based first-line treatment for malaria was based on presumptive treatment for fever, using chloroquine for the first 12 months and then artemisinin-based combination therapy (ACT) for the remainder of the trial. Community health workers were trained to refer young infants under 2 months and children with severe disease to health facilities. Each village also selected at least one female traditional birth attendant per 20–50 households who was trained to provide home-based counselling and care for pregnant women and newborn babies, and to promote healthy pregnancy and care for young infants, facility-based delivery, and the use of clean delivery kits. The traditional birth attendants registered and monitored pregnant women, facilitated access to antenatal care, attended home deliveries with clean delivery kits, promoted newborn hygiene and thermal practices in home births, and did postnatal visits for the first 10 days after birth. Training standards were developed in line with existing country protocols and WHO standards, and all training was delivered by qualified community IMCI trainers. Ten trained community health nurses were hired to train and supervise community health workers and traditional birth attendants. They visited villages twice per month to offer mobile clinic services, which included vaccinations, supplementation, deparasitisation, and growth monitoring for children, as well as basic antenatal and postnatal consultations for pregnant women.

The intervention did not include improvements to the standard health facilities, and these services were shared by people in both intervention and control clusters. Health facilities in the area were mostly so-called type C (ie, basic rural) facilities with 1–4 members of staff, a consultation room, and a basic delivery suite. Only one regional hospital was available in the two districts. All rural facilities had very basic supplies, medicines, and vaccines, and only the hospital was suitably equipped to provide management of severe cases and emergency obstetric care. Facilities were not easily accessible for many villages. Pregnant women in the intervention group who were considered at high risk were encouraged to attend hospitals and were assisted with accommodation, transport, and modest food allowance. All services and treatments at the community level were provided free of charge at the point of delivery.

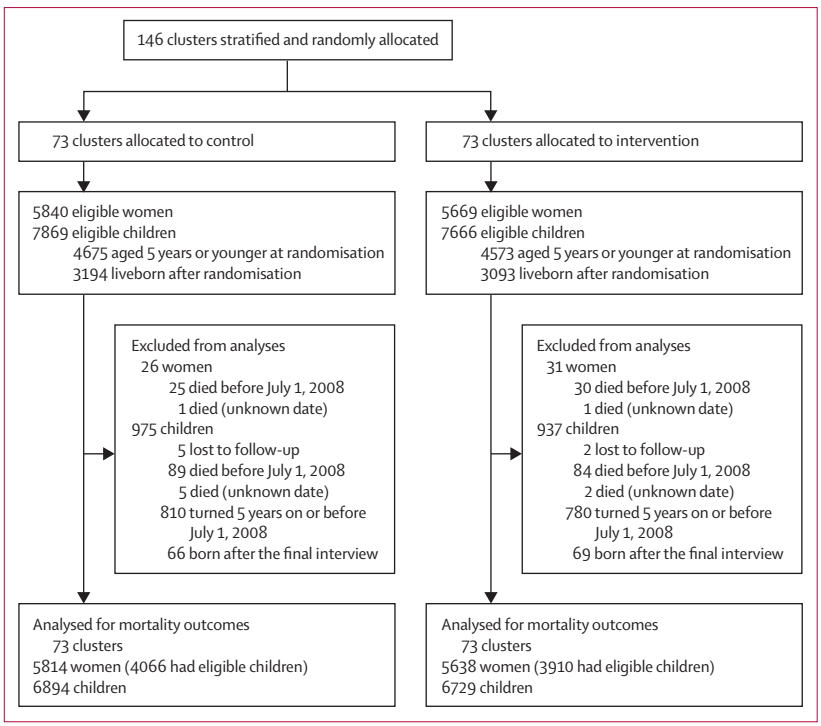


***Figure 1:*** **Trial profile**

| | Control | Intervention |
|---|---|---|
| **Clusters** | | |
| n | 73 | 73 |
| Distance to hospital (walking hours) | 4·1 (2·7) | 3·8 (2·3) |
| **Eligible women at entry** | | |
| n | 5840 | 5669 |
| Ethnic origin—Balanta | 1231 (21%) | 1294 (23%) |
| History of giving birth | | |
| Yes | 4000 (68%) | 3848 (68%) |
| No | 1840 (32%) | 1821 (32%) |
| Age (years) | 26·1 (18–33) | 25·9 (17–33) |
| **Eligible children included in analysis** | | |
| N | 6894 | 6729 |
| Date of birth | | |
| On or before July 1, 2008 | 4491 (65%) | 4403 (65%) |
| After July 1, 2008 | 2403 (35%) | 2326 (35%) |
| Sex | | |
| Male | 3467 (50%) | 3322 (49%) |
| Female | 3427 (50%) | 3407 (51%) |
| Ethnic origin—Balanta | 1517 (22%) | 1567 (23%) |

Data are n, mean (SD), n (%), or median (IQR).

***Table 1:*** **Baseline characteristics of clusters and eligible participants**

Villages in the control group received few or no community-based services apart from annual vaccination campaigns. In some control villages, traditional birth attendants and community health workers had previously been trained, often many years before the trial, but they received no systematic training during the trial period, and did not have medicines or birthing kits to distribute. These villages did not receive any regular mobile clinic services, but pregnant women and children could travel to health clinics and hospitals with full access to available services.

Data were collected by a research team independent of the intervention team. The research team consisted of four groups, each with one supervisor and four female interviewers. The groups were overseen by a field officer. Team members spoke relevant local languages. A careful selection process, followed by intensive training and field tests, was implemented to ensure quality. Survey responses were checked for consistency and accuracy by supervisors in the field.

Pregnancy, birth outcome, and child death data were collected at visits every 3 months to the clusters. If the women were not available at the time of the visit, their relatives or neighbours were interviewed. Deaths were registered and verbal autopsies were done by specially trained interviewers. Two doctors, who were masked to the randomisation, independently assigned a medical cause of death, and a third doctor adjudicated disagreements.

An endline survey was done from Jan 1 to March 31, 2011, with a follow-up survey from April 1 to June 30, 2011, to capture women who were not present in the village during the previous visit. To be included in the endline survey, both the child and the mother or caregiver had to be enrolled in the trial and available, the child had to be younger than 5 years on the day of the interview, and the child had to have lived with the mother or caregiver in the 2 weeks prior to the survey. This survey assessed endpoints unrelated to mortality—ie, health knowledge, morbidity, treatment seeking, and vaccine coverage. The questionnaire was divided into three parts: morbidity, pregnancy or breastfeeding, and health knowledge. For the part on morbidity, we had a recall period of 2 weeks and asked about all children who were present in the village during that period and under 5 years on the day of survey. For the part on pregnancy or breastfeeding, we interviewed all women who were present and had had a livebirth after Jan 1, 2009 (5 months after the intervention package was fully implemented). For the part on health knowledge, we interviewed all women who were present and had a pregnancy during the trial. A data-processing team double-entered the data into an access database. This database was locked in September, 2011, once the trial was complete and data had been cleaned.

## Outcomes

The primary outcome was the proportion of children younger than 5 years who died during the study period. Secondary outcomes were neonatal and infant mortality, age at and cause of child deaths, treatment practices for sick children, mother's or primary caregiver's knowledge

| | Number |
|---|---|
| **Registration** | |
| Eligible women | 10378* |
| Children | 11859* |
| **Community health programme** | |
| Trained community health workers | 165 |
| Trained traditional birth attendants | 180 |
| Total child treatments by community health workers | 40796 |
| **Mobile clinic services** | |
| Mobile clinics | 22 events in 121 locations |
| Antenatal consultations | 7015 |
| Postnatal consultations | 1583 |
| Tetanus vaccines given | 3281 |
| Total child vaccines given | 19668 |
| Total child health checks | 36553 |
| Malnutrition cases managed | 3942 |
| **Health promotion** | |
| Health promoters | 22 |
| Health clubs | 128 |
| **Health clubs sessions** | |
| Year 1 | 22 in 128 locations |
| Years 2 and 3 | 18 in 111 locations |
| **Health club participation†** | |
| Year 1 | 36·3% |
| Years 2 and 3 | 38·4% |

*Results here are for all women and children who resided in intervention clusters, regardless of whether they resided in one of the households selected for analysis in the trial. †Attendance rates were separately calculated for each session at each location and averaged.

***Table 2:*** **Intervention activities**

| | Control | Intervention | Relative risk or hazard ratio (95% CI) |
|---|---|---|---|
| **Child mortality** | | | |
| Born before July 1, 2008 | | | 1·17 (0·90–1·52)* |
| Livebirths | 4491 | 4403 | .. |
| Deaths | 99 (2·20%) | 114 (2·59%) | .. |
| Born on or after July 1, 2008 | | | 1·17 (0·95–1·44)* |
| Livebirths | 2403 | 2326 | .. |
| Deaths | 174 (7·24%) | 197 (8·47%) | .. |
| Total | | | 1·16 (0·99–1·37)* |
| Livebirths | 6894 | 6729 | .. |
| Deaths | 273 (3·96%) | 311 (4·62%) | .. |
| **Cumulative mortality** | | | |
| Neonatal (0–28 days) | | | 1·21 (0·89–1·63)† |
| Deaths | 101 | 117 | .. |
| Cumulative mortality (per 1000 livebirths) | 42·1 | 50·4 | .. |
| Up to 1 year | | | 1·17 (0·93–1·47)† |
| Deaths | 173 | 195 | .. |
| Cumulative mortality (per 1000 livebirths) | 71·6 | 83·3 | .. |
| Up to 5 years | | | 1·17 (0·98–1·39)† |
| Deaths | 273 | 311 | .. |
| Cumulative mortality (per 1000 livebirths) | 110·4 | 128·2 | .. |

*Relative risk. †Hazard ratio.

***Table 3:*** **Child mortality outcomes**

of childhood diseases and safe delivery, child morbidity (prevalence of fever, diarrhoea, and respiratory infections), maternal mortality, age at and cause of maternal deaths, and indicators of safe birthing practices. Cost-effectiveness was not calculated because of the lack of effect on child deaths.

## Statistical analysis

We calculated the target sample size to give 80% statistical power (using a two-sided significance level of 5%) to detect a 30% reduction in the proportion of deaths under age 5 years in the intervention group compared with the control group. We estimated that each cluster would have approximately 48 children younger than 5 years at the time of randomisation, and a further 30 births during the 2·5 years of the trial. To compute the required sample size, we assumed an intraclass correlation coefficient (ICC) of 0·02 to allow for clustering. In a Nepalese trial examining neonatal mortality,[11] the ICC was estimated to be 0·00644, but since there were generally only one or two births per woman and the clusters in that trial were much larger, we used a higher ICC. No other similar trials had been done in Guinea-Bissau, and other data were inadequate to estimate the ICC. We expected that 9% of eligible children in the control group would die before age 5 years during the 2·5 year trial period and assumed a 10% loss to follow-up, and so required 130 clusters in total.

We considered the survival of eligible children from July 1, 2008, until the final quarterly survey between Jan 1 and March 31, 2011. The original intention was to completely cover all intervention clusters with the full intervention package by March 31, 2008. However, because of unexpected delays, the package was not fully introduced across all clusters until July 1, 2008. The delay between randomisation and inclusion for primary analysis of survival outcomes reflects the time needed for the intervention team to register households and roll out most aspects of the intervention. On July 31, 2010, the trial steering committee decided to extend the end of trial from Oct 1 to Dec 31, 2010, to take into account the delays encountered in full implementation of the intervention. Consequently, the starting dates for the analysis were changed from April 1, 2008, to July 1, 2008, and the end date for analysis from the last field visit after Oct 1, 2010, to the last field visit between Jan 1, 2011, and March 31, 2011. These decisions were not based on access to unmasked interim results.

For the proportion of under-5 deaths (the primary outcome) and for maternal mortality, we estimated relative risks (RRs), with 95% CIs, using a generalised linear model with a binary outcome and log link, and that included stratifying variables. We fitted the model using

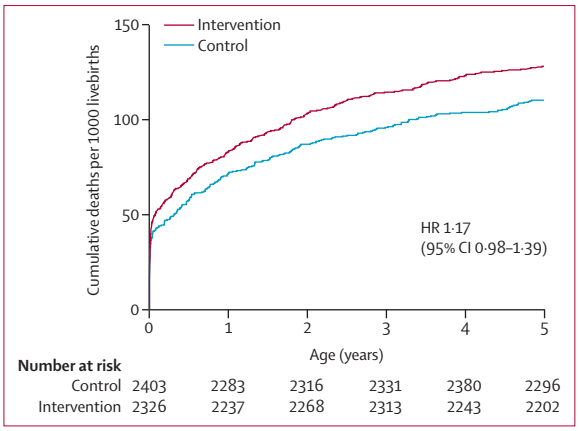


*Figure 2:* **Kaplan-Meier plot of estimated cumulative mortality**
HR=hazard ratio.

| | Control (n=2712) | Intervention (n=2655) |
|---|---|---|
| Diarrhoea | 247 (9·1%) | 208 (7·8%) |
| Caregiver sought appropriate help* | 77/247 (31·2%) | 86/208 (41·3%) |
| Correct answer ("more than usual") given to the question "give drinks to a child with diarrhoea?"† | 1645/2680 (61·4%) | 2314/2568 (90·1%) |
| Cough | 300 (11·1%) | 236 (8·9%) |
| Caregiver sought appropriate help* | 94/300 (31·3%) | 92/236 (39·0%) |
| Acute respiratory infection | 219 (8·1%) | 154 (5·8%) |
| Caregiver sought appropriate help* | 76/219 (34·7%) | 62/154 (40·3%) |
| Correct answer ("antibiotics") given to the question "what medicine should be given to a child with pneumonia?"† | 303/2681 (11·3%) | 1127/2567 (43·9%) |
| Fever | 612 (22·6%) | 489 (18·4%) |
| Caregiver sought appropriate help* | 166/612 (27·1%) | 214/489 (43·8%) |
| Correct answer ("fever") given to the question "Main sign that indicates malaria?"† | 1356/2682 (50·6%) | 2022/2567 (78·8%) |

Data are n (%) or n/N (%). *Defined as help from the government, community health workers, and other public or private services (eg, hospitals, clinics, physicians, or other medical help). †Not all mothers or caregivers responded to the question.

*Table 4:* **Morbidity in children and caregiver knowledge at endline survey**

generalised estimating equations with a so-called working assumption of independence and with robust standard errors to take account of clustering. For secondary binary outcomes, RRs were estimated in an analogous manner.

Survival analysis was done on the age scale (ie, time was defined as time from birth, rather than time from a fixed date such as the date of randomisation). Since not all children started follow-up at birth (and not all children reached age 5 years), survival times were both left and right censored. We produced and used Kaplan-Meier plots to estimate cumulative mortality at 28 days, 1 year, and 5 years. A hazard ratio (HR) comparing survival times in the two groups was estimated from a Cox proportional hazards model adjusting for stratification factors, with robust standard errors to account for clustering.

See Online for appendix

Interim analyses were prespecified and provided confidentially by the trial statisticians to the independent data monitoring committee, which was guided by the Peto-Haybittle rule. The committee met once by teleconference to review interim analyses but did not recommend early stopping. Stata 12 and SAS version 9.3 were used for statistical analysis.

This trial is registered with ISRCTN, number ISRCTN52433336.

### Role of the funding source

Effective Intervention, a UK-registered charity, financed the trial and managed the implementation. The funder was represented on the trial steering committee but was not shown the interim unmasked analysis. After the final analysis, the funder took part in interpretation of the data and writing of the report. The work of all authors on EPICS was funded by Effective Intervention. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

## Results

The baseline survey was done between March 1 and July 31, 2007. 146 clusters were randomly assigned to intervention (5669 women and 7666 children) or control (5840 women and 7869 children; figure 1). Seven children were lost to follow-up (defined in the published protocol[20]). In total, 6729 children in the intervention group and 6894 in the control group were alive and younger than 5 years on July 1, 2008, or were born during the trial.

Table 1 shows the baseline characteristics of enrolled clusters, women, and children. Table 2 shows the numbers included in the intervention and the activities.

311 (4·6%) of 6729 children died under age 5 years in the intervention group, compared with 273 (4·0%) of 6894 in the control group (RR adjusted for stratification variables 1·16 [95% CI 0·99–1·37]; table 3). Cumulative mortality of children by age 5 years was 128·2 per 1000 livebirths in the intervention group, compared with 110·4 per 1000 livebirths in the control group (adjusted HR 1·17 [95% CI 0·98–1·39]; table 3; figure 2). Maternal mortality, a secondary outcome, was 2·04 per 1000 pregnancies (seven deaths in 3430 pregnancies) in the intervention group, compared with 6·15 per 1000 pregnancies (22 deaths in 3576 pregnancies) in the control group (risk ratio 0·33 [95% CI 0·14–0·76]).

In both groups, about 40% of child deaths were attributed to malaria, acute respiratory infections, intestinal infections, and birth asphyxia (appendix p 1). Hypertensive disease and haemorrhage were the main causes of maternal deaths, and were numerically lower in the intervention group than in the control group (appendix p 2). Primary caregivers reported that children in the intervention group had lower incidence of symptoms of disease than did controls. Caregivers in the intervention group seemed to have improved knowledge

regarding how to treat these diseases, and they reported more active treatment-seeking when children had symptoms of disease (table 4).

## Discussion

In our trial, the package of community-based interventions that aimed to improve health knowledge and provide services did not reduce under-5 mortality in rural Guinea-Bissau. However, maternal deaths, especially deaths attributed to hypertension and haemorrhage, were reduced in the intervention group, and primary caregivers' health knowledge and reported health-seeking behaviour improved. Compared with controls, households in the intervention group had lower morbidity and better knowledge of how to treat morbidities, and caregivers were more likely to seek appropriate help when children had symptoms of morbidities. Community health workers and mobile clinics provided substantial antenatal consultations, vaccinations, child health checks, and treatments to the intervention clusters. Fewer postnatal consultations were given, but still amounted to 46% of pregnancies in the intervention clusters (table 2).

Our study had several important limitations. First, the interventions were delivered for only 2·5 years. We know from our analysis and monitoring systems that participation in the intervention group was high—caregivers of children younger than 5 years used the community-based services extensively and the community health clubs were attended, on average, by approximately 50% of women present in the community at the time the community health club was conducted throughout the trial period. Our endline survey of knowledge and practice showed substantial differences between the intervention and control groups (some of these data were published in this Article, and some will be published elsewhere). However, a substantially longer time might be necessary to observe health outcome benefits from improved community knowledge and provision of first-line services.

Second, although health knowledge outcomes suggest that participants in the control group did not benefit from the community health clubs, we cannot be sure that they did not access medical services. However, clusters were separated by a distance of at least 4 km, and nurses, community health workers, and traditional birth attendants were trained to provide services to women as indicated by their registration card.

Third, we collected data every 3 months through field visits to all 146 clusters. Other studies have used people living in the village to collect data on a monthly basis, which might be more accurate. We relied on carers, or their surrogates if the carer was not present, to provide accurate information on pregnancy status, pregnancy outcomes, and child deaths. From April to May, 2010, the research team audited the neonatal outcome results. They did this to verify that neonatal deaths were being appropriately captured, and that the allocation between stillbirths and livebirths was correct. This team was also asked to question mothers to learn if any deaths in the village might have been missed. During this audit of 150 stillbirths, six were found to be wrongly classified and were corrected. Although we did not find evidence of bias when auditing research reports, carers and other surrogate responders might have been reluctant to talk about deaths, particularly in the control villages where no services were provided.

Fourth, in accordance with national protocols, we were restricted until January, 2009, to supplying chloroquine, rather than ACT, for the treatment of malaria. Resistance to chloroquine in west Africa might have lowered treatment effectiveness.[21] The subsequent introduction of ACTs occurred first at health facilities and later through community health workers, so people living in control areas might have accessed it sooner than those in the intervention areas.

Fifth, the rugged and isolated terrain, along with the poor quality of clinical services, might have limited the benefits of any improvements in health knowledge or treatment-seeking behaviour, or both. Although the project did assist with evacuation and clinical costs for pregnant women in the intervention clusters, we did not subsidise these costs for children and their families.

Finally, during the intervention period, there was considerable political instability, with some coup attempts and violence in the capital city of Bissau. The health facilities in the region functioned, but medical supplies were scarce and staff were often unpaid for long periods. Emergency evacuation services rarely functioned. However, we do not believe that such political instability hampered the trial intervention within communities. Given the limitations of this study, more research is needed to better understand how and where there is scope for community-based interventions to improve health, and to learn how to best integrate clinical and community care in highly troubled regions.

Our treatment protocols referred sick children to health facilities while providing first-line treatment in the village. If the first-line treatments were inadequate, and if parents waited to observe outcomes rather than seeking help at health facilities as advised, the community provision might have delayed needed clinic visits.

Evidence, mostly from trials in south Asia,[8–13] suggests that a subset of the interventions implemented in our trial are sufficient to reduce child mortality. The community participation rates and improvements in primary caregivers' health knowledge in our trial were similar to those of other trials in which such measures led to declines in mortality.[22] Therefore, important contextual differences might have accounted for the lack of effect in Guinea-Bissau.

Child mortality has declined rapidly in Guinea-Bissau since 1992.[19] The high prevalence of symptoms of disease (table 4) suggests that children might be frequently exposed to life-threatening morbidities. Failure rates for

first-line therapies[21,23] might be high enough that improved integration with quality clinics, where children can have access to second-line and further treatments, might be essential to prevent children from eventually dying from these frequent bouts of disease. As we did not attempt to improve clinics in this trial, such quality services were not available to people in the intervention or control clusters. We suggest that the distribution of medicines by community health workers might have been problematic because of inadequate protocols in communities, inadequate storage and care of drugs, or delays in referrals by community health workers in interventions villages, or a combination of these factors. We believe that the substantial reduction in maternal mortality was achieved through a combination of effective antenatal care delivered via mobile clinics (which were equipped to provide methyldopa treatment for hypertensive disease of pregnancy), support from trained traditional birth attendants, and, perhaps most importantly, early referral to qualified hospital facilities of women with high-risk pregnancies.

Our results suggest that large-scale reductions in maternal and child deaths in poor, remote regions of west Africa might need to go beyond intensive provision of first-line services at the community level, and might require improved access to reliable emergency evacuation and improved clinical services. Despite the enormous challenges, in the context of weak health infrastructure and fragile environments, community-based IMCI should be embedded in a comprehensive health systems strengthening strategy.

#### Contributors

PB conceived the study, contributed to study design, and arranged financing for the study. DE, IF, CF, CJ, RK, VM, AdS, and PRW contributed to the conception and design of the study. PB, DE, IF, SF, CF, CJ, VM, AdS, and PRW contributed to the organisation of the conduct of the study. IF, SF, CJ, RK, AdS, and PRW carried out the study, including acquisition of study data. GP was originally chair of the independent data monitoring committee, and only after completion of this role did she join the research team. VM did the central statistical monitoring and analysed the baseline survey and interim data. DE, CF, and GP analysed the study data. PB, DE, IF, CF, RK, VM, GP, and PRW interpreted the study data. PB, DE, IF, CF, RK, VM, GP, and PRW drafted the report. SF, CJ, and AdS critiqued the report for important intellectual content. All authors have read and approved the report.

#### Declaration of interests

We declare no competing interests.

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