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Proximity to Health Care Facility Reduces the Risk of Co-morbidities and Severe Illness in Children with Acute Malaria in Rural African Communities

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Research Article

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ABSTRACT

Objective: To investigate the relationship between physical accessibility to a health care facility and the risk of morbidity among children in a rural Gambian district.

Methods: Consecutive children aged 6 months to 10 years attending a rural primary health care clinic in The Gambia with a confirmed diagnosis of malaria were assessed for the presence of co-morbidities. We then compared the prevalence of co-morbidities, number of co-morbidities and disease severity among the children, categorising them by the distance they had to travel to get to the Clinic.

Findings: Residing beyond 10 km from the Clinic was associated with higher prevalence of co-morbidities (adjusted OR (95% CI): 2.5 (1.5, 4.4), P=0.001). Similarly, the number of co-morbidities increased with increasing distance from the Clinic. Incidences of severe malaria and severe illness were respectively 2.7 (1.2, 5.9) times and 3.2 (1.4, 6.9) times higher in distant villages compared with villages within 10 km from the Clinic. Residing more than 10 km away from the Clinic was also associated with a higher risk of anaemia, and severer grades of anaemia.

Conclusion: Living far from a health facility increases the risk of a child dying from common childhood diseases. Such risk is likely to be considerably higher in remote rural communities with very limited efficient means of transportation and fewer choices of health care facilities. Introduction of free, well-resourced and easily accessible primary health care in such communities could enhance child survival.

INTRODUCTION

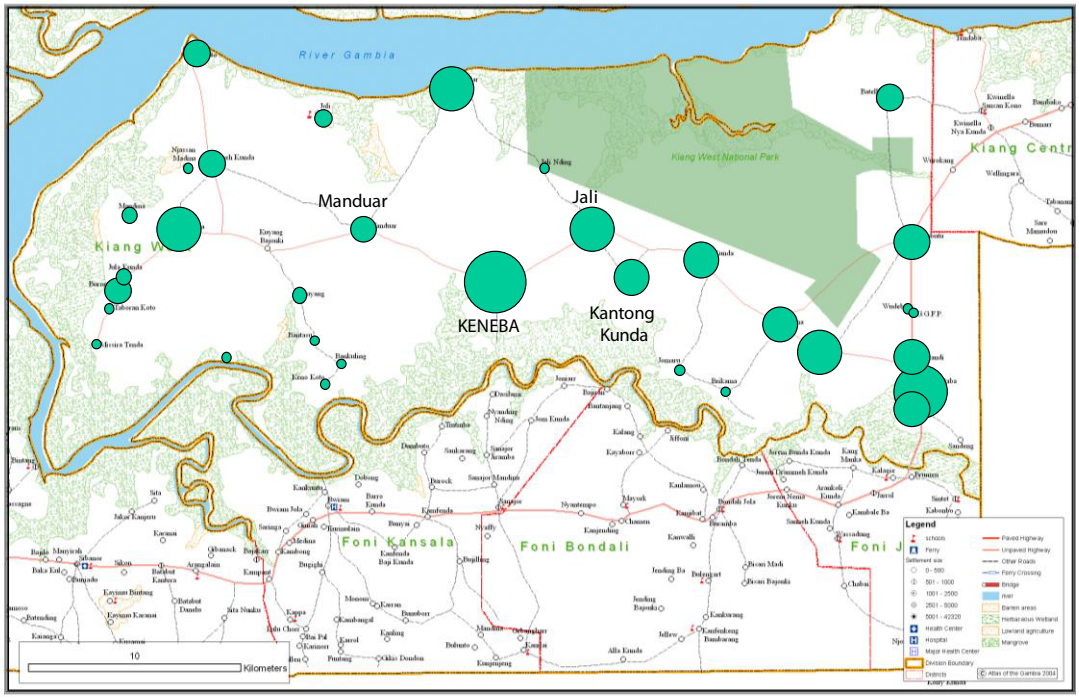
Malaria remains a global public health problem particularly in Africa where *Plasmodium falciparum* malaria is still highly endemic [1]. It is a major cause of morbidity and mortality, particularly in children below 5 years old and pregnant women [2,3]. In addition to reducing the quality of life of the affected child and his or her family, malaria has a significant negative impact on the national, regional and global economy [2,4-7]. While recent reports suggest a declining incidence of malaria in several endemic countries, including The Gambia, malaria still causes significant morbidity and mortality. Part of the reasons for this continued malaria threat include widespread resistance of the malaria parasite to commonly used antimalarials and the poor and dilapidated health care infrastructures in many endemic countries. Rural African communities are more vulnerable because in addition to the general inadequacies of health care provision, basic amenities such as good roads and efficient means of transportation are often lacking, further limiting their ability to access available health care services. Although it has been shown by many studies that

ease of access to health facilities determines willingness to seek care [8-11], only few studies have investigated the relationship of physical accessibility of health care facility to child survival [12-14]. A case-control study in Yemen found that distance to health care was strongly associated with the risk of developing severe malaria in children [15]. In Kenya, the time taken to travel to a health care facility was directly proportional to the risk of being hospitalised [16]. Studies from Burkina Faso [17], Democratic Republic of Congo [18] and Tanzania [14] all reported that distance from the clinic was strongly associated with child mortality. On the other hand, one report from Kenya [12] and an earlier Gambian study [13] found no associations between child mortality and distance from a health facility. The major differences between the studies reporting an association and those that reported no association are density of health care facilities and availability of efficient means of transportation to these facilities. More data from other settings in Africa and elsewhere are therefore needed to further explore the relationship between the distance patients have to travel to get to a health care facility and the risk of morbidity and mortality among children as such information have obvious policy and programmatic implications. We investigated this relationship among two different populations in a rural Gambian district whose major difference is their proximity and ease of accessibility to a health care centre. This study was a part of a larger study that looked at co-morbidities in children with acute malaria. The aim of this and the larger study was to provide information that will assist policy makers in designing appropriate interventions to help minimize childhood morbidity and mortality especially in rural communities.

METHODS

Study site

The study was conducted in the Medical Research Council (MRC) Clinic, Keneba in West Kiang district of the Lower River Region of The Gambia. The West Kiang district is a remote rural district in The Gambia, far removed from all urban and sub-urban centres with very limited alternative means of transportation. It is located at the south bank of the River Gambia, about 80 kilometres from Banjul the capital city. It consists of 35 villages and settlements with a total population of 14,072 (Keneba MRC DSS Database, 2009). The district is poorly accessible due to poor road network. An earthen road runs through the district from the main trans-Gambian highway in the South to the bank of River Gambia in the North. The district therefore presents a good setting for a study on the potential impact of accessibility to health care facility on child survival **(Figure 1).** The climate of the West Kiang District is typical of sub-Sahelian Africa with a long dry season lasting from November to June and sometimes July, followed by a relatively short rainy season from July to October [19].



a. Circle roughly proportional to population
b. Keneba, Manduar and Kantong Kunda are the MRC 'Core Villages' Jali is 4.6 km from Keneba

Figure 1. Map of West Kiang showing the different village groups.

Economic activities are limited to peasant farming, animal husbandry and occasional petty trading. Malaria transmission in the district is seasonal, hyperendemic and follows the rainy season, occurring between July and December (Nweneka CV, Keneba MRC Clinic morbidity audit, unpublished). Government's malaria-control activities in the district consist of distribution of insecticide treated nets, and case finding and treatment.

There are two Health centres in the district, one of which is the Keneba MRC clinic. The other health centre is the Karantaba

health centre, about 20 km from Keneba. The Karantaba health centre is a government-funded healthcare centre staffed by nurses, nurse assistants and an MRC employed midwife. Patients are usually managed empirically at the government health centre due to a lack of laboratory facilities. The government health centre also runs a mobile antenatal (in partnership with MRC) and child welfare clinic. There are also two health outposts–one in Jiffarong village and another in Manduar, both of which are staffed by community health nurses. Each community health nurse oversees a primary health care unit. Each primary health care (PHC) unit consists of a group of communities; each community has a village health worker (VHW) and at least one traditional birth attendant (TBA). The VHWs and TBAs are usually identified by their respective communities and trained by the government on basic first aid and management of uncomplicated labour. They are supervised by the community health worker in charge of their PHC unit.

The Keneba MRC clinic is staffed by 3-4 doctors at any particular point in time including at least one paediatrician, and several nurses and two midwives. The services offered at the centre include five outpatient consultation clinics, a child-welfare clinic, antenatal clinic and a 24 hour emergency service. The Clinic receives laboratory support from the research laboratory of the Keneba MRC field station. All the services including drug supply are free of charge to the patients. Consequently, the majority of the residents of the district patronise the Keneba MRC clinic. Closely tied to their history with the MRC Keneba, three communities–Keneba, Manduar and Kantong Kunda are designated MRC 'Core Villages'. All the core villages are located within 10 km from the Clinic (Manduar 7.5 km, and Kantong Kunda 5.3 km). MRC Keneba provides regular transport to convey patients from these core villages to and from the Clinic. In addition, the centre dispatches vehicles to convey emergency cases from these villages to the Clinic when needed. A fourth village, Jali, though not a core village, enjoys most of the privileges of the core villages by virtue of its closeness (only 4.6 km) to the MRC Clinic in Keneba. In addition, it lies directly along the transport route from Keneba to the main highway. Patients from other parts of the district have to walk to the Clinic in Keneba (some patients walking as long as 40 km), use a donkey-drawn cart or one of the few available 'bush taxis'. Occasionally the patients are lucky to hitchhike with an MRC vehicle or other privately owned cars.

Study design

This was a cross-sectional study conducted on children aged 6 months to 10 years presenting to the Keneba MRC Clinic over two malaria seasons between September and December 2004, and September and December 2005. The inclusion criteria were history of fever in the preceding 24 hours or measured axillary temperature of 37.5 °C and above at consultation, and the presence of parasitaemia of at least 500/µL in the peripheral blood smear. Children returning for the same illness or within one month of a previous illness were excluded. Pneumonia was defined according to the WHO criteria [20] as cough or difficult breathing with raised respiratory rate for age (fast breathing). Urinary tract infection was defined as fever in addition to positive urinary dipstick result (dipstick applied to freshly voided urine, which is positive for leucocytes and nitrites (Combur Test [9], Boehringer Mannheim, Germany)). Full blood count was done using the Medonic auto-analyser (MEDONIC CA 530, Boule, Stockholm, Sweden). Anaemia was defined as haemoglobin concentration less than 110 g/L. Diarrhoea was defined as passage of three or more watery or loose stools over a 24-hour period [21]. Malnutrition was defined as weight-for-height Z (WHZ) scores below –2 standard deviations of the WHO/NCHS standard. Severe illness was defined according to the IMCI protocol as follows: fever with any of the danger signs (unable to drink or breastfeed, lethargic or unconscious, haemoglobin concentration of 70 g/L or less (or a PCV of 21% or less), 'Vomiting everything' and history of convulsions). Severe malaria was defined according to the definition provided by the World Health Organisation (WHO) [22].

Data collection

Consecutive children aged 6 months to 10 years attending the Keneba MRC clinic with a history of fever were screened for malaria after a verbal consent from their parents or guardians. Following a clinical history and physical exam, blood samples were collected for malaria microscopy and full blood count. Urine was also collected for urinalysis. Thick blood films were prepared and stained with Field's stain using standard methods. Field stain was used rather than Giemsa because of the need for rapid results to enable treatment of the children. One hundred fields of the thick blood film were examined under a light microscope using the 100× oil immersion objective before declaring the slide as negative. The number of parasites per high power field was multiplied by 500 to give the estimated parasite density. All the slides were read independently by two laboratory technicians, and discrepancies between the two readings resolved by a third more senior laboratory technician.

A definitive diagnosis was made based on the combination of the clinical findings and laboratory results. Multiple diagnoses were permitted for each child. Only children with a positive peripheral blood smear for malaria parasites, and who also met all the other inclusion criteria, were included in the study. The data were entered into an Epi info version 6 (CDC, USA) database, and subsequently analysed using STATA software, version 8.0 (College Station, TX, USA).

Prevalence of co-morbidities was determined by calculating the proportion of children who have at least one other diagnosis in line with our *a priori* clinical case definitions. The prevalence of the individual co-morbidities was calculated as the proportion of children presenting with that particular co-morbidity. And because more than one clinical condition could co-exist in the same child, the diagnoses were not mutually exclusive. Student's t test was used to compare differences in means of continuous variables; Pearson's Chi-squared test and odds ratios were used to compare categorical variables. Multiple logistic regressions

were used to control for possible confounding by age, gender, place of residence and type of clinic visit. Mantel-Haenszel odds ratio was used to check for trend.

To assess the association between the place of residence and the other variables, the villages were grouped into two. Since all the core villages had relatively equal access to the Clinic and are located within 10 km to the Clinic, they were all grouped into one and coded '0'. Jali village, though not classified as a 'core village' was added to this group by virtue of its proximity to the Clinic which gives its residents increased access to the Clinic. All the other villages located more than 10 km from the Clinic were grouped into one and coded '1'. An association was considered statistically significant if the P-value was 0.05 or below.

The main study, of which this was a part, was approved by the MRC Gambia Scientific Coordinating Committee (SCC) and the Gambia Government/MRC Joint Ethical Committee. Verbal consent was obtained from the parents or guardians of the children prior to their enrolment into the study.

RESULTS

Background characteristics of participants

Demographic data: Over the two malaria seasons, we screened 622 febrile children between ages 9.5 and 120.5 months, out of whom 482 (77.5%) fulfilled the inclusion criteria. **Table 1** describes the characteristics of the participants in the study .

Table 1. Characteristics of the study participants.

Characteristics	Keneba (0 km)	Jali (4.6 km)	Kantong Kunda (5.3 km)	Manduar (7.5 km)	Others (>10 km)	Missing
Age in months (mean ± SD)	66.0 ± 30.6	63.1 ± 28.7	64.5 ± 31.8	69.4 ± 33.8	60.4 ± 31.0	39.5 ± 34.5
Age Groups						
n	128	122	75	32	116	9
≤ 36 months (%)	27 (21.1)	24 (19.7)	15 (20)	9 (28.1)	31 (26.7)	6 (66.7)
> 36 months (%)	101 (78.9)	98 (80.3)	60 (80)	23 (71.9)	85 (73.3)	3 (33.3)
Sex						
n	128	122	75	32	116	9
Female (%)	54 (42.2)	58 (47.5)	27 (36)	15 (46.9)	59 (50.9)	6 (66.7)
Male (%)	74 (57.8)	64 (52.5)	48 (64)	17 (53.1)	57 (49.1)	3 (33.3)
Type of visit (n=413)						
n	117	96	72	29	91	8
Routine visit (%)	104 (88.9)	85 (88.5)	65 (90.3)	28 (96.6)	81 (89.0)	6 (75.0)
Emergency visit (%)	13 (11.1)	11 (11.5)	7 (9.7)	1 (3.4)	10 (11.0)	2 (25.0

There was no association between distance from the clinic and type of visit (P = 0.8), gender (P = 0.1) and age (P = 0.2). Co-morbidities were commoner in children from villages situated more than 10 Km from the Clinic compared with those closer to the Clinic (adjusted OR (95% CI): 2.5 (1.5, 4.4), P = 0.001). Similarly, the number of co-morbidities increased with increasing distance from the Clinic. Incidences of severe malaria and severe illness were respectively 2.7 (1.2, 5.9) times and 3.2 (1.4, 6.9) times higher in distant villages compared with villages within 10 Km from the Clinic. **Figure 2** and **Table 2** demonstrates the association between the different clinical conditions and distance from the Clinic. Residing more than 10 Km away from the Clinic results in a two-and half-fold increase in the risk of anaemia. In addition, severer grades of anaemia were commoner in children living in more distant villages compared with children living within 10 Km from the clinic. Diarrhoea was more frequent in children from villages located more than 10 Km from the clinic (adjusted OR: 2.8, P = 0.01) **(Table 2).** However, there was no difference in the prevalence of malnutrition and pneumonia among children from the different groups of villages **(Figures 2 and 3).**

Table 2. Association between different clinical conditions and distance from the clinic.

Variable		Keneba (0 Km)†	Jali (4.6 Km)	Kantong Kunda (5.3 Km)	Manduar (7.5 Km)	Others (>7.5 Km)	M-H odds ratio (95% CI), P-value
Presence of co-morbidity							
Adjusted odds ratio		Ref	1.32	1.20	0.72	2.92	1.2 (1.1, 1.3), P=0.004
95% Confidence Interval	Lower	--	0.76	0.66	0.32	1.58	
	Upper	--	2.27	2.18	1.65	5.38	
P-value			0.3	0.5	0.4	0.001	
Severe malaria							
Adjusted odds ratio		Ref	0.73	1.52	3.79	3.26	1.4 (1.1, 1.7), P=0.007
95% Confidence Interval	Lower	--	0.19	0.45	0.89	1.13	
	Upper	--	2.74	5.20	16.15	9.38	

P-value			0.6	0.5	0.07	0.03	
Severe illness							
Adjusted odds ratio		Ref	1.99	3.87	5.45	7.29	1.5 (1.2, 1.9), P=0.0007
95% Confidence Interval	Lower	--	0.45	0.93	0.96	1.95	
	Upper	--	8.76	16.02	30.84	27.29	
P-value			0.4	0.06	0.06	0.003	
Presence of anaemia							
Adjusted odds ratio		Ref	1.43	2.04	0.68	3.38	1.3 (1.1, 1.4), P=0.0002
95% Confidence Interval	Lower	--	0.81	1.10	0.27	1.86	
	Upper	--	2.52	3.79	1.68	6.16	
P-value			0.2	0.02	0.4	<0.001	
Malnutrition							
Adjusted odds ratio		Ref	0.27	0.29	0.31	0.34	1.0 (0.9, 1.1), P=0.9
95% Confidence Interval	Lower	--	0.43	0.38	0.17	0.55	
	Upper	--	1.58	1.60	1.65	1.99	
P-value			0.6	0.5	0.3	0.9	
Diarrhoea‡							
Adjusted odds ratio		Ref	1.24	--	1.79	2.68	1.3 (1.0, 1.6), P=0.06
95% Confidence Interval	Lower	--	0.42	--	0.43	1.02	
	Upper	--	3.67	--	7.45	7.08	
P-value			0.7	--	0.4	0.05	
Pneumonia							
Adjusted odds ratio		Ref	1.27	0.88	2.01	0.96	1.0 (0.9, 1.2), P=0.8
95% Confidence Interval	Lower	--	0.53	0.32	0.57	0.38	
	Upper	--	3.03	2.42	7.14	2.39	
P-value			0.6	0.8	0.3	0.9	

Note: †; Keneba is the reference village, ‡: The incidence of diarrhoea was generally low among the study population with Kantong Kunda recording no diarrhoea case.

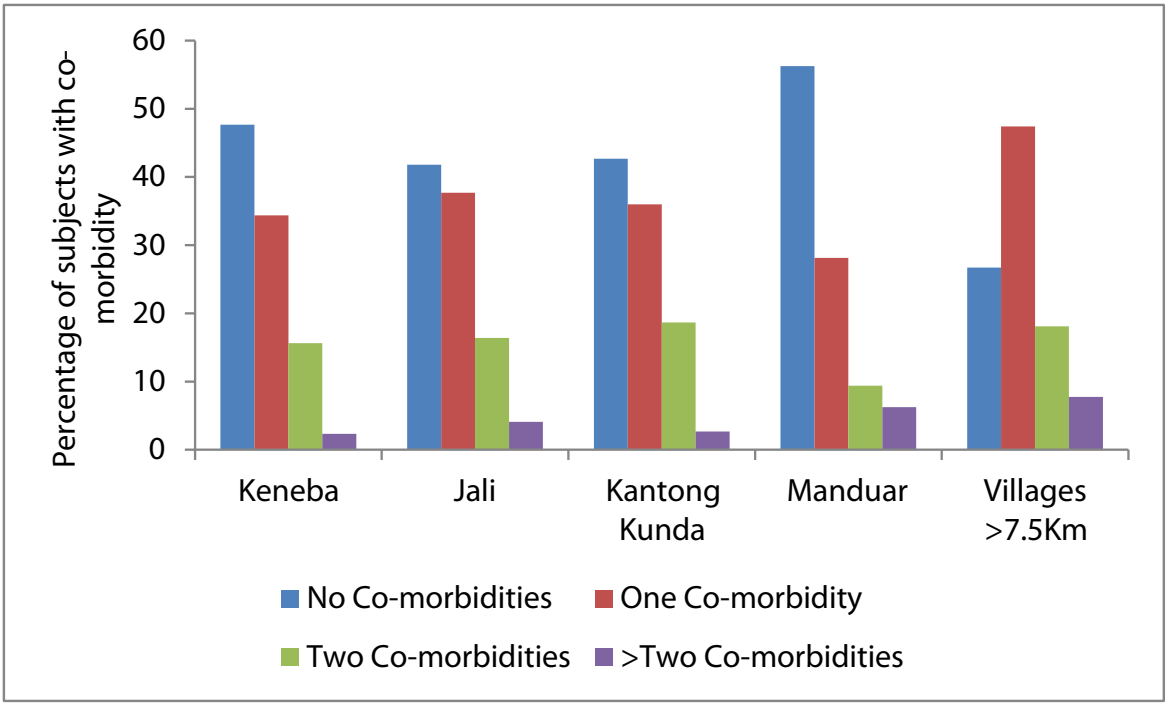


Figure 2. Association between distance from the clinic and number of co-morbidities.

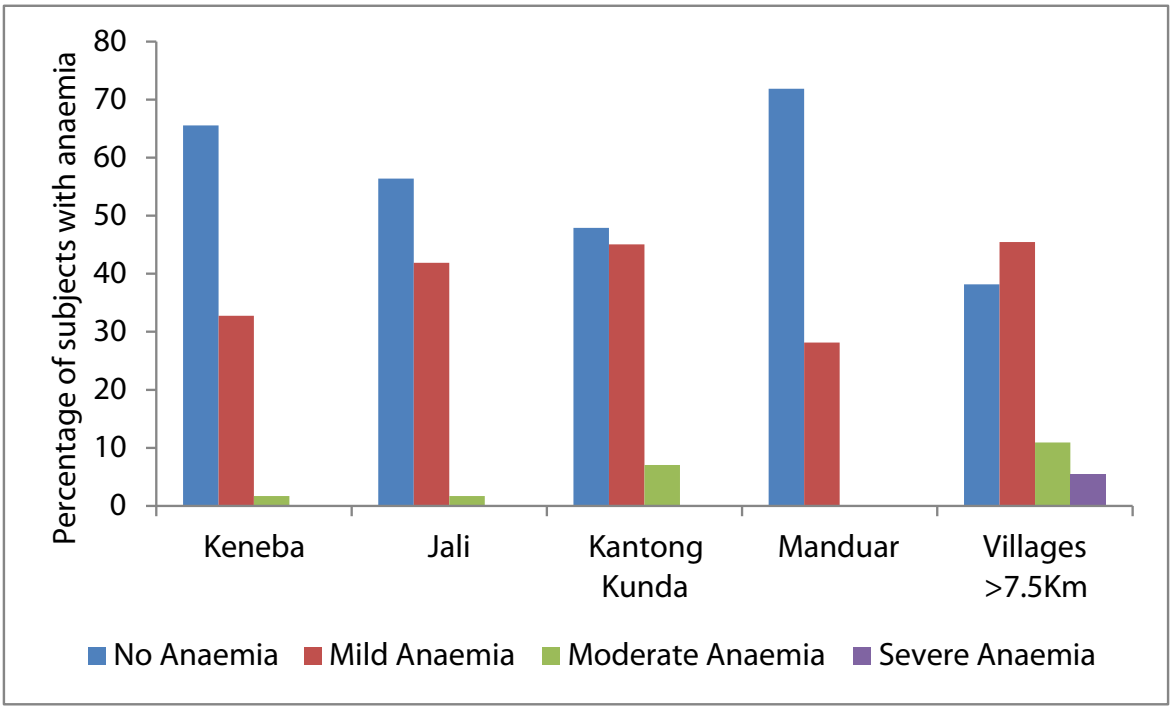


Figure 3. Association between distance from the clinic and severity of anaemia.

Although the management outcome was poorer in children from more distant villages, this did not achieve statistical significance (adjusted OR: 1.9, 95% CI: 0.9 to 4.0, P = 0.1). We also evaluated the differences in all the above parameters between children residing in Keneba and those residing in the other core villages plus Jali but found no significant differences except with anaemia prevalence which was significantly higher in Kantong Kunda than in Keneba **(Figure 2).**

DISCUSSION

The fourth goal in the just concluded Millennium Development Goals aimed to reduce mortality among children under-five by two-thirds in 2015. The progress report showed that while under-five mortality rates decreased by 50% globally, as many as 16,000 children below the age of 5 years still die every day in many developing countries mainly due to preventable causes including malaria. Perhaps more distressing is that sub-Saharan Africa still accounts for about half of all the deaths among under-fives in the developing countries [23]. There are strong suggestions that implementation of currently available interventions such as the IMCI could reduce child mortality in developing countries [24,25]. Therefore, part of the reason for the persisting unacceptably high child mortality is the poor utilization of these interventions. As has been shown in this study, as well as others [14,17-18], that limited access to a health care facility imposed by living far from such facility especially in the face of very little and/or inefficient means of transportation could increase the risk of a child dying. Indeed several reports have shown that one of the key determinants of health seeking behaviour is distance to health care facilities [8-10].

Our findings however differed from a Kenyan study [12] which failed to find any significant association between distance to a health facility and child mortality. In the Kenyan study however, there was a high density of health facilities, all the study participants lived less than 10 Km from a health facility and there were efficient means of transportation to these facilities. In contrast, our study population consisted of two distinct groups–one groups with a relatively easy access to health care, facilitated by the MRC Keneba, while the second group had virtually no means of transportation to the health care facility. In addition, there were very few health facilities in our study area and motorised vehicle movements are very uncommon. It is interesting that the Kenyan study reported a significantly increased risk of dying among children residing more than two hours by vehicular transport away from the hospital compared with those living closer. Similarly a previous Gambian study by Rutherford et al. [13], in which the study population had a relatively easier access to a health facility, did not find any association between travel distance and child mortality after controlling for confounders. It is important to emphasise that in the setting of our study, means of transportation are very limited and it takes great efforts for patients living outside the core villages to get to the clinic. Sometimes patients have to arrive in the middle of the previous night (when they are able to catch one of the few available bush taxis) in order to consult a physician the following morning.

A previous report had shown a dramatic decline in the risk of dying among children residing in the three core MRC villages of Keneba, Manduar and Kantong Kunda over the fifty years that the UK MRC has been operating a research centre in Keneba [26], such that child survival in these communities surpass the national average and competes favourably with those from more advanced communities elsewhere. The present study for the first time provides clearer evidence linking this improvement in child survival to the various health interventions provided by the MRC clinic in Keneba. Of special mention is the fact that all the services, including drugs, transportation and ambulance services to referral centres in the city are all at no cost to the patients.

Although many communities in rural Gambia have village health workers (VHWs) trained in simple first aid and symptom-based treatment of malaria, it is not clear how many of these are patronised by their respective communities and how regularly drugs are available to the VHWs. Anecdotal evidence shows that patients often have to purchase their drugs from these VHWs and often the drugs are not available; thus limiting the impact of these primary health care providers on the health of the communities. In the Philippines, introduction of free VHW-assisted symptom-based early case detection and treatment of malaria with guaranteed drug availability was associated with increased patronage of the VHWs and a decline in parasite prevalence in the communities compared with those communities that had no VHWs [27].

A number of limitations need to be noted in interpreting our findings. While it is safe to assume that nearly all the sick children from the 'core MRC villages' sought medical care from the MRC Keneba clinic, it is likely that only the very ill patients from the more distant villages were brought to the clinic because of the problems with transportation already highlighted; thus introducing a potential selection bias in our study population. However, over the years, probably because of the free and efficient services provided by the centre, the MRC Clinic in Keneba has continued to witness an increasing population of patients from distant villages with all grades of disease severity–including those that come for routine check. Additionally this study measured severe outcomes associated with malaria (rather than all cases) and the malaria itself would encourage referral thus reducing the potential bias compared to an 'all cases' analysis.

In conclusion, our findings support earlier propositions that living far from a health facility increases the risk of a child dying from common childhood diseases. Such risk is likely to be considerably higher in remote rural communities with very limited efficient means of transportation and fewer choices of health care facilities. Introduction of free, well-resourced and easily accessible primary health care in such communities could enhance child survival.

COMPETING INTERESTS

The author declares that they have no competing interests.

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