

Please cite this article as:

hypothesis

Prabhat Jha, Counting the dead is one of the world's best investments to reduce premature mortality. *Hypothesis* 2012, **10**(1): e3, doi:10.5779/hypothesis.v10i1.254 (2012).

Counting the dead is one of the world's best investments to reduce premature mortality

Prabhat Jha¹



ABSTRACT Vital statistics on causes of death (COD) by age, gender, social status and geography have transformed health in developed countries. Robust COD information, especially for adult deaths, remains uncommon in most developing countries as most deaths do not occur in hospitals. I recommend five low-cost options for rapidly improving COD systems in countries with inadequate systems. Implementing these improvements

over the next few years is feasible at low cost given advances in information technology and data capture. COD systems would transform disease control priorities, approaching in quality and matching in relevance what has taken more than a century to produce in many developed countries. Counting the dead is one of the world's best investments to improve global health.

INTRODUCTION In 1869, the Sanitary Commissioner of India wrote “for sanitary purposes it is indispensable to know the relative mortality in small and, as far as possible, well-defined tracts to ascertain the death rates in each of these communities; to see how far this arises from preventable causes; and to apply the remedies”¹.

In this paper, I argue that over 140 years later counting the dead is one of the best

investments to reduce premature mortality worldwide as it is one of the most robust ways to measure accurately the effectiveness of investments aimed at reducing child and adult mortality. With rapid expansion of information technologies, developing countries have an opportunity to improve health by rapidly introducing systems that reliably measure the causes of death (COD) and key risk factors that increase mortality. COD systems implemented worldwide would spur research into avoidable mortality and new risk factors by identifying diseases that are common in one locality but rare somewhere else. These differences must reflect major, measurable differences in largely unknown causative factors and in some intermediate determinants of disease risk. COD systems would also transform disease control priorities, help detect new epidemics, enable the

evaluation of disease control programs and improve accountability for expenditures on disease control^{2,3}. A practicable, worldwide, rapid expansion of COD systems may be able to collect representative data by 2020, particularly for adults, and particularly in sub-Saharan Africa.

About 56 million deaths occur worldwide every year⁴. Certification of deaths with causes assigned by physicians is nearly universal for the 8 million deaths occurring in developed countries. However, death registration and medical attention at the time death is low among the 48 million deaths in developing countries (defined as low- and middle-income countries)⁵. Among 115 countries that reported mortality to the World Health Organization (WHO)⁴, only 64 countries had good quality vital registration that also covered COD. Fully 75 countries, including 90%

of those in Africa, did not provide data on COD for any year after 1990.

HISTORIC DEVELOPMENT OF COD SYSTEMS Earlier crude COD systems in urban European cities were remarkably useful in helping to control plague and other epidemics⁶. Death registration began in the late 1830s in England and even earlier in Sweden. Death by social class was recorded in England beginning in 1921⁷. In 1852, the first mortality report by the Massachusetts Sanitary Commission noted that the average age of farmers who died was 65 years whereas mechanics died at an average of 47 years. The report suggested that this fact “should urge physicians ... to inquire into the causes which shorten the lives of so large a proportion of the inhabitants of our State”⁸.

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Public health in industrialized countries was transformed when vital statistics on age, sex and socioeconomic distribution of births and deaths became available in the late 19th and 20th centuries^{2,3}. COD statistics have demonstrated major reductions in under-five mortality and tuberculosis mortality during the 20th century, but more importantly they have also identified unexpected causes of mortality. For example, in the 1940s, the dramatic increase in lung cancer deaths in British and American men after World War II spurred research leading to the discovery of smoking as a cause of a range of diseases, including lung cancer⁹. In the early 1980s, routine mortality data from San Francisco revealed an exceptional increase in immune-related deaths among young men and signaled the start of the American HIV epidemic¹⁰. Routinely collected data have helped to prompt further research and public health action, and have contributed to the enormous increases in life expectancy in developed countries in the 20th century¹¹.

THE LIMITATIONS OF CIVIL REGISTRATION

Universal civil registration of deaths with medical certification is a laudable goal^{12,13}, but full civil registration can take several decades. Even the United States took the better part of a century to increase death certification, and some states did not

reach complete coverage until the 1970s. Developing countries have shown little progress in the expansion of civil registration, and COD statistics lag further behind¹⁴. Reasons for the low civil registration in developing countries include limited access to medical care and the fact that most deaths occur at home rather than in hospitals. Incentives for households to register deaths in most developing countries are quite limited as pension and insurance schemes or enforceable familial inheritance and property rights are uncommon. Strategies to increase civil registration include increasing medical attention at death and training health care workers¹². Requiring burial or cremation grounds to register deaths is practicable in urban settings, but less so in rural areas.

Basic data on age- and sex-specific death rates can identify trends for rapidly changing diseases such as those in childhood. Similarly, the very large increases in death rates among young adults in selected sub-Saharan countries from 1990-2000 have enabled the estimation of the impact of HIV infection on mortality^{15,16}. This is because the "signal" of HIV-attributable mortality (increased deaths) exceeds the "noise" of misclassification from competing mortality. Civil registration would be similarly useful to

document pandemic influenza, as the overall death rates would increase substantially during the pandemic phase. For example, a simple analysis of age-specific death rates from the census data suggested that 17-20 million Indians died of the influenza epidemic in 1918-19¹⁷.

MODERN RELEVANCE OF COD MEASUREMENT

The modern relevance of various COD systems depends on their specific uses, the disease and age group of interest, and on random or systematic misclassification of COD. The major objective for most low- and middle-income countries would be COD systems that obtain more representative data on age-, gender- and social stratum-specific mortality rates for the major diseases. Hospital records with medical certification of COD are insufficient, given that most deaths occur out of hospital, and given that the age and distribution of causes between hospital and home deaths vary greatly¹⁸.

Verbal autopsies involve a structured investigation of the circumstances and health symptoms leading to the death through an interview of a relative or associate of the deceased¹⁸. The addition of verbal autopsies for child deaths to Demographic and Health Surveys¹⁹ have removed much of the substantial uncertainty that existed in the 1960s

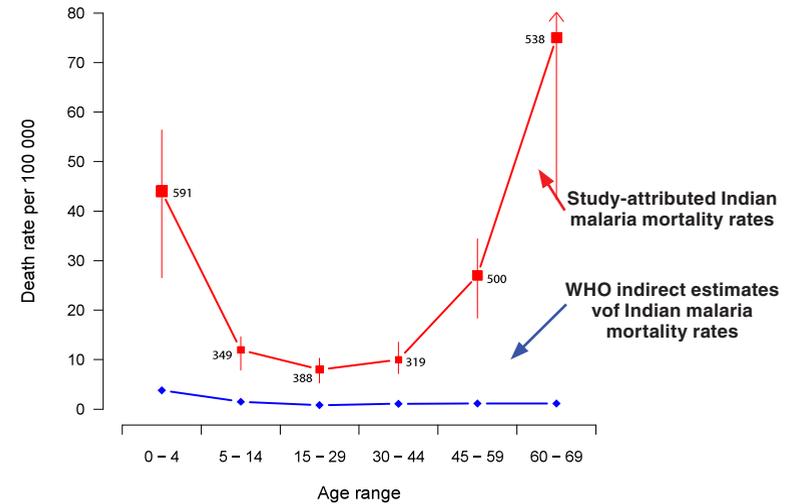


Figure 1 | Age-specific all-India malaria-attributed death rates estimated from the Million Death Study and those estimated indirectly for WHO. Within each age range, the all-India death rates from the present study are standardised in 5-year age groups to the 2005 Indian population. The vertical bars represent the upper and lower bounds based on physician coding. The numbers shown beside the main line represent the number of study deaths finally adjudicated to malaria for each age range²¹.

on information on COD for children²⁰. However, there are still enormous gaps in knowledge for COD of adults worldwide, such as the proportion of adult deaths due to malaria²¹.

For most infectious conditions, such as meningitis, the cause of death is directly related to the infective agent. In contrast, chronic diseases such as myocardial infarction may be caused by several factors such as smoking, elevated blood pressure or blood lipids. Chronic

diseases are already the leading cause of death worldwide²² so reliable measurement of causes of adult mortality and their underlying risk factors is required in particular for developing countries. In Western countries there has been limited use of "co-morbid" codes on death certificates²³ and the completion of these codes on death certificates in developing countries, where implemented, is quite low. Simply asking about the dead person's risk factors can be useful. "Household case-control" methods

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have successfully measured exposure to tobacco in several countries. These involve asking living relatives of those who have died about the tobacco and alcohol use of the deceased and themselves. The Indian Million Death Study (MDS) used such methods to estimate that India currently has about one million deaths from smoking²⁴. A retrospective study of one million deaths in China compared the proportions of smokers and non-smokers who have died of tobacco-attributable diseases versus non-tobacco related diseases (chiefly injuries) to calculate the excess number of deaths in smokers²⁵.

FIVE OPTIONS FOR EXPANDING COD REPORTING

In regions that lack a system for the complete registration of deaths and have low levels of medical attention at the time of death, five complementary approaches are practicable for obtaining better COD data in the medium term (by 2020). The first and most robust option (sometimes called Sample Vital Registration with Verbal Autopsy;²⁶ is the establishment of a Sample Registration System (SRS), such as the one conducted in India.

India's SRS has worked in representative areas of the country since 1971²⁷. China also began a similar system²⁸. From 2001 onward, India's SRS has added an

enhanced version of a verbal autopsy^{18,29}, which reliably classifies the major diseases leading to death prior to age 70 years, but which is much less reliable for deaths above age 70 years^{30,31}. Given that the mean age of deaths in India and other developing countries is far lower than in developed countries, verbal autopsy remains a very relevant approach.

India's SRS efforts are called the Million Death Study as it will eventually capture information on about one million deaths in India (about 300,000 from 1997-2003, and 650,000 from 2004-2014;¹⁸). The first round of results has already established the major causes of maternal³² and child deaths³³ in India. The MDS has attributed about 100,000 deaths to HIV—about a quarter of previous estimates³⁴. It also noted that cancer death rates were similar in rural and urban areas, and cancer death rates were 2-fold higher in the least educated adults compared with the most educated adults³⁵. In all cases, direct measurement through the MDS yields novel insights into India's avoidable mortality.

The MDS identified nearly 200,000 malaria deaths below age 70 years – about 15 times that estimated by WHO using indirect methods (Figure 1;²¹). Similar results from smaller studies in Africa, where malaria is common, have

also shown a “U-shaped” mortality pattern (Figure 2;³⁶⁻³⁸). The relevance of this finding is simple. According to WHO, use of powerful artemisinin combination therapies, as well as prevention through insecticide impregnated mosquito nets, has substantially reduced malaria mortality in children in Africa³⁹. Similar efforts might well reduce adult deaths from malaria worldwide.

A second option for selected African countries with limited or no vital registration and no cause of death data

is to enhance the ongoing INDEPTH network⁴⁰, a group of around 42 demographic surveillance sites (DSS) in 19 countries (Figure 3). This would involve efforts to expand the sample size in each country and make the sites more (or fully) representative of the population. Well-planned DSS efforts, such as the Adult Morbidity and Mortality Project in Tanzania, strengthen vital statistics and survey capacity, and have prompted the use of COD data to monitor and evaluate various national programs at local

and regional levels, including those for malaria and HIV/AIDS⁴¹.

A third option is retrospective surveys of mortality that accompany the globally standardized DHS begun by the US Government and now covering about 90 countries¹⁹. This would use the DHS representative sampling frame to record COD among deaths in DHS households over the last 5-10 years. DHS have limitations, such as small sample size, and an overwhelming focus on child and maternal health. However, addition of a

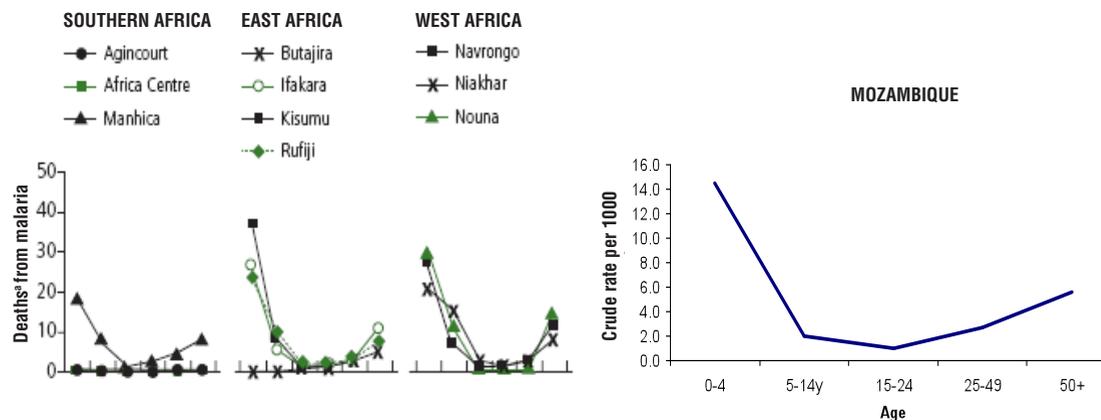


Figure 2 | Age patterns of malaria deaths in selected African countries³⁶⁻³⁸

COUNTRIES WITH DNS AND INDEPTH SITES

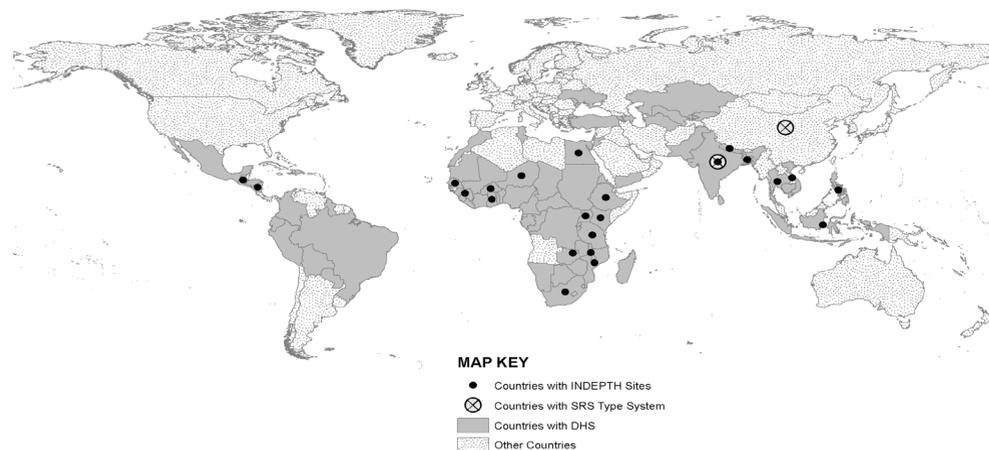


Figure 3 | Low and middle-income countries with Demographic and Health Surveys (DHS), INDEPTH network Demographic Surveillance Sites or Sample Registration Systems (China and India)

module for adult verbal autopsy to the DHS sampling frame is practicable.

A related fourth option for large countries is the implantation of large, well-planned retrospective surveys of mortality using census sample frames. For example, much is known about variation of disease in China as a result of mortality studies that began there nearly three decades ago. A complete national survey of the causes of all deaths, carried out in 1973-75⁴², remains one of the most remarkable epidemiological studies

ever undertaken. The study reviewed 20 million deaths, retrospectively clarifying and coding their causes. By yielding the first assessment of age- and cause-specific mortality rates for each province and county, and for China as a whole, the study revealed the large variation in disease rates across the country, which in turn brought about health interventions and further research. For example, a randomized trial of hepatitis B vaccination of children began after the survey showed that liver cancer rates in Qidong

were 100 times higher than those in the United Kingdom⁴². Mozambique recently conducted a national COD survey of over 11,000 deaths, based on deaths identified in the preceding census³⁸.

Finally, for a small number of countries that have reasonable levels of civil registration of death, but more limited COD data, it is possible to expand medically-certified COD, while concurrently instituting household-based verbal autopsies for deaths that occur without medical attention. Such pilot programs

are currently underway in Iran, Sri Lanka, Thailand and Turkey¹⁴.

CONCLUSION Developing countries can generate within a few years much needed data on COD at low cost – less than \$1 per participant per year^{18,43}. Novel COD systems are feasible within a few years if they can use electronic data capture, mobile phones and the internet. These novel COD systems can match in quality and relevance what has taken more than a century to produce in many developed countries. A global investment of \$100 million dollars might be able to cover about 50 distinct populations (small countries or sub-national regions of large countries) by 2020. The revised United Nations Millennium Development Goals for 2030 should include an explicit goal that each country adopts reliable COD systems. Given the astonishing power of these statistics, counting the dead is one of the world's best investments to improve global health.**H**

The authors declare no conflicts of interest

ACKNOWLEDGEMENTS I thank Philip Setel, Arthur Slutsky and Alan Bernstein for useful comments and Ansely Wong for help with the manuscript. The opinions expressed are not necessarily those of the institutions or partners with which I am affiliated.

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