the opposite study group, as was done in several ITN trials in the 1990s.[12]

Considering the use of indoor residual spraying and LLINs in other areas, it should be remembered that other insecticides can be used for indoor residual spraying: a carbamate or organophosphate insecticide might have given a different result. Similarly, a wide range of insecticide resistance genes are now spreading through Africa (as a direct result of success in scaling up coverage), and each location has its own combination of resistance genes.[13]

As a result of these limitations in the trial evidence, no simple guidance can be provided, which is evident from the guidelines already provided by the malaria policy advisory committee of WHO.[5] Nevertheless, on the basis of the Gambia study,[2] in a setting of intermediate transmission where an ITN programme already maintains high coverage, and where the nets are not compromised by high levels of pyrethroid resistance, there is little likelihood of achieving additional protection by adding DDT-based indoor residual spraying. In view of the uncertainties that persist, it is advisable that all national malaria control programmes investing in the combined use of the two methods should include a rigorous component of monitoring and assessment.

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Making sense of health estimates

Epidemiological data provide the metrics from which burdens attributable to different diseases and conditions causing ill health can be estimated. Comprehensive, consistent, and coherent health estimates, together with information about any associated uncertainties, are indispensable for decision making by governments, non-governmental organisations, practitioners, and national and international funders in helping to gauge and track the changing demands and challenges presented by poor health. Estimates of disease burden are an essential platform for public health policy and priority setting, and for evaluating intervention programmes. Additionally, information about the effectiveness of interventions, their societal acceptability, side-effects, cost-effectiveness, and ultimate cost, are needed for the policy setting process. Here, we argue that in the absence of adequate primary health data collection, it is often reasonable to rely on best estimates of disease burden, derived from other sources and modelling, for national planning and other decision making purposes.

The Global Burden of Disease Study (GBD), coordinated by the Institute of Health Metrics and Evaluation (IHME), provides detailed and comprehensive estimates of disease burden, aimed at summarising disability and loss of life due to all


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specific causes, globally and at national and subnational levels. It uses sophisticated mathematical models, and specified underlying assumptions, to integrate estimates of causes of morbidity and mortality into one framework.[1] UN agencies, including WHO, UNICEF, UNAIDS, and the World Bank, also produce burden estimates for major diseases and conditions, although generally their estimates are less comprehensive than those of IHME.

The availability of reliable and robust population-based data for disease burden varies widely across countries. In many countries, where data are available, they are often limited to a few diseases for which specific surveillance systems have been established—for example, HIV infection. Estimation of disease burden for many low-income and middle-income countries, and particularly fragile states, is especially challenging because of inadequate health information and vital registration systems, which provide the mechanisms for counting births, deaths, immigrations and emigrations, and episodes of ill health. Estimates of disease burden in most low-income and middle-income countries are not the products of perfect enumerations such as a census, but are often modelled estimates based on, at times, disparate data sources and methods. As a result of deficiencies in the underlying data that are used in modelling, there are often substantial uncertainties in the estimates provided for specific diseases and conditions. Modellers attempt to reflect this in the uncertainty intervals associated with, for example, specific estimates of the number of deaths or years of life lost attributable to particular causes. Despite these sometimes substantial imperfections, estimates of disease burden are necessary and useful for priority setting and policy making. In the absence of ideal data, it is reasonable to base near-term policy decisions on the best available evidence, while being cognisant of surrounding uncertainties.

For more on the **UN estimate** see http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2013/en/

It is common for policy makers and others who use estimates of disease burden to focus on point estimates without taking due note of how wide the uncertainty intervals around estimates can be. Various agencies produce estimates of disease burden, and sometimes these estimates are quite widely different, which can cause concern and confusion. Often, however, uncertainty intervals around the different estimates overlap, indicating that what seem to be substantial discrepancies might be within the bounds of the uncertainties associated with different estimation methods. Differences in estimates can be the result of various factors, including different inclusions and exclusions of demographic and health surveys, vital registration and verbal autopsy data, and systematic reviews. Differences might also be attributable to different modelling approaches.

In *The Lancet*, Richard Horton has drawn attention to differences in maternal mortality estimates for countries such as India, for which, in 2013, the GBD estimate was 71 792 deaths and the UN estimate was 49 754 deaths.[2] However, what was not highlighted were the widely overlapping uncertainty intervals: 52 723–94 564 for the GBD estimate and 32 967–76 244 for the UN estimate.[3] Although it is of interest to study why the point estimates are substantially different,[4] the underlying issue is the scarcity of high-quality primary data for either organisation to generate robust estimates, which limits the inferences that can be drawn from either estimate. This example underscores the need to view estimates with uncertainty in mind.

It is important that, when different agencies produce estimates of disease burden, they should be transparent about the underlying data used and how they arrived at point estimates, which would help to identify the specific factors that account for differences. For example, during an exercise that compared mortality estimates for children younger than 5 years by IHME and the UN, large discrepancies were found to be primarily caused by the choice of the input data and the way data were processed before entering the statistical models for final estimation.[5] An extensive effort comparing mortality estimates for diarrhoea and pneumonia found that the largest differences in estimates were for countries with the least available data, which were typically countries with low coverage of vital registration or without any data.[6] In *The Lancet*, an Article on the global trends in incidence and mortality from HIV, tuberculosis, and malaria compared the data sources and methods used by IHME and the UN agencies in detail.[7] It was found that the differences in mortality estimates for HIV and malaria by the two organisations were becoming less marked, with overlapping uncertainty intervals in most recent years.[7–9] These serve as useful examples

for communicating to the global health community the methodological and technical nuances behind such differences in point estimates.

Imprecision and variation in estimates of disease burden underscore the urgent need to increase investments in primary data collection, especially in low-income and middle-income countries. In the longer term, we should reduce reliance on complex statistical models and strive for full civil registration and vital statistics systems, as well as credible disease and risk surveillance in all countries, which would make it possible to record every birth, death, and major event of poor health. The contention in interpreting differences in present burden estimates can best be mitigated by creating and strengthening disease surveillance systems that yield more reliable and timely primary data.[10,11] Timely responses to infectious disease outbreaks, for example the humanitarian crisis caused by the current Ebola outbreak in west Africa, are only possible with strong health surveillance systems.[12,13]

Finally, in debates about estimates, we should not lose sight of the major progress that has been made in burden of disease and mortality estimates over the past 15 years. Estimates continue to improve and, increasingly, policy makers across the world use them. The demand for reliable disease-burden data is real and growing, and it will be important to continue investments concurrently in primary data collection, methods of estimation, sharing of data and methods, and sound scientific discourse. This will all lead to the continuing improvement of comprehensive estimates of mortality, morbidity, and risks.

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