

Health Statistics 3

Interpreting health statistics for policymaking: the story behind the headlines

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This is the third in a *Series* of four articles about health statistics

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Politicians, policymakers, and public-health professionals make complex decisions on the basis of estimates of disease burden from different sources, many of which are “marketed” by skilled advocates. To help people who rely on such statistics make more informed decisions, we explain how health estimates are developed, and offer basic guidance on how to assess and interpret them. We describe the different levels of estimates used to quantify disease burden and its correlates; understanding how closely linked a type of statistic is to disease and death rates is crucial in designing health policies and programmes. We also suggest questions that people using such statistics should ask and offer tips to help separate advocacy from evidence-based positions. Global health agencies have a key role in communicating robust estimates of disease, as do policymakers at national and subnational levels where key public-health decisions are made. A common framework and standardised methods, building on the work of Child Health Epidemiology Reference Group (CHERG) and others, are urgently needed.

“Hunger kills 6 million children a year”.¹ Such public health estimates are often headline news and can affect decisions about how resources are allocated to tackle health problems. Many readers, even with access to the scientific report behind the headline, are ill-equipped to assess the quality of the information provided, or to understand how the estimate underlying the headline was arrived at (in this example, undernutrition was just one of many causes that killed half of 11 million children in 2000). Politicians, policymakers, and public-health professionals are increasingly faced with making complex decisions that require the interpretation of estimates of disease burden. The quality of their decisions reflects their ability to assess and interpret this quantitative information, which often comes from different sources and is marketed by skilled advocates.

It is time to revisit basic issues related to interpreting estimates of public-health indices. In the first of the *Lancet* Health Statistics series, Boerma and Stansfield described the increasing demand for, and complexity of, public-health statistics and called for a rationalisation of measurement strategies.² In the next article, Murray discussed the poor availability of health statistics for the Millennium Development Goals health indicators, and recommended explicit and comprehensive data audit trials.³ In this third article of the series, we discuss different types of global public-health estimates, and offer basic guidance to those who use them in decisionmaking about how to assess and interpret them. The final article⁴ will look at enhancing the use of health statistics for decisionmaking at the country level.

We describe seven levels of estimates used to quantify disease burden and its correlates. We then suggest five questions that consumers should ask about any health estimate, to gauge its validity and implications for decisionmaking. Finally, we offer basic tips to

governments, donors, and individuals involved in public-health decisionmaking on how to understand and interpret estimates.

Levels of estimation

In public health, different levels of estimate correspond to different relations to a disease or other cause of illness or death. Panel 1 shows the hierarchy of these levels, based on the relation of the indices to mortality or morbidity. Understanding how closely linked a type of statistic is to disease and death rates is crucial in designing health policies and programmes.

Broad determinants of health status

At the broadest level, poverty determines both the risk and adequacy of response to infectious diseases,

Panel 1: Levels of statistics about disease burden

- 1 Broad determinants of health status, including socioeconomic status
- 2 Risk factors, such as smoking, environmental exposures, diet, or genetic predispositions
- 3 Underlying causes, the most recognised of which is undernutrition
- 4 Direct causes of mortality or morbidity—such as infectious diseases, non-communicable diseases, or injury
- 5 Indirect causes, whereby one health condition predisposes to another
- 6 Future disease burden, such as can be anticipated from future infection prevalence
- 7 Costs and economic consequences of health status, including direct and indirect costs to families for illness care, being orphaned, economic productivity, costs of interventions, costs saved by intervention, and cost-effectiveness

nutritional deficiencies, and other disorders. Although this is so self-evident that estimation of the size of the effect is hardly necessary, it is inappropriate to conclude, as some have, that the way to reduce the disease rates in low-income countries is to simply wait for economic development.^{5,6} The estimation of determinants and causes of disease at lower levels can contribute to the selection of policies and programmes that can reduce disease burden in the shorter term while poverty reduction strategies are underway. If these policies and programmes are designed to reduce inequities within countries, they can have the greatest effect on the poorer segments of the population that have the highest disease burden, so estimation at this level can be useful.

Risk factors and underlying causes

Estimates of disease burden caused by risk factors such as tobacco use or sexual behaviour, or underlying causes of disease such as nutritional deficiencies, can be helpful in the identification of preventive interventions with large and long-lasting benefits. On the other hand, inappropriate aggregation of risk factors, for example attempting to assess the contribution of all “environmental” risk factors to a health condition,⁷ can yield large attributable fractions of global disease burden, but are not useful in prioritising interventions to address the particular environmental exposures (or deficiencies). Traditionally, policymakers have been slow to recognise the importance of risk factors and the cost-effectiveness of preventive interventions despite these having greater benefits than therapeutic or palliative interventions in addressing the direct causes of death. The rapid scale-up of antiretroviral therapy—rather than prevention programmes—for people with HIV/AIDS in developing countries is a good example. Whether the momentum generated by the US President’s Emergency Plan for AIDS Relief (PEPFAR), WHO, and others in promoting prevention will be matched by real investment remains to be seen.

Direct causes

The most commonly used estimates of disease burden are measures of death, illness, and disability. Whether these are used as direct or summary measures, such as disability-adjusted life years (DALYs), their contribution is crucial in establishing priorities in disease control. But such statistics can be used in misleading ways. Estimation of the proportions of child deaths from specific diseases at regional and national levels can be important when organising priorities, but can be confusing if used out of context. For example, global advocacy statements that HIV/AIDS is rolling back generations of gains in child survival in Africa⁸ might be true for a few countries, but is misleading because HIV/AIDS is responsible for less than 10% of child deaths in sub-Saharan Africa.⁹ The use of specific target

populations as a context for estimates can also be misleading. Statements such as “Measles is the biggest killer among the vaccine-preventable diseases”,¹⁰ for example, is technically correct, but diverts attention from the fact that measles contributes to very few of the total number of infectious disease deaths in children, even in areas where it remains endemic.¹¹

Indirect causes

Clinical observations and the results of placebo-controlled trials have shown that some diseases can not only kill directly, but can also have indirect effects through non-fatal illness that increase the risk of death from other infectious diseases. But not all estimates of disease burden include these indirect effects. The indirect contribution of malaria to childhood deaths from other communicable diseases and anaemia, for example, is supported by the finding that some malaria prevention trials have shown a greater reduction in deaths than can be attributed directly to malaria infection.¹² These results could have been due to misclassification of the cause of death by the verbal autopsy methods used, or because non-fatal malaria predisposes to subsequent pneumonia or other fatal infections. Quantifying this possible indirect effect is difficult, but efforts to prioritise among disease interventions must take into account the possible indirect effects of many infectious diseases—eg, the contribution of diarrhoea to nutritional deficiencies that place children at higher risk of death from subsequent infections,^{13,14} or the fact that infection with HIV predisposes to other diseases such as tuberculosis.¹⁵ An awareness of these indirect causes of disease and death, and the hierarchies used to assign a single cause of death, is essential in assessing and interpreting burden estimates correctly.¹⁶

Future disease burden

Estimates of future disease burden from emerging and potentially epidemic diseases are particularly difficult. Some infections, such as Ebola haemorrhagic fever, receive undue attention in the media and trigger large public-health preparedness efforts, perhaps because of the horrific form of death in many of those infected, despite the very low risk to the rest of the population. Objective estimation of the true risk of this and similar rare diseases would be useful even if imprecise. It can be almost impossible to predict future risk from viruses such as influenza virus H5N1 because an estimate requires speculation about microbial evolution, changes in transmission potential, and human behaviour. Avian influenza has spread from southeast Asia to other parts of the world, killing a small number of people who have had direct contact with infected birds. But if this virus were to mutate into one that could spread from people to people, the numbers could rapidly increase. WHO has estimated that the potential human deaths, if the

virus spreads more widely, range from 2 to 100 million.¹⁷ Other analysts say even the high end of this range is too conservative and that a pandemic could kill more than one billion people.¹⁷ What is the prudent action against a disease that could kill none or just as plausibly kill one billion?

Costs and economic consequences

Finally, estimates of the costs of existing and future disease can be useful in public-health decisionmaking. This is particularly true of costs at the household or community level, such as figures suggesting that the direct and indirect cost of severe illness to families can result in a descent into poverty.¹⁸ At the societal level, these estimates are often subject to large assumptions about the consequences of ill health. For example, iron-deficiency anaemia can slow the body's development, including that of the brain, which could have important economic consequences for society, yet iron supplementation trials show a benefit of only 1–2 IQ points. The effect of this benefit on productivity in largely agrarian societies is unknown.^{19–21}

Five questions decisionmakers should ask about estimates

A complete methodological discussion of estimates in public health is beyond the scope of this paper. Instead, we suggest questions to help users of disease burden estimates assess and understand their strengths and limitations.

What metric is used in the statistic?

Absolute numbers, rates, or ratios have different meanings. How an estimate is presented can make an enormous difference in its interpretation. Cumulative measures and lifetime risks are particularly hard to understand. Take the example of HIV/AIDS. Advocates of funding for this disease often quote the cumulative number of global deaths from HIV/AIDS since it was first identified.²² But, if historical estimates were used for other diseases, the number of HIV/AIDS deaths would be small in comparison. For example, if the same statistical procedures were applied for pneumonia as for HIV/AIDS, the cumulative deaths since 1975 would be about 60 million²³—almost three times the estimated cumulative deaths from AIDS in the same time period.²²

Even estimates of prevalence and incidence of a disease can be misleading. For example, the mean survival time of an adult with HIV/AIDS, without treatment, is 9–10 years.²⁴ HIV prevalence is a period measure that stretches over that time. Early in an epidemic, the number of people living with HIV or AIDS and the adult prevalence rises rapidly, as new people are infected and few die. Later these numbers and the rate of increase change as mortality rates begin to rise. By selectively switching between the rate of

increase in new epidemics, the number of people living with infection in an older epidemic, and the cumulative number of deaths, one can focus attention selectively on the statistic that most strongly supports the importance of the disease. All the facts are correct, but their juxtaposition is often orchestrated to make the strongest possible impression of importance on the consumer without valid comparisons with other health conditions.

Policymakers and the public often have difficulty in understanding rates. Ratios tend to be more effective in communicating advocacy messages accurately. Statements like “Maternal mortality is 100-fold higher in many low-income countries than in high-income countries” sends a clear message with respect to inequities, but no information about the absolute magnitude of the problem. Statements more useful to decisionmakers are those that use a standard metric to provide sets of meaningful comparisons. For example, the ratio of inequity between low-income and high-income countries for deaths from severe neonatal infections is far lower, at 11-fold. In absolute numbers, however, two to three times as many lives are lost to neonatal infections each year (1.4 million) in developing countries than to maternal mortality (500 000).²⁵

Finally, users of health statistics must distinguish between crude, corrected, and predicted statistics, which is addressed in another article in this Series.³

Is the statistic a valid measure of population health?

Users of public-health estimates often assume that a measure is a direct or indirect reflection of disease burden or future health risk. This is not always the case. For example, the 2003 WHO report on tuberculosis presents portraits of two young people—one from Italy and one from Russia—accompanied by the statement “One-third of the world is infected with tuberculosis—that’s almost 2 billion people.”²⁶ Not stated is that this estimate is based on positive skin tests indicating latent rather than active infections; in the USA, for example, only about 5% of individuals with latent infections will develop active tuberculosis in the first year after infection, and an additional 5% will develop clinical disease later in life.²⁷

How good are the input data and estimation methods?

Few public-health decisionmakers are provided with adequate information or equipped with the technical skills needed to assess the quality of an estimate. Not only are most current estimates based on few data, but also these data may not be representative of other populations and are widely variable in quality. There are strong biases toward locations where data collection is possible and funding for field research is available.²⁸ Many countries have adequate data on key public health topics (eg, HIV estimates based on sentinel surveillance

sites in 137 out of 157 larger population countries²⁹) but accessing these data requires a lot of time and resources. For most public-health issues there are few valid country-specific data, and a large proportion of country estimates are generated through extrapolation and modelling techniques.

Not only are adequate epidemiological data scarce, support for new data collection has decreased to nearly zero over the past 20 years in some fields such as child health.²⁸ Unless major new epidemiological data-gathering efforts are begun soon, future estimates, for example those to assess progress toward the Millennium Development Goals,³⁰ will be based on fewer data than those available today.

Not only that, but the methods used to arrive at most disease burden estimates had not been available for public or peer review. The table illustrates this point by summarising how well global mortality estimates for specific conditions fare when assessed with five basic quality criteria: (1) whether the estimate was reviewed by an independent technical group; (2) whether the estimation methods and input data have been published in a peer-reviewed scientific journal; (3) whether the data underlying the estimates are available for public review; (4) whether tools and software have been developed and are available for review and application; and (5) whether the estimation process was done at country level, where the validity of assumptions and the appropriateness of input data are likely to be best.

The wide variability in methodological transparency across burden estimates reflects an absence of standard procedures for developing, reporting on, and supporting use of disease burden estimates across the various domains of public health. Until such standards are

developed and widely used, the onus of assessing the validity of disease burden estimates rests almost entirely with health policymakers.

Do contextual factors have a role?

Users of quantitative estimates must learn to examine every estimate and to decode the considerable communications artistry that goes into their construction. For example, a common practice is to present an estimate at the global or regional level and then to elaborate on it by giving a specific and often unrepresentative example. HIV/AIDS advocates talking about the effect of AIDS on under-5 mortality often use as examples countries in southern Africa where AIDS accounts for 30–50% of deaths in under-5s. But for sub-Saharan Africa as a whole, AIDS is thought to account for less than 10% of under-5 deaths.⁴⁶

A second way that estimates are “spun” by HIV/AIDS spokespersons and advocates is to use worst-case scenarios in projecting the effect of an epidemic. For example, several public-health leaders say that unless we act quickly, the HIV epidemic in Asia will soon look like the epidemic in sub-Saharan Africa.^{38,47} This projection is apparently based on the assumption that all epidemics have the same trajectory. In fact, evidence available for some time suggests that the characteristics and evolution of the HIV epidemic in India and other Asian countries are fundamentally different from those in most of Africa.⁴⁸ Given similarities in measures of socioeconomic development, the future of Asia’s HIV epidemic is more likely to resemble that of South America where the epidemic started much earlier but where adult prevalence rates have hovered around 0·6% for the past 6 years.^{28,49} Using worst-case scenarios to

	Primary organisations creating estimates and models	Estimate reviewed by independent technical reference group? (external to UN)	Methods and input data published in peer-reviewed scientific journal?	Input database available for public review?	Estimation software or tools available for review and application?	Methods for estimating uncertainty or range for the estimate?	Estimate developed at country level?
HIV/AIDS	UNAIDS, WHO, UNICEF	UNAIDS Reference Group on Estimation, Projection and Modelling	1999–2003 ^{31–33}	Available at www.census.gov	Yes	Yes ^{44,45}	Yes
Tuberculosis	WHO	One-time panel	1999–2003 ^{35,34}	No	No	Yes	No
Cause-specific under-5 mortality (multiple causes)	WHO, LSHTM	CHERG	2006 ^{35,36}	Yes	No	Yes	No
Pneumonia	WHO	CHERG	2002 ²³	Yes	No	Yes	No
Diarrhoea	WHO, UNICEF	CHERG	In preparation	Yes	No	No	No
Malaria	CDC, WHO	Malaria M&E Reference Group (MERG), CHERG	2006 ³⁷	Yes	No	Yes	No
Measles	WHO	CHERG & EPI/WHO	2003 ³⁸	No	No	No	No
Neonatal causes	WHO, LSHTM	CHERG	2005 ^{39,40}	No	No	Yes	No
Maternal mortality	WHO, UNICEF, UNFPA	Ad hoc panel	1999, 2001 ⁴¹	Yes	No	Yes	No
Nutrition as an underlying cause of child mortality	JHU, WHO	CHERG	1993, 2003 ^{42,43}	No	No	No	No

LSHTM=London School of Hygiene and Tropical Medicine. UNFPA=United Nations Population Fund. JHU=Johns Hopkins University.

Table: Basic characteristics of mortality estimates in public health

create a sense of urgency around a disease is not unique to HIV/AIDS, and users of estimates should be alert to this practice.

A third example of the influence of context on estimates stems from the competition for disease recognition, priority in policymaking, and, most importantly, funding. In the absence of clear standards for assessing and reporting disease burden estimates, advocates for specific causes understandably choose methods that have the best chance of keeping a particular disease at the top of the health priority list. The Centers for Disease Control and Prevention has estimated that obesity kills 400 000 each year in the USA. This statement resulted in a re-evaluation of the deaths attributable to tobacco use, driven in part by concern among advocates that resources might be reallocated from tobacco control to obesity prevention. Adapting their estimation methods to match those used for obesity, the estimated number of deaths attributable to tobacco use rose from 435 000 to 640 000.⁵⁰ Individuals who compare statistics must attempt to determine whether comparable methods were used for all the estimates, and public-health leaders must advocate for the development and use of normative standards.

How is uncertainty addressed?

Estimates are, by definition, imprecise. Determinants of the extent of imprecision include the volume of data (in theory, more data mean less uncertainty), the number of steps between data gathering and disease burden estimation (more methodological complexity often means more uncertainty), and potential biases in data gathering or analysis. Often, raw data are used directly to calculate the metric in which the estimate is presented. But each step in the process of transforming raw data to final estimates has associated uncertainty, and as assumptions are combined, the error or uncertainty around the estimate of the final index increases. An approach for estimating measles mortality is an example. First, there is uncertainty in the estimate of vaccination coverage, which is based on country-reports. Second, there is an assumption that all unvaccinated children will develop measles if exposed to the pathogen. Finally, a case-fatality rate (CFR) is estimated and applied to predict the number of new infections, resulting in an estimate of deaths due to measles. The uncertainty associated with this estimate is a combination of the errors in vaccination coverage, assumptions about exposure and illness, and the error associated with the estimated CFR.⁵¹

Estimates that do not specify the level of uncertainty, either with ranges or confidence bounds, should always be questioned. Those who generate disease estimates have a responsibility to be transparent about the process used and should provide information about the precision of their estimate, even if this is only a range of uncertainty.

Of course, simply providing a range for an estimate does not guarantee that it is correct. There are better and worse ways to construct and use uncertainty ranges. An article by Jeffrey Sachs in the *New England Journal of Medicine*, calling for better malaria control is a good example.⁵² Sachs begins the article by stating “Malaria currently kills up to 3 million people per year worldwide, most of them children in sub-Saharan Africa”. What he does not mention is that the best estimate for deaths directly caused by malaria is 1.2 million,⁵³ with 3 million being the upper limit estimated using all worst-case assumptions and including possible indirect causes that are normally ascribed to other diseases. This failure to provide the full range in the estimate, and the selective use of only the upper end of the range are clear signs that the article is trying to exaggerate the importance of the problem.

Policymakers are often asked to make decisions about competing priorities based on estimates (eg, this disease kills more than that disease; the rate of increase of this disease means that it will have a higher burden than another in 5 years so more money should be spent) when in fact the uncertainty around the estimates suggests that there are no meaningful differences among them.

Conclusion

Estimates of disease burden, along with considerations of feasibility and cost, should be central to decisions about public-health interventions. Even if the role of evidence in public-health decision-making is balanced by strong political, social, and other contextual factors,^{54,55} estimates provided to decision-makers should be based on sound and transparent methods, applied in comprehensive and systematic ways to the various levels of disease burden assessment, and to diseases and conditions within levels. Our intention is to promote healthy scepticism of health statistics, not cynicism.

Estimates would be more credible if they come from technical groups that are independent of the organisations that implement programmes and advocate for funds. This effort has begun over the past few years in groups like the Child Health Epidemiology Reference Group (CHERG) and the UNAIDS Reference Group on Estimates, Projections and Modelling, through which independent technical experts advised the WHO, UNICEF, and UNAIDS on estimates of disease burden related to pneumonia, diarrhoea, malaria, measles, neonatal illness, undernutrition, and HIV/AIDS. The recent formation of WHO’s Health Metrics Network is a promising means for improving national capacity in this area, providing more and better building-blocks for future estimates of disease burden.

In panel 2, we match news headlines with the “full story”, reflecting the basic rules of communication we

For the UNAIDS Reference Group on Estimates, Projections and Modelling see <http://www.epidem.org>

For the Health Metrics Network see <http://www.who.int/healthmetrics/en/>

Panel 2: Public health estimates in the headlines**Hunger kills 6 million children a year.¹ BBC news story, 2005**

Few children actually die of starvation alone. An estimated 11 million children younger than 5 years died in the year 2000. Undernutrition was an underlying cause of more than 50% of these deaths, as were several infectious diseases such as diarrhoea, pneumonia, and malaria.

AIDS, without a doubt, is the greatest epidemic in the history of mankind.⁵⁶ Peter Piot, Executive Director of UNAIDS, 2004

An epidemic is a time-limited simultaneous occurrence of disease in a population, often caused by a new infectious agent introduced from the outside. AIDS is therefore no longer an epidemic—it has existed for more than 25 years. It is true that more than 20 million people have died of AIDS during this time. But the 1918 influenza epidemic, which lasted for 2 years, is estimated to have killed up to 100 million.⁵⁷

"I will tell you today unequivocally that the risk of another pandemic influenza is one. It's a one."⁵⁸ Michael Osterholm, director of the Center for Infectious Disease Research and Policy, 2005

As pandemic influenza does occur routinely, technically the probability of it occurring again in an unspecified time period is 1. However, we do not know whether the pandemic will occur next year, in 10 years, or in 50 years, or even whether if the virus mutates it will occur in a highly virulent and deadly form.

have proposed for the presentation of public-health estimates. Clearly, the full-story versions are not going to make the front page: they are too long and too nuanced for a news story. Thus, modifying the practices of those who develop estimates and prepare technical reports will not be enough to ensure well-informed policy decisions. Not only that, but news reporters will always be pressured to write attention-grabbing headlines, and not all readers will be able to—or need to—process complex scientific information. What is needed is a combination of normative principles for the development and communication of estimates, combined with efforts to improve the skills of policymakers in interpreting them.

Good public-health decisions will always be a shared responsibility between those who generate data and estimates, and those who use them to make decisions. In panel 3, we present some tips to discern real evidence. But this is only a starting point. Academic institutions and those working in professional development fields can go further to help key public-health figures build practical skills in assessing the quality of estimates and in their interpretation.

Our comments on specific examples should not be interpreted as attacks on individuals or organisations

Panel 3: How to use public-health estimates

- 1 Ignore any estimate that is not accompanied by a clear description of input data, assumptions, and methods
- 2 Examine the quality of the estimate: has it been reviewed by independent technical experts who are identified by name? Are the tools and input data available for review? Have country-level scientists participated in the development and validation of the estimate?
- 3 What metric is being used in the estimate? Think about how different metrics for the same disease or condition might lead to different interpretations. When comparing across diseases, the comparisons should be done across a range of metrics, not just one.
- 4 Examine the measure being estimated—is it meaningful and comparable to the other conditions being considered in the priority-setting process?
- 5 Be sceptical about "exemplar-based estimates" and insist they be put in an appropriate context.
- 6 Question every change (whether point or trend) to determine how much might be due to changes in methods or data inputs.
- 7 Demand information on uncertainty, and use it to determine whether reported differences are meaningful in public-health terms.

that have developed estimates or used them to advocate for specific actions. In fact, the diseases from which we have drawn examples are in general those for which there are efforts underway to educate and advocate about particular diseases or programmes. However, policymakers and health-care professionals are asked to prioritise some disease programmes over others, and need a broader view than that presented by disease-specific groups. Objective and methodologically sound estimation of disease burden should be a priority of UN agencies, such as WHO and UNICEF, who are responsible for global health, in collaboration with bilateral donors and international finance institutions. Such efforts must also be applied at national and subnational levels because this is where priorities need to be set and thus need to be informed by the best evidence. A common framework and standardised methods, building on the work of CHERG and other groups, are urgently needed. Recent efforts by WHO to establish common ground rules for estimation are important steps in the right direction.⁴⁴

Conflict of interest statement

We declare that we have no conflict of interest.

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