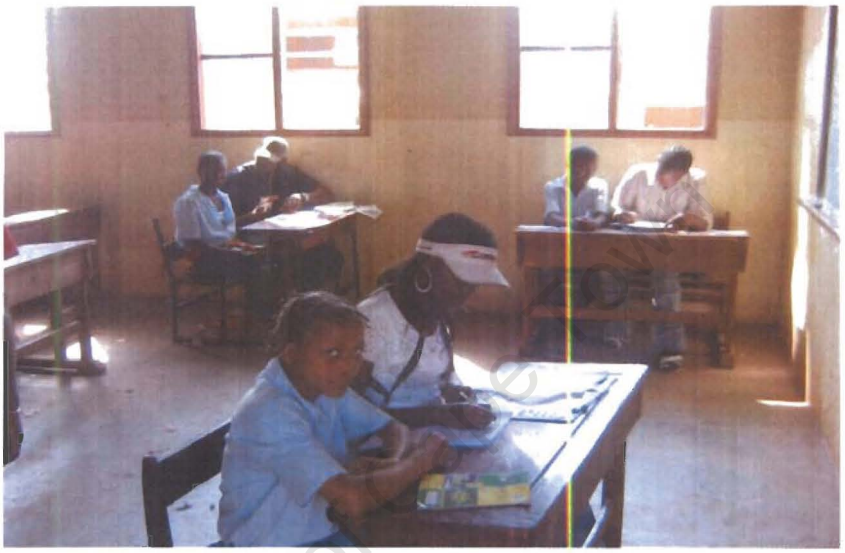
A school- based intervention for improving malaria-related knowledge and practices in Maputo Province, Mozambique: A Randomised controlled Trial



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Student declaration

I, Maria José Pires Machai, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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List of abbreviations

ACTs	Artemisinin-based Combination Therapy
AS-SP	Artesunate plus Sulfadoxine-Pyrimethamine
CI	Confidence interval
DPE	Direcção Provincial de Educação (Provincial Directorate of Education)
DPS	Direcção Provincial de Saúde (Provincial Directorate of Health)
EPC	Escola Primária Completa *(*primary schools including grade 6 and 7)
GPS	Global Position System
HC	Health Centre
HF	Health Facility
HP	Health Post
IEC	Information, Education and Communication
IQR	Interquartile Range
IRS	Indoor Residual Insecticide Spraying
ITNs	Insecticide Treated bed Nets
KAP	Knowledge, Attitude and Practices
LSDI	Lubombo Spatial Development Initiative
MISAU	Ministério de Saúde (Ministry of Health)
MMed	Master in Medicine
MOH	Ministry of Health
OR	Odds Ratio
PNCM	Programa Nacional de Controlo da Malária (National Program for Malaria Control)
SADC	Southern Africa Development Community
SEACAT	South East African Combination Antimalarial Therapy
Vs	Versus

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MMed candidate's contributions Included:

- Study Design
- Development of the manual for the interviewers
- Training of the interviewers
- Study supervision
- Development of IEC material
- Teachers' training
- Key informants' interview
- Meetings with community leaders
- Data analysis

Abstract

Aim

The aim of the study was to evaluate the impact of a school-based malaria education intervention and its effectiveness in changing knowledge and practices related to malaria at randomly selected schools in Maputo Province.

Study design

A randomised controlled trial to evaluate a school-base education program using before and after intervention surveys of teachers, scholars and community members conducted between July 2007 and April 2008.

Study population

Eligible schools were the 27 schools with Grade 6 and 7 learners in Namaacha and Matutuíne districts in southern Mozambique, from which ten schools (4 in Namaacha and 6 in Matutuine) were randomly selected and then randomised as intervention or control schools. The total study population included 38 teachers and 654 scholars from these ten schools, and 294 community members (household heads) living near the 10 study schools. All participants had given written consent or, for scholars, assent after prior written consent of the parents' representatives.

Study Methods

The study used three semi-structured questionnaires both pre- and post-intervention to survey teachers, scholars and community members, respectively.

- The teachers' questionnaire included 18 questions about their knowledge and practices regarding malaria prevention and treatment, a self evaluation of their teaching skills and their role in the community dissemination of malaria information.
- The scholars' questionnaire included 12 questions on their knowledge and practices regarding malaria prevention and treatment, as well as their role in the community dissemination of malaria information.

- The community questionnaire, administered to household heads, was similar to that for scholars, but excluded the question regarding the role of scholars in community dissemination of malaria information. Prior to the study these questionnaires were piloted and then refined according to the pilot study findings.

Information, Education and Communication (IEC) materials were developed, and edited, in coordination with Ministry of Education and participating teachers. This material included teachers' manual, posters, pamphlets and exercise books for scholars that contained information about how to prevent malaria, when to suspect the disease, the importance of prompt treatment seeking and full adherence, as well as how teachers and scholars can contribute to the fight against malaria.

During the intervention teachers were given three days of problem-based training regarding malaria and how to communicate key messages effectively to scholars. After the training course, teachers were expected to teach scholars about malaria through developing and integrated malaria education within their teaching on other subjects. Both teachers and scholars were asked to develop activities to disseminate information to improve knowledge and practices regarding malaria prevention, treatment seeking and adherence, in their surrounding communities.

Results

The demographic characteristics and baseline knowledge of the teachers, scholars and community members in the study were generally similar; although more teachers in the intervention group taught natural science than in the control group (9/24 vs. 1/14, p=0.04). Among scholars, more in the intervention group responded that they would seek treatment at public health facility (hospital, health centre, health post) for malaria related symptoms [363/414 (88%) vs. 188/241 (78%), p=0.001]. At the community level, more households in the control group responded that fever was one of the symptoms of malaria [64/156 (41%) vs. 33/138 (24%), p=0.002] and that they would first seek treatment for malaria related symptoms at a hospital [86/156 (55%) vs. 51/138 (40%), p=0.002].

After the intervention there was a greater improvement in the malaria-related knowledge and reported practices among the teachers in the intervention group than in the control group. More teachers in the intervention group identified convulsions and high fever as symptoms of severe malaria [7/14 (50%) vs. 1/11 (9%), p=0.03 and 5/14 (36%) vs. 0/11 (0%), p=0.03 for convulsions and high fever respectively], when compared with the control group. There were also more teachers in the intervention than control group responding that artesunate plus sulfadoxine-pyrimethamine was the current medication recommended for malaria treatment [0/11 (0%) vs. 6/14 (43%); p=0.01]. The post-intervention questionnaire score was higher in the intervention than in the control group [median (IQR) 8 (7-9) vs. 6 (5-6); p=0.0001].

Among the scholars there was also a greater improvement in the malaria-related knowledge and reported practices in the intervention group than in the control group for most of the questions in the post-intervention study. More scholars in the intervention group knew that malaria was transmitted by a mosquito [286/363 (79%) vs. 121/192 (63%), p <0.001] and could be prevented through Indoor Residual Insecticide Spraying [63/363 (17%) vs. 6/192 (3%), p <0.001]; 27% responded that eliminating stagnant water was a malaria prevention strategy. Almost all scholars [353/369 (96%) in the intervention group vs. 178/192 (93%) in the control group; p=0.14] knew that treatment for malaria symptoms should be sought in the public sector. Although few scholars knew which treatment was recommended for the treatment of malaria (artesunate plus sulfadoxine-pyrimethamine), more in the intervention groups knew about quinine [88/363 (24%) vs. 16/192 (8%), p<0.001] and artemether-lumefantrine [37/363 (10%) vs. 4/192 (2%), p= 0.001]. Scholars in the intervention group responded more often that they would share their knowledge about malaria with others [183/363 (50%) vs. 67/192 (35%), p=0.003]. The total post-intervention questionnaire score was higher in the intervention than the control group [median (IQR) 5 (4-5) vs. 4 (3-5), p=0.009].

The intervention did not show a significant improvement in the knowledge and reported practices related to malaria at community level, although there was a trend towards more respondents in the intervention group than in the control group reporting that malaria treatment should be sought within 24 hours [88/153 (58%) vs. 43/95(45%), p=0.06)

Despite there being no intervention, there was also some improvement in the malaria-related knowledge and reported practices among teachers and scholars in the control group, when the post-intervention survey results were compared with those form the pre-intervention survey. There was a trend toward more teachers responding in the post-intervention study that prevention could be achieved through IRS [from 3/14 (21%) to 6/11 (55%), OR=4.4 (95% CI 0.6-37), p=0.09], bed net use [from 8/14 (57%) to 6/11 (90%), OR=7.5, (95% CI 0.64-378), p=0.06] and through stagnant water elimination [from 5/14 (36%) to 8/11(73%), OR=5 (95% CI 0.7-39), p=0.007]. The number of teachers responding that malaria treatment should be sought at a health post increased from 3/14 (21%) to 7/11 (64%) [OR=6. (95% CI 0.8-55), p=0.03].

Among scholars in the control group a significant improvement in malaria related-knowledge and practices was also observed in the post-intervention survey when compared with the pre-intervention survey. More scholars in the post-intervention survey responded that they had heard about malaria [from 205/240 (85%) to 183/192 (96%), OR=3. (95% CI 1.6-8.4), p=0.0007], that malaria is transmitted by mosquito bite [from 99/240 (47%) to 121/192 (63%), OR= 2.4 (95% CI 1.6-3.6), p<0.001] and could be prevented through Indoor Residual Spraying [from 1/240 (0.4%) to 6/192(3%), OR= 8. (95% CI 0.9-356), p=0.03]. More also responded that they shared what they knew about malaria with others [from 38/240 (16%) to 67/192 (35%), OR=3.4(95% CI 2- 5.4), p<0.001].

The total cost of the intervention was $17925 and $11668 including or excluding the competition, respectively. The total cost per scholar of the whole intervention was $17.93. This was reduced to $11.67 if the competition was excluded and to $5.63 per scholar if only the Teachers' Training programme was provided.

Conclusions:

A school-based education program aiming at strengthening malaria control by improving knowledge and practices regarding malaria prevention, treatment seeking and adherence could be an important strategy in fighting malaria in Mozambique and other developing countries where access to health care education remains a challenge. The findings of our study revealed a significant improvement in the knowledge and some practices related to malaria among teachers and scholars in the intervention schools, when compared with the control schools. A limited impact on the knowledge and practices of community members was observed. Thus, we were unable to prove that students can be used as agents of health changes at the community level.

Key words: School based education intervention, malaria control, community, scholars, teachers.

1. Introduction

Despite the large burden of malaria and renewed interest in malaria prevention and control, there are still no significant initiatives to strengthen malaria control through education in the African continent (Ijumba and Kitua 2004). Effective interventions to prevent and cure malaria are available but the burden persists, partly because most people at risk of malaria are unaware of these interventions, are unable to afford them or the interventions are inaccessible (Sarbib et al 2006, Muhe 2002). The malaria situation in sub-Saharan Africa is further exacerbated by poor access to care, poor health service infrastructure, and limited financial or human resources. Thus malaria control remains a major challenge in this region where malaria kills an African child every 30 seconds and where 90% of the global malaria cases and deaths occur (Muhe 2002, Sarbib et al 2006, Opiyo et al 2007).

Malaria and its health complications are responsible for high rates of absenteeism in the school system each year and have a tremendous social and economic impact in the community. They also impact on child survival and long term development (WHO, 2007). It is estimated that between 0.16% and 2.1% of all schooldays are lost because of malaria in Africa, which accounts for 2-8% of all absenteeism (Lalloo et al 2006).

Countries that have made strides in controlling malaria indicate that strong political leadership and effectively deploying the right tools can make a difference (Sarbib et al 2005). Strategies for malaria control include Insecticide Treated bed Net (ITN), Indoor Residual Spraying (IRS) and prompt effective anti-malarial treatment, preferably with an artemisinin-based combination treatment (Sarbib et al 2005).

Rational use of the artemisinin-based combination therapy (ACT) that was recently introduced as malaria treatment policy in Mozambique requires education of the community as well as healthcare providers. Community members can contribute to ensuring rational ACT use by limiting the number of treatments needed by supporting mosquito vector control through IRS, ITNs and environmental cleaning, as well as by seeking treatment promptly and adhering fully to the recommended treatment course.

2. Background

2.1 Malaria Burden in Mozambique

This study was conducted in Mozambique (Figure 1), where malaria is the main cause of illness and death. About 48% of total outpatient consultations and 63% of all hospital admissions in the pediatric wards are for malaria. It causes about 26.7% of the total mortality of the country (DPS 2004, MISAU 2006). In Mozambique, mortality due to malaria affects mostly the young and female population, with 76% of deaths occurring in those under 18 years of age (Riquelme et al 2008).

An economic evaluation conducted In 2002 in Namaacha and Matutuíne districts revealed that 32 - 34% of the households surveyed incurred catastrophic costs for a single malaria episode, 3-times higher than those in Mpumalanga (9-10%) and (11-13%) in Kwazulu Natal, South Africa (Riquelme et al 2008). Catastrophic payments were measured as either "out-of-pocket" payments that exceeded 10% of monthly household income or those exceeding 40% of non-food expenditure (Prestcott 1999; Xu et al 2003). However, given the decrease in the prevalence of malaria through IRS (Sharp et al 2007) in conjunction with the fact that artemisinin-based combination therapy has become available free of charge at all public health facilities , the household burden and cost of malaria is likely to have been reduced substantially.

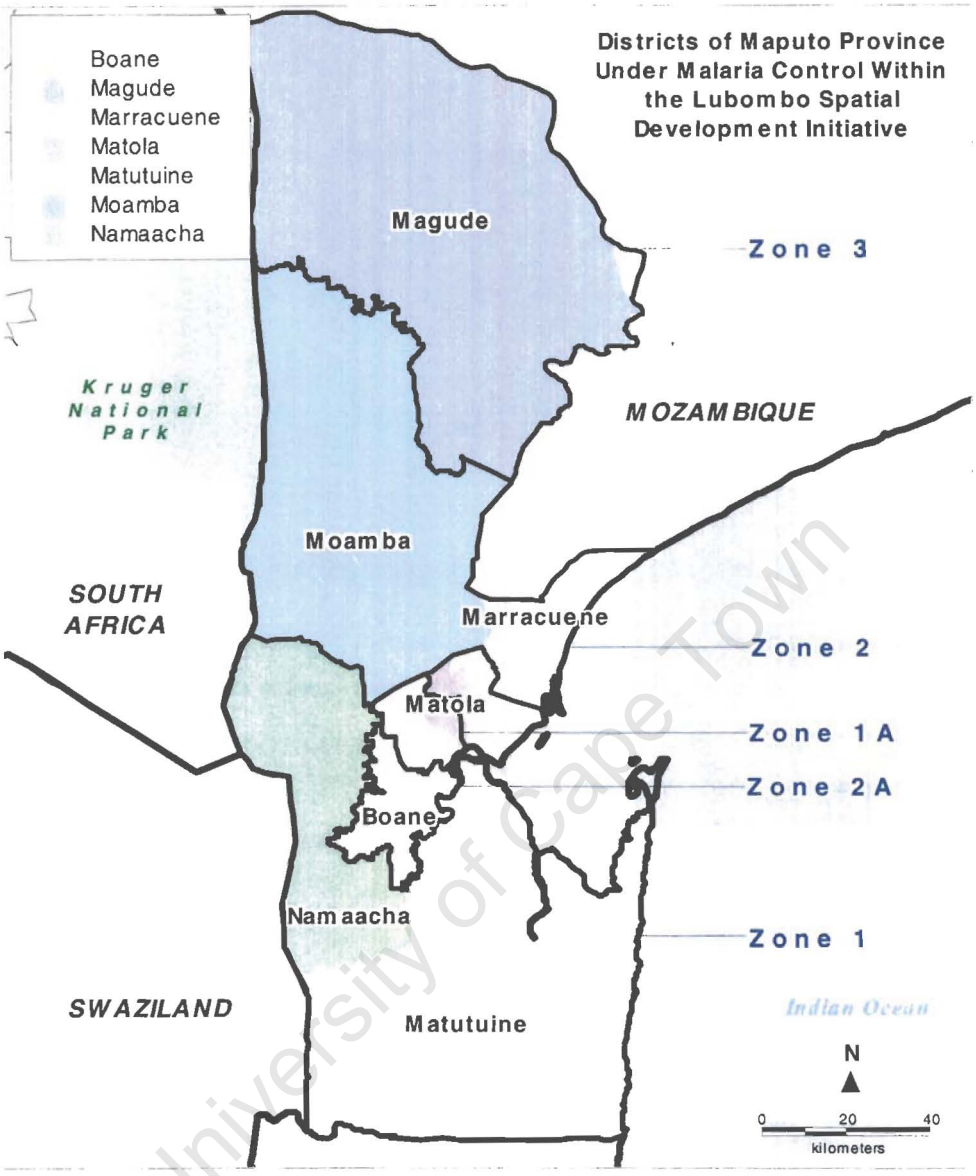


Figure 1: Geographic location of Mozambique (Source: Medical Research Council Malaria Lead Programme, Durban, South Africa)

2.2 Malaria Control

Communities are expected to benefit most from effective treatment if this is implemented together with an effective vector control program using Indoor Residual Insecticide Spraying (IRS) or Insecticide Treated Bed Nets (ITNs) (Raman et al 2008, Dike et al 2006). Great benefit is seen with Artemisinin based Combination Therapies (ACTs) as these directly reduce malaria transmission by reducing gametocytes (the stage of the *P. falciparum* lifecycle responsible for malaria transmission).

As a result of widespread and high-level chloroquine resistance, found to vary between 15-40% (MISAU, 2006), the Mozambican Ministry of Health (MOH) adopted an interim policy for uncomplicated malaria treatment using amodiaquine plus sulfadoxine-pyrimethamine in 2002, with the intention of introducing an ACT as soon as possible. To inform the ACT policy decision, the Maputo Provincial health directorate received a special permit for the phased implementation of the combination of artesunate plus sulfadoxine-pyrimethamine (AS-SP) starting first in Namaacha District and the locality of Catuane in Matutuine District, in April 2004 (Sharp et al 2007). The implementation was supported by the Lubombo Spatial Development Initiative (LSDI) and the South East African Combination Antimalarial Therapy (SEACAT) evaluation. The LSDI's objectives include reducing malaria morbidity and mortality through phased implementation of IRS (started in 2001); definitive malaria diagnosis using rapid diagnostic tests (started in 2003) and early effective treatment with AS-SP (started in 2004). All the districts in Maputo Province had this combination therapy policy implemented by 2006, when it became national malaria treatment policy.

2.3 Current educational interventions

So far the LSDI has focused mainly on educational interventions at healthcare provider level, and not enough attention has been paid to the role of the communities and schools in the management of malaria. Effective treatment requires early treatment-seeking at appropriate healthcare facilities and adherence to the full course of treatment. Mosquito vector control requires high coverage rates with IRS (or ITNs) (Kolaczinski et al, 2007).

The Director of Education of Maputo Province identified inadequacies in malaria education in the current school curriculum. The gaps are that the program has been largely focused on malaria recognition and prevention (with far more attention paid to ITNs than IRS), and that this is limited to grade 4, when children may be too young (~9 years) to take messages home (Boletim da República, 1992)

Other key informants, such as the Director of the National Malaria Program, concurred that insufficient information is provided at schools, and that there is very

limited coordination of Information, Education and Communication (IEC) programs in schools and health facilities.

Only limited information on IRS is provided through the community leaders and/ or spray operators to the community members and almost no information is provided to the community on malaria treatment seeking and adherence. Since the ACT treatment policy is new, there is no community knowledge of recommended medicines or their dose or duration. Healthcare facility-based training programs only reach those who seek treatment at these facilities.

2.4 Current malaria-related knowledge, attitude and practices in southern Mozambique

The current understanding of malaria-related Knowledge, Attitudes and Practices (KAP) in Maputo Province (in Namaacha and Matutuíne) was based on results of the SEACAT evaluation Focus Group Discussions held in 2001 and household surveys conducted from 2002 to 2003 in both Namaacha and Matutuine districts. The LSDI conducted KAP surveys in 1999, 2003 and 2005 at all sentinel sites where cross sectional malaria prevalence surveys are conducted annually. Further information on the community perspectives on malaria prevention and treatment were based on the queries that arose during meetings with over 400 community leaders in 2004 and 2005, conducted in Namaacha, Catuane, Boane and Maraccuene by the MMed candidate.

According to these surveys most community members were happy about the IRS programs and there was some community memory of the success of IRS in the past, which was discontinued in Mozambique in the 1970s (Sharp et al 2007, Potal do governo de Moçambique, 2006). However there were some concerns and misunderstanding or fears that the insecticide kills chickens, that it is too dilute because spray men sell insecticide, that they will be robbed as spray men can tell thieves about their possessions, and a perceived lack of effectiveness of the insecticide (LSDI reports (2007). These fears led to some refusals in accepting the program in some communities. In relation to ITNs they felt that these were too expensive and the Mozambican culture prioritizes the protection of men (and boys), not high risk groups (children under 5 year old and pregnant women). Regarding

treatment-seeking, this was sometimes delayed to wait for authorization from the mother-in-law. Before ACT introduction patients complained that chloroquine was ineffective and caused itchy skin, and that private "nurses" in isolated communities gave patients antimalarials at lower recommended dose (Zonjo, J, unpublished SEACAT evaluation report, 2003). During the meetings with the community leaders, they mentioned the need for effective medicines for malaria treatment because chloroquine was ineffective, which revealed that they were not aware of the new recommended antimalarial treatment.

Issues identified on ACT compliance were that generally there were high levels of self reported ACT adherence (>95%) but patients didn't want to wait for the recommended 1 hour post-dose observation period at the health facility so they absconded. It was reported that the medicine was "too good" so some stopped taking it as soon as they felt better to save it for future use, or they shared it with other relatives who got the same symptoms. In addition patients vomiting at home did not return to the clinic for extra tablets. In the private sector fewer tablets are sold than needed if patients could not afford the treatment full course.

2.5 School based education programs

Recent international trends emphasize the concept of children working together with others in the communities to solve health problems (Onyanho-Ouma et al 2005). Such school-based health education programs offer a number of advantages:

- Rural communities have greater access to primary schools than health facilities (Sahota et al, 2001) (Table1).
- The literacy level is often higher among senior primary school children than adults in rural communities (Lallo et al, 2006).
- The education of students in the school setting has the potential to benefit the individual by reducing the number of days lost from school caused by malaria. In view of the number of adolescent mothers and the high burden of malaria in infants and pregnant women, a school- based education program

would be an important tool to educate scholars not only about their own health, but also about their children's health (Lalloo et al 2006).

- The major interventions for reducing the burden of malaria depend on the improvement of the knowledge of the disease and its control, leading to changes in practices and this is enhanced by increased educational attainment (Dike et al, 2006). Short to medium-term health education campaigns about the causes, manifestations, control and treatment of malaria can have a positive impact on its control (Okabayashi et al. 2005, Nonaka et al. 2008). Thus, school-children could be agents for change by helping promote a community understanding of malaria (Muhe 2002, Okabayashi et al 2005, Nonaka et al 2008,).

Table 1: Complete Primary Schools (EPC "Escola Primaria Completa", i.e. those primary schools that include grade 6 and 7) and Health Facilities (HFs) per study District

District	Schools (total)	Scholars (total)	Teachers (total)	Health Facilities
Namaacha	EPC Mugado	1190	30	Namaacha HC
	EPC G. Machel	1170	31	Namaacha HC
	EPC 7 de Abril	512	15	Namaacha HC
	EPC Mafuiane	738	21	Mafuiane HP
	EPC Culula	321	8	Culula HP
	EPC Chigubuta	404	10	None
	EPC Mahelane	667	19	Mahelane HP
	EPC Changalane	536	18	Changalane HP
	EPC Goba	484	13	Goba HP
	EPC Maria Auxiliadora	351	14	Namaacha HC
Matutuine	EPC Pochane	229	7	None
	EPC Bela vista	887	25	Bela vista HC
	EPC Salamanga	500	14	Salamanga HP
	EPC N`sime	267	9	N'sime HP
	EPC Mungazine	262	9	None
	EPC Pedreira	306	8	None
	EPC Djabula	170	9	None
	EPC Tinonganine	248	8	None
	EPC Chucha	200	8	None
	EPC Machangulo	304	8	Ndelane HP
	EPC Ponta de Ouro	491	11	Ponta de Ouro HP
	EPC Mahau	316	9	Mahau HP
	EPC Zitundo	91	8	Zitundo HP
	EPC Ndlala	195	11	None
	EPC Missão Roque	*omitted data	8	None
	EPC Ndelane	207	8	Ndelane HP
	EPC Hindane	165	8	Hindane HP

***Source**: Maputo Provincial Education Directorate annual report 2006*

HC: Health center, HP: Health post

3. Study Objectives

The aim of the study was to evaluate the impact of a school-based malaria education intervention and its effectiveness in changing knowledge and practices related to malaria at randomly selected schools in Maputo Province.

The primary objective of this study was to develop, implement and evaluate a school-based education program aimed at strengthening malaria control by improving knowledge and practices regarding malaria prevention, treatment seeking, and adherence in Maputo Province, Mozambique

The secondary objective of this study was to use schoolchildren and teachers as change agents to strengthen malaria control by improving community knowledge and practices regarding malaria prevention, treatment seeking, and adherence.

3.1 Study endpoints

Assuming that intervention and control groups were similar pre-intervention, the main study endpoints were prospectively defined as the comparisons between the intervention and control groups post-intervention, in terms of:

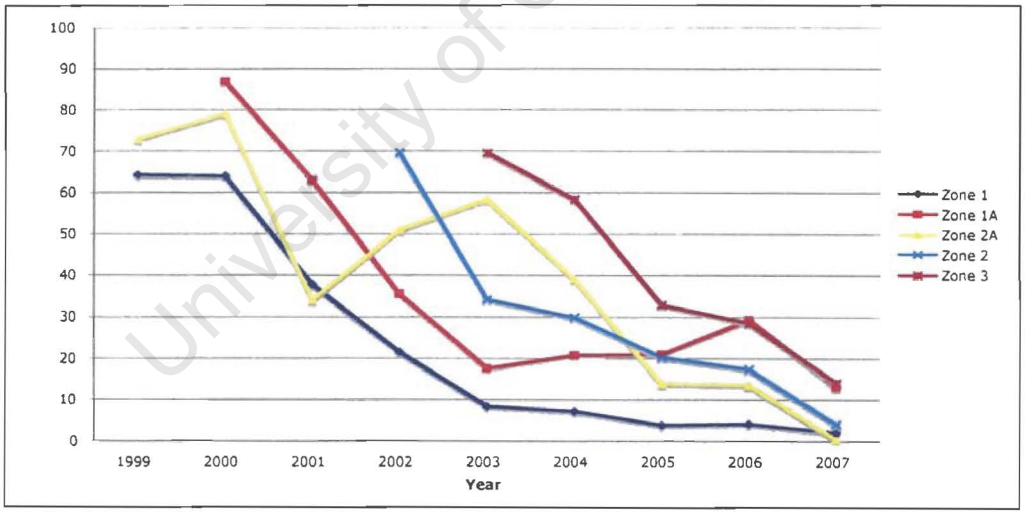
1. Proportion correctly answering key questions
2. Total questionnaire score.

The total cost of the intervention (excluding the cost of monitoring) was considered a secondary endpoint.

4. Study sites

The study was conducted in Namaacha and Matutuine districts in Maputo Province (figure 1), the first districts in which IRS was implemented in November 2000 and followed by definitive malaria diagnosis using rapid diagnostic tests in 2003, and the introduction of the artesunate plus SP combination in 2004. As a combined result of these interventions, there has been a marked reduction of malaria prevalence from over 60% in 1999 / 2000, to below 10% since 2004, with a prevalence of only 1.9% observed in June 2007(Sharp et al 2007) (Zone 1 in Figure 2). These two districts were purposively selected to be representative of rural areas of Maputo Province where highly effective malaria control has been achieved. It was expected that, as the burden of malaria decreases, the community may become less likely to accept IRS, seek treatment early and adhere fully with treatment.

Figure 2: Annual cross sectional prevalence of Plasmodium falciparum parasitaemia



Source: LSDI progress report 2007

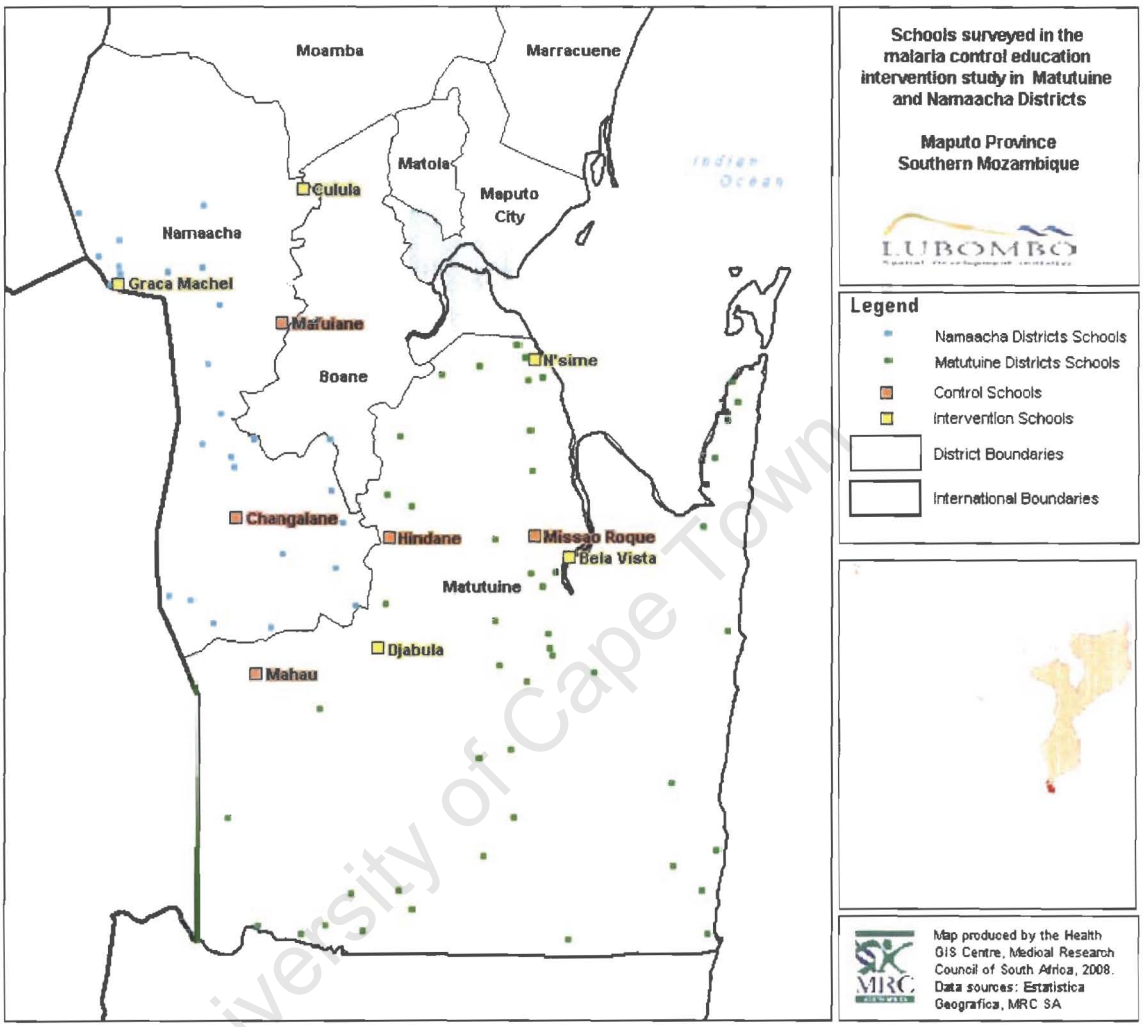
4.1 Matutuíne

Matutuine is a rural district (rate of urbanization 7%) with about 37000 inhabitants, located in the South-eastern extreme of Maputo Province (Instituto Nacional de Estatistica, 2007) (figure3). Thirty nine percent of the population is younger than 15 years of age. Matutuíne is one of the poorest districts in Maputo Province, where

agriculture is the main source of economy. The informal trade and border trade with South Africa is the source of employment for 12% of the active population and 8% of economically active women from the district (Ministério de Administração Estatal, 2005). The majority of Matutuíne's population belongs to the Ronga ethnic group. The other ethnic groups are the Nguni (related to the Zulu and the Swazi groups), Tsuas or Vatsua (from Inhambane) and the Changanas (from Gaza and Maputo). The dominant language is Xichangana, and only 38% of the population is Portuguese speaking (Ministério de Administração Estatal, 2005).

Matutuine has 19 public health facilities and 75 schools, of which there are 17 Complete Primary Schools, with 899 scholars attending grade 6 in 2007 (Direcção Provincial de Educação, relatório estatístico 2007). Only 43% of the population, mainly in Bela Vista and Catuane, attend or have attended school, mostly only at the primary school level. Consequently only 36% of the population are literate; these are predominantly males (Instituto Nacional de Estatística 2007, Ministério de Administração Estatal, 2005).

Figure 3: Geographic location of Namaacha and Matutuíne districts and LSDI zones in Maputo Province, southern Mozambique.



Data source: Medical Research Council Malaria Lead Program, Durban, South Africa

4.2 Namaacha District

Namaacha is also classified as a rural district, although the level of urbanization 28% is higher than the 7% in Matutiune. Namaacha has a population of about 42,000 inhabitants located in south-western Maputo Province (Figure3). Approximately 40% of the population is below 15 years of age (Instituto Nacional de Estaística 2007). The majority of the Namaacha population belongs to the Ronga and Swazi ethnic groups. The dominant language is Xichangana, although 63% speak Portuguese (Ministério de Administração Estatal, 2005).

Namacha has 13 public sector health facilities and 77 schools, among which there are 10 Complete Primary Schools with 1142 scholars attending grade 6 in 2007 (Direcção Provincial de Educação, relatório estatístico 2007). Approximately 63% of its inhabitants, mainly residents from Namaacha Town, attend or have attended school, the majority only for the primary school level (Ministério de Administração Estatal, 2005). In Namaacha approximately half of the population is literate, predominantly males.

Namaacha is one of the poorer districts in Maputo Province. Agriculture is the main source of the district's economy, with 5% of the population in a vulnerable situation in terms of food security. Other sources of income include financial support from Mozambican emigrants working in South Africa and Swaziland, informal commerce and border commerce, production of soap and the selling of charcoal, alcohol and ceramic products (Ministério de Administração Estatal, 2005).

5. Study Design and Methods

A randomised controlled trial to evaluate a school-based education program using before and after intervention surveys of teachers, scholars and community members was conducted between July 2007 and April 2008. The study used three semi-structured questionnaires both pre- and post- intervention to survey teachers, scholars and community members, respectively.

5.1. Study population

Eligible schools were those 27 with grade 6 and 7 learners in Namaacha and Matutuíne districts in southern Mozambique, from which 10 schools (4 in Namaacha and 6 in Matutuine) were randomly selected and then randomized as intervention or control schools. Study participants were all consenting grade 6 teachers and students from selected schools that lived in the study areas and who expected to be there until the first semester of 2008, and consenting adults from 30 households in each of the 10 communities surrounding the selected schools. Schools included in the pilot study, and schools that already had a grade 6 school-based malaria education program introduced before the study, were excluded.

5.2 Sample size and power

The sample size was estimated assuming there were between 20 and 60 children in grade 6 per school, and used a single-stage cluster sampling method (i.e. random selection of schools and then including all consenting teachers and scholars within that school). Assuming an expected 25% increase in scores, starting from pre-intervention scores between 35 and 60%, a minimum of 3 schools were needed for both the intervention and control arms. Since many of these assumptions were uncertain, this study included 5 schools in the intervention and 5 schools in the control arm (2 in Namaacha and 3 in Matutuine in each arm).

5.3 Selection of the study schools, teachers and scholars

The schools were listed in alphabetic order, numbered and divided by the sample size (4 in Namaacha and 6 in Matutuíne). That result was added to the first number of the list to select the other schools. The method of throwing a coin was used to

select the intervention and control schools, with heads selecting intervention schools and tails the control schools. There were no schools with a school-based malaria program in place in grade 6. All grade 6 teachers and students from the selected schools who gave written informed consent or assent were included in the study [i.e. 63% (24/38) teachers at the intervention schools and 37% (14/38) teachers at the control schools and 63% (414/654) of scholars at intervention schools and 37% (240/654) at the control schools].

In the post-intervention study a list with the names of the scholars from grade 6 in 2007 was obtained and compared with those who passed to grade 7 in 2008. Those who failed grade 6 where identified and followed until study completion. Those who were in grade 7 in 2008 because they had failed that grade in 2007 were excluded from the post-intervention study. Eligible scholars were not included in the post-intervention study if they were absent from school on the day that it was conducted.

Table 2: Number of schools in pilot study, in the intervention and control arms of the main study and total number of schools and teachers per district.

District	No. schools included in pilot study	No. schools in Intervention arm	No schools in control arm	Total number of EPC schools	Total no of teachers grade 6
Namaacha	1	2	2	10	62
Matutuine	2	3	3	17	80

5.4 Study period

After the pre-intervention study in August 2007, a school-based malaria program was introduced to target schools in October 2007. Teachers had an active role during the planning and implementation of the program and decided on the teaching methodology without researcher interference. The timing and the number of lessons were not assessed by the researcher and varied from one school to another. The post-intervention study was conducted in April 2008, 6 months later.

5.5 Selection of the community members

Thirty households from the community nearby each school were selected to participate in the study. A list was compiled of all houses in that community, using relevant references [e.g. Global Position System (GPS) latitude and longitude] of each house. The total number of the houses that were found was divided by 30 and added to the first house, to randomly select households for the survey.

Consenting adults from the selected houses were interviewed. If no one was at home at the time of the visit, the next house on the right- hand side was selected and interviewed. Local guides were used to help to identify the selected houses. For the post-intervention study the guides and references were used to find the same houses included in the pre-intervention sample. Where the same adult could not be found, the adult that was at home at that time was interviewed. Due to the fact that the questionnaire was anonymous it was not possible to confirm how many respondents participated in both pre- and post-intervention questionnaires.

5.6 Ethical Issues

The study was approved by the University of Cape Town (UCT) Research Ethics Committee, South Africa and the Mozambique National Research Ethics Committee. Prior to the study, a meeting was held with the community leaders and parents/guardians at all 27 eligible schools in both districts, to inform them about the study. This "community consent" was obtained to facilitate the study interviewers being accepted by the community and to permit the assenting scholars' participation in the study (in accordance with article 124 of the relevant Mozambican regulations). The participants were fully informed about the study, assured about the confidentiality and anonymity of their responses and that their participation would be entirely voluntary. They were also informed that they could withdraw from the study at any time. Written consent was obtained from adults who could write and a fingerprint obtained from illiterate adults. Written assent was also obtained from the scholars.

5.7 Data collection and management

In order to ensure high data quality, 20 interviewers were selected from interested university students (from 2nd to final year). Of these 3 could not participate in the post-intervention study for academic reasons. Selection criteria included those studying medicine, social science, law, geography, psychology or economy; experience in conducting interviews in medical and social areas; and willingness to work in the field.

A two-day training course was given to all personnel involved in data collection and data capturing. This included training on all the standard procedures to be followed by interviewers, supervisors and data capturers. Interviewers were given practice in using the questionnaires for teachers, scholars and community members. At the end of the training a manual covering issues related to the study was handed to the interviewers to be consulted if necessary. This included sections on data collection and data management techniques, as well as how to complete the questionnaire. Before each phase of the study, a review of their training was given to the interviewers in order to revise the essential information, and to discuss and correct any errors identified during the field work.

5.8 Pilot study

Pilot testing of the pre-intervention questionnaire was done in 3 schools (1 from Namaacha and 2 from Matutuíne) and in the households in the communities surrounding these schools.

The pilot study took place in the primary schools of Ponta de Ouro and Zitundo, a peri-urban and rural area in Matutuíne, respectively and the primary schools of Goba in Namaacha District. These schools were selected because they are located very far from the study's selected schools, so as to avoid interference with the results of the study. All consenting grade 6 scholars (n=78) and teachers (n=6) present at the selected schools at the time of the pilot study were interviewed; consenting adults (n=60) from the 20 randomly selected households in the communities surrounding each school were also interviewed using the pilot questionnaire.

The purpose of the pilot study was to refine the questionnaire, further develop the interview experience of data collectors and to delineate strategies for conducting the main study. In addition, the draft teaching material and methods that had been developed in coordination with the Ministry of education were piloted by the teachers and scholars in the pilot schools. The teaching manual contained information about how to prevent malaria (particularly the importance of IRS), when to suspect the disease, the current treatment, importance of prompt treatment seeking and full adherence with treatment. Feedback from teachers and scholars in the pilot study was used to refine the training program and edit the teaching manual and exercise books.

One of the main findings in the pilot study was that all drugs were called "quinine". To ensure a more accurate understanding of what drugs were currently used for malaria treatment, a chart with antimalarial and other tablets and packaging was made for respondents to point out which one was recommended for malaria treatment (Figure 4).

Figure 4: Study chart of tablets and packaging

5.9 Study questionnaires

The main study consisted of the pre-intervention and post-intervention questionnaires administered to all consenting teachers and scholars, and a survey conducted in 30 households randomly selected from each of the communities surrounding the participating 10 schools.

The content of the questionnaire was informed by findings from the LSDI KAP surveys and SEACAT evaluation focus group discussions and household surveys,

as well as publications from Mozambique, and finalized based on key stakeholder[1] opinion of what the questions most relevant to each study population were.

At the community level, for those who could not speak Portuguese the questionnaires had been translated into Xichangana, and then independently back translated into Portuguese to verify accuracy of translation. The questionnaires were conducted in Xichangana, although the answers to open questions were recorded in Portuguese. Some questions were further modified for the post-intervention questionnaire to be more understandable to respondents and user friendly for the data punchers. Changes comprised replacing open questions with a combination of tick boxes and open questions, without changing the content tested in the pilot and pre intervention studies.

5.10 Intervention

Three days of problem-based training regarding malaria prevention and treatment and how to effectively communicate key messages to scholars was given to the participating teachers from the intervention schools. Thirty-eight grade 6 teachers from the selected schools were invited by the MMed candidate to participate in the training. Because not all teachers could leave their duties at the same time, only some of them, selected by the school director, were sent to attend the training. This workshop was attended by 23 teachers and 2 representatives of Maputo Provincial Educational Directorate. The workshop was also used to refine the IEC material and to improve the teacher's manual. Teachers from 2 intervention schools who did not attend the workshop received the information from other teachers who had attended. Once finalized, the teachers' manual and IEC material was promptly distributed to all intervention schools but only distributed to the control schools at the end of the study.

[1] Stakeholders included Director of the National Malaria Control Program, Provincial Director of Education, Provincial Malaria Technical Advisory Group, members of the Regional Malaria Control Commission, Community Leaders.

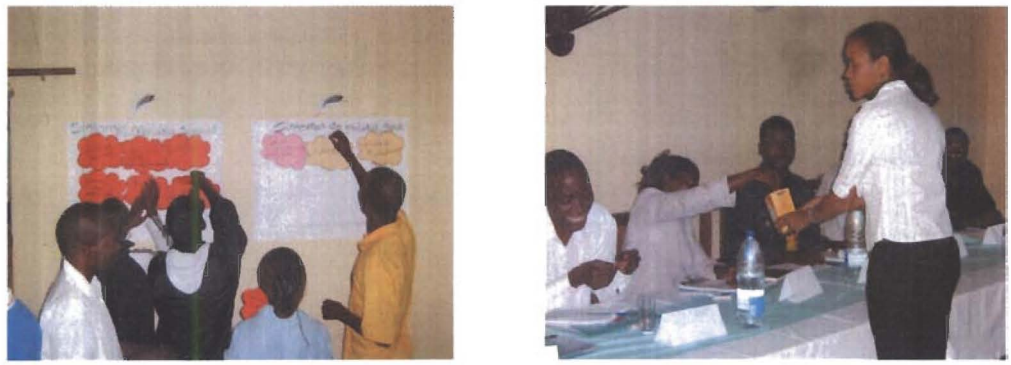


Figure 5: Teachers' problem-based training workshop

After the training course, teachers taught scholars about malaria by integrating malaria education within the other subjects taught. Examples included:

Drawing pictures (Figure 6) and singing songs or school theatre about malaria;

Sending messages about malaria prevention and treatment from scholars to the community members;

Teachers giving talks to other teachers and to the parents during meetings at school as well as giving talks to the communities; and

Environmental cleaning campaigns held in the schools and surrounding community to destroy the mosquito breeding sites.

Figure 6: Examples of the scholars' drawings about malaria

5.10.1 Scholars' Competition

The three schools that participated in this competition were those that volunteered themselves.

A competition was held where community communication tools developed by the scholars were presented on Southern African Development Community (SADC) malaria commemorative day. To avoid interference with the results in the post intervention study, this competition could not be held in Namaacha or Matutuine district. Scholars were transported to Boane, the closest district (Figure 3). Scholars from the nearest school in Boane were the jury who selected the prizes. Prizes were given to the best school, the best theatre, dancing and singing groups as well as the individual scholar with the best drawing. The best IEC material (posters and pamphlets) developed were printed and given to teachers and scholars for community education (Figure 7).

5.10.2 Information, Education and Communication materials

Scholars received schoolbooks with malaria information on the back cover about the disease, transmission, prevention, early treatment seeking and adherence and their role in fighting against malaria in the community (Figure 7). These were distributed to the children to be used during the natural science lecture so that they could recall the information. They were also provided with stationery to develop to draw issues related to malaria transmission, prevention and early treatment seeking.

Two different posters containing information about signs and symptoms of malaria and the right and wrong responses to the disease by teachers and parents were developed and given to the scholars. One thousand posters (500 of each) were printed. Pamphlets were developed so that malaria-related information would be available in the schools' waiting rooms (for teachers, scholars and parents or guardians) and be distributed to parents and the community members of the surrounding communities during the dissemination of the information.

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Figure 7: Examples of the Information, Education and Communication material developed

5.11 Data management and analysis

The data were coded and entered by two independent data punchers into a specifically designed Microsoft Access 2004 database, where the data was cleaned by the MMed candidate. The cleaned database was exported via Microsoft Excel into Stata 10 (StataCorp LP, College Station, Texas, USA) for analysis.

To analyze the overall change in knowledge and practices related to malaria, the pre-intervention and post-intervention total questionnaire scores were compared. Scoring was based on selecting key questions (indicated in Appendixes 1,2 and 3) for which the true answers score = 1, the false=0 and for responding that the time to seeking treatment $\leq$1 day score =2, for 2 days score =1; for >2 days score = 0. Those who did not answer the questions, or whose reply was "I don't know" or was irrelevant, also scored 0 for that question. The maximum score achievable was 11 for the teachers and 10 for scholars and community members. Teachers were asked an additional question to define features of severe malaria.

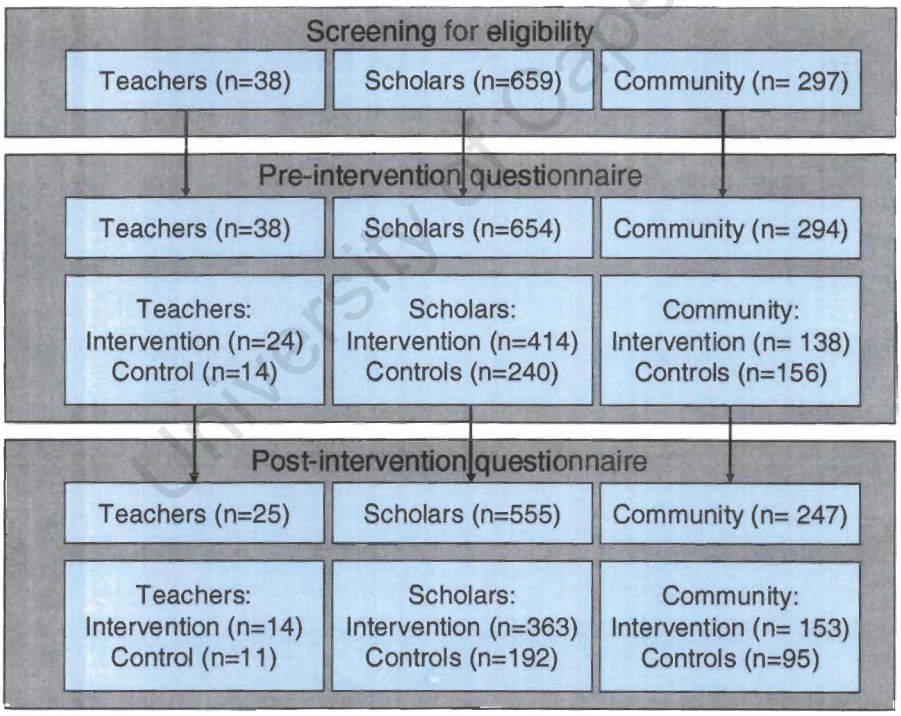
The statistical tests performed for comparison between the intervention and control groups, were the chi-squared (x^2) test for categorical variables and Student's two sample t-test for normally distributed continuous variables and the Kruskall Wallis test for non-parametric continuous variables. A 2x2 table was used to compare the Odd ratios between the pre- and post- intervention study.

6. Results

6.1 Study subjects

The study was conducted in ten Grade 6 primary schools in Maputo Province (5 intervention and 5 control schools). None of these schools had a malaria education program established, although health promotion (related to diarrhea, dental health, anaemia, worms and nutrition) is generally part of the school curriculum. During screening for the pre-intervention study, there were 38 teachers, 659 grade 6 scholars from the ten selected schools and 297 household members from their surrounding communities found to be eligible. Of these, 38 (100%), 654 (99.2%) and 294 (99%) respectively participated in the pre-intervention study, with 5 scholars and 3 household members not giving assent or consent to be interviewed.

Figure 8: Disposition of study subjects



From the subjects enrolled in the pre-intervention study, 555 (85%) of the scholars and 247 (84%) of the household members completed the post-intervention questionnaire. It is of concern that there were more household members in the intervention group (110%), while there were fewer in the control group (61%), participating in the post-intervention survey than the pre-intervention survey.

Among the teachers, only 66% completed the post-intervention questionnaire. The reasons given for this were that study teachers were absent or attending a teachers' training seminar throughout the time of the post-intervention assessment, and two had been transferred to another school. More of the teachers from the intervention schools than control schools were lost to follow up, but this was not statistically significant (10/38 vs. 3/14; p=0.20) The demographic characteristics of teachers ad scholars in terms of age, sex and teaching years remained the same in pre and post intervention study. The main reason for the loss to follow up of teachers was participation in a training course, while among the scholars this was absenteeism and school withdrawal. At the community level migration and missing references points (which prevented finding some houses) and one death explained the majority of those lost to follow up. The unexpected increase in household members in the intervention group participating in the post-intervention survey may reflect self-selection by community members who asked interviewers to include them in the study, even though interviewers had been trained not to interview households not included in the pre-intervention survey.

The demographic characteristics of the teachers, scholars and community members in the study were generally similar, although among the teachers, more in the intervention group taught natural science than in the control group [9/24 vs. 1/14; p=0.04]. Overall, the teachers' ages varied from 22 to 43 years and there were more male than female teachers 17:21]. Their years of teaching experience varied from 1 to 19 years, with a median (IQR) of 3 (2 – 6) and 4 (2 - 6) years in the intervention and control groups, respectively. Only 2 of the teachers, 1 in each arm, had received malaria related training before.

The age of the scholars varied from 11 to 28 years, with a median of 14 years. The older ages of a few of the scholars was because those attending night classes in grade 6 (n=15) were also included in the study. Almost a quarter (23%) of the scholars lived in a peri-urban area.

To keep the interview time to a minimum, demographic characteristics were not collected from the participating community members. The provision of informed consent with a thumb print indicated that 40 (26%) of 153 community members in the intervention group and 44 (46%) of 95 in the control group were not literate.

6.2 Pre-intervention questionnaire

The malaria-related knowledge and practices were generally similar for teachers, scholars and community members in the intervention and control arms. However, a few differences were detected during the pre-intervention questioning:

6.2.1 Teachers

In the pre-intervention study, most teachers knew malaria transmission occurred through a mosquito bite, that treatment should be sought on the same day (within 24 hours) and at a public sector facility; only one teacher (in the intervention group) did not respond that treatment should be sought at a hospital, public health centre, or health post. About half of the teachers knew that malaria could be prevented through use of bed nets and that fever was a symptom of uncomplicated malaria, but few knew about severe malaria symptoms, indoor residual insecticide spraying (IRS) or the current treatment for malaria (Table3).

Table 3: Baseline characteristics and knowledge of teachers at control and intervention schools

	Control (n=14)	Intervention (n=24)	P-value
Teachers' age (years), median (IQR)	27 (25 - 28)	27.5 (26 – 30)	0.32
Teaching years, median (IQR)	4 (2 - 6)	3 (2 – 6)	0.69
Teaches natural science	*1 (7%)*	*9 (38%)*	*0.04*
Had malaria training	1 (7%)	1 (4%)	0.74
Talked about malaria to other people	4 (29%)	5 (21%)	0.64
Transmission			
Mosquito bite	14 (100%)	22 (92%)	0.27
Prevention strategies			
Stagnant water elimination	5 (36%)	7 (29%)	0.68
Bed nets	8 (57%)	13 (54%)	0.86
Indoor Residual Spraying	3 (21%)	8 (33%)	0.44
Symptoms			
Fever	7 (50%)	16 (67%)	0.31
Headache	9 (64%)	14 (58%)	0.72

Severe malaria symptoms			
High fever	2 (14%)	4 (17%)	0.85
Convulsions	1 (7%)	1 (4%)	0.69
Delay in treatment seeking			
≤1 day	11 (79%)	21 (88%)	0.47
2 days	0	0	-
>2 days / not known	3 (21%)	3 (12%)	0.47
Where to get treatment			
Health post	3 (21%)	8 (33%)	0.44
Health centre	5 (21%)	8 (33%)	0.88
Hospital	7 (50%)	10 (42%)	0.62
At any public health facility	14 (100%)	23 (96%)	0.44
Recommended treatment			
Quinine	1 (7%)	2 (8%)	0.89
Artesunate plus SP	3 (21%)	3 (13%)	0.47
Artemether-lumefantrine (Coartem®)	2 (14%)	2 (8%)	0.56
Correct treatment (drug + duration)	6 (43%)	6 (25%)	0.25
Total score (out of 11): Median (IQR)	7 (6 - 8)	7(6 - 8)	0.98

6.2.2 Scholars

Responses to the questionnaire were generally similar among the scholars in the intervention and control schools. However, more in the intervention group responded that they would seek treatment for malaria related symptoms at a public health facility (hospital / health centre / health post) than in the control group [363/414 (88%) vs. 188/241 (78%); p=0.001].

In the pre-intervention survey, most had heard about malaria, but less than 50% knew that it is transmitted by a mosquito bite; most related the disease with lack of personal, food and water hygiene. The malaria prevention method most known by scholars was bed net use [66/240 (28%) and 91/414 (22%) in the control and intervention groups, respectively]. Only one scholar in both the control and intervention group mentioned IRS for malaria prevention. The malaria symptom most often mentioned by the scholars was headache followed by fever. Most of the

scholars knew that treatment should be sought at a public health centre, health post or hospital, but less than 50% mentioned that this should be within 48 hours (preferably within 24 hours) of symptom onset. Very few scholars knew the recommended treatment for malaria (table 4)

Table 4 Baseline characteristics of scholars at the control and intervention schools

	Control (n=240)	**Intervention (n=414)**	**P-value**
Scholar's age (years), median (IQR)	13 (13-15)	13 (12-14)	0.33
Heard about malaria	205 (86%)	371(90%)	0.11
Transmission			
Mosquito bite	99 (41%)	195 (47%)	0.15
Prevention strategies			
Stagnant water elimination	4 (2%)	10 (2%)	0.52
Bed nets	66 (28%)	91 (22%)	0.11
Indoor Residual Spraying	1 (0.4%)	1 (0.2%)	0.69
Symptoms			
Fever	14 (6%)	31 (7%)	0.42
Headache	78 (33%)	118 (29%)	0.28
Convulsions	1 (0.4%)	1 (0.2%)	0.69
Where to get treatment			
Health post	25 (10%)	76 (18%)	*0.0007*
Health centre	49 (20%)	138 (33%)	*<0.001*
Hospital	117 (49%)	313 (76%)	*<0.001*
At any public health facility	188 (78%)	363 (88%)	*0.001*
Recommended treatment			
Quinine	13 (5%)	19 (5%)	0.64
Artesunate plus SP	21 (9%)	32 (8%)	0.65
Artemether-Lumefantrine	13 (5%)	38 (9%)	0.08
Delay in treatment seeking			
≤1 day	86 (36%)	151 (36%)	0.84
2 days	30 (12%)	56 (14%)	0.69
>2 days / not known	125 (52%)	207 (50%)	0.65
Total Score: Median(IQR)	4 (2-5)	4 (2-5)	0.19

6.2.3. Community

More community members in the control group than the intervention group responded that:

- Fever was one of the symptoms of malaria [64/156 (41%) vs. 33/138 (24%), p=0.002].
- They would first seek treatment for malaria related symptoms at a hospital [86/156 (55%) vs. 51/138 (40%), p=0.002], although a similar proportion in the intervention and control groups responded that they would seek treatment at a public health facility (hospital / health centre / health post) for malaria related symptoms [142/156 (91%) vs. 128 / 138 (93%); p=0.59].

At the community level, the majority in the pre-intervention study had heard about malaria but fewer than 50% knew that malaria is transmitted by a mosquito bite. Bed nets were most often mentioned as a prevention measure, and very few mentioned IRS. The malaria symptom most often mentioned by the community was headache followed by fever. The community members knew that treatment for malaria should be sought at a public health post, health centre or hospital and most mentioned that this should be within 24 hours. Very few knew the recommended treatment for malaria (table 5).

Table 5 Baseline characteristics of household members in the control and intervention communities

	Control (n=156)	**Intervention (n=138)**	**P-value**
Heard about malaria	147 (94%)	132 (96%)	0.58
Transmission			
mosquito bite	72 (46%)	67 (49%)	0.68
Prevention strategies			
Stagnant water elimination	13 (8%)	9 (7%)	0.56
Bed nets	38 (24%)	43 (31%)	0.19
Indoor Residual Spraying	8 (5%)	7 (5%)	0.98
Symptoms			
Fever	64 (41%)	33 (24%)	*0.002*
Headache	83 (53%)	73 (53%)	*0.96*

Convulsions	1 (0.6%)	1 (0.7%)	0.93
Where to get treatment			
Health post	91 (58%)	60 (43%)	*0.01*
Health centre	16 (10%)	39 (28%)	*<0.001*
Hospital	86 (55%)	51 (37%)	*0.002*
At any public health facility	142 (91%)	128 (93%)	*0.59*
Recommended treatment			
Quinine	6 (4%)	5 (4%)	0.92
Artesunate plus SP	38 (24%)	27 (20%)	0.32
Artemether-Lumefantrine (Coartem®)	7 (4%)	8 (6%)	0.61
Delay in treatment seeking			
≤1 day	103 (66%)	96 (70%)	0.52
2 days	15 (10%)	17 (12%)	0.46
> 2 days / not known	38 (24%)	25 (18%)	0.19
Correct treatment (Drug + duration)	18 (12%)	16 (12%)	0.99
Total score: Median(IQR)	4 (3-5)	4 (3-5)	0.98

6.3 Post-intervention questionnaire

6.3.1 Teachers

In the control group there was some improvement in the teachers' knowledge and reported practices in the post-intervention questionnaire, when compared with their pre-intervention questionnaire results:

- There was a trend towards more teachers responding that malaria prevention could be achieved through IRS [from 3/14 (21%) to 6/11 (55%), OR=4.4 (95% CI 0.6-37), p=0.09] and through bed net use [from 8/14 (57%) to 6/11 (90%), OR=7.5, (95% CI 0.64-378), p=0.06].
- Malaria prevention through stagnant water elimination increased [from 5/14 (36%) to 8/11(73%), OR=5 (95% CI 0.7-39), p=0.007]
- The number of teachers that mentioned that malaria treatment should be sought at a health post increased [from 3/14 (21%) to 7/11 (64%), OR=6.0 (95% CI 0.8-55), p=0.03].

The improvement in the teachers' knowledge and reported practices after the intervention was however greater in the intervention group than in the control group. The total post-intervention questionnaire score was higher in the intervention than the control group [median (IQR) 8 (7 – 9) vs. 6 (5 – 6), p=0.0001]. (Table 6) for specific questions:

- More teachers in the intervention than control group taught about malaria [11/14 (79%) vs. 4/11 (36 %); p=0.01].
- There was a trend towards more intervention than control teachers knowing that malaria can be prevented through IRS [12/14 (86%) vs. 8/11(36%), p=0.06] and knowing the recommended duration of treatment [6/14 (36%) vs. 1/11 (9%), p=0.06].
- More teachers from the intervention than control group identified convulsions and high fever as symptoms of severe malaria [7/14 (50%) vs. 1/11 (9%), p=0.03 and 5/14 (36%) vs. 0/11 (0%), p=0.03, for convulsions and high fever respectively]
- There were more teachers in the intervention than control group responding that artesunate plus SP was the medication currently recommended for malaria treatment [6/14 (43%) vs. 0/11 (0%), p=0.01].

However, despite these improvements, less than 50% of teachers recognised high fever as a symptom of severe malaria (none in control group and 36% in the intervention group) and less than 50% of the teachers knew the current malaria treatment. More teachers in the control than intervention group responded that headache was a symptom of malaria [11/11(100%) vs. 10/14 (71%); p=0.05].

Table 6: Post-intervention questionnaire results on the knowledge and reported practices of teachers at control and intervention schools

	Control (n=11)	**Intervention (n=14)**	**P- value**
Had malaria training	0	13 (93%)	*<0.001*
Talked about malaria to other people	4 (36%)	11 (79%)	*0.01*
Transmission-			
Mosquito bite	11 (100%)	14 (100%)	-

- "That malaria can be prevented through IRS" [from 1/240 (0.4%) to 6/192(3%), OR= 8.0 (95% CI 0.9-356), p=0.03].
- "That they share what they know about malaria with others" [from 38/240 (16%) to 67/192 (35%), OR=3.4 (95% CI 2- 5.4), p<0.001].

The total post-intervention questionnaire score was higher in the intervention than the control group [median (IQR) 5 (4-5) vs. 4 (3-5), p=0.009]. The improvement in the malaria-related knowledge and reported practices was also greater among the scholars in the intervention group than in the control group for most questions. (Table 7):

- More scholars in the intervention group knew that malaria was transmitted by a mosquito and could be prevented through IRS. However, despite this improvement, only 17% of students in the intervention group responded that malaria could be prevented through IRS, none mentioned bed nets, and 27% noted eliminating stagnant water as a malaria prevention strategy.
- There was a trend towards the proportion of scholars recognising that fever is a malaria symptom, although more scholars in the intervention than control arm knew that headaches and convulsions could be malaria symptoms.
- Almost all scholars knew that treatment for malaria symptoms should be sought in the public sector [353/369 (96%) in the intervention group vs. 178/192 (93%) in the control group; p=0.14].
- Although equally few scholars in the intervention and control groups responded that the current first line treatment (artesunate plus SP) was recommended for the treatment of malaria, more in the intervention group than the control group knew about quinine [88/363 (24%) vs. 16/192 (8%), p<0.001] and artemether-lumefantrine [37/363 (10%) vs. 4/192 (2%), p=0.001].
- Scholars in the intervention group responded more often that they would share their knowledge about malaria [183/363 (50%) vs. 67/192 (35%), p=0.003].

Surprisingly, there was a trend towards more scholars in the control than intervention schools responding in the post-intervention survey that malaria treatment should be sought within 24 hours of symptom onset [107/192 (56%) vs. 178/363 (48%), p=0.09]

Table 7: Post-intervention questionnaire results on the knowledge and reported practices of scholars in control and intervention schools

	Control (n=192)	Intervention (n=363)	P- value
Scholar's age (years), median (IQR)	14 (13-15)	14 (13-15)	0.91
Heard about malaria	183 (96%)	358 (99%)	0.018
Transmission			
mosquito bite	121 (63%)	286 (79%)	*<0.001*
Prevention strategies			
Stagnant water elimination	21 (11%)	97 (27%)	*<0.001*
Bed nets	0	0	-
Indoor Residual Spraying	6 (3%)	63 (17%)	*<0.001*
Symptoms			
Fever	47 (24%)	114 (31%)	0.09
Headache	94 (49%)	252 (69%)	*<0.001*
Convulsions	0	16 (4%)	*0.003*
Where to get treatment			
Health post	152 (79%)	130 (36%)	*<0.001*
Health centre	18 (9%)	228 (63%)	*<0.001*
Hospital	14 (7%)	9 (2%)	*0.007*
At any public health facility	178 (93%)	353 (96%)	*0.14*
Recommended treatment			
Quinine	16 (8%)	88 (24%)	*<0.001*
Artesunate plus SP	19 (10%)	31 (9%)	0.59
Artemether-Lumefantrine	4 (2%)	37 (10%)	*0.001*
Delay in treatment seeking			
≤1 day	107 (56%)	178 (48%)	0.09
2 days	35 (18%)	88 (24%)	0.13
> 2 days/ Not known	50 (26%)	103 (28%)	0.64
Correct treatment (drug+ duration)	9 (5%)	32 (9%)	0.09
Share information	67 (35%)	183 (50%)	*0.003*
Total score: Median (IQR)	4 (3-5)	5 (4-5)	*0.009*

6.3.3 Community

At the community level the overall results comparing post-intervention questionnaire responses in intervention and control groups indicate that there was not a statistically significant improvement in the knowledge and reported practices related to malaria for the majority of questions (Table 8). However, there was a trend towards more respondents in the intervention than control communities reporting that malaria treatment should be sought within 24 hours [88/153 (58%) vs. 43/95 (45%), p=0.06]. More respondents in the intervention group responded that they would seek treatment at a health centre, while more in the control group would seek treatment at a health post.

Even after the intervention, there were substantial gaps in the community members' knowledge about malaria. Fewer than 50% of the community members knew that malaria is transmitted by mosquito bite, while only 24% and 7% knew that measures for malaria prevention included bed nets and IRS, respectively. Fever was mentioned as a malaria symptom by only 52% of the households and only 17% knew the correct treatment.

Table 8: Post- intervention results on the knowledge and reported practices of Households at control and intervention schools

	Control (n=95)	Intervention (n=153)	P- value
Heard about malaria	86 (90%)	141 (92%)	0.17
Transmission			
Mosquito bite	53 (56%)	75 (49%)	0.30
Prevention strategies			
Stagnant water elimination	16 (17%)	27 (18%)	0.87
Bed nets	27 (28%)	37 (24%)	0.46
Indoor Residual Spraying	5 (5%)	10 (7%)	0.69
Symptoms			
Fever	40 (42%)	79 (52%)	0.14
Headache	59 (62%)	95 (62%)	0.99
Convulsions	1 (1.0%)	1 (0.7%)	0.73
Where to get treatment			
Health post	79 (83%)	70 (46%)	*<0.001*

Health centre	1 (1%)	67 (44%)	*<0.001*
Hospital	7 (7%)	6 (4%)	0.23
At any public health facility	83(87%)	137 (90%)	0.60
Recommended treatment			
Quinine	2 (2%)	7 (5%)	0.31
Artesunate plus SP	27 (28%)	45 (30%)	0.87
Artemether-Lumefantrine	8 (8%)	12 (8%)	0.87
Delay in treatment seeking			
≤1 day	43 (45%)	88 (58%)	0.06
2 days	31 (33%)	33 (22%)	0.05
> 2 days / not known	21 (22%)	32 (21%)	0.82
Correct treatment (Drug + duration)	22 (23%)	26 (17%)	0,23
Total score: Median(IQR)	5(4-7)	5 (4-7)	0.68

7. Total cost of the school-based malaria education intervention

The school-based malaria education intervention involved 3 components: The IEC material development and printing, the teachers' training course and the scholars' competition. The IEC material cost $6041 in total, and included posters, pamphlets and schoolbooks that were aimed at reaching 1000 scholars' and their surrounding community members. However, the total cost of the school books for 1500 scholars would have been the same as for 1000 schoolbooks, so 1500 were printed so as many scholars as possible could benefit.

The teachers training course involved 3 days of training and cost $5627 in total for 25 teachers. The expenditure included a per diem of $ 47 per teacher per day, stationery, the Teachers' Training manual, the facilitators and the driver. As described above, the total cost for printing 250 Teachers' Manuals was the same as for 35 Teachers' Manuals, so 250 teachers' manuals were printed. Including more teachers would be more expensive in terms of per diem ($47) and stationery but with relation to the printing of the teaches manual, the cost per teacher would be reduced as the total cost for printing for all schools in the study districts was the same as for just the study schools.

The total cost of the scholars' competition was $6257 USD and included the car rental for scholars transport, the facilitators' per diem of $71 per facilitator per day, the DPS (Direcção Provincial de Saúde, e.g. Provincial Health Directorate) representatives per diem of $43.75 per day, the teachers' per diem of $33 per day, refreshments during the competition, stationery (e.g. cardboard, coloured pens) supplied to the scholars so that poorer students were not disadvantaged, prizes for the 3 top schools and for the best school overall, prizes for scholar participation and for school participation, as well as a photograph for each student and each school.

Table 9 Breakdown of the Cost of school-based malaria education intervention

Total cost of school- based malaria education intervention				
Details	Quantity	Items	Price per unit (USD)	Total cost (USD)
IEC material	500	Poster 1	$3.46	$1,730
	500	Poster 2	$3.46	$1,730
	1000	Pamphlets	$0.68	$675
	1500	School books*	$1.25	$1,879
	1 x 1 day	Distribution Per diem	$27.00	$27
	Subtotal			$6,041
Teacher's training	25 teachers x 3 days	Per diem	$43.88	$3,291
	25 teachers x 3 days	Stationary	$29.08	$727
	250	Teachers manual*	$4.81	$1,203
	2 x 3 days	Facilitators	$50.00	$300
	1 x 3 days	Driver	$35.33	$106
	Subtotal			$5,627
Competition	2	Car rental	$200.00	$400
	2	Facilitators Per diem	$71.00	$142
	4	DPS Per diem	$43.75	$175
	4	Teachers Per diem	$33.00	$132
	150	Refreshments	$4.24	$636
	1200	Stationery#	$2.54	$3,052
	3	Prizes top 3 schools	$64	$193
Prizes	1	Prize best school	$267	$267
	70	Scholar Participation	$5.89	$412
	28	School Participation	$9.61	$269
	70	Photographs	$4.70	$329
	Subtotal			$6,007

DPS: Direcção Provincial de Saúde (Provincial Health Directorate)

 # Stationary provided to each participating scholar so that poorer students were not disadvantaged

The total cost of the intervention (including printing for both intervention and control schools) was $17925 and $11668 including or excluding the competition, respectively. The total cost per scholar of the whole intervention was $17.93. This was reduced to $11.67 if the competition was excluded and to $5.63 per scholar if only the Teachers' Training programme was provided (Table 10).

The cost of monitoring was excluded as the RCT approach and assessment in such a large sample size at teacher, student and community, was study specific and would not be feasible for large scale deployment of an educational intervention.

Following the post-intervention assessment, the remaining IEC material was distributed to the control schools.

Table 10: Total cost, and cost per student of the school-based education intervention

Total costs	Total cost of intervention	$17,675
	Total cost of intervention excluding competition	$11,668
	Total cost of only the Teachers' Training Programme	$5,627
Costs per student	Total cost of intervention per scholar	$17.68
	Total cost of intervention per scholar excluding competition	$11.67
	Total cost of teachers' training per scholar	$5.63

8. Strengths and limitations of the study

A key strength of this study is the inclusion of control teachers, scholars and communities. The improvements observed even in the control group showed that even without any intervention, conducting the pre-intervention questionnaire increased malaria awareness among teachers and scholars (and possibly community members). The fact that participants had been asked questions on malaria previously was likely to have increased their awareness and may have prompted them to search for further information by themselves. This effect could have explained (or contributed to) the benefit that was attributed to the school-based education interventions in the Thailand, Kenya, and Indonesia, which did not have any control groups (Okabayashi et al. 2006, Onyango-Ouma et a l.2005, Marsh et al. 1996).

Our study intervention was carefully designed to meet the school and health priorities identified by key informants at all levels, and was informed by the household surveys and focus group discussions previously conducted in the study sites. The areas of concern consistently identified during these assessments were households refusing IRS, poor ITN coverage and delay in treatment seeking and poor adherence with treatment. This study also addressed the issue of a lack of coordination between planning by the education and health sectors that was identified by both these Ministries, as well as the need to find alternative ways of educating the rural community, where access to the health facilities is known to be poor.

The limitations of the study are described below:

- An important limitation of the study is that the study analysis did not take account of the clustering in schools', although this was a consideration in the sample size calculation. This is important as statistical adjustments are required to allow for confounders. Failure to adjust for clustering in the analysis increases the chance of a Type 1 error. However, complex general estimating equation and hierarchical modeling techniques were beyond the scope of this mini-dissertation.
- The impact of the study may have been reduced by the fact that only 25 of the selected 38 teachers participated in the training intervention. As schools

could not allow all their Grade 6 teachers to leave school simultaneously to attend a 3-day training course, the study was designed to explore the impact of a feasible, if not ideal, teachers' training intervention. Selection bias may have occurred as the teachers included in our study, were those that were volunteered by the school principal. The teachers included may not necessarily have been those interested in health promotion or those who were part of the School Health Team (Rhode et al 1980), so the most appropriate teacher may not have been included in the study. This may have had a negative impact on the effectiveness of our intervention.

- Teachers who did not attend the workshop got the information from other teachers in 2 of the intervention schools (Graça Machel, and Bela Vista), but this strategy was not adopted by all schools. Including teachers who did not receive the training in the intervention group could have contributed to the lower than expected improvement in the knowledge after the intervention for both teachers and scholars.

- There were a high proportion of teachers who participated in the pre-intervention survey that were not available for the post intervention survey [45% (11/24)]. The higher proportion lost to follow up among the intervention teachers may have introduced a bias in our results by underestimating the impact of the intervention, as those that remained in the study may be more committed to improving teaching. However, 78% (7/9) of natural science teachers who participated in the pre-intervention survey were not available for the post intervention survey. This also could have influenced our results underestimating the expected impact as they would be more motivated and committed to improve their malaria knowledge and share this with their scholars. The smaller sample post-intervention may also have had the effect of reducing the power of the study to detect changes in the teachers' behaviour following the intervention.

- During the teachers' training, options available for community education were discussed, but the teachers were not given specific instructions and training for educating community members. This approach was selected as it creates ownership and better involvement by the teachers (Opiyo et al. 2007) and was considered most similar to the normal context within the Mozambican education system. However, the use of specific teachers' training and provision of community education tools in those studies which

have shown an impact on the community suggest that better results might have been more likely if our study had adopted this approach.

- Data on the malaria related health promotion activities of each school / teacher included in this study were not systematically collected, so our results include those of teachers whose practices were not altered by the intervention and those of one teacher in the intervention group who did not participate in the teachers training program. We are also unable to comment whether any malaria-related activities were introduced during study by the control teachers / schools. While this may have diluted or underestimated the effect of our intervention, it is likely to reflect the reality of variable uptake of a training programme.

- To minimize the number of questions asked, information on scholars' sex was not collected, so this study is unable to comment on whether gender has any effect on the impact of educational interventions.

- In the community questionnaire the question "how do students think that the health education could be improved in order to control malaria" was not included. This would have been a useful question to gain insight into the acceptability of this approach to the community and also would be a valuable contribution for future interventions.

- To minimize the number of questions asked, the demographic characteristics of the community members was not collected in our study. Thus, their association with malaria related knowledge and reported practices could not be explored. Nor could the similarity of the community members included in our study with those in the other studies be compared. This limits our ability to comment on the generalizability of our study's findings.

- If the person interviewed in the pre-intervention study was not found at home for the post intervention questionnaire, another adult household member present at that time was interviewed. Thus not all the community members included in the post intervention survey had the benefit of having been previously asked similar questions. Further bias could have been introduced by the apparent self selection of the community members into the intervention group for the post intervention survey, given the number of participants increasing from 138 in the pre-intervention survey to 153 in the post-intervention survey. To preserve anonymity of study participants, no participant identifier was recorded, so it was not possible to exclude post-

intervention survey participants who had not participated in the pre-intervention survey.

- The 61% loss to follow up of community members in the control group may also have introduced a bias, although it cannot be predicted if this would have affected the study results negatively or positively, depending on whether community members with either more or less malaria knowledge were those predominantly lost to follow up.
- In one community the planned method for selection of households could not be followed systematically, as this community was found to have a very sparse population density and very few households; in this community all households found were included in the study. There is no reason to believe this would have compromised our study results.

9. Discussion

Rational use of the artemisinin-based combination therapy (ACT) that was recently introduced as malaria treatment policy in Mozambique requires education of the community as well as healthcare providers. Community members can contribute to ensuring rational ACT use by limiting the number of treatments needed by supporting mosquito vector control through IRS, ITNs and environmental cleaning. This would reduce both the cost of treatment and potentially delay the development of antimalarial drug resistance (by reducing drug pressure), as well as reducing malaria morbidity in the community. Seeking treatment promptly and adhering fully to the recommended treatment course should further reduce morbidity and antimalarial drug resistance.

Although the benefit of the school-based educational intervention failed to be proven among the community members participating in our study, the improvement in malaria-related knowledge and reported practices among the study teachers and scholars was significantly greater in the intervention group, when compared with the control group. However these results should be interpreted with caution, as the study analysis did not take account of the effect of clustering. We also did not follow up those students who were absent and those who had failed Grade 7 in 2007; the exclusion of these scholars from the post-intervention survey could have overestimated the results of our study by excluding weaker students.

After the intervention more teachers talked to the scholars as well as to community members and parents about malaria, recognized high fever and convulsions as symptoms of severe malaria, knew that artesunate plus SP was recommended for malaria treatment, and most importantly responded that malaria could be prevented with IRS and that treatment should be sought at any public health facility within the first 24 hours of malaria symptoms.

Discussions with the participating teachers about the reasons for the observed improvements among teachers' performance during the post-intervention questionnaire found that their increased knowledge about malaria, their training and the education material developed encouraged them to discuss this issue more with their scholars. Soon after the intervention many teachers started to apply their

knowledge and acquired skills by integrating malaria education within the different subjects they teach scholars. Some of the teachers also started outdoor activities aimed at destroying mosquito breeding sites at their school and within the surrounding community. A few of the teachers delineated plans for activities related to malaria to put in place throughout the following school year. Some teachers took the opportunity to teach other teachers about malaria. At the community level, teachers had acted as facilitators for the scholars' activities and 78% (11/14) gave talks in the communities. Three of these teachers selected those communities where they had heard that there were refusals in accepting the IRS, in order to sensitize them to accept the LSDI spraying their houses with insecticide. The teachers' knowledge of malaria could be improved if the Teacher Training colleges included malaria control in the curriculum. This would enable the key messages to be effectively and systematically transmitted to teachers, and subsequently to the scholars to further improve their knowledge.

After the intervention, more scholars not only mentioned that they had heard about malaria but also reported that they had shared their knowledge on malaria with other people. In addition to these reported changes in behaviour, a clear improvement in the scholars' knowledge after the intervention was seen. Although more scholars in the intervention than control group mentioned the role of IRS for malaria prevention, it is of concern that only few scholars (17%) knew about IRS and none had mentioned ITN use. The success of a spraying program can be attributed to many factors which include intensive community information preceding the spraying campaign (Sharp et al 2002). The disappointing improvement in IRS knowledge observed in our study may be attributed to the very low knowledge prior to the intervention, possibly as a consequence of the infrequent spray campaigns which happen only once or twice a year. This may constitute an alert to the spraying program as the spray operators are supposed to provide malaria information during the campaigns and sensitize the community to accept their houses to be sprayed. Since malaria in now better controlled in these areas people may not be as concerned about the risk of malaria as in the past. Other issues identified were the perception of lack of effectiveness of the insecticide and side effects related to its use. These findings are in accordance with the Nigerian study (Brieger et al, 1995) where study participants complained about the lack effectiveness of IRS and were more in favour of ITN use as this protects them better from the mosquito. Lines et al (1987) suggest that people tend to notice the side-effects of vector control

operations as much as their intended benefits'. Our study results indicate that the malaria control program needs to intensify community education on malaria related issues, particularly just before spray campaigns, with emphasis on transmission and preventive measures, remembering the schools' role in helping fight against malaria.

There was, however, a clear increase in the number of scholars recommending environmental cleaning in order to eliminate the mosquito breeding sites, with particular emphasis on stagnant water elimination as a measure for malaria prevention. This might reflect this being the focus of the scholars' participatory activities in their schools and communities.

Knowledge and practices learnt after the intervention were mostly similar among teachers and scholars, with both identifying fever and convulsions as malaria symptoms, noting that IRS was one of the strategies for malaria prevention and reporting that they have talked more about malaria at school and in the community. However, the improvement in the scholars' knowledge after the intervention was generally greater than for the teachers. This could reflect that scholars are better able to learn health related messages. The latter explanation is in accordance with the Child-to-Child (CTC) approach in which children are believed to have the potential to spread health messages and practices (to younger children, peers, family members and community members) and that they should enjoy and benefit from doing so (Nonaka et al 2008, Onyango-Ouma et al 2004, Kobayashi et al 2006). However, this difference could simply reflect the larger sample size for the scholars and their lower pre-intervention scores. The statistical significance found in this study should be interpreted with caution as the analysis of the study did not take in account the clustering in schools.

Feedback from the scholars was generally that after they had been trained they became more involved and enthusiastic about participating in activities as they could play a role as educators, disseminating information through drawing, singing, theatre and doing talks to other scholars and community members on malaria related issues (prevention through IRS acceptance, early treatment seeking and adherence).

The results achieved among our teachers and scholars were similar to other studies which found that the key for a successful intervention lies in teachers' training, supported with specialized malaria teaching materials and participatory learning methods conducted in Western Kenya, Lao, Thailand (Onyango-Ouma et al 2005, Nonaka et al 2007, Okabayashi et al 2006). Our intervention was most similar to a study conducted in Thailand, where teaching material and a textbook for schoolchildren with information on symptoms, treatment and prevention methods were developed and 3 days of teacher training was given. After the teachers training manuals and schoolbooks were distributed and lectures were given on malaria related issues, malaria education was integrated within their school subjects; drawing pictures, singing songs and outdoor activities were also carried out. Schoolchildren also produced IEC material that they took to their homes and held community events for malaria prevention by involving parents and community members (Okabayashi et al 2006). This study differed from our study in that our study included a control arm, and monitored the impact of the intervention in the community as well as in teachers and scholars; the duration of the Thai study was 10 months, compared with 6 months for our study.

In our study we hoped to prove that following a teacher training program, scholars would be able to act as agents to improve community knowledge and practices regarding malaria prevention and treatment. However, our only positive result at the community level was the trend towards more community members in the intervention group than the control group knowing that treatment for malaria should be sought within 24 hours (88/153 vs. 43/95; p=0.06). Since most responded that treatment should be sought at public healthcare facilities (hospitals, health centre and health posts) that are all supplied with the recommended ACTs, this prompt treatment seeking could be potentially life-saving. This is particularly important if partial immunity in this community has decreased following the marked reduction in malaria prevalence from >60% to <5% (Sharp et al 2007). As a similar proportion of community members in both the intervention and control groups report that treatment should be sought in a public healthcare facility, the statistically significant differences between the control group mostly reporting seeking treatment at health posts and the intervention group seeking treatment at the health centre is unlikely to have much public health significance.

Although not demonstrated in our study, three studies conducted in Indonesia, Kenya and Lao found that a school-based education programme could improve community knowledge about malaria (Rhode et al 1980, Onyango-Ouma et al 2005, Nonaka et al 2008). The endpoints of these studies were a change in knowledge and practices related to malaria and diarrhoea following a school-based education approach. It has also been shown that knowledge can be delivered to the community through school-based health education in an area where it was known that negative culture believes delay treatment for severe malaria, such as the belief that convulsions are caused by bad spirits so children are first taken to the traditional healer (MISAU, 2006). The prestige and proximity of the teacher to the community appear to have facilitated school-based health promotion in these communities.

The studies conducted in Lao and Kenya reported that school children can act as health change agents at the rural community level (Onyango-Ouma et al, 2005, Nonaka et al, 2008). In both studies where scholars succeeded as health change agents, the impact of the educational intervention on the community was measured only in the parents and guardian of the study scholars (thus with a ratio of study community members to study students of 2:1 and 1:1, respectively (Onyango-Ouma et al 2005, Nonaka et al 2008). Our study communities were more broadly defined as those eligible to send their children to the study school. Another difference was that our study design did not include specific interventions to be conducted in the community and allowed teachers and scholars to self-select these. In the Lao study teachers were tasked to conduct campaigns to educate the mothers or guardians of scholars in their class and were provided with flipcharts to do so. The Indonesian study children were encouraged through homework tasks to share the information about malaria with their families.

There are a number of other possible reasons why our study failed to demonstrate an impact on the community, when others have shown a benefit at this level. Teachers in our study developed their plan for dissemination of malaria-related knowledge by themselves, without the interference of the study researchers. This design was considered realistic and appropriate from the viewpoint of developing a cost-effective, sustainable intervention. This approach is supported by a study conducted in Japan in which they show that schools could successfully plan and implement malaria control activities to change the scholars' knowledge, behaviour

and attitudes towards malaria prevention by themselves, with limited additional support (Kobayashi et al, 2006).

Our intervention was limited to a single 3-day teachers' training course and the development of IEC material for distribution by the intervention schools. The intervention in a study conducted in the Lao PDR included a 2-day training course for teachers during which they were provided with information on malaria. The educational tools used were flipcharts, which were then distributed to the children to present to their family members and the village residents. The scholars also conducted a 1-day campaign at the village involving almost all residents. During the campaign children demonstrated how to treat the bed nets with insecticide and mosquito larvae were shown to the villagers. The villagers were then given a quiz on the information presented in the flipchart. The score before and after the intervention were compared between the methods used for the intervention (flipchart alone or in combination to the campaign, only campaign, or not having any intervention) (Rhode et al, 1980). The Kenyan study involved schoolchildren and their parents or guardians. A 2-day training workshop was held to introduce teachers to action-oriented methodologies including the child-to-child (CTC) approach, followed by one month of follow up training to clarify methods and modalities of implementation as well as visits to participating schools. The overall student teaching period was 2 months and involved the use of drawing, role-plays, drama, songs and poems (Onyango- Ouma et al, 2005).

The lack of impact at a community could in part be due to the short time elapsed (6 months) from the intervention to the post-intervention assessment, with a two months interruption due to the school holidays. In the Kenyan study, the interval between the intervention and the post-intervention assessment was longer at 14 Months (Onyango-Ouma et al. 2005).

In order to avoid data contamination between the intervention and control schools, in our study the competition where malaria educational tools were presented by the scholars to the community was held in a non-study district, so did not benefit the study communities.

How well the scholars delivered the information to their communities also could have affected our results. To what extent the methods chosen by teachers and scholars actually reach the target population, whether these were considered acceptable, and whether they understood the key messages and the extent of retention of the information was not assessed systematically in this study, due to time and resource constraints. A Ugandan study on community-based HIV/AIDS education found that by using a multiple methods, the different approaches work synergistically to reinforce messages and overcome weaknesses inherent in individual channels (Mitchell et al 2001). Similarly, a multi-pronged educational intervention was successfully used to enhance use of ITNs on the Kenyan coast; this included both a school-based education program and intensive teaching in the community through community educators (Marsh et al 1996).

In our study the teachers training was not repeated in the control schools because the intervention had limited effect among scholars and a minimal effect at the community level. . It was concluded that implementing this program in the control schools was unlikely to be of public health significance, and would probably not cost effective. However, all the IEC material developed during this study was provided to the control schools.

9.1 Implications for future research

The issue of how best to deliver the messages about malaria to ensure an impact at the community level is a matter for future studies in Mozambique, as a clear need remains to improve knowledge and practices about malaria. In our study, despite the intervention, less than 50% of community members related malaria transmission to a mosquito, and very few scholars and community members mentioned either ITNs or IRS as measures for malaria prevention. A similar lack of knowledge was found in a before-after study of an educational intervention conducted in Mali (Rhee et al. 2005). The lack of knowledge among these communities is of major concern as ITNs and IRS are only effective as malaria control strategies if high coverage levels are achieved (Kolaczinski et al.2007).

Even if high levels of knowledge are achieved about the need for mosquito control measures, changes in knowledge are not always translated into practice. A change

in behavior, especially for deeply held cultural beliefs and perceptions, requires a long-term process (Mwenesi 2005, Opiyo et al 2007). Thus further monitoring is needed to determine whether improved knowledge alters the time to treatment seeking, ACT adherence, and IRS / ITN coverage and most importantly whether the burden of malaria can be reduced by a school-based educational intervention. It is plausible that our school-based intervention may have had an impact on community behaviour, even though there was not a statistically significant improvement observed in the post-intervention questionnaire, as "lack of evidence of effectiveness does not necessarily mean evidence of ineffectiveness" (Sahota et al. 2001). However, the monitoring of changes in e.g. IRS coverage and parasite prevalence is beyond the scope of this study.

As our study may not have allowed sufficient time for knowledge and skills acquired from the school-based malaria education programme to filter into the community, and since changes in behaviour generally take a longer time to happen than changes in knowledge, assessing the impact of the intervention on IRS coverage and parasite prevalence should ideally take place in the second semester of 2008. This is when the routine LSDI sentinel site surveys of the prevalence of P *falciparum* parasitaemia among children and monitoring of IRS coverage will take place. This data will then be compared between intervention and control communities.

9.2 Potential Public Health Impact of Study

The findings of our study are considered important and relevant to the National Program for Fighting against Malaria (PNCM) 2006-2009 Strategy of Mozambican MOH, which recognized the limited impact of previous strategies to deliver health education to the target population (MISAU, 2006). Our study has demonstrated that a school-based health malaria education is an effective tool to change teachers' and scholars' malaria-related knowledge and reported practices in Maputo Province, Mozambique.

The study has already led to a change in behaviour in some of the participating intervention and control schools. They reported that the study activities have continued to take place and have become part of their current teaching program. This was confirmed by the MMed candidate during subsequent visits to the study sites, when informal discussions with the teachers, school directors and the

Provincial directorate representatives revealed that they felt the study was very useful, not just for them as individuals but for all the schools and the community in general. They confirmed their willingness to continue with these activities. This should be taking in account by policy makers at educational and health Ministries, as the key elements of community-based disease control are the generation of a feeling of empowerment, local awareness and responsibility (Opiyo et al, 2007).

Our study could be considered as a pilot intervention for possible adaptation and inclusion in the existing school-based health education program, based on the assessment by the Ministries of Health and Education of this study's findings and the subsequent LSDI results comparing IRS coverage and malaria prevalence in intervention and control communities. The feasibility of introducing such a malaria education programme in Mozambique is enhanced by the health education programme being well established in the Mozambican school curriculum, even though to date this has focused on other diseases. Since some teachers have already been trained, they could be used for training other teachers and scholars, under supervision of the health professionals. Closer partnership between the schools and community should be developed to allow for multi-pronged approaches to improve community knowledge and practices about malaria prevention and treatment. Funding opportunities could be created through such a collaboration; for instance, it was suggested during this study that profits from the sale of the IEC material developed in the study could be used to fund modest community-based malaria education program.

9.3 Conclusion

A school-based education program aimed at improving knowledge and practices regarding malaria prevention, treatment seeking and adherence can be an important strategy in controlling malaria in Mozambique and other developing countries where access to health education remains a challenge. From the study results, significant improvement in the knowledge and some practices related to malaria prevention and treatment were observed among teachers and scholars in the intervention schools, when compared with the control schools. As limited impact on the knowledge and practices of community members was observed, we were unable to prove that students can be used as agents of health change at the community level. Further research is needed to determine whether improved knowledge translates into altered behaviour, particularly better coverage with IRS, and to reduce malaria prevalence in intervention communities.

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