A comparison of maternal mortality estimates from GBD 2013 and WHO

Despite rough agreement in global estimates of maternal mortality in 2013, results from the WHO[1] and Global Burden of Disease (GBD) 2013[2] collaborations differed by 147 000 deaths for 1990, diverged by at least 20% in 120 countries in 2013, and provided very different narratives on progress toward Millennium Development Goal 5. The differences are crucial for global monitoring as well as national policy formulation and programme planning.

GBD 2013 used over twice as many site-years of data—and from more countries—as WHO (table), including subnational data from urban and rural India, 33 provinces in China, 13 regions of the UK, and 32 states of Mexico. Incompleteness, under-reporting, and misclassification corrections were individualised for each data source, country or subnational site, and year. This is more aligned with the need to systematically assess data biases[3] than the WHO strategy of assuming misclassification is uniform for each type of data source. GBD 2013 implemented a Bayesian noise reduction algorithm to address stochastic fluctuation and small numbers, whereas WHO effectively excluded observations equal to zero, leading to upward bias. Maternal mortality was calculated differently for different groups of countries by WHO; only three predictive covariates were used in their models, and no objective measures of out-of-sample model performance were applied. By contrast, GBD 2013 estimated maternal mortality using nine covariates, ensured maternal mortality estimates are internally consistent with estimates of all other specific causes of death, and systematically evaluated out-of-sample predictive validity. The GBD ensemble model tracks the data closely. GBD 2013—like WHO estimates for tuberculosis, malaria, child causes of death, and UNAIDS estimates for HIV—appropriately assumed uncertainty intervals are uncorrelated across countries, whereas the WHO estimates include very large global uncertainty levels owing to an unusual hybrid approach that assumed uncertainty was 50% correlated and 50% uncorrelated.

Divergence in country-specific maternal mortality rate (MMR) estimates are driven by different combinations of the above factors. In India, WHO included a modelling study by Bhat[4] that is not based on primary maternal mortality data, is 15% higher than the primary data, and is likely to have influenced the global regression coefficients. WHO also did not correct Sample Registration System data either for completeness—estimated to be 80·4% in 2013[5]—or diagnostic misclassification, but did so for the USA and UK. The steeper slope in the WHO estimates, driven by model covariates, therefore overestimates the pace of progress in India (see figure in appendix). In China, collaboration with the Maternal and Child Health Surveillance System and the China Centers for Disease Control provided two independent sources of province-level data for the GBD study for every year from 1990 to 2012. Conversely, WHO estimates are based on only five national-level MMR observations, effectively estimating the MMR trend on the basis of covariate values alone and, in so doing, has underestimated the pace of progress in China (see figure in appendix). In Nigeria, the WHO regression coefficients predict a spurious time trend, driving PM (proportion maternal among deaths of females of reproductive age) 17% lower than the GBD estimate in 2013 and well below the available data. Although the very high all-cause mortality estimates applied by WHO tended to mitigate the divergence of estimates for Nigeria in 2013, the same cannot be said for 1990 estimates or for other countries in central and western sub-Saharan Africa.

See Online for appendix

We make several observations. First, WHO's uniform misclassification and under-reporting across all countries with vital registration, and none in countries with Sample Registration System or surveillance data, seems implausible given the wide variation in cause-of-death data quality. Second, given the importance of reliably estimating reproductive-age mortality for maternal mortality estimation, particularly in sub-Saharan Africa, greater efforts and focus on measuring levels of mortality in these countries is urgently required. Finally, in contrast to the GBD 2013 methods, the simple mixed-effects linear model used by WHO in countries without good vital registration does not reflect or adequately capture those cases where data show more or less progress than expected on the basis of gross domestic product, skilled birth attendance, and general fertility. In our view, it is difficult to defend a measurement model that does not reflect local data trends; in many ways, it undermines the concept of accountability.

	WHO	IHME
Datasets (n)		
Vital registration and sample registration	2138	4877
Surveillance	119	626
Census	18	73
Sibling history or other survey	1050	1213
Other source (e.g. verbal autopsy, literature)	22	267
Total	3347	7056
Countries covered	163 of 183 (89·1%)	180 of 188 (95·7%)

IHME=Institute for Health Metrics and Evaluation. GBD=Global Burden of Disease.

Table: **Comparison of GBD 2013 and WHO datasets for estimating maternal mortality**

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1 WHO. Trends in Maternal Mortality: 1990 to 2013. WHO. http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2013/en/ (accessed Nov 17, 2014).
2 Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, et al. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; **384:** 980–1004.
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Maternal mortality estimates

Nicholas Kassebaum and colleagues' Article (Sept 13, p 980)[1] provides maternal mortality estimates. These data probably rely on death certifications, which have often revealed consistent under-reporting.[2]

In Italy the latest official estimate through national death certificates reports a maternal mortality rate (MMR) of three deaths per 100 000 livebirths. In 2010, Hogan and colleagues[3] reported that Italy ranked first among 181 countries with the lowest MMR (3·9 deaths per 100 000 livebirths). In the same year, the Italian National Institute of Health implemented a project to improve accuracy by linking records between Death Registry and Hospital Discharge Database. The computed MMR was 11·8: only 37% of all maternal deaths had been included in the official data.[4] This retrospective study has provided the background for a prospective pilot surveillance system of maternal mortality, which is currently underway in six Italian regions. Preliminary results of the first year of active surveillance report an MMR of 10 per 100 000.

It was therefore surprising that Kassebaum and colleagues[1] again reported low MMR for Italy (4·3 per 100 000). We suggest that comparisons between countries should not be restricted to maternal mortality rates published by the national offices for statistics. In fact, we strongly believe that assessment of pregnancy-related mortality, in addition to severe morbidity, remains unsatisfactory, even in developed countries where efforts to prevent avoidable maternal deaths should be improved.

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1 Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, et al. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; **384:** 980–1004.
2 Bouvier-Colle MH, Mohangoo AD, Gissler M. What about the mothers? An analysis of maternal mortality and morbidity in perinatal health surveillance systems in Europe. *BJOG* 2012; **119:** 880–89.
3 Hogan MC, Foreman KJ, Naghavi M, et al. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 2010; **375:** 1609–23.
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We believe that maternal mortality in Greece was considerably overestimated in Nicholas Kassebaum and colleagues' Article.[1] In Greece, the official data for maternal mortality are provided exclusively by the Hellenic Statistical Authority, who have followed the International Classification of Diseases (ICD)-9 (codes 630-676) classification since 1979. Therefore, despite the official data for 1990 reporting only one maternal death in Greece that was attributable to direct causes, we were surprised that Kassebaum and colleagues reported ten maternal deaths for that year. We cannot help but question what source they used for their data, which provided a value ten times larger than the number of maternal deaths. Similarly, in 2003 the official number of maternal deaths in Greece was two (one from direct causes and one caused by abortion) whereas the authors claim that nine maternal deaths occurred. Finally, by extrapolating their estimates to 2013 (official 2013 data have not yet been published), they estimated a maternal mortality rate in Greece of 9·1 per 100 000 livebirths, which would make it the second highest among the countries of western Europe, as seen in their table 1.[1] However, according to the 2010 data provided by WHO, UNICEF, UNFPA, and the World Bank, maternal mortality in Greece was the lowest of all western European countries.[2]

We agree that maternal mortality rates in Greece, as in other developed countries, are not completely reliable. Clearly, simple measures, such as the inclusion in the standard death certificate of a separate question on pregnancy at the time of a woman's death or within the past 12 months, could substantially improve estimates.[3-5]

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1 Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, et al. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; **384:** 980–1004.
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