

Frequently Asked Questions and Answers

“Adult and child malaria mortality in India: a nationally representative mortality survey”

Disclaimers:

The aim is to give only information, not recommendations, to governments, organisations and individuals.

Note on Indian and western numbers: 1 lakh=100 thousand, 10 lakh=1 million, 1 crore=10 million

Q: What is the Million Death Study?

A: The Million Death Study (MDS) is large-scale, epidemiological research study intended to document the causes of child and adult deaths in India and their key risk factors for the years 1998 to 2014. The MDS works within the Sample Registration System (SRS), which is a large, ongoing demographic survey organized by the Registrar General of India (RGI). In this particular report, deaths due to malaria were analysed for the first phase of the MDS, from 2001 to 2003.

Q: Who carried out the study, how much did it cost and who funded it?

A: The SRS is funded and implemented by the RGI. The MDS is led by the Centre for Global Health Research (CGHR) at the Li Ka Shing Knowledge Institute, St. Michael's Hospital and University of Toronto, Canada. The study was conducted in close partnership with the RGI, St. John's Research Institute, the Post Graduate Institute of Medical Research and Education, the Indian Council of Medical Research, and the Clinical Trials Service Unit and Epidemiological Studies Unit at Oxford University. The MDS cost approximately \$1 million Canadian dollars (Rs. 4 crore) over a five year period and was primarily funded by the U.S. National Institutes of Health and the Canadian Institutes of Health Research. The funding agencies had no role whatsoever in writing the final scientific paper, as this was the responsibility of the investigators.

Q: How was data for this study obtained?

A: Using SRS data about all deaths that occurred during the 2001-2003 period, a team of approximately 800 trained, non-medical field staff obtained individual narratives (or “verbal autopsies”) from household members about the circumstances surrounding the deaths in their homes during these years. Interviewers obtained half-page narratives about each death, plus answers to specific questions about the severity and course of any fevers. Quality control methods, including random spot checks, were conducted routinely.

Q: How was cause of death determined?

A: Based on the local language of the narrative, each field report was randomly assigned to at least two of 130 physicians. Using the information provided in the verbal autopsies, the physicians independently coded the underlying causes of death using a 3-character International Classification of Diseases (ICD-10) code. Physicians were instructed to use their best medical judgment to determine the cause of death, and were advised to exclude malaria if there was evidence of pneumonia, diarrhoea, burning during urination, rash, blisters, heatstroke or evidence of other specific infection. Any differences between the two coders were resolved either through anonymous reconciliation or adjudication by a third physician. Physicians were provided with the state and date of death; however these factors were not included in the criteria for coding malaria deaths.

Q: What are the key findings of this study?

A: Key findings:

- 1.8 million (18 lakh) annual deaths of those under 70 years old occur in India where fever is the main symptom; of these, 1.3 (13 lakh) million deaths occur in rural areas without prior medical attention
- Of the 75 342 study deaths at ages 1 month to 70 years, 2681 (3.6%) were attributed to malarial fever
- Projected to the entire population, malaria is calculated to cause 205 thousand (2.05 lakh) deaths per year before age 70 in India, which is much higher than the World Health Organization (WHO) estimate of 15 thousand deaths from all ages
- Plausible lower and upper bounds were 125 thousand (1.25 lakh) to 277 thousand (2.77 lakh) malaria deaths, respectively
- Of these malaria-attributed deaths, 55 thousand were in early childhood, 30 thousand were in children 5-14 years old, and 120 thousand (1.2 lakh) were in adults 15-69 years old
- There were high mortality rates in early childhood and in later middle age
- 90% of malaria-attributed deaths were in rural areas and 86% were not in any health facility
- Half of the malaria-attributed deaths before the age of 70 occurred in a few high-malaria states:
 - Orissa alone accounted for over 50 thousand annual malaria deaths. Compared to the national average of 1.8%, individuals in Orissa had a 12.5% overall probability of dying from malaria before the age of 70 years
 - Other states with relatively high annual malaria deaths are: Jharkhand (20 thousand), Madhya Pradesh (20 thousand), Chhattisgarh (12 thousand), and Assam and other north-eastern states (16 thousand)
- In the absence of other causes, Indians have about a 2% probability of dying from malaria before the age of 70 years, but this percentage is much greater in high-malaria states
- These are also the states where the Indian malaria control program finds a high prevalence of the most dangerous type (*Plasmodium falciparum*) of malaria parasite, but they are not states with a particularly high prevalence of other diseases that could have been mistaken for malaria

Q: Why are malaria death rates difficult to estimate?

A: Accurate worldwide and regional malaria mortality rates have been difficult to estimate for three reasons:

- 1) Reported malaria cases are usually treated and cured, and therefore do not contribute to mortality rates. Conversely, unreported malaria cases are usually not treated and result in death, but are not represented in reported mortality figures;
- 2) In studies of fever-related deaths where specific cause of death was not declared, malaria and other fever-related illnesses can easily be mistaken for each other; and
- 3) In most rural areas where death from malaria is common, proper medical attention at the time of death is uncommon.

Q: Why are the results from this study so different from the World Health Organization estimates?

A: The malaria mortality estimates reported by the World Health Organization (WHO) are indirect calculations based on confirmed malaria cases reported by formal healthcare facilities. While their estimates are adjusted for underreporting by facilities, they do not account for those who do not (or cannot) visit these healthcare facilities. This is especially relevant for rural populations, where health clinics may not be accessible.

This study was conducted to provide a better understanding of what was actually happening in the community, and especially in rural areas. Since an estimated 86% of the deaths due to malaria occurred outside of healthcare facilities, and mostly in rural areas, the majority of malaria deaths were unobservable until now.

It is important to note that of the 1.8 million annual fever deaths of those under 70 years old in India, malaria caused only a significant minority of these, accounting for only about 11% of all fever deaths, below pneumonia (28%), other specific infection (20%), tuberculosis (17%), and diarrhoea (17%). However, even considering the lower bound MDS estimate of malaria deaths (125 thousand, or 1.25 lakh), the WHO estimate (15 thousand) is less than one eighth of this figure.

Q: Do these results correlate with any independently collected data?

A: Estimated malaria-attributed deaths were supported by the following relationships with independent data that were collected outside of the Million Death Study (MDS):

- MDS malaria deaths in each state correlated strongly with state-reported malaria deaths that were clinically confirmed through positive blood slides for malaria parasites;
- MDS malaria deaths strongly correlated with the malaria transmission rates reported in each district;
- MDS malaria deaths showed a solid correlation with the proportion of households in each district that reported fever;
- MDS malaria deaths did not correlate with national data on three diseases (dengue, typhoid and meningitis) whose symptoms could be mistaken for malaria; and
- MDS malaria deaths rose following the start of the wet season, as would be expected from the breeding patterns from mosquitoes.

Q: How can we tell whether the causes of death were accurately coded for malaria?

A: The accurate diagnoses of malaria can be supported by three main factors. Firstly, previous hospital-based studies have shown that the use of verbal autopsies for malaria diagnoses in children and adults is reasonably “specific” (i.e., they can correctly identify non-malaria causes of death with reasonable accuracy). Higher specificity, as in this case, indicates a lower chance that malaria deaths were overestimated. Secondly, the lack of correlation between national data on three diseases that could have been mistaken for malaria (dengue, typhoid and meningitis) supports the accurate diagnosis of malaria versus other malaria-like diseases. Finally, aside from fever, the symptoms for malaria were different from those of other infectious diseases. For example, symptoms including shivering, body aches/headaches and sweat were more commonly diagnosed as malaria, whereas coughing and diarrhoea was more commonly assigned to other infectious diseases.

Q: Does malaria only kill children?

A: No. Our study finds that malaria not only kills a significant number of children below the age of 5 years, but also a large number of adults. The U-shaped pattern of malaria-attributed mortality by age group, with high rates in both early childhood and in later middle age, is consistent with the age relationships previously reported for malaria mortality from three independent sources of data: (1) selected urban hospitals in India; (2) family-reported causes of death from a national household survey in 1998-1999; and (3) a network of community-based mortality studies in rural Africa.

It is worth noting that this U-shaped age-specific pattern is not consistent with WHO malaria mortality rates.

Q: Why do the results only include those under the age of 70?

A: Assigning cause of death in old age is particularly difficult, and the proportion of total deaths without a classifiable cause rises sharply after the age of 70. For this reason, the major analyses of this study were conducted for those under 70 years old, with older ages considered separately. An additional 71 thousand malaria-attributed deaths were estimated for those aged 70 years and older.

Q: How do these findings compare to mortality rates from HIV in India?

A: HIV deaths occur at almost all ages between 15-59 years old, whereas malaria deaths tend to occur in childhood and later middle age. The Million Death Study (MDS) estimated a total of approximately 100 thousand (1 lakh) HIV deaths in those aged 15-59 in 2004 (see British Medical Journal article at: [http://cghr.org/publications/BMJ_Jha_et_al_340_\(232\)_c621_aids_paper.pdf](http://cghr.org/publications/BMJ_Jha_et_al_340_(232)_c621_aids_paper.pdf)). In this same age group, a comparable number of deaths (84 thousand) were found to be caused by malaria.

Q: Why is the burden of malaria during pregnancy not addressed?

A: A separate study will examine the direct and indirect causes of malaria deaths in pregnant women.

Q: Who participated in this study?

A: The Registrar General of India (RGI) funds and organises the Sample Registration System (SRS), which monitors all births and deaths in 1.1 million (11 lakh) homes covering all geographic regions of India. Field workers interviewed 122 thousand (1.22 lakh) households located in 6671 areas (4436 rural and 2235 urban) that were chosen to be representative of the entire population.

Q: What are some of the limitations of this study?

A: One of the main limitations of this study is the fact that most deaths in rural areas occurred without prior attention by a medical professional, and therefore causes of death must be attributed only after the review of household narratives about past circumstances. Consequently, malaria and other infectious diseases can be confused, leading to the possible misclassification of fever-related deaths.

However, symptoms of untreated malaria can be distinct from other infectious diseases, and our results are supported by several correlations with data collected independently of this study. For example, states such as Orissa, Chhattisgarh, and other states independently known to have high malaria rates were found by the MDS to have higher percentages of fever deaths attributed to malaria (generally, 20% to over 40%) compared to other states (generally under 10%).

Q: Since physicians coded narratives in their local languages, is there any chance that the results reflect the bias of physicians in certain regions?

A: Coding physicians mostly resided in the capitals, and would not be aware of how common malaria was in any of the districts where the deaths occurred. However, there was a tendency for physicians coding in Oriya, the main language of Orissa, to assign a greater proportion of fever deaths to malaria. While this could be the result of physician bias, it more likely reflects the fact that malaria deaths were more common in rural Orissa. The higher malaria mortality rate found in Orissa accounts for only a 5% increase in the total number of national malaria deaths estimated in this study.

Q: Are these results outdated since the analysed data are from 2001-2003?

A: The malaria mortality rate estimated from this study is likely still valid now since previous interventions were not designed to handle the true magnitude of malaria in the country. In addition, the World Health Organization (WHO) reports a comparable number of malaria deaths between 2000 and 2008, and only a very slight decline in all malaria cases over the same time period. This is the first phase of research findings from the Million Death Study (MDS) and data will continue to be collected until 2014.

Q: What does this study say about the suitability of the current mortality reporting system in India?

A: One of the key findings of this study is the considerable proportion of malaria deaths that occur in rural areas (90%) and outside of healthcare facilities (86%). Consequently, this research tells us that we cannot rely solely on government reports from hospitals and healthcare facilities because it only captures for a small fraction of the illnesses and deaths that occur in the country. Additionally, because so many deaths occur without prior medical attention, the causes of death are difficult to certify. As a result, alternative systems are needed to adequately document the causes of most deaths in India. The Registrar General of India (RGI) has recognised this need for supplementary information, and through its Sample Registration System (SRS), has been sending field workers to regularly survey a nationally representative sample of individual homes regarding the deaths that have occurred in the household, rather than passively collecting mortality data from healthcare centres.

Q: What do these results mean?

A: Cost efficiency is an important consideration in national planning. Malaria control is a major enterprise that alone accounts for 35% of the central government's health budget. Accurate figures for malaria-attributed deaths are essential for the government to improve the health of its people and implement effective prevention- and treatment-based interventions.

The challenge of estimating realistic figures for malaria-attributed deaths required a country-wide scientific study. For the first time, this vital information has been generated using modern scientific methodology that was executed and peer-reviewed by the international community. This information is now available in the global scientific and public domain. These findings will help the Indian government, international community, and donor agencies to upscale resources adequately at appropriate locations for India's National Vector Borne Disease Control Programme (NVBDCP) to meet the Million Development Goals and beyond.

Q: What types of policy recommendations would these findings suggest?

A: The intent of this study was not to provide malaria control advice, but to report a more realistic estimate of malaria mortality in India. While we do not make policy recommendations, we do provide information that can be used to help improve malaria prevention and treatment. Unlike cancer or AIDS, we know from studies independent of this one that malaria can be completely cured with effective and inexpensive drugs, if diagnosed early.

Improved malaria diagnosis could involve diagnosing all fevers by microscopic examination of blood smear or Rapid Diagnostic Test. Standard treatment for those who test positive for malaria is a full course of antimalarials for the particular species of the malaria parasite, as recommended by India's National Vector Borne Disease Control Programme (NVBDCP). Malaria prevention in high-risk groups in endemic areas would be important. Effective prevention measures could include the use of long lasting insecticide treated mosquito nets, repellents and chemoprophylaxis.

Frequently Asked Questions about Malaria

Q: What is malaria?

A: Malaria is a serious illness that may be fatal. Malaria patients are very sick and have a high fever. Ignoring the fever or delaying medical treatment can lead to severe malaria and death. The cost to treat severe malaria is often high and the outcome is uncertain. Malaria-caused illness, complications and death are avoidable by early diagnosis and prompt and complete treatment.

Q: What causes malaria?

A: Malaria is an infectious disease caused by a parasitic infection. There are five known species of parasites that cause malaria in humans; however the most dangerous infection is caused by *Plasmodium falciparum*, which can cause severe malaria, cerebral malaria (coma) and death.

Q: How is malaria transmitted?

A: Malaria is transmitted through the bite of infected, female mosquitoes of the *Anopheles* genus. When a mosquito bites an infected host, malaria parasites are taken up with the blood that the mosquito ingests. Within about a week to ten days, these parasites mature within the body of the mosquito. During subsequent bites, infected mosquitoes transfer the malaria parasites to new hosts.

Q. Is malaria curable?

A. Yes. Malaria is curable if patients receive medical attention in the early stages of the disease; preferably within 24 hours of the onset of symptoms. After a proper diagnosis is confirmed, a full course of antimalarial drugs must be taken for the full recovery from the disease. However, if prompt treatment for malaria is not provided, the disease can progress to severe malaria and death.

Q: How is malaria diagnosed?

A: To make a clinical diagnosis of malaria, malaria parasites need to be identified in a blood test. The presence of malaria parasites can be confirmed by visually identifying them in a blood sample under a microscope (referred to as 'slide-positive' for malaria) or by an analysis called a Rapid Diagnostic Test.

Q: What are the symptoms of malaria?

A: Malaria symptoms starts with general unwellness, fever, chills, headaches, muscle pain, fatigue, body pain, flu-like symptoms, vomiting, rigor followed by profuse sweating, and a fever that might reach as high as 40-40.5°C. Malaria symptoms recur at 48- or 72-hour intervals. Malaria is a common disease and symptoms may be often mistaken for influenza or gastrointestinal infections. *P. falciparum* requires immediate diagnosis and medication as delay may lead to complications such as kidney failure, multi-organ failure, seizures, coma and, in some cases, death.

Q. How much does it cost patients to treat malaria in India?

A. Malaria treatment is free in government health facilities (e.g., public healthcare clinics and hospitals). In the private sector, early diagnosis and prompt and complete treatment for malaria is affordable. If the disease progresses to severe malaria, treatment becomes very expensive and the outcome is uncertain.

Q. If malaria treatment is free in India, why are so many people still dying from it?

A. The results of this study indicate that 90% of malaria deaths occurred in rural communities, which can be hours or even days away from the closest healthcare facility. Malaria can become life-threatening within hours, and if too much time elapses before an infected patient receives treatment, the disease may have progressed too far to be treated effectively. In addition, since the health reporting system was not actively looking for malaria-attributed deaths outside of medical centres, the need for more effective preventive and treatment measures in high-risk populations could not be properly identified.

Q: Who is at risk of contracting malaria?

Anyone visiting or living in a malaria-endemic area can contract malaria. Half of the world's population is at risk of malaria and transmission occurs in over 100 countries. Children below the age of 5, pregnant women and travellers to malaria-endemic countries have high malaria risk, that could potentially be life-threatening. Malaria infection rates can vary, and depend on geographic location, season, particular species of mosquito, and many other determinants.

Q. How can we reduce the risk of contracting malaria?

A. The risk of malaria can be reduced by taking the following steps:

Protection from mosquito bites

- Regularly using mosquito nets; preferably treated or long lasting insecticide treated mosquito nets
- Screening all doors and windows
- Using mosquito repellents and coils
- Wearing long-sleeved shirts and long trousers if outdoors between dusk and dawn

Control of mosquito breeding

- Eliminating all unwanted standing water (i.e. by draining or covering it)
- If standing water is necessary, treating it with fishes that eat mosquito larvae and spray it with larvicides such as temephos, fenthion, bacillus thuringiensis or bacillus sphaericus

Control of adult mosquitoes

- Spraying rooms with pyrethrum spray to inhibit mosquitoes from biting
- Participating in the mosquito control activities offered by the health department, such as indoor residual spraying and fogging