1. The burden of malaria in Africa

About 90% of all malaria deaths in the world today occur in Africa south of the Sahara. This is because the majority of infections in Africa are caused by *Plasmodium falciparum*, the most dangerous of the four human malaria parasites. It is also because the most effective malaria vector – the mosquito *Anopheles gambiae* – is the most widespread in Africa and the most difficult to control. An estimated one million people in Africa die from malaria each year and most of these are children under 5 years old (*1*).

Malaria affects the lives of almost all people living in the area of Africa defined by the southern fringes of the Sahara Desert in the north, and a latitude of about 28° in the south. Most people at risk of the disease live in areas of relatively stable malaria transmission – infection is common and occurs with sufficient frequency that some level of immunity develops. A smaller proportion of people live in areas where risk of malaria is more seasonal and less predictable, because of either altitude or rainfall patterns. People living in the peripheral areas north or south of the main endemic area (Figure 1.1) or bordering highland areas are vulnerable to highly seasonal transmission and to malaria epidemics.

In areas of stable malaria transmission, very young children and pregnant women are the population groups at highest risk for malaria morbidity and mortality. Most children experience their first malaria infections during the first year or two of life, when they have not yet acquired adequate clinical immunity – which makes these early years particularly dangerous. Ninety percent of all malaria deaths in Africa occur in young children. Adult women in areas of stable transmission have a high level of immunity, but this is impaired especially in the first pregnancy, with the result that risk of infection increases.

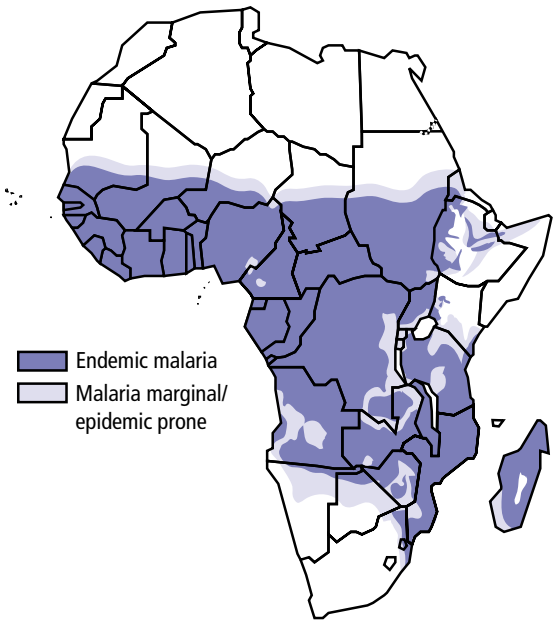
Malaria has been well controlled or eliminated in the five northernmost African countries, Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, and Tunisia. In these countries the disease was caused predominantly by *Plasmodium vivax* and transmitted by mosquitoes that were much easier to control than those in Africa south of the Sahara. Surveillance efforts continue in most of these countries in order to prevent both a reintroduction of malaria parasites to local mosquito populations, and the introduction of other mosquito species that could transmit malaria more efficiently (a particular risk in southern Egypt). The malaria situation in these countries is not considered further in this report.

Malaria is endemic in some of the offshore islands to the west of mainland Africa – Sao Tome and Principe and São Tiago Island of Cape Verde. In the east, malaria is endemic in Madagascar, in the Comoro islands (both the Islamic Federal Republic of the Comoros and the French Territorial Collectivity of Mayotte),

Roll Back Malaria target

The global target of Roll Back Malaria is to halve malaria-associated morbidity and mortality by 2010 compared with levels in year 2000.

Distribution of endemic malaria



Source: reference *2*

Figure 1.1

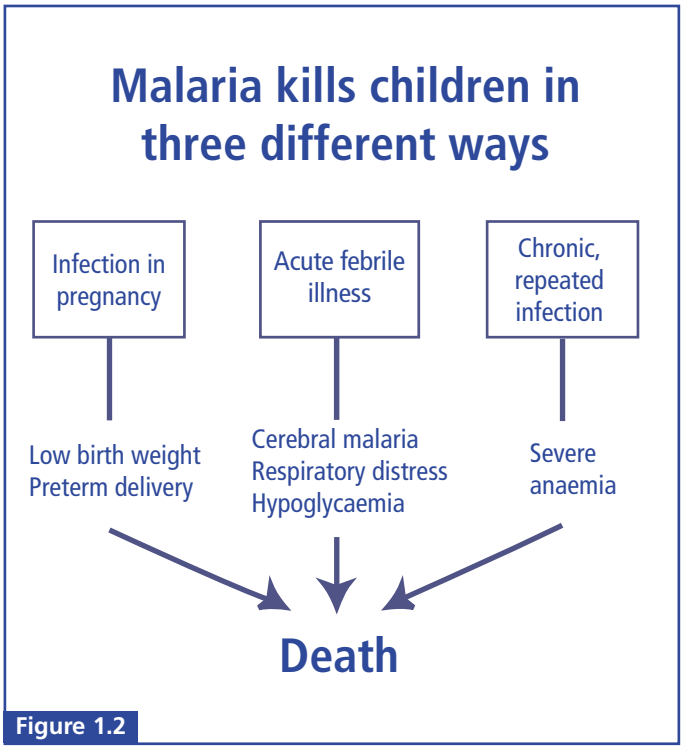


Figure 1.2

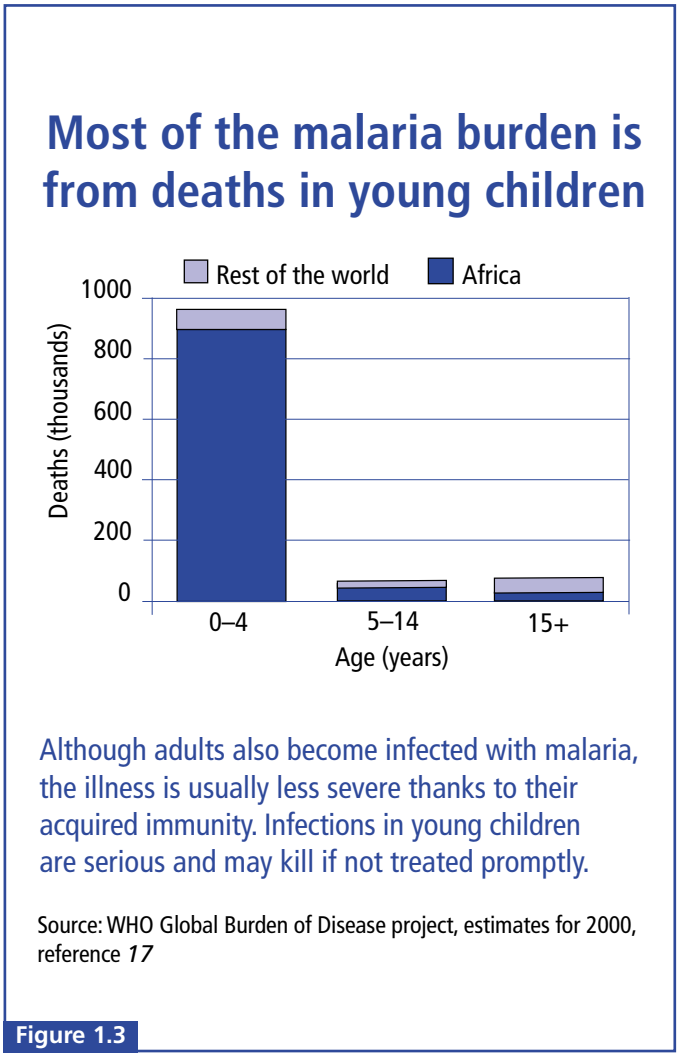


Figure 1.3

and on Pemba and Zanzibar, but has been eliminated from the island of Reunion. In Mauritius, malaria has been well controlled since the 1950s, but occasional outbreaks of vivax malaria occur, the last in association with a cyclone in 1982. Since that year there has been a steady decrease in cases and risk is now extremely low. Seychelles has been free of malaria since 1930, and malaria vectors are believed to no longer exist there.

1.1 Burden of malaria on health in Africa

Mortality

There are three principal ways in which malaria can contribute to death in young children (Figure 1.2). First, an overwhelming acute infection, which frequently presents as seizures or coma (cerebral malaria), may kill a child directly and quickly. Second, repeated malaria infections contribute to the development of severe anaemia, which substantially increases the risk of death. Third, low birth weight – frequently the consequence of malaria infection in pregnant women – is the major risk factor for death in the first month of life (*3*). In addition, repeated malaria infections make young children more susceptible to other common childhood illnesses, such as diarrhoea and respiratory infections, and thus contribute indirectly to mortality (*4*).

The consensus view of recent studies and reviews is that malaria causes at least 20% of all deaths in children under 5 years of age in Africa (Figures 1.3 and 1.4). Although respiratory disease caused by a variety of infectious agents results in a similar proportion of deaths, *P. falciparum* is the most important single infectious agent causing death among young children.

Morbidity and long-term disability

Children who survive malaria may suffer long-term consequences of the infection. Repeated episodes of fever and illness reduce appetite and restrict play, social interaction, and educational opportunities, thereby contributing to poor development. An estimated 2% of children who recover

from malaria infections affecting the brain (cerebral malaria) suffer from learning impairments and disabilities due to brain damage, including epilepsy and spasticity (*5*).

1.2 Burden of malaria on African health systems

In all malaria-endemic countries in Africa, 25–40% (average 30%) of all outpatient clinic visits are for malaria (with most diagnosis made clinically). In these same countries, between 20% and 50% of all hospital admissions are a consequence of malaria (see country profiles for details). With high case-fatality rates due to late presentation, inadequate management, and unavailability or stock-outs of effective drugs, malaria is also a major contributor to deaths among hospital inpatients (Figure 1.5).

This high burden may in fact be partly a result of misdiagnoses, since many facilities lack laboratory capacity and it is often difficult clinically to distinguish malaria from other infectious diseases. Nonetheless, malaria is responsible for a high proportion of public health expenditure on curative treatment, and substantial reductions in malaria incidence would free up available health resources and facilities and health workers' time, to tackle other health problems.

1.3 Burden of malaria on the poor

Poor people are at increased risk both of becoming infected with malaria and of becoming infected more frequently. Child mortality rates are known to be higher in poorer households and malaria is responsible for a substantial proportion of these deaths. In a demographic surveillance system in rural areas of the United Republic of Tanzania, under-5 mortality following acute fever (much of which would be expected to be due to malaria) was 39% higher in the poorest socioeconomic group than in the richest (*6*).

A survey in Zambia also found a substantially higher prevalence of malaria infection among the poorest population

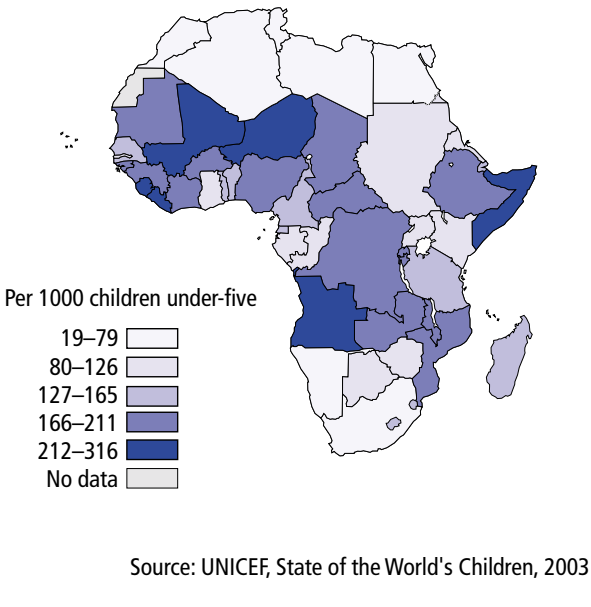
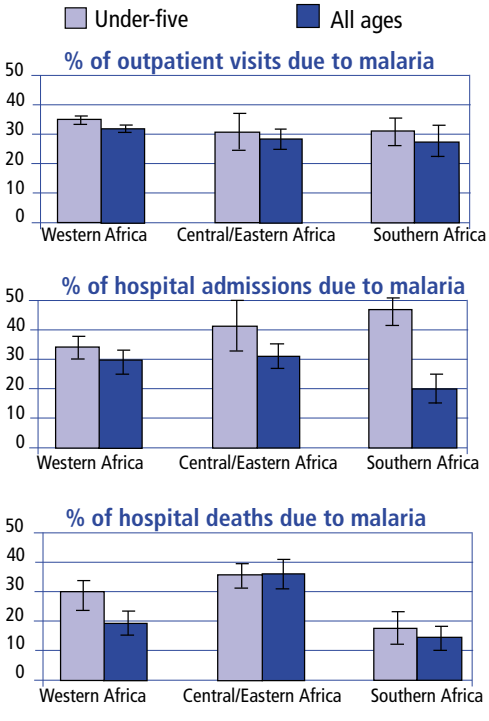


Figure 1.4

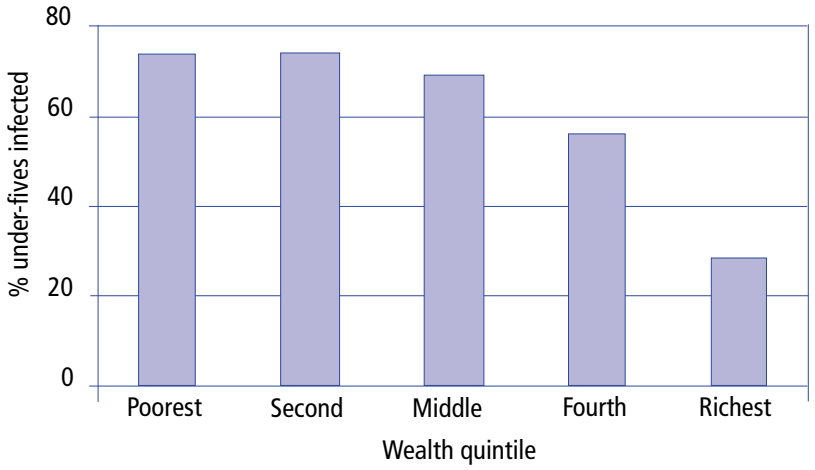


Source: AFRO routine Health Information System data. Averages 1998–2001. Error bars give the standard errors.

Figure 1.5

Parasite prevalence is higher in poor children

The prevalence of malaria infection was higher in under-fives from poorer families in 10 districts suveyed in Zambia.



Source: reference *7*

Figure 1.6

groups (*7*) (Figure 1.6). Poor families live in dwellings that offer little protection against mosquitoes and are less able to afford insecticide-treated nets. Poor people are also less likely to be able to pay either for effective malaria treatment or for transportation to a health facility capable of treating the disease.

Both direct and indirect costs associated with a malaria episode represent a substantial burden on the poorer households. A study in northern Ghana found that, while the cost of malaria care was just 1% of the income of the rich, it was 34% of the income of poor households (*8*).

1.4 Recent trends in the burden of malaria

Routine case detection and reporting

Data from health facilities are potentially useful for monitoring time trends in the number of malaria cases and deaths but have severe limitations (Figure 1.7). In Africa, most cases of malaria are diagnosed on the basis of clinical symptoms and treatment is presumptive, rather than based on laboratory confirmation. Moreover, malaria parasitaemia is common among clinic attendees in many endemic areas, so that a positive laboratory result does not necessarily mean that the patient is ill with malaria. The main clinical symptoms of malaria – fever and general weakness – are nonspecific and may well be due to other common infections.

Reporting from facilities to districts and from districts to the ministry of health varies in its completeness and timeliness from country to country and often does not include nongovernment facilities. Thus, routine reports of the number of malaria cases and deaths have limited value for comparisons of the malaria burden between countries. Demographic and health surveys (DHS) and other sources (*9*) indicate that less than 40% of malaria morbidity and mortality is seen in formal health facilities – a small fraction of the total burden. However, routinely collected data are often the only information available over a prolonged period and over a wide geographical area. While these data are of use for local programme planning, major investment in improving both the quality of health information systems and access to health services would be required before their utility for monitoring changes in malaria disease trends could be assessed.

At present, the most reliable data available on trends in malaria deaths in children under 5 years of age is obtained from demographic surveillance systems (DSS), which measure deaths and possible causes prospectively over time in populations of known size and composition. The number of DSS sites is increasing: 24 sites in 13 African countries are collaborating under the INDEPTH network (International Network of field sites with continuous Demographic Evaluation of

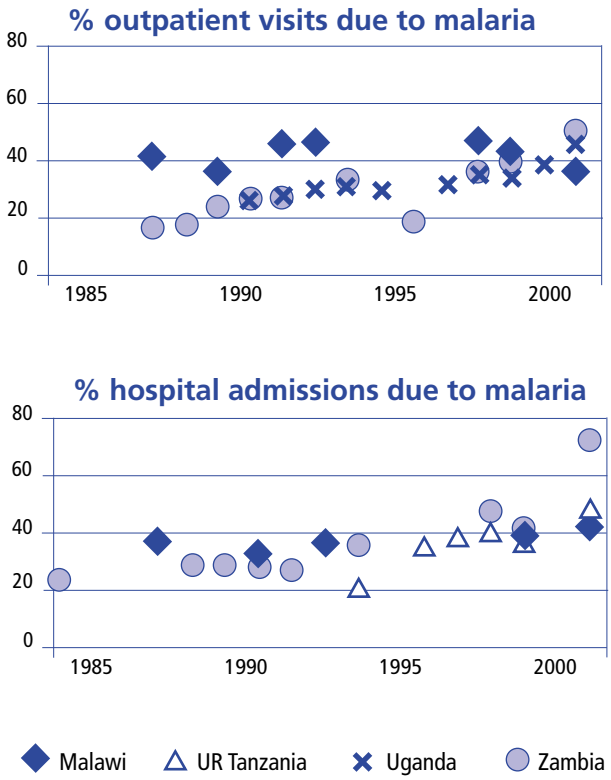
Populations and Their Health) (*10*). Most of these sites are in eastern and southern Africa; there are a few sites in the west of the continent but none in central Africa.

Recently, data from 1982–1998 were analysed across 28 DSS sites, adjusting for the specificity and sensitivity of verbal autopsies that were used to attribute deaths to malaria (*11*). Malaria mortality in under-5s almost doubled in eastern and southern Africa over the period 1990–1998 compared with 1982–1989. It is known that the prevalence of malaria infections caused by chloroquine-resistant parasites increased substantially from the late 1980s in these same areas (Figure 1.8). Thus, although the methodology cannot prove cause and effect, it is very likely that some of this increase in child mortality was related to some extent to the spread of chloroquine-resistant malaria. In west Africa the mortality rate remained the same; here too, however, malaria became proportionally more important (*11*). Analysis of mortality data being collected from INDEPTH using standardized verbal autopsy questionnaires since 2000 should soon provide further insight into more recent disease trends.

Throughout Africa south of the Sahara, the decrease in all-cause under-5 mortality that was apparent during the 1970s and 1980s levelled off in the 1990s (Figure 1.9), perhaps partially as a result of increased malaria mortality. Some of the important factors that may have contributed to the increasing malaria burden in these African settings include:

- drug resistance (*12*)

Trends in outpatient visits and hospital admissions for malaria

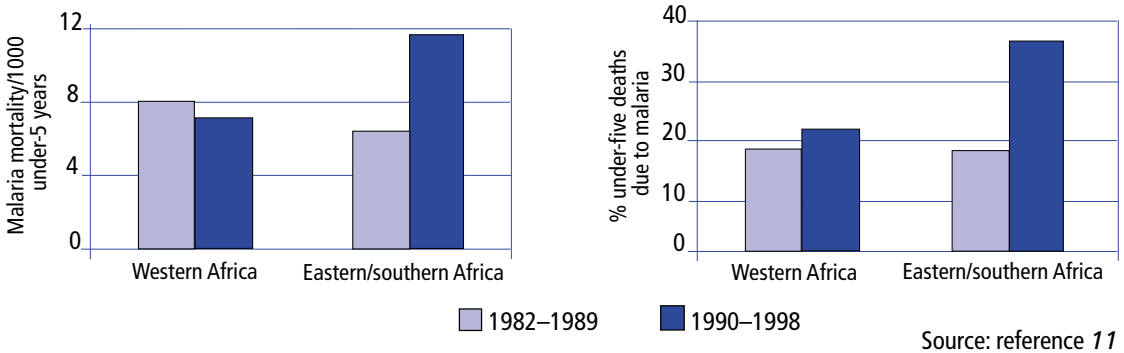


Source: Routine health information system data, AFRO, for under-fives

Figure 1.7

Malaria mortality in DSS sites

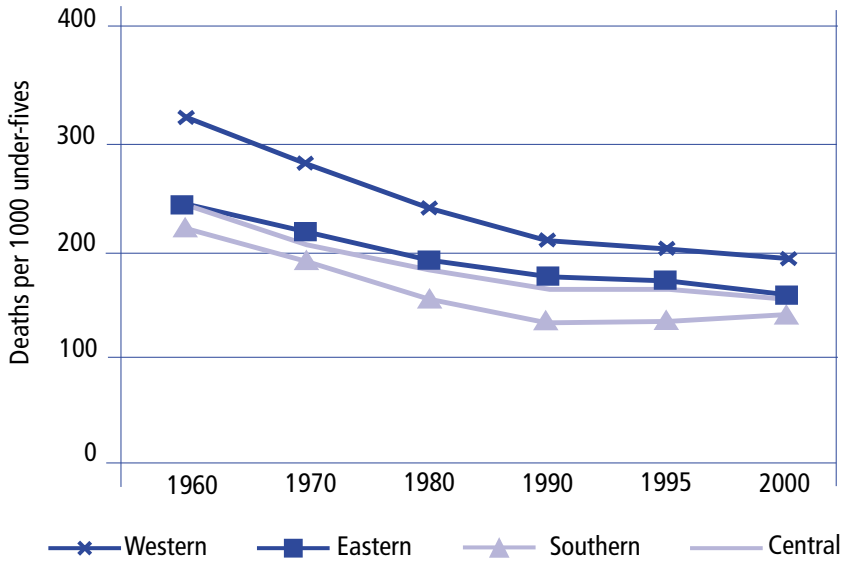
Estimates for average prevalences of *Plasmodium falciparum* of 63% in western Africa and 39% in eastern and southern Africa, adjusted for variations in the sensitivity and specificity of verbal autopsy.



Source: reference *11*

Figure 1.8

Trends in all-cause, under-five mortality in Africa



Source: DHS

Figure 1.9

- more frequent exposure of non-immune populations
- emergence of HIV/AIDS (*13*, *14*)
- climate and environmental change (*15*)
- breakdown of control programmes (*16*).

1.5 Future prospects

From the time trends shown, it appears that RBM is acting against a background of increasing malaria burden. With the typical 2–3-year delay in national-level data becoming available, it is still too early to evaluate the extent to which RBM has achieved a levelling-off or reversal of the rising trend in the malaria burden. The very low level of coverage with ITNs and untreated nets documented in 2000 and 2001 falls far below the coverage levels in the ITN trials that demonstrated substantial health benefits. It should therefore come as no surprise that significant reductions in child mortality have yet to be observed. The impact of treatment coverage levels is more difficult to estimate, given both a lack of information on promptness and dosage, and varying levels of drug effectiveness. Coverage levels approaching the Abuja target of 60% will probably be required before the full effect of ITNs and effective treatment on child health will become apparent.

References

1. *The World Health Report 2002: reducing risks, promoting healthy life*. Geneva, World Health Organization, 2002.

2. MARA/ARMA collaboration (Mapping Malaria Risk in Africa), July 2002. www.mara.org.za.

3. Steketee RW et al. The burden of malaria in pregnancy in malaria-endemic areas. *American Journal of Tropical Medicine and Hygiene*, 2001, 64(1,2 S):28–35.

4. Molineaux L. Malaria and mortality: some epidemiological considerations. *Annals of Tropical Medicine and Parasitology*, 1997, 91(7):811–825.

5. Murphy SC, Breman JG. Gaps in the childhood malaria burden in Africa: cerebral malaria, neurological sequelae, anemia, respiratory distress, hypoglycemia, and complications of pregnancy. *American Journal of Tropical Medicine and Hygiene*, 2001, 64(1,2 S):57–67.

6. Mwageni E et al. Household wealth ranking and risks of malaria mortality in rural Tanzania. In: *Third MIM Pan-African Conference on Malaria, Arusha, Tanzania, 17–22 November 2002*. Bethesda, MD, Multilateral Initiative on Malaria: abstract 12.

7. *Report on the Zambia Roll Back Malaria baseline study undertaken in 10 sentinel districts, July to August 2001*. Zambia, RBM National Secretariat, 2001.

8. Akazili J. Costs to households of seeking malaria care in the Kassena-Nankana District of Northern Ghana. In: *Third MIM Pan-African Conference on Malaria, Arusha, Tanzania, 17–22 November 2002*. Bethesda, MD, Multilateral Initiative on Malaria: abstract 473.

9. Breman JG. The ears of the hippopotamus: manifestations, determinants, and estimates of the malaria burden. *American Journal of Tropical Medicine and Hygiene*, 2001, 64(1,2 S):1–11.

10. *Population and health in developing countries. Vol. 1. Population, health and survival at INDEPTH sites*. Ottawa, International Development Research Centre, 2002.

11. Korenromp EL et al. Measuring trends in childhood malaria mortality in Africa: a new assessment of progress toward targets based on verbal autopsy. [*Lancet Infectious Diseases*, conditionally accepted, March 2003].

12. Trape J-F. The public health impact of chloroquine resistance in Africa. *American Journal of Tropical Medicine and Hygiene*, 2001, 64(1,2 S):12–17.

13. Grimwade K et al. HIV-infection in adults increases rates of severe and fatal falciparum malaria in regions of unstable transmission. In: *XIVth International AIDS conference 2002, Barcelona, Spain*: abstract ThPeC7604.

14. Nwanyanwu OC et al. Malaria and human immunodeficiency virus infection among male employees of a sugar estate in Malawi. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 1997, 91(5):567–569.

15. Mouchet J et al. Evolution of malaria in Africa for the past 40 years: impact of climatic and human factors. *Journal of the American Mosquito Control Association*, 1998, 14(2):121–130.

16. Sharp B et al. Malaria control by residual insecticide spraying in Chingola and Chililabombwe, Copperbelt Province, Zambia. *Tropical Medicine and International Health*, 2002, 7(9):732–736.

17. *The World Health Report 2001. Mental health: new understanding, new hope*. Geneva, World Health Organization, 2001.