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Abstract

A community based malaria control intervention using insecticide treated mosquito nets (IMN) has been implemented and tested in 13 villages of the Yombo Division, Bagamoyo District in the Coastal Region, Tanzania, an area holoendemic for *P. falciparum* malaria. Following extensive sociological research into local perceptions of malaria, the programme was implemented. It was decided by consensus that village mosquito net committees would be the appropriate local level implementors. These were formed and provided with IMN's which were sold to villagers at subsidised cost. The income was invested for use by the committees for sustaining the activity. Use patterns were determined and high coverages were obtained among the community, particularly after promotions e.g. plays, school meetings etc. Malaria morbidity was measured among children 6–40 months of age in 7 index villages prior to the intervention in 1992 and in a comparison study between 3 villages using nets and 4 villages not using nets in 1993. Examination of the 7 cohorts of children was done from June to October each year covering the period of most severe transmission. The children using nets showed marked improvement in several malariometric indices. Following an initial clearance of parasitaemia with sulphadoxine/pyrimethamine, when compared with unprotected children, those with nets were slower to become re-infected (Relative Risk 0.45), had lower parasitaemias and showed marked improvement in anaemia (RR 0.47). use of IMN's produced a 54% reduction in the prevalence of anaemia among young children. Attempts are being made to ensure that the programme is locally sustained.

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Introduction

Insecticide impregnated mosquito nets (IMN) have been tested as an innovative means of vector control and shown to be effective in reducing malaria induced morbidity in communities (e.g. Alonso et al., 1991; Beach et al., 1994; Stich et al., 1994 among others). The use of these nets is gaining acceptance as an intervention which has the potential to be a locally sustainable village based system (Curtis et al., 1990; Greenwood and Pickering, 1993; Winch et al., 1994; Makemba et al., 1995). However, apart from the major programmes in China and in the Gambia where nets and netting are widely used, almost all studies to date have been carried out in communities where IMNs have been provided and treated free by the authorities. Such programmes are not sustainable without major commitments from governments or donor agencies, and it is necessary to determine whether rural communities would be interested in helping themselves address the public health issues involved and participate in a programme which has the potential to be sustainable.

In Zanzibar Stich et al. (1994) indicated that the nets were gladly accepted by villagers because they provided protection from the mosquitoes. However, Winch et al., (1994) found that in the Bagamoyo District of Coastal Tanzania, mosquito nuisance was seen as a seasonal problem and without adequate promotion and educaiton, net usage may decline when the nuisance causing culicine mosquito populations became less obvious but when malaria was still being transmitted by late night biting and less conspicuous anophelines. Use patterns of treated mosquito nets and local perceptions of the intervention are still outstanding issues (Bermejo and Veeken, 1992). Also questions remain concerning the success of the intervention when transmission is holoendemic and intense for most of the year and where nets are not given away as a free commodity. In the Bagamoyo District, Makemba et al., (1995) have described methods to involve communities to participate and to sell impregnated nets at subsidised prices to villagers and to set up a community based structure to manage a revolving fund and implement a control programme with supervision and regulation from a central authority.

This paper presents data collected during such a community based intervention. The work was done to measure the impact on malaria infection and illness as seen in young children who, along with their families use IMN's and also have village based chemotherapy on request. A variety of malariometric morbidity indices were measured over two years, first as baseline and then to determine efficacy of the intervention. Data are presented to show the impact of widespread use of IMN by rural communities on the transmission and prevalence of malaria induced morbidity in children in a holoendemic area with year round transmission.

Materials and methods

Location and Demography. The project area is in the Bagamoyo District of Coastal Tanzania. It is several km south of the town of Bagamoyo and 80 km north of Dar es Salaam (Fig. 1). Ecologically the area is uniform comprising coastal plains with sandy soils and occasional rocky outcrops with hilly ridges. Large groves of coconut palms as well as cashew and mango trees dominate the vegetation. There are numerous marshy areas which may be associated with rivers or water courses where rice is cultivated during the long rains (March-June). An all weather road extends from Dar es Salaam to Bagamoyo, other roads in the area are passable for most of the year, although during the heavy rains communication is unreliable. The area is bounded in the north and west by the Ruvu river, on the east by the Indian Ocean and on the south by the Ruvu Forest Reserve which is uninhabited and the Mpiji River to the south-east. It is some 360 km^2 and comprises 13 villages with a population of approximately 21,000. A census was carried out by the project staff in 1990 but because of immigration and emigration, these numbers were only be taken as indicators of the residents. A second census of children under 6 which recorded individual names and identifiers was carried out in April-May 1992 to serve as a baseline for assessing child mortality. Ethnically the population is mainly Zaramo, Kwere and Swahili particularly along the coast (Winch et al., 1994). The political organization of each village follows the'Ujamaa' model with a village government led by a village chairman who is elected periodically by the villagers. The village government authority is provided through the District Commissioner. The villages may be spread over large areas, several km in extent. The homesteads are grouped into units of 10–30 with each unit responsible to one 10-cell leader. Information to and from the villagers and the village government is carried by the 10-cell leaders. Health clinics or dispensaries are distributed throughout the area. Each village has the minimum service of a village health worker (VHW), a volunteer provided with subsistence resources by the community. A family health programme has been operating in the area since 1983 so good records exist of child health and a high level of immunization has been achieved locally (Mtango and Neuvians, 1986). The study area was divided into four groups for convenience of implementation and to enable monitoring of the intervention. Group I consisted of the coastal villages, Kondo, Mlingotini and Pande; Group II were along the main Bagamoyo-Dar road, Zinga, Kerege and Mapinga; Group III in the centre of the area, Kiromo, Mataya and Buma and Group IV on the western side consisted of 4 villages, Matimbwa, Kondo, Yombo and Chasimba (Fig. 1). The programme was implemented in a staged manner in that sales and impregnation of nets was started with Group I, and proceeded sequentially at approximately six monthly intervals through the area.

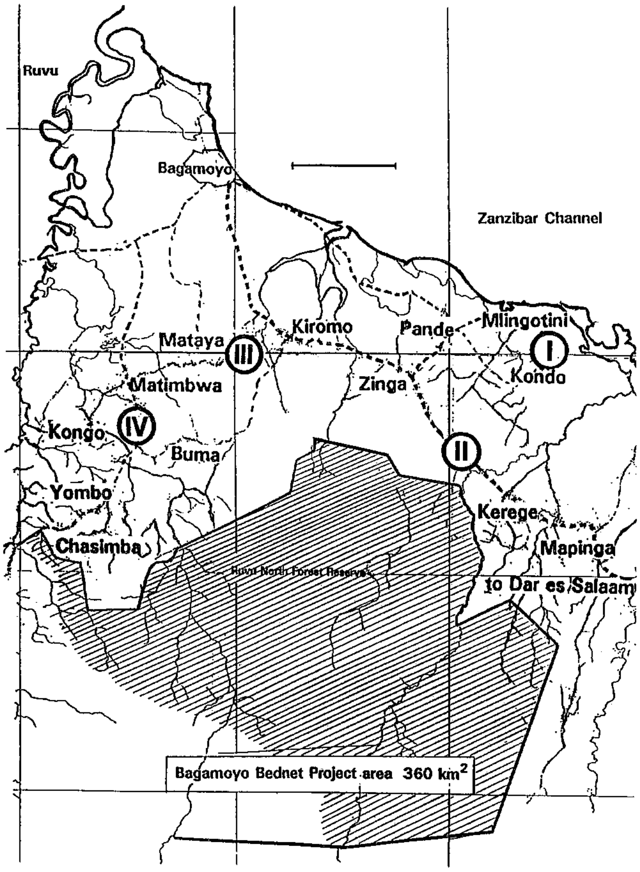

Fig. 1 Map of the Bagamoyo Bed Net Project Area showing layout of villages, main roads, geographical boundaries and disposition of the four groups Gp. I, Gp II, Gp III and Gp IV. Scale 5 km.

Malaria morbidity studies. Assessment of malaria infection and morbidity in the community was confined to a sample of young children between the ages of 6 and 40 months from seven of the 13 villages in the study area. Children in this age group are considered to be most susceptible to malaria and therefore a sensitive indicator of transmission. For purposes of experimental design the indicator villages were confined to two groups, those along the Bagamoyo-Dar road, Group II and those on the western area, Group IV. In 1993, Group II represented the intervention and Group IV the controls for purposes of assessment. Regular entomological collections also were made fortnightly in selected houses in the same villages to determine the extent of the mosquito population and the infectivity of the vector mosquitoes in the area (Shiff et al., 1995). For assessment of malariometric data children were selected by simple random sampling from a list of those eligible derived from the detailed census of children under 6. Mothers were advised of the opportunity to have their children examined regularly and were requested to attend the enrollment clinic on a particular date. Following enrollment, children were examined and a questionnaire was administered to the mother regarding the health status of the child. As most children were enrolled in the family health programme, reference was also made to their health status cards for verification. The following examinations were made at recruitment: Age, weight, axillary temperature, spleen rate (this was classified into palpable or non palpable), haematocrit (PCV), thick and thin blood film, any recent history of fever, other illnesses, presence of ectoparasites and a series of questions to determine the health status of the child. The special malaria clinics (so called to avoid confusion with the normal ante and post natal clinics held normally under the Ministry of Health auspices) were held regularly for 5 months (June to October) each year, extending over the period of most intense malaria transmission (Shiff et al., 1995). Ethical clearances for this work were obtained from the Muhimbili College of Health Sciences and The Johns Hopkins University Committee on Human Volunteers.

Surveillance of Malaria Morbidity. The Special Malaria Clinics operated under direct medical supervision. They were used to characterise transmission patterns of the infection and disease. In order to clear parasitaemia from the cohort, all children admitted to the clinics were treated with sulphadoxine/ pyrimethamine (S/P) following the initial examination. The dosage was 1/4 tablet for children less than one year. Older children were given 1/2 tablet. Some peanuts and a drink was offered simultaneously to avoid any nausea or spitting out of the medication. Close supervision of the children was maintained for two weeks after treatment to detect any reaction to the drug. No problems were observed. During 1992 and 1993 both active and passive surveillance was carried out on the children for the 5 month following recruitment through the main malaria transmission period. Special clinics were held regularly each fortnight. Mothers were requested to attend with the children. Attendance varied from 70–90% of the number recruited. At times talks, productions (play acting) and other means of communication and education were held to stimulate attendance and to convey appropriate messages to the parents (Winch et al., 1994). At these meetings children were examined and treated for a variety of ailments at the request of the parent. Crosssectional blood slide surveys were carried out at visit 2 (4 weeks), visit 6 (12 weeks) and visit 10 (20 weeks) on all children attending those clinic meetings. PCV measurements were made on all children attending at time 0 and time 10. Additionally blood smears were taken if a child attending the clinic was found to be febrile and chloroquine was administered. This drug was used to conform with the Ministry of Health guidelines for village health workers. In the period between each clinic mothers were asked to take any child who developed a fever to the village health worker (VHW). The VHW also visited the homes of participants to help identify febrile episodes among the clinic children. The VHW examined such children, took a thick smear and treated them with chloroquine. Slides were examined by project staff to see if the fever was accompanied by parasitaemia. This information was analysed to determine incidence of febrile episodes accompanied with parasitaemia.

Definition of parasitaemia, severe parasitaemia and re-infection. Information of the parasite load per µl was obtained from blood smears taken from each child at enrollment, at time 2, time 6 and time 10 of the series. The parasite to leucocyte (P/L) ratio was calculated as the ratio between the parasite load and the mean standard leucocyte count (8 000 leucocytes per µl of blood). Parasitaemia was considered positive if at least one trophozoite was counted. Severe parasitaemia was defined as positive for a P/L ratio greater than or equal to 0.625, which is equivalent to 5 000 parasites per µl. Re-infection in children was defined as the next positive blood smear after treatment with S/P at enrollment. We decided to use any level of parasitaemia with fever as an indicator of potential morbidity in the children. Reduction of this would be a sensitive indication of decreased transmission due to use of the intervention.

Definition of anaemia and severe anaemia. Blood samples were obtained from each child at enrollment and at the last visit (time 10) each year. Anaemia was defined as having a packed cell volume measured by haematocrit (PCV) lower than 33 per cent. Severe anaemia ws defined as having a PCV less than 20 per cent.

Data analysis. Although the data were collected longitudinally, analysis was carried out on a series of crosssectional time points, 0 (recruitment), 2, 6, and 10 fortnights. The risk ratio or relative risk (RR), was used as a measure of effect of the intervention and was estimated as the ratio of prevalence rates between Group II and IV at each time point. Ninety five per cent confidence intervals were also calculated (Katz et al., 1978). Relative risk with 95 % CI below 1.00 indicated the intervention was protective. RR and 95 % CI were calculated for parasitaemia, severe parasitaemia and incidence of fever with or without parasitaemia.

Because of the association of age and anaemia, liklihood ratio tests (LRT) were performed to assess group differences after adjusting for age (age categories were arranged in 6-month intervals), Chi^2 test was used to examine differences in age and sex within cohorts with respect to parasitaemia. Incidence of fever with or without parasitaemia was followed longitudinally in the cohorts of children from the two village groups in 1992 and 1993. Actual occurrence of fever was detected passively by normal clinic attendance when slides were taken from children presenting with fever, or actively during the fortnightly special malaria clinics when children were examined regularly and again slides were taken from febrile cases. The total population of children in the villages was determined in 1992 by detailed census of all under six year old children for mortality surveillance (Premji et al., in prep.). Attributable risk for malaria and associated sequelae with or without IMN use was calculated from these data.

Distribution of Impregnated Mosquito Nets. The methodology for the distribution and sale of IMN's in the community is described elsewhere (Makemba et al., 1995). Following initial sale of nets in Group I in April and May 1992, villages in Gp II were offered nets for purchase in November 1992. Thus Gp II villages were in the intervention area for all of the 1993 surveillance period. As children under 40 months of age were being monitored as indicators of the efficacy of the intervention it was necessary to know whether they were sleeping under IMN's. Thus in 1993, all children in the Gp II study population were visited to see if they were in fact sleeping under nets and if not, the parents were urged to purchase nets and use them for the entire family. However, no nets were given out free and no attempt at coercion was made. In the questionnaires used in 1993, parents were asked if the child was sleeping regularly under a treated net.

Coverage and Use of Treated Nets. The nets used in this work were green nylon (100 denier, 156 mesh) rectangular nets of two sizes, 70 cm wide recommended for children and 1.0 m wide for use with beds. All nets were 1.7 m long with a skirt of 1.58 m. Rings sewn into the corners and midway along the length allowed the nets to be suspended easily from rafters or wooded beams in the roofs of the huts. The nets were treated with permethrin (Peripel 55) Roussel Uclaf UK, at a nominal rate of 500 mg permethrin per m^2 immediately after sale. The nets were dipped in an aqueous emulsion of insecticide, wrung out, placed in black polythene bags and handed to the purchaser with an illustrated pamphlet showing how to set up and use the nets. Chemical analysis carried out on cuttings made from test nets showed a range from 350 mg–550 mg/m^2. Bioassay carried out on a laboratory strain of *Anopheles gambiae* colonised from local mosquitoes indicated 3 min immediate knockdown of over 90% eleven months after impregnation. The methods for motivating the community to purchase nets and to use them and have them re-impregnated regularly have been discussed elsewhere (Makemba et al., 1995). A variety of methods of communication have been used, but meetings, play acting and the development of village bed net committees were the most effective (Makemba et al., 1995). Proceeds of all net sales were deposited in a local bank on behalf of the committee for future use for procuring nets, insecticide and other activities associated with sustaining the intervention. Work in this regard is still under way. In Table 1 the needs assessment and coverage measured by sales of nets is given for villages in Gps I and II. Subsequent use surveys were carried out on samples of households to inspect the nets and to see if they were actually used. The villagers in Gp I

Table 1 Showing the extent of coverage with insecticide treated bed nets in villages in Group I and Group II, Bagamoyo District.

Village Group	Village name	Date nets offered	No. nets required[1]	No. nets sold (until Dec 93)
Group I	Pande	Apr '92	630	498
	Mlingotini	Apr '92	906	578
	Kondo	Apr '92	698	542
Group II	Mapinga	Nov '92	1399	1196
	Kerege	Nov '92	1170	1112
	Zinga	Nov '92	1125	1013

1 Needs assessed according to beds or sleeping places in all houses determined by Village Bed Net Committee.

Table 2 Malaria Positivity and Relative Risk of infection by *Plasmodium falciparum* for Groups II and IV in 1992 (baseline) and 1993 (intervention) during 5 month observation period. (time in fortnights).

Visit	Group II total cohort (6–40 months old)		Group IV total cohort (6–40months old)		Prevalence (%) (		Relative risk 95 % CL)	
	+ ve	– ve	+ ve	– ve	GpII	GpIV	R/R	
0:1992	117	25	167	29	82.4	85.2	0.97	(0.88–1.06)
2:1992	26	99	37	142	20.8	20.7	1.01	(0.64–1.57)
6:1992	83	24	119	35	77.3	77.6	1.00	(0.88–1.15)
10:1992	105	26	135	34	79.9	80.2	1.0	(0.90–1.12)
0:1993	145	40	211	30	78.4	87.6	0.89	(0.81–0.97)
2:1993	11	136	77	130	7.5	37.2	0.20	(0.11–0.36)
6:1993	63	102	186	27	38.2	88.3	0.43	(0.35–0.53)
10:1993	55	93	158	35	37.2	81.9	0.45	(0.36–0.57)

*Relative Risk compares risk of infection in the two cohorts at the same time. If R/R < 1, infection has declined; R/R = 1.0 no difference; R/R > 1.0 means increased level of infection during the two periods.

registered good sales with coverage on a household basis varying from 69 % to 85 %. Initially when nets were offered in April 1992, demand was lower than finally achieved. This was due to several factors e. g. shortage of cash at that time, inappropriate promotion messages, confusion as to size of nets available. After determining the extent and nature of the problem, nets were again offered for sale in September 1992 and a large number were distributed.

Sale of nets in Gp II was carried out in November 1992 and emphasis was placed on the importance of nets for children during the communication exercises (Makemba et al., 1995). Coverage was excellent and when children were recruited to the Special Malaria clinics in June, only 20 out of 185 were not actually sleeping under nets. Re-impregnation exercises were carried out every six months, initially at no charge but as people were able to perceive the benefits of impregnated nets over plain mosquito nets, an economic charge was made for insecticide.

Results

Basic descriptors of the study population

In 1992, 338 children aged 6 to 40 months were recruited into the study from the two groups of villages, 142 from Gp II and 196 from Gp IV. The sex ratio of males to females was 1.15 in Gp II and 1.12 in GpIV. The age distribution of children in the samples was similar.

In 1993, 426 children aged 6 to 40 months were recruited into the study from the two groups of villages, 185 were from Gp II and 241 were from Gp IV. The sex ratios of males to females were 1.34 in Gp II and 1.43 in Gp IV. Although there were more male children in both samples, age distribution from the samples in GpII and GpIV villages was similar. (Pearson chi^2 between groups, P = 0.968).

Immunization history was excellent in all villages. BCG coverage was 98.8 %, DPT1 98.5 %; DPT2 97.9 %; DPT3 97.6 %and measles vaccination covered 85.5 %. This high level of immunization is an important reason why the child mortality rate in the area was low. (6/1000 1–6 year olds in 1992-3 and 9/1000 of the same age group in 1993–4; (Premji et al. in prep).

Malaria Positivity

Data were collected from the seven indicator villages during 1992 (baseline) and 1993 (intervention in Gp II only) and are presented as prevalence of infection among children recruited in Gp II and Gp IV villages at time 0; time 2 (4 weeks) time 6 (12 weeks) and time 10 (20 weeks) after recruitment (Table **2**). All children were treated with S/P immediately after recruitment, hence the decline in prevalence at time 2.

In Table **2** the prevalence of infection by *P. falciparum* is given for both groups of villages and compared by relative risk. In 1992, there was no significant difference between the prevalence in both groups of villages. However, in 1993, when children in Gp II had the use of IMN's for the 6 months prior to recruitmen there was already a significant decline in the prevalence even at recruitment without any therapy, RR = 0.87. Following treatment with S/P after recruitment and at all times following, the intervention group was significantly less affected than the controls.

Prevalence of severe infection

Prevalence of severe infection (> 5 000 trophozoites per µl) is shown in Table **3** along with geometric mean parasite counts per infected case. In Gp II villages

Table 3 Showing the numbers with severe parasitaemia (>125 trophozoites/200 WBC) and geometric mean parasite load in the cohorts of children from Group II and Group IV.

		1992			1993			
Group II	Time	n	no.+ ve	GMP load	n	no + ve	GMP load	P
	Jun (0)	142	34	1905	196	32	1148	NS
	Nov (10)	131	32	1819	147	2	794	< 0.001
Group IV	Jun (0)	196	74	5129	233	48	1513	< 0.001
	Nov (10)	169	28	1412	193	24	1585	NS

Table 4 Incidence of fever with and without *Plasmodium falciparum* infection in children 6–40 months old in Group II and Group IV villages in Bagamoyo District, Coastal Province, Tanzania, June–October 1993.

Children with febrile episodes Visits 1–10	Number in Gp II	Number in GP IV	Relative Risk (95 %) CL)
Febrile episodes per person week with parasitaemia 1992	195/2840	194/3920	1.39 (1.12–1.65)
Number of febrile episodes with negative slide 1992	33/2840	20/3920	2.28 (1.31–3.96)
Febrile episodes per person week with parasitaemia 1993	58/3640	193/4820	0.398 (0.29–0.53)
Febrile episodes per person weeks without parasitaemia 1993	37/3640	31/4820	1.58 (1.07–2.34)

Table 5 Proportion of children with anaemia measured by packed cell volume stratified by age in the study area. Baseline information collected June 1992.

Age of cohort	No. examined	PCV < 33 %	Percent anaemic
6–12 months	72	63	87.5
13–24 months	120	101	84.2
25–36 months	124	69	67.6
> 36 months	31	16	51.6

the prevalence of severe parasitaemia between June 1992 and June 1993 did not change significantly, but there was a significant decrease when comparing October 1992 and October 1993 ($P < 0.001$). This was after 11 months of IMN use in the Group. Severe parasitaemia showed a sharp decline in Group IV villages in 1992 between June and October 1992. This was likely a reflection of the very high parasitaemia seen at recruitment in June 1992 (visit 0) which was then reduced with chemotherapy. However, in 1993 there was no significant change noted in Group IV between time 0 and time 10.

In Group II 1993, with the IMNs use as well as chemotherapy, there was a significant decline in severe parasitaemia compared with the same time the previous year ($P < 0.001$) and a drop in the geometric mean parasite count.

Morbidity due to Malaria

Morbidity due to malaria infection in holoendemic areas is variable and profound, however one of the most dramatic effects in young children is the production of anaemia. Additionally the incidence of fever with parasitaemia or severe parasitaemia can be an indicator of morbidity although there is considerable discussion regarding severe parasitaemia.

Incidence of febrile episodes with or without parasitaemia

Continual surveillance of the children recruited into the special clinics enabled calculation of incidence rates of febrile episodes with or without parasitaemia during 1992 and 1993. (Table 4). In 1992, incidence of both malaria fever and other fevers was higher in Gp II villages than in Gp IV villages, although only significantly so with non malaria fever. In 1993, the relative risk of malaria fever was significantly less in Gp II villages whereas the incidence of non malaria fevers remained about the same in both groups.

There was also a reduction in the number of episodes of fever with severe parasitaemia between Gp II and Gp IV villages in 1993. In Gp II children there were 43/1150 episodes and in Gp IV children there were 87/1547 episodes (RR = 0.63; 95 % CI 0.44–0.89).

Measurement of anaemia

Anaemia as measured by PCV is age related in this community of children with 87.5 % of children under 12 months age having PCV < 33 % at baseline (Table 5). However use of treated mosquito nets has had a dramatic effect on anaemia in all age groups. The data (Table 6) were analysed to account for age and Group. No difference was found between Gps II and IV at time 10 in 1992 (LRT Chi^2 $P = 0.78$). Statistical differences were found between Gps II and IV at time 0 ($P < 0.01$) and time 10 ($P < 0.01$) in 1993. Relative risk of anaemia was 0.75 (95 % CI: 0.64–0.88) and 0.46 (95 % CI: 0.33–0.63) at times 0 and time 10, respectively.

These data (Table 6) enable calculation of attributable risk of anaemia when comparing use and non-use of IMNs. Thus implementation of IMN use with

Table 6 Relative risk of anaemia in two cohorts of children from Group II and Group IV villages pre intervention and 6 and 11 months after intervention commenced in Group II villages.

	Group II			Group IV			
	No. tested	No. anaemic	% anaemic	No. tested	No. anaemic	% anaemic	Rel. risk
Pre intervention	142	108	76.0	193	150	78.0	0.98 (0.87–1.10)
6 months*	185	99	54.0	205	139	67.8	0.75 (0.64–0.88)
11 months*	146	35	23.9	186	94	50.5	0.46 (0.33–0.63)

* = post intervention in Group II

chemotherapy on demand (Gp II) reduced the proportion of anaemic children by 54% as compared with those having chemotherapy alone (Gp IV).

Discussion

Effective malaria control needs a multi-faceted approach involving the community, the vector mosquito and appropriate treatment as required to cure overt disease. Both the human host and the vector mosquitoes are mobile and are both indoor and outdoor resting, therefore planning for an effective intervention must accommodate the needs and habits of both the people and the vectors themselves. The design of the Bagamoyo Bed Net Project was developed so that the intervention should protect the inhabitants within the villages where they lived and for the most part where they worked and were likely to visit. The project attempted to address the issue of control on several levels, personal protection, reduction in the number of infected vector mosquitoes on an area wide basis, local awareness promotion and the presence of available chemotherapy on demand through the regular village based health programmes.

The population selected for monitoring, children between the ages of 6–40 months, was chosen because these persons would be most sensitive to infection with little residue of passive immunity derived from the mother and before they had built up major levels of acquired immunity. It also represented a section of the population which may be judged less likely to benefit from the use of insecticide treated mosquito nets in a rural African community with low income. Prevalence of infection, prevalence of severe parasitaemia (> 5 000 trophozoites/μl) geometric mean parasite loads and incidence of episodes of fever with parasitaemia were all used to determine the baseline in 1992 when there was no intervention and again in 1993 when the intervention covered Group I, II and III, but not Group IV. In all instances, children in the monitored cohorts as well as any other inhabitants had readily availabe chloroquine on demand when needed.

Morbidity due to malaria is difficult to gauge especially under holoendemic conditions (Greenwood 1987). However we decided to measure point prevalence of parasitaemia and packed cell volume (PCV) by microhaematocrit as well as incidence of febrile episodes with accompanying parasitaemia as indicators of morbidity. Anaemia was age related and showed accompanying parasitaemia as indicators of morbidity. Anaemia was age related and showed a clear relationship with the high malaria associated mortality seen in the 6–12 months children (Premji et al., 1995). In 1992, the prevalence of anaemia in Gp II and Gp IV was similar. However in 1993 at time 0 when new cohorts of children were recruited and had been in houses using IMN's for 6 months (Gp. II) and at time 10 when the study was concluded, there was a significant reduction in anaemia in all children in Gp II compared with Gp. IV. Similarly there was a decrease in the prevalence of parasitaemia and in the parasite burdens in the cohorts of children from the intervention area. Incidence of febrile episodes with parasit-aemia in Gp. II when compared with Gp. IV, was also reduced. In the absence of any other confounding variables, these effects were due to the use of IMN's by the children and their parents.

The results provide rationale for local village based antimalarial interventions. First they address a concern that malaria control may not be feasible in areas of high transmission because inoculation rates cannot be sufficiently reduced to achieve an effect (Molineaux, Garki Project 1973; Beier et al., 1992) and that treated nets only provide protection indoors while the mosquitoes feed and presumably transmit malaria both indoors and outdoors. In this study area four major vector species occur, *Anopheles gambiae*, *An. arabiensis*, *An. merus* and *An. funestus*. Biting by infected mosquitoes was recorded both indoors and outdoors (Davis et al., 1995; Shiff et al., 1995) and both infection rates and mosquito densities were extremely high, of the order of 300–900 infective bites per year would be sustained by local residents. However the data as recorded show that the use of nets on a village scale reduced the reinfection sustained by the children and also reduced the level of anaemia in that population most susceptible to malaria associated mortality.

Secondly the results indicate that a village based intervention is feasible if the community is effectively motivated and has perceived a need which can be addressed through the purchase and the regular retreatment of mosquito nets. This involves appropriate explanations to the community and their motivation to participate in the necessary activities. The process of health communication must be based on a thorough understanding of the local perceptions of malaria and malaria associated syndromes. Western orientated concepts of this disease may be misunderstood by rural communities as shown by Winch et al. (1994). Educational programmes must accomodate the issues relevant to local people. They should base explanations of benefits on local understanding and priorities. Disease processes which may be caused by the infection but perceived by the population as the result of some other phenomenon must be carefully explained.

As in any true public health measure, long term sustainability is important. Using innovative methods for involving the community we have demonstrated that insecticide treated mosquito nets will have an impact on malaria disease over a period as short as 11 months. The question remains, will the community be able to maintain public interest? What is the level of government support and regulation which is needed to ensure that the level of effort is sustained? Further monitoring and support is essential to help answer these fundamental questions.

Finally there is some thought among health authorities that mortality is the only outcome indicator for a successful malaria control programme and that a decline in the morbidity seen in children does not justify such efforts on the part of communities and government. In a recent review on the pathology of malaria, Miller et al. (1994) discussed the role of *P. falciparum* infection on the prevalence of severe anaemia in children. Premji et al., (1995) have suggested that severe anaemia in children associated with malaria infection may be a prime cause of child mortality. The decline in anaemia shown in these communities under study and the reduction of the relative risk of developing this condition in children during the two most susceptible years of life show that the intervention can be effective in reducing the burden of this disease even in communities living in holoendemic conditions.

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