ENVIRONMENTAL HEALTH PROJECT

Activity Report 134

National Malaria Prevalence Survey (2000–2001)

The State of Eritrea Ministry of Health

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Acronyms

ITNs	Insecticide-treated nets
MOH	Ministry of Health
NMCP	National Malaria Control Program
NRS	Northern Red Sea
OR	Odds ratio
P. falciparum	Plasmodium falciparum
P. vivax	Plasmodium vivax
pLDH	Parasite Lactase Dehydrogenase
RDT	Rapid Diagnostic Test
SP	Sulfadoxine-pyrimethamine (Fansidar®)
SRS	Southern Red Sea

About the Author

David Sintasath served as a Johns Hopkins Child Survival Fellow in Eritrea from 2001–2003, providing technical support to the National Malaria Control Program. He received his MSc. from the London School of Hygiene and Tropical Medicine in 2000 and is presently studying for a PhD in Public Health at Johns Hopkins University.

Executive Summary

The State of Eritrea's Ministry of Health leads the country's intersectoral National Malaria Control Program (NMCP). The NMCP began implementing a new five-year plan of action in October 1999, developed as part of the international Roll Back Malaria partnership initiative. At the start of this period, one of the NMCP's highest priorities was to improve its understanding of the distribution of malaria throughout the country. The NMCP performed a series of studies, including a national survey of vector distribution, longitudinal studies of vector ecology, short-term studies to characterize vector biting behavior, and a national survey of malaria prevalence. These studies were undertaken with the overall objective of developing a clear model of the spatial and temporal stratification of malaria in Eritrea. This report describes results from the prevalence survey.

Eritrea is situated in the Horn of Africa, bordered by the Red Sea to the east, Sudan on the north and west, Ethiopia to the south, and Djibouti on the southeast. The country has an area of 124,320 km^2 with three main topographical regions — the western lowlands, central highlands, and eastern coastal lowlands.

The country is divided into six administrative regions (or *zobas*), with 56 sub-zobas, comprising approximately 1,500 villages. The estimated population of Eritrea is 3.5 million with approximately 15% of the population living in urban areas and the remainder living in rural areas scattered around the country. The population density is approximately 33 persons per km^2.

Culturally, Eritrea is a diverse country with nine known ethnic groups and probably as many distinct languages. The major religions are Muslim, Coptic Christian, Roman Catholic and Protestant.

The average life expectancy at birth is about 45 years. The crude birth rate and crude death rate are 48/1,000 and 18/1,000, respectively, with a steady population growth rate of 3.8%. At the time of the survey, malaria was considered the country's most serious public health problem, with 67% of the population living in endemic areas. It was the leading cause of death among those five years of age and older and the third leading cause of death of those under five. At the time, malaria accounted for approximately one-third of all hospitalizations in Eritrea each year.

Current Malaria Situation

Epidemiologically, the country is divided into three distinct strata:

- In the western lowlands, at elevations between 700 and 1,500 meters above sea level, malaria is highly seasonal, and the area is prone to epidemics. Transmission generally is seen along rivers, valleys, and dams, as well as irrigation projects.
- The coastal plains (0–1,000 meters above sea level) experience minimal malaria transmission because of a lack of precipitation. Nevertheless, there are areas prone to malaria epidemics during the rainy season.

- The highlands (1,500–2,000 meters above sea level) are generally free from malaria but are still highly prone to malaria epidemics because of the lack of significant immunity in these populations.

The two groups at highest risk for malaria are children under five years and women ages 5–45. Non-immune individuals from the highlands are also at great risk when traveling to endemic areas. Available data indicate that malaria accounts for about 30% of outpatient morbidity and 28% of all hospital admissions. The case fatality rate in hospitalized children is 7.4%. Malaria also is a major cause of morbidity and mortality among pregnant women.

The most prevalent malaria parasite is *Plasmodium falciparum (p. falciparum),* which accounts for more than 91% of all malaria cases. *Plasmodium vivax* (*p. vivax*) is the second most important parasite species. Possible vectors that have been implicated in spreading the disease are members of the *Anopheles gambiae* complex (94%). Secondary vectors include *An. funestus, An. pharoensis,* and *An. culicifacis adenensis*. There are two main malaria transmission seasons in the country — September to November in the western lowlands and January to March in the coastal region. Despite the generally low prevalence of malaria, overall the risks for malaria outbreaks and epidemics are great. In 1998, there was a significant malaria epidemic, and since then the government has been taking necessary prevention and control measures to minimize future outbreaks.

The objectives of this survey are:

- to stratify the prevalence of malaria in various zones of the country
- to determine the distribution of *P. falciparum* and *P. vivax* in the country
- to identify the risk factors associated with malaria prevalence.

1. Methods

Sampling selection. The number of samples collected from each zone was proportional to population size and density. Using ecological maps, villages in the Anseba zone were stratified into sub-zones based upon ecological factors such as levels of precipitation and altitude. More villages were sampled from sub-zones showing greater ecological diversity. For example, an effort was made to sample five to six villages per sub-zone in Anseba and NRS, while three to four villages were selected from the less ecologically diverse sub-zones of Debub, Gash Barka and Maekel. In total, the number of villages surveyed ranged from 15 in Maekel to 52 in Anseba.

A total of 52 and 46 villages were selected in Anseba and NRS, respectively, as a result of the significant ecological diversity found in these zones. At least 20 households were randomly sampled from each village by two different teams — with one team sampling houses in the center, and the other team surveying houses located on the periphery of the village. Only 10 houses were sampled each in the other three zones (Debub, Gash Barka, and Maekel) — five from the periphery and five from the center.

In the Gash Barka and Debub zones, 10 villages used in the previous entomological survey and two from the behavioral study were selected in each zone. An additional 20 new villages were selected randomly for the parasite survey, while still based on ecological diversity found in the zones. In all, a total of 32 villages each were selected for the survey in the Gash Barka and Debub zones.

Only 15 villages were chosen from the Maekel zone, with ten houses randomly selected from each village. Seven of these were from the previous entomological survey, with eight new villages randomly selected, for a total of 15 villages.

It was anticipated that approximately 80–100 individuals per village would be surveyed in the Anseba and NRS zones, while around 50 individuals would be screened from Gash Barka, Debub and Maekel. Since there were on average five individuals per household, it was estimated that 5,200 persons would be screened in Anseba, 4,600 persons in NRS, 1,600 each from Gash Barka and Debub, and 750 from the Maekel zone.

Houses were randomly selected by the field teams as they moved within the village virtually in a straight line or as much as the terrain would permit. Every third house encountered by the team was assigned a serial household number, screened for malaria parasites, and administered two questionnaires. Half the houses surveyed were located in the center and the other half in the periphery of the village.

Questionnaire format. The questionnaire form (P1) (Appendix 1) asked interviewers to record the name, age and sex of the respondents. After obtaining consent from the respondents, an OptiMal® Rapid Test Kit was used to determine whether or not the individual was infected with either form of malaria parasites, *P. falciparum* or *P. vivax*. The results were recorded on the form, and treatment of those infected followed the country's guidelines for the treatment of malaria. Individuals with other ailments at the time of the screening were advised to visit the nearest health facility. Questions regarding overnight travel, fevers and any anti-malarial drug treatments within the previous two weeks were also posed.

Each household was also administered a household questionnaire (Form P2) (see Appendix 2). This form included questions on domicile characteristics, risk factors for malaria (i.e., sleeping outdoors) and methods of anti-mosquito control. The total time spent in each household depended on the number of individuals in the household, thereby dictating the number of OptiMal tests that were administered. In general, the team of interviewers spent approximately 15–30 minutes with each household.

Training. Each team of interviewers for each village included four to five members. The interviewers were given a refresher course in the basic life cycles of the malaria parasites, morphology of the four parasite species and transmission mechanisms. They were also trained on filling out the various questionnaire forms and performing the serological test using the OptiMal Rapid Test Kits. Finally, they were given extensive training in the precautions needed in handling blood and blood products. The three-day training concluded with a field exercise on the final day, when the questionnaire forms were piloted and the participants had the opportunity to practice with the serological test kits. It should be noted that the training and survey for NRS was conducted later than the other four zones because of its unique transmission period.

Community sensitization. Because human subjects were involved in the study and blood was drawn from them, it was important that the community understand and appreciate the objectives of the study. Community sensitization was conducted in the villages prior to the start of the study, either the day before the examination or the day of the examination if prior communications about the survey and how it was being conducted had not yet been delivered. Verbal consent was obtained from each adult screened. Consent for the screening of children was also obtained from parents or guardians.

OptiMal Rapid Test Kit. The OptiMal Rapid Test Kit utilizes an immunological detection assay for the enzyme parasite dehydrogenase (pLDH) to diagnose *P. falciparum* and *P. vivax*. The enzyme is present in and released from infected red blood cells. The administration of the OptiMal Rapid Test Kit was performed according to the manufacturer's suggested protocol. The finger that was to be pricked was cleaned with methylated spirit. Using a sterile and disposable lancet, several drops of blood were obtained for the serological test while also being captured on filter paper (Whatman No. 40) for the drug sensitivity tests that used genetic markers.

To the extent possible, universal biosafety precautions were observed. Investigators were instructed to wear gloves, to use the disposable lancet only once and to ensure proper disposal of any materials that had contact with blood.

To ensure compliance from small children, it was advised to start pricking the adults before the children. Young children less than one month of age were excluded from the survey to avoid unnecessary trauma.

Implementation. The first phase of the parasite survey was carried out from mid-September to mid-November 2000 to cover the peak transmission season in the Gash Barka, Debub, Maekel and Anseba zones. The second phase of the parasite survey was conducted in the Northern Red Sea zone in February 2001 to cover the peak malaria transmission period there.

Data collection and analysis. All questionnaire forms were checked by the team leader following the survey in each village. A summary sheet (Form P3) (see Appendix 3) for each village was completed by the team leader and sent to the Program headquarters on a bi-weekly basis. There, the questionnaire forms were again checked for errors. A data entry clerk entered the data into a Microsoft Excel spreadsheet. The data were exported into SPSS (Version 10.0) for further analysis.

2. Results

2.1. General profile of the study zones

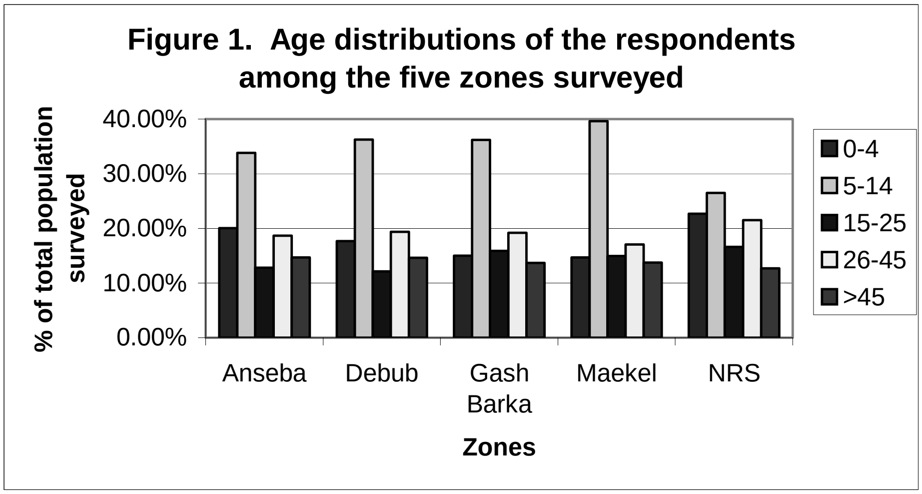
Five of the six zones in Eritrea were included in the prevalence survey. The average number of villages per sub-zone surveyed was 4.7 for Anseba, 2.9 for Debub, 2.5 for Gash Barka, 3.0 for Maekel and 5.1 for the NRS zone, all within the range of the intended sampling design. A total of 177 selected villages were surveyed throughout the five zones, with a target population of 15,004 (Table 1).

Table 1. General demographics of the zones in the survey.

Zones	Sub-zones	Villages	Target Population
Anseba	11	52	5,647
Debub	11	32	1,852
Gash Barka	13	32	2,009
Maekel	5	15	1,054
NRS	9	46	4,442
Total	49	177	15,004

2.1.1. Age distributions

Age distribution appeared to be similar among four of the five zones surveyed (Figure 1), except for the NRS zone. The 5–14 age group seemed to comprise the largest segment of the population surveyed in Anseba, Debub, Gash Barka and Maekel. Although the proportion of 5–14 year-olds appeared to be different in NRS compared to the other zones, the age distributions among the five zones were not statistically significant. One reason for the decrease in the 5–14 age group was that the interviewers in the NRS were instructed to exclude from the survey members of the household who had not slept in the house within the past two weeks. In the other four zones, the interviewers did not exclude those who had been away from the house for more than two weeks before the interview.



Analysis of the age distribution data collected revealed that all five zones had very similar means, medians, standard deviations and overall skewness of the distribution (Table 2). A skewness value of 1.0 indicates that the distribution is normally distributed, while a number greater than 1.0 means that the distribution is skewed to the right and a number less than 1.0 is skewed to the left. Mean values lie well within the upper and lower bounds of the 95% confidence intervals. It should be noted that a number of questionnaire forms (98) from all five zones were not filled in completely — Anseba (3), Debub (4), Gash Barka (36), Maekel (4) and NRS (51). Consequently, these missing values were excluded from the age analysis.

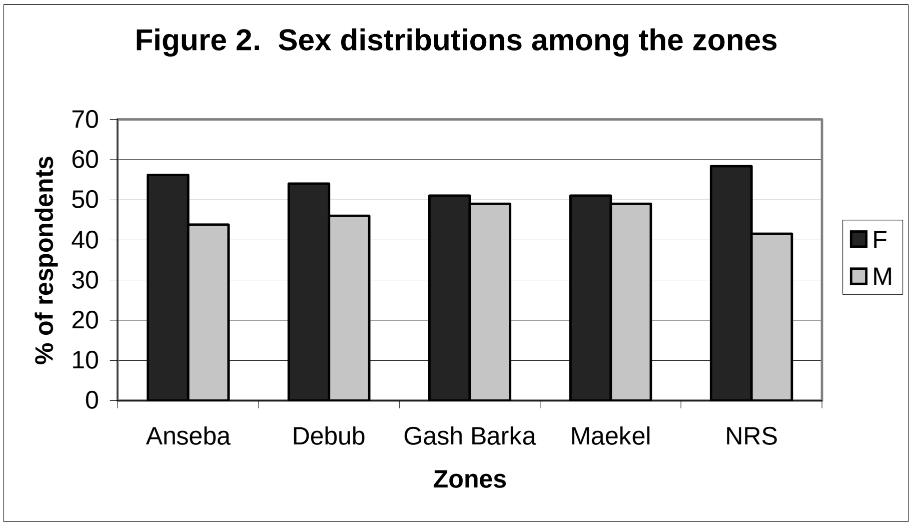
Table 2. Age distribution of the respondents among the five zones.

Zone	N	Mean	Median	Std.[1]	Skewness	Min	Max	CI 95%
Anseba	5644	21.08	13.0	19.43	1.005	0.17	87.0	20.6, 21.6
Debub	1848	21.34	13.0	19.82	1.097	0.50	100.0	20.4, 22.2
Gash Barka	1973	21.42	14.0	18.45	0.977	0.33	100.0	20.6, 22.2
Maekel	1050	20.90	13.0	19.26	1.195	0.17	93.0	19.7, 22.1
NRS	4391	21.45	15.0	18.90	0.94	0.17	87.0	20.9, 22.0

[1] Std = standard deviation

2.1.2. Sex distributions

Analysis of the distribution between females and males at the zonal level revealed that females generally outnumbered their male counterparts (Figure 2). This trend was also observed at the sub-zonal and village levels. Perhaps this was a result of mobilization of men for the National Service, with soldiers prepared for the military at a number of training sites, particularly in Gash Barka and Debub.



The overall male-to-female ratios for the five zones were: Anseba (0.78), Debub (0.85), Gash Barka (0.96), Maekel (0.96) and NRS (0.71) (Table 3). Selected sub-zones had more males than females, most likely as a result of the increased presence of soldiers stationed in these areas.

Table 3. Male-to-female ratios of respondents among selected sub-zones.

Anseba	M:F	Debub	M:F	Gash Barka	M:F	Maekel	M:F	NRS	M:F
Aditeklezan	0.77	Adi Keih	0.71	Agordat	0.90	Berik	1.11	Adobuha	0.65
Asmat	0.71	Adiquala	0.74	Barentu	1.49	Gala Nefhi	0.98	Afabet	0.75
Elabered	0.70	Areza	0.88	Dighe	0.96	NW Asmara	1.07	Foro	0.69
Gheleb	0.97	Dekemhare	0.82	Forto	1.09	SereJeka	0.85	Gelaelo	0.84
Habero	0.87	Dibarwa	0.93	Gogne	0.82	SW Asmara	0.78	Ghinda	0.59
Hagaz	0.60	Emni Haili	1.12	Guluj	0.94			Karura	0.98
Halhal	0.75	Mai Aini	0.88	Haikota	0.75			Massawa	0.60
Hamelmalo	0.83	Mai Mine	0.80	Logo-Anseba	1.00			Nakfa	0.75
Keren	0.80	Mendefera	0.76	Mensura	0.93			Shieb	0.68
Kerkebet	0.89	Segeneiti	0.83	Mogolo	0.84				
Sela	1.21	Tserona	0.90	Mulki	1.18				
				Shamboko	0.71				
				Tesseney	1.07				

2.1.3. Household composition

The average household size among the five zones surveyed was 5.7 persons per household (Table 4), with ranges of 4.8 in NRS to 6.4 in Maekel. One of the reasons average household size was lower for the NRS was that individuals who had not slept in the house the previous night were excluded from the survey and were therefore not counted as household members.

Table 4. Household composition, socio-economic status and education status

Zones	No. of households	Persons/ household	Possession of radio (%)	% of household heads ever attended school (average in yrs.)	% of mothers ever attended school (average in yrs.)
Anseba	1057	5.1	49.5	23.5 (4.7)	18.0 (3.2)
Debub	318	5.8	78.0	49.4 (4.3)	30.6 (3.5)
Gash Barka	323	6.2	40.9	29.5 (3.9)	13.1 (3.3)
Maekel	165	6.4	89.6	60.0 (4.8)	40.4 (4.0)
NRS	916	4.8	44.2	13.9 (5.0)	8.3 (3.6)
Total	2779	5.7	60.4	26.9 (4.5)	16.9 (3.4)

Six out of 10 households surveyed owned a radio among the five zones. A majority of the households in Maekel and Debub owned a radio — although whether or not the radio was functioning was not addressed in this survey. Consequently, the possession of a radio could serve as a crude marker for the socio-economic status of the household, and the data seemed to correlate with the observation that households closer to the urban areas tended to be higher on the socio-economic scale. Similarly, in terms of education status, it appeared that zones closer to the urban centers (Maekel and Debub) tended to have greater accessibility to education. The zones with the lowest proportion of heads of households ever attending school were NRS (13.9%), Anseba (23.5%) and Gash Barka (29.5%), with a total average of 4.5 years in school. As with many countries in the world, Eritrean women tended to receive less schooling than their male counterparts. Overall, less than 17% of the mothers surveyed had any formal schooling, averaging only 3.4 years in school.

2.2. Prevalence

A total of 13,279 individuals among the five zones were screened for both *P. falciparum* and *P. vivax* malaria parasites. The positivity rates of infection from both parasite species are shown in Table 5. The prevalence of malaria was highest among respondents in Gash Barka (6.98%) and lowest in Maekel, where only one individual tested positive. This 44 year-old male was from the village of Adi Musa in Gala Nefhi sub-zone and did not report having recently traveled out of the village within the previous two weeks. Highland malaria outbreaks are becoming increasingly common, and it will be critical to monitor the incidence of malaria cases in these densely populated areas with non-immune populations.

Table 5. Population screened for malaria parasites and prevalence for the four zones

Zone	Villages sampled	Population screened	Pf +ve (%)	Pv +ve (%)	Total +ve	Prevalence Rate
Anseba	52	4892	39 (88.6)	5 (11.4)	44	0.90%
Debub	32	1686	33 (91.7)	3 (8.3)	36	2.14%
Gash Barka	32	1691	109 (92.4)	9 (7.6)	118	6.98%
Maekel	15	763	1 (100)	0 (0)	1	0.13%
NRS	46	4247	76 (88.4)	10 (11.6)	86	2.02%
Total	177	13279	258 (90.5)	27 (9.5)	285	2.15%

The distribution of prevalence rates among sub-zones was significantly different, particularly in Debub ($p<0.032$), Gash Barka ($p<0.002$) and NRS ($p<0.021$). The prevalence of malaria cases among the different sub-zones demonstrated an interesting distribution of infection (Table 6). For example, in Gash Barka, the sub-zones of Agordat, Barentu, and Shamboko had prevalence rates of 13.8%, 20.2%, and 24.5%, respectively. In comparison, the prevalence rates of Mogolo and Haikota were 0.98% and 1.23%, respectively. The higher prevalence areas seemed to be the major towns with altitudes ranging from 600–1,000 meters above sea level. At the sub-zonal level, and even at the village level, significant differences in malaria prevalence may not only be the result of ecological variations, but also population density and mobility.

Table 6. Prevalence rates of malaria parasites among the different sub-zones

Anseba	**%**	**Debub**	**%**	**Gash Barka**	**%**	**Maekel**	**%**	**NRS**	**%**
Aditeklezan	1.58	Adi Keih	-	Agordat	13.79	Berik	-	Adobuha	1.22
Asmat	0.33	Adiquala	5.58	Barentu	20.19	Gala Nefhi	0.38	Afabet	0.12
Elabered	1.98	Areza	0.87	Dighe	8.49	NW Asmara	-	Foro	3.48
Gheleb	-	Dekemhare	-	Forto	4.65	SereJeka	-	Gelaelo	5.34
Habero	-	Dibarwa	1.27	Gogne	9.79	SW Asmara	-	Ghinda	2.61
Hagaz	0.84	Emni Haili	3.75	Guluj	2.45			Karura	0.42
Halhal	-	Mai Aini	0.49	Haikota	1.23			Massawa	1.52
Hamelmalo	0.19	Mai Mine	9.62	Logo-Anseba	2.94			Nakfa	-
Keren	3.76	Mendefera	1.85	Mensura	5.39			Shieb	0.71
Kerkebet	-	Segeneiti	0.61	Mogolo	0.98				
Sela	-	Tserona	0.66	Mulki	3.88				
				Shamboko	24.53				
				Tesseney	6.57				

Age-adjusted prevalence rates also show an interesting distribution of malaria infection. In Anseba, the risk of malaria infection was about the same in all age groups (Figure 3). In Debub and Gash Barka, however, the prevalence of malaria infection was greatest among the 5–14 year-old age group. This data seemed to suggest that malaria transmission was highly seasonal in Anseba and NRS, where all age groups were equally susceptible to malaria infection. The picture was different for Debub and Gash Barka, where the 5–14 year-old age group had the highest prevalence of infections. The curve suggested that malaria transmission was more endemic, since the older age groups tended to acquire additional protective immunity with each malaria infection.

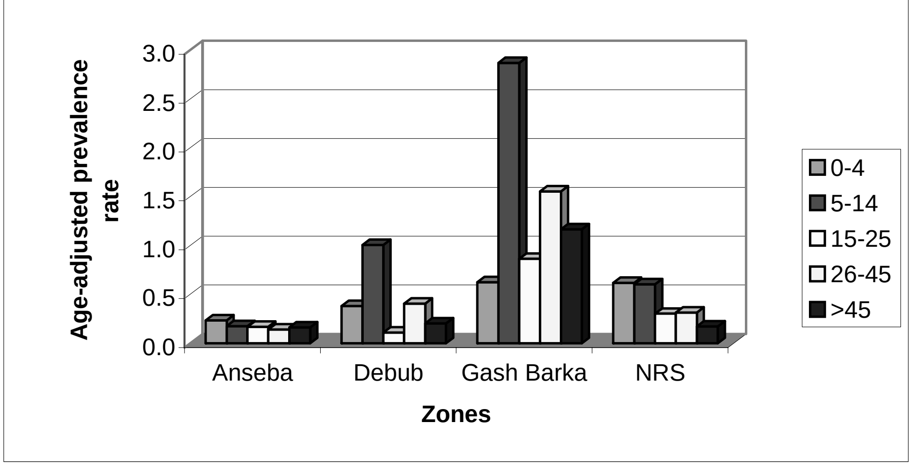


Figure 3. Age-adjusted prevalence rates

2.3. Parasite distributions

The distribution of the two most common malaria parasite species was similar to the previously reported proportions of 90% for *P. falciparum* and 10% for *P. vivax* and was not statistically significant between the zones (Figure 4). Maekel only had one individual who tested positive for *P. falciparum*. However, it should be noted that this zone had the highest proportion of absenteeism as well as the fewest number of individuals screened for malaria parasite infection (Table 5).

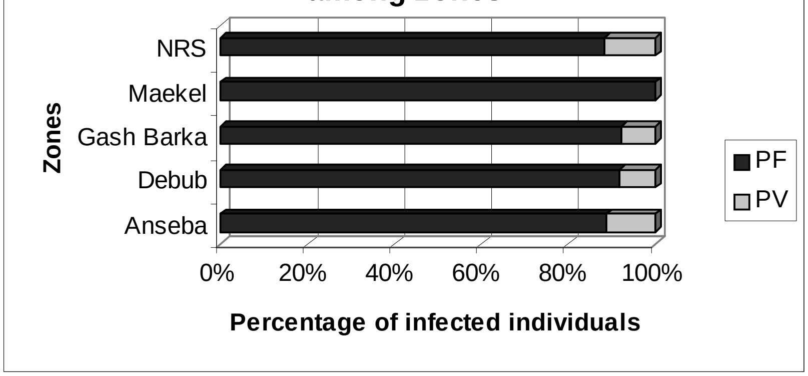


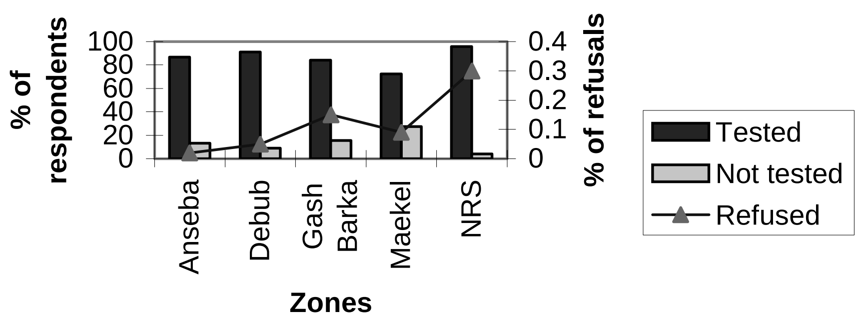
Figure 4. Distribution of malaria parasites among zones

2.4. Response rate

The number of respondents who were not screened for malaria parasites because they were absent from their homes at the time of the survey varied from zone to zone. Some of the reasons given for their absence included enlistment in the National Service, shopping in town, tending farm animals or working in the field. A significant number of children were away at school and therefore were also missed by the prevalence survey. The interview teams were instructed to return to the houses for follow-ups if children were away at school, but this was difficult to monitor.

The highest proportion of individuals (27.4%) who were absent at the time of the survey were from Maekel zone, while the highest percentage of refusals to take the serological test came from NRS zone (0.3%) (Figure 5). In general, the number of refusals was minimal, and the response rate was quite acceptable. However, in the future more efforts should be made to follow-up with those absent at the time of the survey, or to conduct the survey during non-planting or harvesting seasons.

Figure 5. Response rate among the five zones of the survey



2.5. Risk factors

House location. The design of the survey ensured that houses both at the center and at the periphery of a village would be sampled equally. The difficulty arose in the accuracy of the definition and categorical divisions about what was in the center or the periphery. Some houses were clearly in the center, while others were obviously in the periphery. However, it was sometimes difficult to differentiate those houses that fell in between the two categories.

When aggregated by zones, there was no significance between the location of the houses and the malaria positivity rates in four of the five zones. In Gash Barka, however, there was an association ($p<0.006$) between houses located in the center and an increase in positive cases. This was a generally held notion, which was surprising and contradictory, that mosquito densities were greater in the peripheral areas when compared to the center. Transmission of malaria may not be solely dependent on mosquito densities, but rather on the number of infective mosquito bites. Also, the locations of the houses were described in relation to the town center and not relative to the location of breeding sites. It is possible that houses described as being in the center were located closer to breeding sites than houses in the periphery.

Roof type. Roofing materials varied from zone to zone. In Anseba and Gash Barka, the most common type of roofing material was grass. In Debub and Maekel, tin was more frequently used. In the NRS, the distribution of roofing material was most diverse, ranging from grass to tin to wood/mat. However, statistical analysis showed that there was no association found between the type of roofing material used and positivity rates in the five zones. This is not particularly surprising since the questionnaire specifically asked about the roof type on the outside of the house. It was very common to find houses of various roofing materials lined with a plastic sheet or mat on the inside. It would be interesting to see if these linings had an effect on the reduction of mosquito densities, since these linings were often sprayed with residual insecticide. At the same time, it was clear that open eaves were associated with positivity rates among all the households. In other words, the mean positivity rates among houses with open eaves were significantly greater ($p<0.037$) than houses with closed eaves. Houses with open eaves allowed more mosquitoes to enter, though the correlation between mosquito densities and transmission has not yet been shown.

Wall type. The type of material used for walls also varied a great deal among the zones. Approximately one-third of all households surveyed lived in structures with mud-plastered walls. One-quarter of all households (mostly from the NRS zone) used sticks and mats as wall materials. Overall analysis of the association between wall type and the mean number of positive cases revealed that there was a correlation ($p<0.004$) between mud walls and an increase in positive cases. When aggregated by zones, there was a significant difference within each zone, particularly in Anseba ($p<0.004$), Debub ($p<0.04$) and Gash Barka ($p<0.02$). In other words, in Anseba, the highest mean number of positive cases was found in houses with plaster material, while in Debub and Gash Barka, there appeared to be an association with mud materials. No correlation of wall material and mean number of positive cases was found in the Maekel or NRS zones.

Travel. Traveling is often associated with an increased risk for malaria, particularly for non-immune populations temporarily staying in endemic areas. When an individual travels from one locality to another, it may be for several reasons — visiting family and friends, working in the fields, or trading and commerce. It is unlikely that these individuals would have brought with them appropriate preventive measures, especially if they foresaw a brief trip.

In Eritrea, however, there did not appear to be an association between those who reported having traveled within the past two weeks and those who tested positive with the rapid diagnostic test (RDT). Only 5% of the population surveyed reported having traveled within the past two weeks, and among these, almost 50% were from NRS zone. Ironically, in this zone, traveling appeared to be a protective behavior.

Animal pen. Information regarding the existence of an animal pen within 20 meters of the respondents' house was only collected for the NRS since this parameter was only added during the second phase of the survey. The question sought to determine whether the presence of animals close to the dwelling increased the number of mosquitoes and thus, the risk for malaria. Two-thirds of the respondents reported that they had an animal pen within 20 meters of their residence. Among those who reported the existence of an animal pen, there did not appear to be an increase in malaria positive cases. In fact, the mean prevalence was the same, regardless of the existence of an animal pen. In other words, the presence of an animal pen was neither a risk nor a protective factor for malaria infection. Again, since this question was asked only among respondents in NRS, the effect of animal pens may have had a different effect in different settings.

Sleeping outdoors. Throughout the world in settings where mosquitoes are exophilic, one of the behaviors associated with increased risk for malaria transmission is sleeping outdoors. The survey indicated that few individuals in Anseba and Debub zones reported that anyone in the household slept outdoors. The Gash Barka and NRS zones, on the other hand, had the highest proportion of respondents reporting that someone in the household slept outdoors — 63% and 49%, respectively. When the results were aggregated into households with at least one person sleeping outdoors and those that did not, it was interesting to find that no significant associations were found among the zones, except in the NRS. Households in the NRS reporting that at least one member of the family slept outdoors had a significantly higher risk of being positive for malaria parasites ($p<0.001$). More research into the biting behavior of mosquitoes in this zone might shed some light into the reasons for this increased risk.

2.6. Treatment and prevention

Fevers. The symptoms of malaria are difficult to diagnosis, as they are very similar to other febrile illnesses. In situations where most malaria cases are treated primarily based upon clinical diagnoses, it is important to determine the likelihood that in the absence of any other symptoms, a fever case is in fact malaria. This survey asked each respondent in the household whether they had had a fever within the past two weeks. The interpretation of these results should be considered carefully, as there may be serious recall biases by the respondents. Still, the survey indicated that among those who tested positive for malaria parasites, approximately 33% (Anseba), 31% (Debub), 34% (Gash Barka) and 69% (NRS) reported that they had experienced a fever within the past two weeks. In other words, the likelihood that a fever was associated with the malaria infection was greatest in NRS (OR = 23.7) compared to the other zones: Anseba (OR = 7.0), Debub (OR = 8.6) and Gash Barka (OR = 2.7). One reason for this finding could be that malaria is seasonal in the NRS, with sporadic outbreaks and epidemics, while it is much more endemic in the Gash Barka region. Therefore, partial immunity to malaria may explain the decreased association between fevers and parasitemia in Gash Barka.

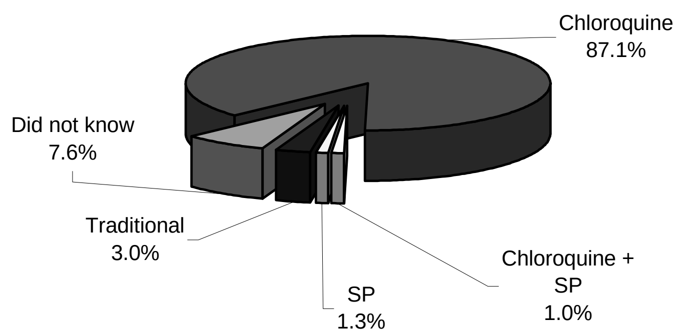
Anti-malarial drugs. The use of anti-malarial drugs to treat bouts of fever differed significantly among the zones ($p < 0.001$) (Table 7). In general, a higher proportion of individuals in the Debub and NRS zones used anti-malarial drugs to treat their most recent fever episode. This could be the result of a greater awareness about the symptoms and treatment of malaria, or a more accepting attitude toward Western medicine. In contrast, the prevalence rate of malaria infection as well as the rate of reported fevers was approximately three times higher in Gash Barka than in Debub. Yet, the proportion of individuals using anti-malarial drugs to treat bouts of fever in Gash Barka was lower. Lack of accessibility to health facilities and awareness of the treatment of malaria in the latter zone may account for this difference. More studies regarding treatment-seeking behavior will be needed to target future malaria control strategies.

Table 7. Proportion of individuals with fevers who reported using anti-malarial drugs

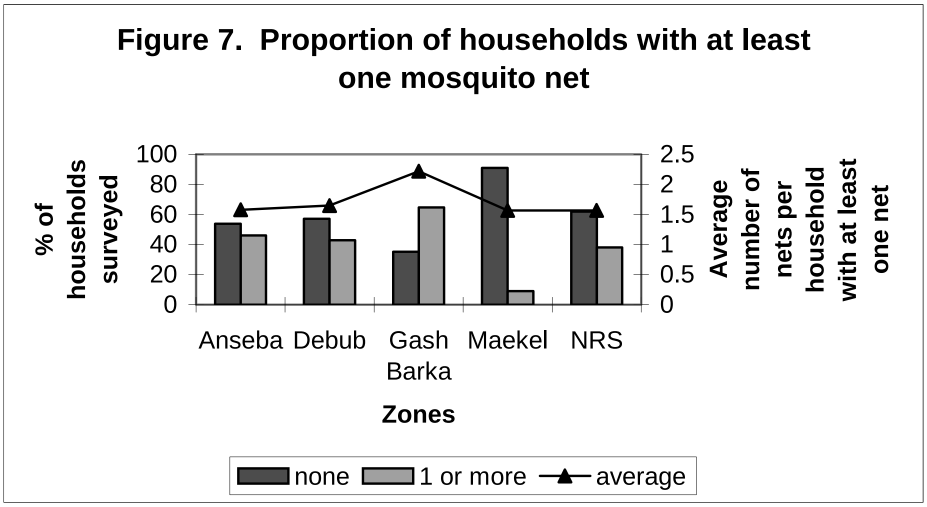
Zone	No. with fever within the past two weeks	No. with fever within the past two weeks taking anti-malarial drugs	%
Anseba	291	62	21.3
Debub	88	39	44.3
Gash Barka	293	82	28.0
Maekel	32	3	9.4
NRS	376	188	50.0
Total	1,080	374	34.6

Following completion of the first phase of the survey, in the second phase the investigators added a question regarding the type of anti-malarial drug used for treatment — that is, in the NRS survey. Although the data were not representative of the different zones, it did provide a general sense of the types of anti-malarial drugs being used in the communities (Figure 6). The majority (87.1%) of the respondents reported using chloroquine, the official first-line anti-malarial drug according to national treatment guidelines, to treat their fever episode within the past two weeks. A little more than 1% of the respondents in the NRS reported using Fansidar, or sulfadoxine-pyrimethamine (SP), and approximately the same proportion used both chloroquine and SP — though it was not clear whether these drugs were administered sequentially following chloroquine failure or as a combination therapy.

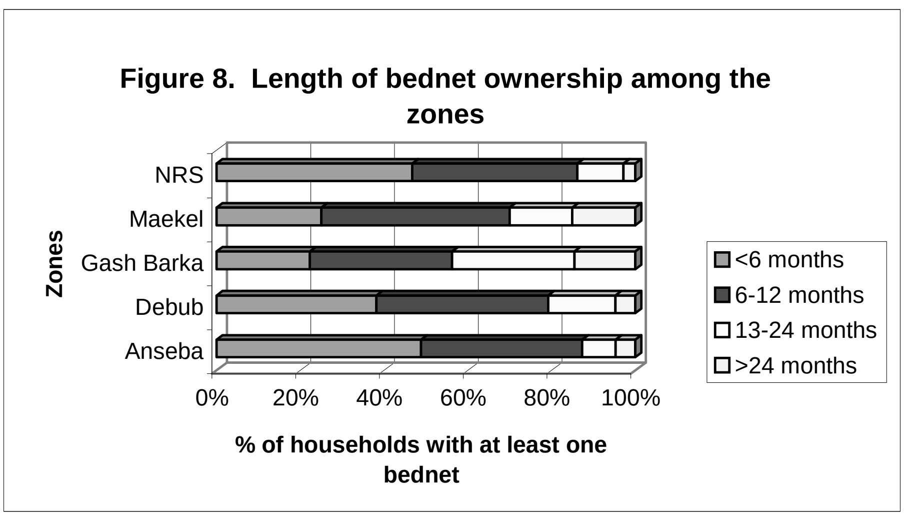
Figure 6. Distribution of anti-malarial drug use among respondents in NRS zone reporting a fever within the past 2 weeks



Insecticide-treated nets (ITNs). The proportion of households with at least one mosquito net (either treated or untreated) was greatest in Gash Barka. Nearly two-thirds of households reported that they had at least one mosquito net (Figure 7). Among households with at least one mosquito net, the average number of mosquito nets owned was 2.2 per household compared to approximately 1.5 in the other zones. This was not particularly surprising since in Gash Barka the average household size was more than six. In addition, the fact that almost all households surveyed in Maekel did not even own a single mosquito net may be cause for concern, particularly as outbreaks of highland malaria are on the increase in Africa. Entomological data show that mosquito densities in some of these highland villages may be enough to propagate malaria transmission.



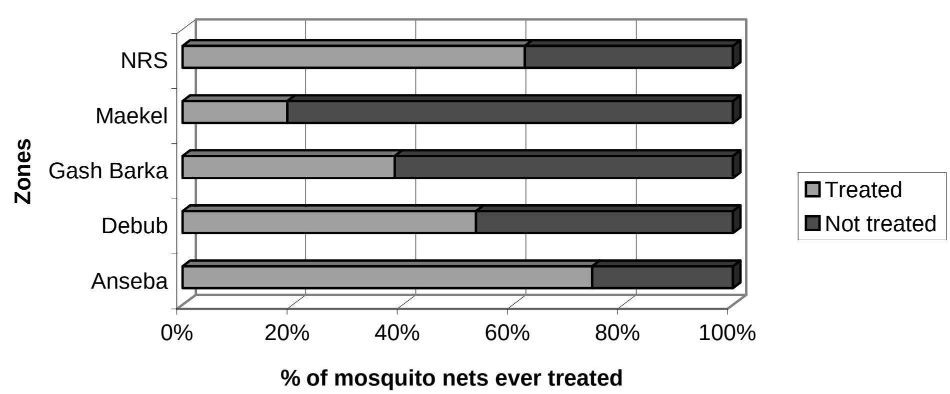
The length of mosquito net ownership was also interesting. A majority (79%) of the bed nets distributed among the five zones was less than one year old, perhaps because of the increased promotion of ITNs in recent years. The average length of mosquito net ownership was 8.3 months in Anseba, 10.4 months in Debub, 17.3 months in Gash Barka, 30.9 months in Maekel and 7.6 months in the NRS. Furthermore, almost half of the bed nets in Gash Barka were more than a year old, and almost 20% were more than two years old (Figure 8). Excluding Maekel, which only had a total of 21 mosquito nets, the bed nets in Gash Barka were significantly older ($p<0.001$). It would appear that keeping mosquito nets, particularly in Gash Barka, was considered acceptable. One household even reported owning the same mosquito net for 10 years. The mean number of individuals sleeping under a mosquito net the previous night for the five zones was 1.87 individuals per net, with ranges of 1.49 (Gash Barka) to 2.2 (Debub). In Anseba, the maximum number of persons under one mosquito net was seven.



Re-treatment of ITNs. The proportion of households that reported re-treatment of mosquito nets among the zones was also considerably different. Among the five zones, Anseba had the highest proportion of respondents reporting that their mosquito net had been treated (74.4%), followed by NRS (62.1%), Debub (53.3%), Gash Barka (38.5%) and Maekel (19.0%) (Figure 9). Interestingly, almost two-thirds of the mosquito nets in Gash Barka were reported to have never been treated. This could be the result of a lack of awareness in this zone of the need to retreat mosquito nets. Individuals may have received ITNs (either purchased or obtained without charge) that had been impregnated with insecticide prior to distribution but may not have fully understood that the nets had already been treated. This may have led the respondents to report that the mosquito net that they had received was not treated with insecticide, when in fact it had been.

The average number of months of reported last treatment of mosquito nets from the date of the interview was significantly different among the zones. Respondents from the NRS reported that their mosquito nets on average had been treated 4.7 months ago, while the average for Anseba, Debub and Gash Barka was 3.3 months. This correlated with the peak malaria transmission seasons for these zones, while the transmission period for the NRS occurs a few months later.

Figure 9. Proportion of mosquito nets ever treated



Mosquito control methods. Distinct differences in mosquito control methods were found among the five zones surveyed (Figure 10). The respondents of Anseba zone showed the greatest diversity in their mosquito control measures and were the only group using environmental sanitation as an anti-mosquito control activity. Households in Maekel and the NRS tended to do nothing for mosquito control. In Maekel, the low density of mosquitoes warranted such an approach. In the NRS, while the housing structures did not provide any protection from mosquitoes since many of the houses were built with sticks and grass and were open to the elements, there was little a household could do to keep mosquitoes away except mosquito nets for personal protection. Even the use of mosquito nets did not appear to have a significant impact on the reduction of malaria risk. In fact, in Anseba ($p<0.011$) and NRS ($p<0.011$), the results indicated that households that reported using mosquito nets as a method of control had a significantly higher rate of detected malaria infection than those that did not use mosquito nets. There are several possible explanations for such findings (e.g., the biting behavior of the vector could be such that most of the infective bites were occurring before people retired under the mosquito net or the nets were not treated properly with insecticide or the reports of net usage were in error).

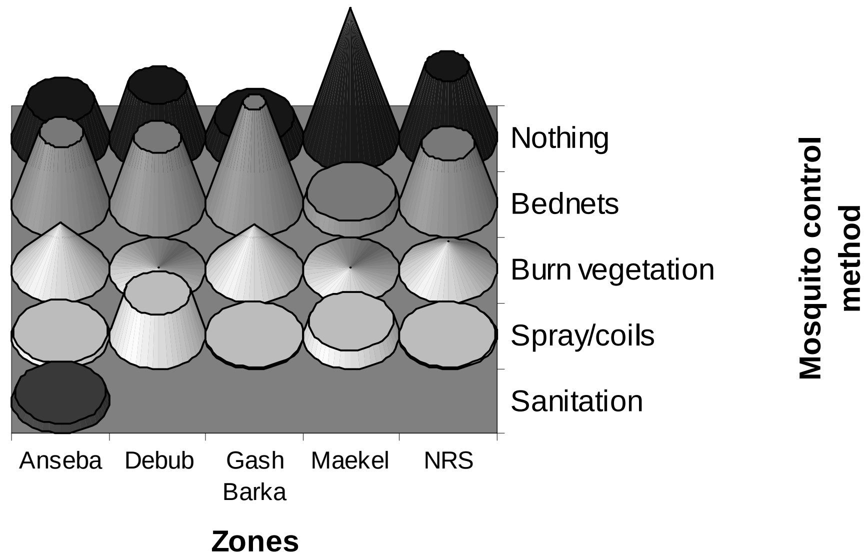


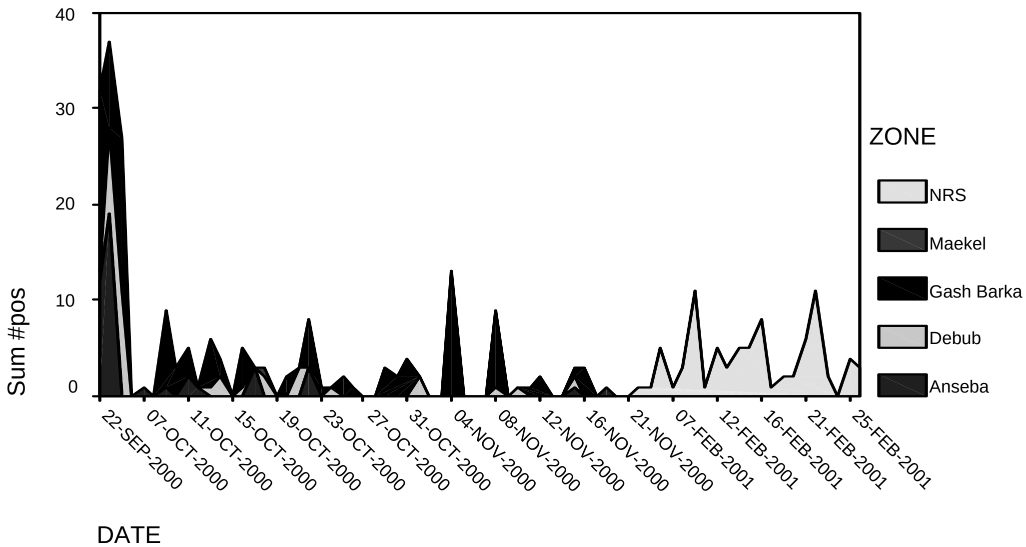
Figure 10. Distribution of mosquito control measures in the different zones

Insecticide residual spraying (IRS). In general, insecticide residual spraying appeared to be an effective malaria control activity. Particularly in Anseba and NRS, houses reported to have been sprayed were associated with a marked decrease in the mean number of positive cases. The association was statistically significant for households in Anseba ($p<0.005$) and NRS ($p<0.006$). However, in Gash Barka, houses that were sprayed actually had a higher incidence of malaria cases than those that were not sprayed, though not in a statistically significant way. The effectiveness of IRS methodologies in Gash Barka needs to be assessed and evaluated promptly.

2.7. Timing of the survey

The prevalence survey was completed in two different phases in an attempt to capture the maximum number of cases during peak transmission months. For Anseba, Debub and Gash Barka, it appeared that commencing the study in late September may have only caught the tail end of the peak in these zones (Figure 11). For the NRS, the number of positive cases detected appeared to be evenly distributed throughout the study period. It should be noted that individuals from the NRS zone commented that the study should have been conducted one to two months earlier.

Figure 11. Time series plot of positive cases



3. Discussion

Poor diagnosis of malaria continues to hamper effective malaria control throughout the world. There are several reasons for this: the non-specific clinical presentation of the disease; the high prevalence of asymptomatic infections in some areas; a lack of resources and insufficient access to trained health care providers and health facilities; and the widespread practice of self-treatment for clinically suspected malaria. As a result, one of the prime interventions of the Global Malaria Control Strategy remains prompt and accurate diagnosis and treatment.

Microscopy has long since been considered the “gold standard” for confirmed laboratory diagnosis. In recent years, the development of alternative diagnostic techniques has sought to complement microscopy. The use of rapid diagnostic tests (RDTs) has many advantages over traditional microscopy. RDTs are much easier to perform and to interpret. The procedure does not require electricity, special equipment or training in microscopy. RDTs can be shipped and stored under ambient conditions, though the shelf life of these tests is somewhat limited. Another advantage of RDTs is that since they detect circulating antigens, they may detect *P. falciparum* infections even when the parasites are sequestered in the deep vascular compartment, and are therefore undetectable by microscopic examination of a peripheral blood smear. A final advantage of RDTs is that it is an important diagnostic tool in outlying health centers where microscopy is not always available.

At the same time, there are also a number of disadvantages to this new technology and RDTs are not recommended as a general replacement for microscopy. First, RDTs are usually limited in the range of species that it can identify. Some kits, such as the OptiMal Rapid Test Kit, can differentiate between *P. falciparum* and *P. vivax* species, but most RDTs are usually limited to the optimal identification of only one species at a time. Second, RDTs are generally more expensive than microscopy, with costs per test ranging from US$0.60 to US$2.50 or more. Third, RDTs are not quantitative. That is, the kits cannot provide information on parasite counts, which are necessary to determine the therapeutic efficacy of anti-malarial drugs. RDTs can usually detect parasitemias of at least 100 parasites per microliter, and those with very low parasitemias would result in a negative result. A final drawback is that RDTs that detect pLDH enzymatic by-products of infected red blood cells may yield false positive results. That is, the antigenic by-products of the infected red blood cells may still persist in the peripheral blood even after parasitemia has cleared. As a result, such tests are useful for epidemiological purposes in determining current or prior infection, but are of limited value in diagnosis in order to guide treatment and management of the disease.

The use of the OptiMal Rapid Malaria Test has proved useful in determining the prevalence of malaria *P. falciparum* and *P. vivax* infections in five out of the six zones of Eritrea. The most prevalent species detected was *P. falciparum*. Although *P. falciparum* is the more fatal of the two parasite species, *P. vivax* should not be neglected. Appropriate diagnosis and treatment for the latter species remains critically important because of the recrudescence of parasites even months after the initial infection.

The distribution of malaria prevalence was significantly different among the zones, particularly in Gash Barka, where the village prevalence rates ranged from 0% to 36%. One of the key questions that arose from this survey was why certain villages had such high prevalence rates, while others had very low prevalence rates. Was it the result of the different ecologies of the areas? Perhaps it was the result of environmental factors such as altitude and rainfall? The villages were classified into risk categories based upon altitude and rainfall — ranging from low risk (1) to high risk (4). Analysis of the risk stratification showed that there was a strong correlation ($p<0.0001$) between these arbitrary risk categories and malaria prevalence. However, no association was found between mosquito densities (data not shown) and malaria prevalence, suggesting that a number of other epidemiological factors were maintaining the propagation of malaria transmission. Thus, the determination of the entomological inoculation rate (that is, the product of the sporozoite rate in mosquitoes and the man-biting rate) will be very important in understanding the epidemiology of malaria transmission.

Age-specific malaria risk was an interesting finding. In Anseba, the prevalence of malaria infection was evenly distributed among the different age groups. This suggested that malaria transmission was relatively low and highly seasonal, and acquired immunity may not be an important factor in the epidemiology of the disease in this zone. In other words, the fact that the malaria infection rates were similar in all age groups implied that the population in general had little immunity to malaria and was therefore equally susceptible to the disease. On the other hand, in Gash Barka, infection rates peaked among the 5–14 age group, and showed a decreasing trend among the older members of the community — perhaps attributable to the highly endemic nature of malaria transmission in this area that led to an acquired immunity. In areas with high transmission, malaria occurs frequently and predominantly among young children. The relatively low prevalence among the youngest children (under five years) may be attributed to the high availability (and use) of mosquito nets, since these young children tend to sleep with their mothers under mosquito nets.

There were a number of interesting observations that came out of the prevalence survey relative to the risk factors of malaria infection. Insecticide residual spraying, in general, is still widely effective in Eritrea. However, mud walls were found to be highly associated ($p<0.004$) with an increase in household positivity rates. It is known that insecticide spraying of mud materials may not be entirely effective, since its toxic effects are quickly absorbed into the mud, thereby requiring more frequent applications. It was interesting to note that particularly in Gash Barka, the structures that were reported to have been sprayed actually had higher rates of malaria per household. It will be crucial to re-evaluate spraying techniques and other operational details on various surfaces to optimize the impact of targeted spraying.

Another interesting outcome of this study was that a large proportion of households in Gash Barka and the NRS reported that at least one member of the family slept outdoors. It was found that households in the NRS had a greater risk of malaria infection if they reported that someone in the family regularly slept outdoors. Unfortunately, the survey did not address whether that person used a mosquito net when he/she was sleeping outdoors. More research into the use of mosquito nets will be needed. Furthermore, the survey data indicated that those who used ITNs had a higher risk of malaria infection. It will be important to understand whether this risk was due to an increased number in the mosquito populations, their biting behavior (that is, their tendency to bite before people go to bed), or mosquito nets simply not being treated properly if at all.

The timing of the survey had an important impact on determining the prevalence of malaria, particularly in Eritrea where peak malaria transmission is seasonal. It appeared that the first phase of the survey (Anseba, Debub, Gash Barka and Maekel) was conducted towards the tail end of the peak transmission season. Therefore, the actual prevalence rates for these zones may be greater. Similarly, it had been suggested that the second phase of the survey (namely, for the NRS) should have been conducted between late December and January. Instead it was delayed until February, when the number of positive cases were already trending downward. Although undoubtedly it is difficult to precisely time the peak transmission periods, every attempt should be made to capture as accurately as possible the malaria transmission in the country using morbidity and mortality data from previous years. Accurate prevalence rates will allow the National Malaria Control Program to make more informed, evidence-based decisions regarding various malaria control strategies.

4. Conclusions

This prevalence survey was intended to assess the prevalence and distribution of malaria parasites in Eritrea. The questionnaire that was developed sought to obtain preliminary data on the risk factors associated with malaria and the methods of treatment and prevention used by the participating households. The data collected from this broad survey was intended to assess the malaria situation in the country and to highlight certain areas for further operational research activities. By itself, the results of this survey cannot be used to evaluate malaria control activities. But when used in conjunction with other pertinent data, the survey results can serve as a guide to improve current malaria control operations.

The use of the OptiMal Rapid Malaria Test Kit was both effective and efficient for the purposes of this study — that is, in its ability to determine the prevalence of *P. falciparum* and *P. vivax* parasites in the country. Although the use of RDTs has been justified in low transmission areas because low prevalence reduce the predictive value of clinical diagnoses, RDTs are not meant to replace microscopy. Rather they serve to complement it. Indeed, in several settings, it has been demonstrated that RDTs can help in the prevention and management of severe malaria. Because of their low levels of immunity, malaria patients in areas of low to moderate transmission rates are at greater risk of developing severe cases of the disease. For such patients, early diagnosis and treatment remains critical.

One of the first conclusions that was drawn from this study was that the prevalence of malaria was relatively low throughout Eritrea. There are a number of factors that may have contributed to this — a period of limited rainfall, a reduction of mosquito breeding sites and the timing of the survey. These factors are all interrelated: the lack of rainfall directly impacts the availability of mosquito breeding sites and therefore alters the expected malaria transmission seasons. Compared to previous years, the year in which the prevalence survey was conducted received an unusually small amount of rain.

The distribution of malaria prevalence was also remarkably varied among the zones. This was most likely the result of the wide ecological diversity within each zone. The topography and ecological landscape of Eritrea is diverse, even within each zone. In general, the high transmission areas were those found between 500 and 1,000 meters above sea level. Those areas that received more than 400 mm of rainfall annually were especially malaria endemic. Barentu, which is situated 980 meters above sea level and receives more than 400 mm of rain per year, has a relatively high prevalence of malaria cases. The fact that this area is concentrated with young people in the National Service, with their low to non-immune status, puts them at great risk for contracting malaria. Therefore, the issue of population mobility of non-immune highlanders to the endemic lowlands may also play a role in the high prevalence of malaria in selected "hotspots."

Prevalence rates when adjusted for age also showed an interesting pattern of malaria infection. In Anseba, malaria infection was evenly distributed among all the age groups, suggesting two things: first, the transmission of malaria in Anseba is relatively low and second, the population in this zone has relatively little immunity against malaria. That is, all segments of the population are equally at risk for malaria. Compared to Gash Barka, where malaria appears to be more endemic, the prevalence of malaria infection decreases with age, and acquired immunity may play more of a role.

The distribution of *P. falciparum* and *P. vivax* was found to be similar to previous reports in the country. Overwhelmingly, the number of malaria cases detected were linked to *P. falciparum*, while *P. vivax* was found in less than 10% of the cases in the country. Although *P. falciparum* malaria has the potential to lead to fatal consequences, the prevalence of *P. vivax* should not be discounted, as this parasite can linger in the liver, and recrudescence of the parasites can occur several months after the initial infection. *P. vivax* malaria has a large impact on morbidity and loss of productivity.

Finally, the timing of the survey may have had a significant impact on the relatively low prevalence rates detected in the countrywide survey. Evidence from the cumulative number of positive cases over time suggested that the survey was conducted at a period after the actual peak in transmission. Perhaps this was one of the main reasons for the low prevalence in the five zones of the country.

5. Recommendations

1. **Timing of the survey should be improved**. The timing of the survey may have had a great impact on finding a relatively low overall prevalence in the country. Should similar prevalence studies be conducted in the future, it will be critical to time the survey just before and after the peak of transmission, so that the actual malaria prevalence could be estimated.
2. **IEC activities on anti-malarial drug use and self-treatment should be strengthened**. The use of anti-malarial drugs was seen to be an area that still lacks solid information. The data from the survey suggested that people overwhelmingly used chloroquine to treat their bouts of suspected malaria. Still, almost 8% of the people surveyed in NRS alone did not know what drug they had taken to treat their fever. More information, education and communication materials need to be made available to improve the quality and appropriateness of home treatments.
3. **More studies on the distribution of anti-malarial drug use and prescribing practices should be conducted**. A majority of the people surveyed (in one zone alone) reported using chloroquine to treat their suspected malaria, which is encouraging considering that chloroquine is still the first line treatment for malaria. But at the same time, the usage of Fansidar (sulfadoxine-pyrimethamine) unofficially is reported to be on the increase. More information is needed on the distribution and use of anti-malarial drugs in the country and the role that rural drug vendors play in self-medication.
4. **Awareness of reimpregnation of ITNs should be improved**. Although it was observed from the survey that a large proportion of households actually have mosquito nets, the use of such protective measures has yet to be evaluated. Furthermore, the awareness of reimpregnation needs to be emphasized since many mosquito net owners were uncertain about whether their mosquito nets had been treated. Recipients of ITNs need to understand if their nets had been treated with insecticide and need to be educated in the proper handling and maintenance of their mosquito nets.
5. **Future questionnaires should be more focused and request more specific information**. In general, the questionnaire that was used allowed the investigators to collect relevant preliminary data regarding household composition, mosquito control practices and certain factors associated with malaria risk. The results from this broad questionnaire raised many other areas of operational research, many of which should be investigated further to improve current malaria control strategies.

References

World Health Organization. 1993. A Global Strategy for Malaria Control. Geneva: World Health Organization.

World Health Organization. 1999. New perspectives: Malaria diagnosis. Report of a Joint WHO/USAID Informal Consultation, 25-27 October. Geneva: World Health Organization.

Annex 1. Form P1

Household #_______

Form P1

HOUSEHOLD QUESTIONNAIRE

Zone ____________________ Date ________________ (DD/MM/YY)

Sub-zone__________________

Village (Name/Number)____________________ Time ________________

Interviewer's Name ________________

#	Name	Age	Sex	Time	+/-	Spp Pf/Pv	Travel w/in 2 wks? Y/N	Fever w/in last 2 wks? Y/N	If yes, treated with anti-malarials ? Y/N	If Yes, which drug? CQ = chloroquine SP = Fansidar Q = quinine T = traditional 99 = don't know
01										
02										
03										
04										
05										
06										
07										
08										
09										
1b0										
11										
12										
13										
14										

Total Tested _______ Total Positive Pf _______

Total Positive Pv _______

Annex 2. Form P2

Household #______

Form P2

HOUSEHOLD QUESTIONNAIRE

Zone_____ Sub-zone____________ Village_____________________ Village #____

Interviewer______________________ Respondent Name______________________

Date___/_____/___ Latitude___________N Longitude_________E Altitude_____ feet
(DD/MM/YY)

1. House location: 1.___ Central 2.___ Periphery

2. Roof type (outside):
(Mark only one answer)
1.____ Grass
2.____ Tin
3.____ Hudumo
4.____ Other ________________________
5.____ Wood + mat

2a. Open eaves? 1.___ Yes 2.___ No

Is there an animal pen in use within 20 meters of this house? 1.___Yes 2.___No 3.__Don't know

IF NO INTERVIEW DONE, GIVE REASON HERE AND GO TO NEXT HOUSE
1.____ No adult home
2.____ Refused
3.____ Other reason ______________________________

****

3. How many people live in this house? _______

4. Type of inside walls:
(Mark only one answer)
1.___ Mud
2.___ Stone
3.___ Wood
5.___ Other ___________________________
6.___ stick + mat
4a.___ Plastered
4b.___ brick
4c.___ concrete block

5. Has anyone in this house been ill with malaria in the past year? Yes___→ How many? ___
No___

6. What do you do to control mosquitoes in this house?
1.___ Nothing
2.___ Burn vegetation indoors
3.___ Sprays/Coils
4.___ Put screens on windows
5.___ Other ________________________________
6.___ Use bednets

6a. IF USE BEDNETS: How many mosquito nets in this house? ____

Household #______

6b. For 1st NET:

6b 1. How long ago did you get it? ____ months (Don't know=99)

6b 2. Has it ever been treated with insecticide?

1.___ Yes
2.___ No
3.___ Don't know

6b 3. How many months ago was it last treated? _____months (Don't know=99)

6b 4. Who slept under it last night?__________ [USE PERSON NUMBERS FROM Form P1; No-one=99]

6c. For 2nd NET:

6c 1. How long ago did you get it? ____months (Don't know=99)

6c 2. Has it ever been treated with insecticide?

1.___ Yes
2.___ No
3.___ Don't know

6c 3. How many months ago was it last treated? _____months (Don't know=99)

6c 4. Who slept under it last night?______ [USE PERSON NUMBERS FROM Form P1; No-one=99]

If more than 2 bednets, write information for each additional net on back of this sheet and tick here __

7. Has your house ever been sprayed for mosquitoes? **(Not pyrethrum spray collection)**

1.___ Yes → when was the latest spraying (month/year)_____/_____
2.___ No
3.___ Don't Know

8. Do you have a radio in this house?

1.___ Yes
2.___ No

9. Did the head of this household ever attend school?

1.___ Yes → How many years_____
2.___ No
3.___ Don't Know

10. Did the mother of the children in this house ever attend school?

1.___ Yes → How many years _____
2.___ No
3.___ Don't Know

12. Does anyone in this house sleep outdoors at night?

1.___ Yes
2.___ No
3.___ Don't Know

12a. Which person (s) ________________

12b. In which season?

1.___ Dry
2.___ Wet
3.___ Don't know

Thank you for your help in answering our questions today.

Annex 3. Form P3

Form P3

Village Summary Report

Zone____________

Sub-zone_____________

Village name______________-

Village number_____________

1	Total number of houses in village	
2	Total number of forms completed	
3	Total number of houses selected (include not at home or refusal)	
4	Total number of houses participating	
5	Total number of people tested by OptiMal	
6	Total number of filter papers collected	
7	Total positives for Pf	
8	Total positives for Pv	
9	Date of last rainfall in the village	
10	Any comments or problems encountered during this survey	

Name of Team Leader_____________________

Signature_______________________________

Date__________________