Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013

Nicholas J Kassebaum, Amelia Bertozzi-Villa, Megan S Coggeshall, Katya A Shackelford, Caitlyn Steiner, Kyle R Heuton, Diego Gonzalez-Medina, Ryan Barber, Chantal Huynh, Daniel Dicker, Tara Templin, Timothy M Wolock, Ayse Abbasoglu Ozgoren†, Foad Abd-Allah†, Semaw Ferede Abera†, Tom Achoki†, Ademola Adelekan†, Zanfina Ademi†, Arsène Kouablan Adou†, José C Adsuar†, Emilie E Agardh†, Dickens Akena†, Deena Alasfoor†, Zewdie Aderaw Alemu†, Rafael Alfonso-Cristancho†, Samia Alhabib†, Raghib Ali†, Mazin J Al Kahbouri†, François Alla†, Peter J Allen†, Mohammad A AlMazroa†, Ubai Alsharif†, Elena Alvarez†, Nelson Alvis-Guzmán†, Adansi A Amankwaa†, Azmeraw T Amare†, Hassan Amini†, Walid Ammar†, Carl A T Antonio†, Palwasha Anwari†, Johan Ärnlöv†, Valentina S Arsic Arsenijevic†, Ali Artaman†, Majed Masoud Asad†, Rana J Asghar†, Reza Assadi†, Lydia S Atkins†, Alaa Badawi†, Kalpana Balakrishnan†, Arindam Basu†, Sanjay Basu†, Justin Beardsley†, Neeraj Bedi†, Tolesa Bekele†, Michelle L Bell†, Eduardo Bernabe†, Tariku J Beyene†, Zulfiqar Bhutta†, Aref Bin Abdulhak†, Jed Blore†, Berrak Bora Basara†, Dipan Bose†, Nicholas Breitborde†, Rosario Cárdenas†, Carlos A Castañeda-Orjuela†, Ruben Estanislao Castro†, Ferrán Catalá-López†, Alanur Cavlin†, Jung-Chen Chang†, Xuan Che†, Costas A Christophi†, Sumeet S Chugh†, Massimo Cirillo†, Samantha M Colquhoun†, Leslie Trumbull Cooper†, Cyrus Cooper†, Iuri da Costa Leite†, Lalit Dandona†, Rakhi Dandona†, Adrian Davis†, Anand Dayama†, Louisa Degenhardt†, Diego De Leo†, Borja del Pozo-Cruz†, Kebede Deribe†, Muluken Dessalegn†, Gabrielle A deVeber†, Samath D Dharmaratne†, Uğur Dilmen†, Eric L Ding†, Rob E Dorrington†, Tim R Driscoll†, Sergei Petrovich Ermakov†, Alireza Esteghamati†, Emerito Jose A Faraon†, Farshad Farzadfar†, Manuela Mendonca Felicio†, Seyed-Mohammad Fereshtehnejad†, Graça Maria Ferreira de Lima†, Mohammad H Forouzanfar†, Elisabeth B França†, Lynne Gaffikin†, Ketevan Gambashidze†, Fortuné Gbètoho Gankpé†, Ana C Garcia†, Johanna M Geleijnse†, Katherine B Gibney†, Maurice Giroud†, Elizabeth L Glaser†, Ketevan Goginashvili†, Philimon Gona†, Dinorah González-Castell†, Atsushi Goto†, Hebe N Gouda†, Harish Chander Gugnani†, Rahul Gupta†, Rajeev Gupta†, Nima Hafezi-Nejad†, Randah Ribhi Hamadeh†, Mouhanad Hammami†, Graeme J Hankey†, Hilda L Harb†, Rasmus Havmoeller†, Simon Hay†, Ileana B Heredia Pi†, Hans W Hoek†, H Dean Hosgood†, Damian G Hoy†, Abdullatif Husseini†, Bulat T Idrisov†, Kaire Innos†, Manami Inoue†, Kathryn H Jacobsen†, Eiman Jahangir†, Sun Ha Jee†, Paul N Jensen†, Vivekanand Jha†, Guohong Jiang†, Knud Juel†, Edmond Kato Kabagambe†, Haidong Kan†, Nadim E Karam†, André Karch†, Corine Kakizi Karema†, Anil Kaul†, Norito Kawakami†, Konstantin Kazanjan†, Dhruv S Kazi†, Andrew G Kemp†, Andre Pascal Kengne†, Maia Kereselidze†, Yousef Saleh Khader†, Shams Eldin Ali Hassan Khalifa†, Ejaz Ahmed Khan†, Young-Ho Khang†, Luke Knibbs†, Yoshihiro Kokubo†, Soewarta Kosen†, Barthelemy Kuate Defo†, Chanda Kulkarni†, Veena S Kulkarni†, G Anil Kumar†, Kaushalendra Kumar†, Ravi B Kumar†, Gene Kwan†, Taavi Lai†, Ratilal Lalloo†, Hilton Lam†, Van C Lansingh†, Anders Larsson†, Jong-Tae Lee†, James Leigh†, Mall Leinsalu†, Ricky Leung†, Xiaohong Li†, Yichong Li†, Yongmei Li†, Juan Liang†, Xiaofeng Liang†, Stephen S Lim†, Hsien-Ho Lin†, Steven E Lipshultz†, Shiwei Liu†, Yang Liu†, Belinda K Lloyd†, Stephanie J London†, Paulo A Lotufo†, Jixiang Ma†, Stefan Ma†, Vasco Manuel Pedro Machado†, Nana Kwaku Mainoo†, Marek Majdan†, Christopher Chabila Mapoma†, Wagner Marcenes†, Melvin Barrientos Marzan†, Amanda J Mason-Jones†, Man Mohan Mehndiratta†, Fabiola Mejia-Rodriguez†, Ziad A Memish†, Walter Mendoza†, Ted R Miller†, Edward J Mills†, Ali H Mokdad†, Glen Liddell Mola†, Lorenzo Monasta†, Jonathan de la Cruz Monis†, Julio Cesar Montañez Hernandez†, Ami R Moore†, Rintaro Mori†, Ulrich O Mueller†, Mitsuru Mukaigawara†, Aliya Naheed†, Kovin S Naidoo†, Devina Nand†, Vinay Nangia†, Denis Nash†, Chakib Nejjari†, Robert G Nelson†, Sudan Prasad Neupane†, Charles R Newton†, Marie Ng†, Mark J Nieuwenhuijsen†, Muhammad Imran Nisar†, Sandra Nolte†, Ole F Norheim†, Luke Nyakarahuka†, In-Hwan Oh†, Takayoshi Ohkubo†, Bolajoko O Olusanya†, Saad B Omer†, John Nelson Opio†, Orish Ebere Orisakwe†, Jeyaraj D Pandian†, Christina Papachristou†, Jae-Hyun Park†, Angel J Paternina Caicedo†, Scott B Patten†, Vinod K Paul†, Boris Igor Pavlin†, Neil Pearce†, David M Pereira†, Konrad Pesudovs†, Max Petzold†, Dan Poenaru†, Guilherme V Polanczyk†, Suzanne Polinder†, Dan Pope†, Farshad Pourmalek†, Dima Qato†, D Alex Quistberg†, Anwar Rafay†, Kazem Rahimi†, Vafa Rahimi-Movaghar†, Sajjad ur Rahman†, Murugesan Raju†, Saleem M Rana†, Amany Refaat†, Luca Ronfani†, Nobhojit Roy†, Tania Georgina Sánchez Pimienta†, Mohammad Ali Sahraian†, Joshua Salomon†, Uchechukwu Sampson†, Itamar S Santos†, Monika Sawhney†, Felix Sayinzoga†, Ione J C Schneider†, Austin Schumacher†, David C Schwebel†, Soraya Seedat†, Sadaf G Sepanlou†, Edson E Servan-Mori†, Marina Shakh-Nazarova†, Sara Sheikhbahaei†, Kenji Shibuya†, Hwashin Hyun Shin†, Ivy Shiue†, Inga Dora Sigfusdottir†, Donald H Silberberg†, Andrea P Silva†, Jasvinder A Singh†, Vegard Skirbekk†, Karen Sliwa†, Sergey S Soshnikov†, Luciano A Sposato†, Chandrashekhar T Sreeramareddy†, Konstantinos Stroumpoulis†, Lela Sturua†, Bryan L Sykes†, Karen M Tabb†, Roberto Tchio Talongwa†, Feng Tan†, Carolina Maria Teixeira†, Eric Yeboah Tenkorang†, Abdullah Sulieman Terkawi†, Andrew L Thorne-Lyman†, David L Tirschwell†, Jeffrey A Towbin†, Bach X Tran†, Miltiadis Tsilimbaris†, Uche S Uchendu†, Kingsley N Ukwaja†, Eduardo A Undurraga†, Selen Begüm Uzun†, Andrew J Vallely†, Coen H van Gool†, Tommi J Vasankari†, Monica S Vavilala†, N Venketasubramanian†, Salvador Villalpando†, Francesco S Violante†, Vasiliy Victorovich Vlassov†, Theo Vos†, Stephen Waller†, Haidong Wang†, Linhong Wang†, Sharon XiaoRong Wang†, Yanping Wang†, Scott Weichenthal†, Elisabete Weiderpass†, Robert G Weintraub†, Ronny Westerman†, James D Wilkinson†, Solomon Meseret Woldeyohannes†, John Q Wong†, Muluemebet Abera Wordofa†, Gelin Xu†, Yang C Yang†, Yuichiro Yano†, Gokalp Kadri Yentur†, Paul Yip†, Naohiro Yonemoto†, Seok-Jun Yoon†, Mustafa Z Younis†, Chuanhua Yu†, Kim Yun Jin†, Maysaa El Sayed Zaki†, Yong Zhao†, Yingfeng Zheng†, Maigeng Zhou†, Jun Zhu†, Xiao Nong Zou†, Alan D Lopez‡, Mohsen Naghavi‡, Christopher J L Murray‡, Rafael Lozano‡*

Summary

Background The fifth Millennium Development Goal (MDG 5) established the goal of a 75% reduction in the maternal mortality ratio (MMR; number of maternal deaths per 100 000 livebirths) between 1990 and 2015. We aimed to measure levels and track trends in maternal mortality, the key causes contributing to maternal death, and timing of maternal death with respect to delivery.

Methods We used robust statistical methods including the Cause of Death Ensemble model (CODEm) to analyse a database of data for 7065 site-years and estimate the number of maternal deaths from all causes in 188 countries between 1990 and 2013. We estimated the number of pregnancy-related deaths caused by HIV on the basis of a systematic review of the relative risk of dying during pregnancy for HIV-positive women compared with HIV-negative

Published **Online** May 2, 2014 http://dx.doi.org/10.1016/S0140-6736(14)60696-6

*Corresponding author

†Authors listed alphabetically

‡Joint senior authors

Institute for Health Metrics and Evaluation (N J Kassebaum MD,

A Bertozzi-Villa BA, M S Coggeshall BA, K A Shackelford BA, C Steiner MPH, K R Heuton BS, D Gonzalez-Medina BA, R Barber BS, C Huynh BA, D Dicker BS, T Templin BA, T M Wolock BA, Prof L Dandona PhD, M H Forouzanfar MD, S S Lim PhD, Prof A H Mokdad PhD, M Ng MD, A Schumacher BS, Prof T Vos PhD, H Wang PhD, M Naghavi PhD, Prof C J L Murray PhD, Prof R Lozano MD), **Department of Neurology** (D L Tirschwell MD), **Pediatric Anesthesiology and Pain Medicine, Seattle Children's Hospital, School of Medicine** (N J Kassebaum), **University of Washington, Seattle, WA, USA** (R Alfonso-Cristancho PhD, P N Jensen MPH, D A Quistberg PhD, M S Vavilala MD); **Hacettepe University Institute of Population Studies, Ankara, Turkey** (A Abbasoglu Ozgoren MA, A Cavlin PhD); **Faculty of Medicine, Cairo University, Cairo, Egypt** (Prof F Abd-Allah MD); **School of Public Health, College of Health Sciences, Mekelle University, Mekelle, Tigray, Ethiopia** (S F Abera MSc); **Ministry of Health, Gaborone, Botswana** (T Achoki PhD); **Public Health Promotion Alliance, Osogbp, Nigeria** (A Adelekan PhD); **Centre for International Child Health** (S M Colquhoun PhD), **University of Melbourne, Melbourne, VIC, Australia** (Z Ademi PhD, J Blore PhD, R G Weintraub MB, Prof A D Lopez PhD); **Association Ivoirienne Pour Le Bien Etre Familial, Abidjan, Côte d'Ivoire** (A K Adou MD); **University of Extremadura, Cáceres, Spain** (Prof J C Adsuar PhD); **Institution of Public Health Sciences, Stockholm, Sweden** (E E Agardh PhD); **Makerere University, Kampala, Uganda** (D Akena PhD, L Nyakarahuka MPH); **Ministry of Health, Muscat, Oman** (D Alasfoor MSc, M J Al Kahbouri PhD); **Debre Markos University, Debre Markos, Amhara, Ethiopia** (Z A Alemu MPH); **National Guard Health Affairs, Riyadh, Saudi Arabia** (S Alhabib PhD); **University of Oxford, Oxford, UK** (R Ali MSc, Prof S Hay DPhil, K Rahimi DM); **School of Public Health, University of Lorraine, Nancy, France** (Prof F Alla PhD); **Ministry of Health, Belmopan, Cayo, Belize** (P J Allen MPH); **Saudi**

women. We also estimated the fraction of these deaths aggravated by pregnancy on the basis of a systematic review. To estimate the numbers of maternal deaths due to nine different causes, we identified 61 sources from a systematic review and 943 site-years of vital registration data. We also did a systematic review of reports about the timing of maternal death, identifying 142 sources to use in our analysis. We developed estimates for each country for 1990–2013 using Bayesian meta-regression. We estimated 95% uncertainty intervals (UIs) for all values.

Findings **292 982 (95% UI 261 017–327 792) maternal deaths occurred in 2013, compared with 376 034 (343 483–407 574) in 1990. The global annual rate of change in the MMR was –0·3% (–1·1 to 0·6) from 1990 to 2003, and –2·7% (–3·9 to –1·5) from 2003 to 2013, with evidence of continued acceleration. MMRs reduced consistently in south, east, and southeast Asia between 1990 and 2013, but maternal deaths increased in much of sub-Saharan Africa during the 1990s. 2070 (1290–2866) maternal deaths were related to HIV in 2013, 0·4% (0·2–0·6) of the global total. MMR was highest in the oldest age groups in both 1990 and 2013. In 2013, most deaths occurred intrapartum or postpartum. Causes varied by region and between 1990 and 2013. We recorded substantial variation in the MMR by country in 2013, from 956·8 (685·1–1262·8) in South Sudan to 2·4 (1·6–3·6) in Iceland.**

Interpretation **Global rates of change suggest that only 16 countries will achieve the MDG 5 target by 2015. Accelerated reductions since the Millennium Declaration in 2000 coincide with increased development assistance for maternal, newborn, and child health. Setting of targets and associated interventions for after 2015 will need careful consideration of regions that are making slow progress, such as west and central Africa.**

Funding **Bill & Melinda Gates Foundation.**

Introduction

Since the 1980s, the global health community has focused on reducing maternal mortality through a sequence of initiatives, beginning with the Safe Motherhood movement in 1987, to the creation of the Partnership for Maternal, Newborn and Child Health in 2005.[1,2] The priority accorded to reductions in maternal mortality is shown by its choice as one of the eight Millennium Development Goals (MDGs). Despite these efforts and visibility, there was broad concern that little or no progress was being made, which prompted intensified efforts by the UN Secretary General through the launch of Every Woman Every Child in 2010, and the subsequent creation of the Commission on Information and Accountability for Women's and Children's Health.[2,3] In 2010, a comprehensive assessment of global trends in maternal mortality suggested that the maternal mortality ratio (MMR; number of maternal deaths per 100 000 livebirths) had decreased by 1·3% per year since 1990.[4] Subsequent revisions of the historical estimates have shown even larger worldwide rates of change, from –1·9% to –3·1% per year.[5,6] This evidence collectively suggests that, although concerns about the rate of change of maternal mortality might have been too pessimistic, there is substantial uncertainty about how rapid the decrease has been and about the actual numbers of deaths in several large populations. If policy debates about acceleration of maternal mortality reductions are to be usefully informed, goals established, and targets set for reproductive health, up-to-date monitoring of the levels and trends in maternal mortality is essential.[7]

Compared with child mortality, maternal mortality has been more difficult to track over time at the national level.[8] Several major challenges have to be addressed in any measurement effort: misclassification of maternal deaths to other causes in countries with complete vital registration and medical certification of causes of death; substantial sampling error in measurements that depend on survey recall because few maternal deaths are reported; large non-sampling error in survey and census measurements as demonstrated in settings with repeated overlapping measurements; variation in the demographic assessment of reproductive-age mortality from all causes, particularly in the 1990s; and the need for models to synthesise data from several studies or generate estimates when data are sparse.[9–11] The substantial differences between global modelling efforts, which are at times substantial, emphasise the influence of each of the analytical steps used to estimate maternal mortality.[12] Political attention to how countries are progressing towards MDG 5 targets is intensifying.[1,13] Donors, global health partners, and national programme managers are understandably frustrated by the wide uncertainty intervals and the variability of estimates from different analysts.[8]

Here, we use the systematic approach of the Global Burden of Diseases, Injuries, and Risk Factors Study 2013 (GBD 2013) to measure levels and track trends in maternal mortality, the key causes contributing to maternal death, and the timing of maternal deaths. In GBD 2013, with application of rigorous statistical methods to critically appraise and synthesise data from different sources to estimate levels and causes of death in each age and sex group, a consistent and holistic approach to the challenges of maternal mortality measurement is used that enables comparisons across time, country, and other important causes of death in women of reproductive age. Algorithms for cause of death reclassification are applied consistently across all causes and modelling strategies use methods with clearly

quantified out-of-sample predictive validity.[14] On the basis of recent trends in MMR, we also project an MMR scenario for 2030 to inform policy debates by identifying which countries are in greatest need of intensified focus.

Methods

Maternal mortality 1990–2013

Data

We used the GBD 2013 cause of death database, which extends from 1980 to 2013, to estimate maternal mortality. Although we report estimates for the MDG period 1990–2013, data for 1980–90 are included in the analysis to improve the robustness of the time trend estimation. Naghavi and colleagues[15] provide substantial detail about the inclusion criteria and data processing of studies across all causes. Briefly, building on previous analyses, we identified data from 180 of 188 GBD countries, including 4877 site-years of vital registration data, 1213 site-years of sibling histories from Demographic and Health Surveys (DHS) and Reproductive Health Surveys (RHS) providing information about the pregnancy-related fraction of reproductive-age deaths, 73 site-years of censuses, 626 site-years of maternal mortality surveillance, and 267 site-years of verbal autopsy analyses covering women of reproductive age.[4,5,16] We identified the above data sources through a systematic review (appendix), from analyses by Lozano and colleagues[5] and GBD 2010 analyses,[16] searches of Ministry of Health websites, and a search of the Global Health Data Exchange.

There has been much debate about which deaths of women of reproductive age should be included as maternal deaths. To be classified as maternal, pregnancy needs to be a causal factor in death. It can either have a direct effect (complications of the pregnancy or childbirth, or postpartum complications) or indirect effect (exacerbation of a pre-existing condition). Therefore, accidental or incidental deaths in which pregnancy had no causal role are not classified as maternal deaths. Definitions for national use based on the International Classification of Diseases (ICD) have differed from other recommendations for international comparisons of the MMR. All definitions include direct and indirect causes during pregnancy and within 6 weeks of the termination of pregnancy (figure 1). ICD-10 definitions also include late maternal deaths between 6 weeks and 1 year after termination.[6,17] For some causes, such as suicide, there is national variation in whether they are coded as incidental or indirect.[18,19] MDG guidance for cross-country comparisons of MMR recommends that all HIV-related deaths during pregnancy or within 6 weeks should be included in the MMR,[20] but the UN group estimating maternal mortality uses only 50% of these deaths in their estimation.[6,20] Conceptually, only the fraction of deaths aggravated by pregnancy should be included, because that is the definition of an indirect cause of maternal mortality.

We included direct and indirect deaths during pregnancy and within 6 weeks of delivery, plus late maternal deaths up to 1 year after delivery and the fraction of HIV-related deaths aggravated by pregnancy. Late maternal deaths were not coded in ICD-9 so data are only available for ICD-10 (ie, from 1994). Additionally, because maternal deaths in the age group 10–14 years have been consistently reported in our data sources, we have estimated the number of maternal deaths in this age group but have not included them in the computation of the MMR because no standard estimates of birth rates are available for this group.

In vital registration and verbal autopsy data, maternal deaths are often misclassified as deaths attributable to

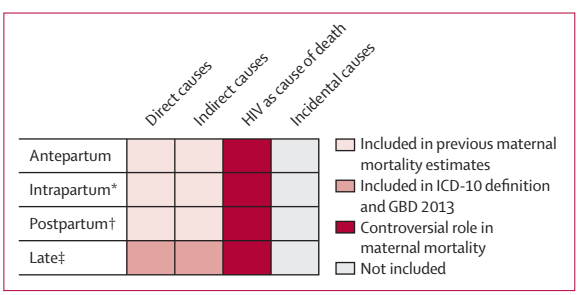

Figure 1: **Definitions of maternal death**
ICD-10=International Classification of Diseases, version 10. *During labour and up to 24 h after delivery. †Between 24 h and 6 weeks after delivery. ‡Between 6 weeks and 1 year after delivery.

Ministry of Health, Riyadh, Saudi Arabia (M A AlMazroa MD, Prof Z A Memish MD)**; Charité Universitätsmedizin Berlin, Berlin, Germany** (U Alsharif DMD, S Nolte PhD, C Papachristou PhD)**; Spanish Observatory on Drugs, Government Delegation for the National Plan on Drugs** (E Alvarez PhD)**, and Division of Pharmacoepidemiology and Pharmacovigilance, Spanish Medicines and Healthcare Products Agency** (F Catalá-López PhD)**, Ministry of Health, Social Services and Equality, Madrid, Spain** (E Alvarez PhD)**; Universidad de Cartagena, Cartagena de Indias, Colombia** (Prof N Alvis-Guzmán PhD)**; Albany State University, Albany, GA, USA** (Prof A A Amankwaa PhD)**; Department of Epidemiology, University of Groningen, Groningen, Netherlands** (A T Amare MPH)**; College of Medicine and Health Sciences, Bahir Dar University, Bahir Dar, Ethiopia** (A T Amare)**; Kurdistan Environmental Health Research Centre, Kurdistan University of Medical Sciences, Sanandaj, Kurdistan, Iran** (H Amini MSPH);

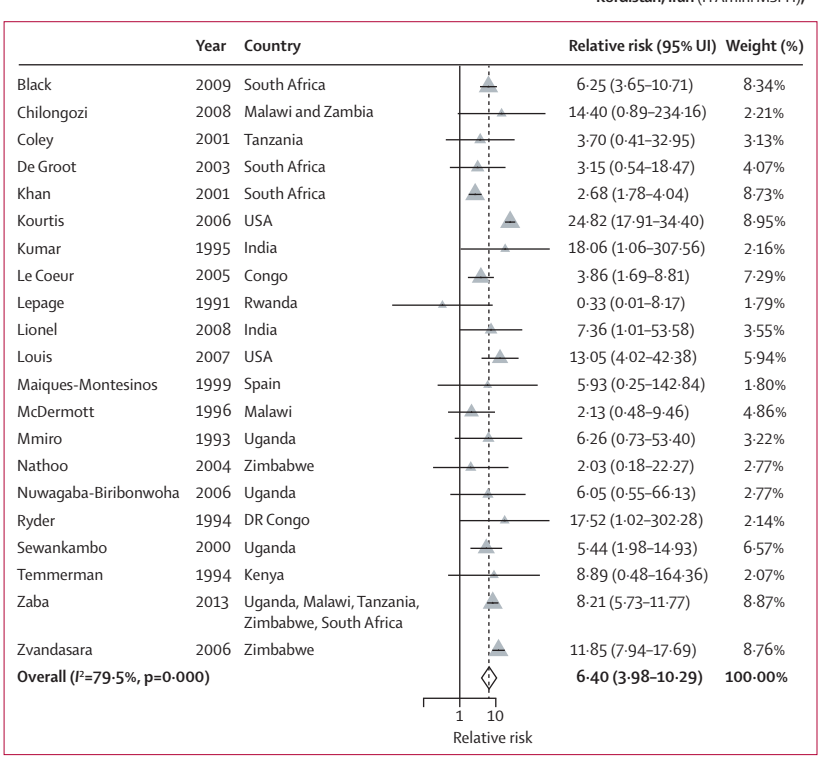

Figure 2: **Forest plot of the relative risk of death during pregnancy for women with HIV infection compared with women without HIV infection**
Weights are from random effects analysis. Size of the triangles is proportional to the weighting of each study in the meta-analysis. UI=uncertainty interval.

Ministry of Public Health, Beirut, Lebanon (W Ammar PhD, H L Harb MPH); **College of Public Health, University of the Philippines Manila, Manila, Philippines** (C A T Antonio MD, E J A Faraon MD); **UN Population Fund, Kabul, Afghanistan** (P Anwari MSc); **Uppsala University, Uppsala, Sweden** (J Ärnlöv PhD, Prof A Larsson PhD); **Institute of Microbiology and Immunology, School of Medicine, University of Belgrade, Belgrade, Serbia** (Prof V S Arsic Arsenijevic PhD); **Median, Windsor, ON, Canada** (A Artaman PhD); **Ministry of Health, Amman, Jordan** (M M Asad PhD); **Field Epidemiology and Laboratory Training Program, Islamabad, Pakistan** (R J Asghar MD); **Mashhad University of Medical Sciences, Mashhad, Iran** (R Assadi MD); **Ministry Of Health, Wellness, Human Services and Gender Relations, Sans Souci, Castries, Saint Lucia** (L S Atkins MPH); **Public Health Agency of Canada, Toronto, ON, Canada** (A Badawi PhD); **Sri Ramachandra University, Chennai, India** (K Balakrishnan PhD); **School of Health Sciences, University of Canterbury, Christchurch, New Zealand** (A Basu PhD); **School of Medicine** (L Gaffikin DrPH), **Stanford University, Stanford, CA, USA** (S Basu PhD); **Oxford University, Ho Chi Minh City, Vietnam** (J Beardsley MBChB); **College of Public Health and Tropical Medicine, Jazan, Saudi Arabia** (N Bedi MD); **Madawalabu University, Bale Goba, Oromia, Ethiopia** (T Bekele MPH); **Yale University, New Haven, CT, USA** (Prof M L Bell PhD); **King's College London, London, UK** (E Bernabe PhD); **Addis Ababa University, Debre Zeit, Ethiopia** (T J Beyene MSC, K Deribe MPH); **Aga Khan University Medical Centre** (Prof Z Bhutta PhD), **Aga Khan University** (M I Nisar MSc), **Karachi, Pakistan; University of Missouri-Kansas City, Kansas City, MO, USA** (A Bin Abdulhak MD); **General Directorate of Health Research** (B Bora Basara PhD, U Dilmen MD, G K Yentur PhD), **Ministry of Health, Ankara, Turkey** (S B Uzun MD); **World Bank, Washington, DC, USA** (D Bose PhD); **University of Arizona, Tucson, AZ, USA** (Prof N Breitborde PhD); **Universidad Autonoma**

other underlying causes. We reassigned deaths assigned to causes that are unlikely to be underlying causes of death with standardised algorithms.[14] The causes of death that are partly reassigned to maternal causes are shown in the appendix.[15] We reanalysed DHS and RHS microdata for sibling deaths that were related to pregnancy by year using Gakidou-King weights to deal with potential survivor bias.[21] We used a Bayesian noise reduction algorithm to preprocess data to avoid the issue of large stochastic fluctuations and zero counts leading to distorted time trends (appendix). When different DHS surveys provided data for reproductive-age deaths and the number that were related to pregnancy for the same year, we pooled results for that year to reduce stochastic measurement error. Additionally, for some vital registration data, no maternal deaths are reported in specific age group or for a specific period. Noise reduction algorithms again help to reduce upward bias because all zero counts would otherwise be dropped from natural logarithm death rate and logit cause fraction models. Data were unavailable for only eight countries, for which we relied entirely on model predictions for maternal mortality estimates.

HIV-related mortality

Because of the rapid increase in reproductive-age mortality due to the HIV epidemic in eastern and southern Africa, disentangling the fraction of HIV deaths during pregnancy that are incidental (ie, not related to pregnancy) from those aggravated by pregnancy (ie, maternal deaths) is important. Assessment of HIV-related mortality during pregnancy has two steps: estimation of the fraction of deaths during pregnancy or within 6 weeks of delivery that are related to HIV, and estimation of the fraction of these HIV-related deaths that are aggravated by pregnancy. For the first step, we updated Calvert and Ronsmans' systematic review[22] (appendix). We identified one new study, giving a total of 21 for which we could examine mortality risk during pregnancy for HIV-positive versus HIV-negative women.[23–43] We excluded data from non-representative populations, from sources that did not include postpartum deaths, and any deaths more than 1 year after delivery. Most studies did not specify antiretroviral therapy (ART) status. We undertook a DerSimonian-Laird meta-analysis of the relative risk (RR) of death. Studies were heterogeneous and the pooled RR was 6·40 (figure 2). We identified no clear geographical pattern to explain why some studies are significantly above or below the pooled estimate, nor any clear relation with other study attributes, meaning that we had an insufficient basis for further weighting of input studies.

We used the RR and estimated HIV prevalence in pregnant women (based on the UNAIDS Spectrum model) to estimate the population attributable fraction of pregnancy-related deaths that are related to HIV. To estimate the fraction of HIV-related deaths aggravated by pregnancy, we did another systematic review (appendix). We could identify only two studies to inform this fraction, with a pooled RR of 1·13 (95% UI 0·73–1·77),[44,45] corresponding to a frequency of all HIV-related deaths during pregnancy that should be counted as maternal deaths of 11·5% (0–43·5). Several additional studies did not show increased risk of HIV-related mortality during pregnancy, but were excluded because stratification of the study population on the basis of stage of HIV or ART status was not completed.

Modelling

Following Lozano and colleagues' methods,[5] we used the Cause of Death Ensemble model (CODEm) to model maternal mortality by age (appendix). With CODEm, many models are developed and their performance is assessed objectively.[46] We selected nine covariates for CODEm to test on the basis of previously reported associations that also have a plausible causal association with maternal mortality: age-specific fertility rate, total fertility rate, age-standardised HIV death rate for female individuals aged 15–49 years, neonatal death rate, lag-distributed gross domestic product (GDP) per person (GDP per person computed with a triangle lag that weights more recent years more heavily), proportion of deliveries occurring in facilities, proportion of deliveries overseen by skilled birth attendants, coverage of four visits of antenatal care, and malnutrition in children younger than 5 years (<2 SD below mean weight for age; used as a proxy for adult nutritional status; appendix).

We divided covariates into three groups to enable computation. Level 1 covariates had the strongest likely relation with maternal mortality; covariates in levels 2 and 3 had weaker likely relations. CODEm tests all combinations of level 1 covariates and nearly every combination of level 2 and level 3 covariates using four families of models: mixed effects linear regression of the logit-transformed cause-specific mortality fraction, spatial-temporal Gaussian Process Regression (ST-GPR) of the logit-transformed cause-specific mortality rate, mixed effects linear regression of the natural log of the maternal death rate, and ST-GPR of the natural log of the maternal death rate.[46] 30% of the data were not included in the models. Models were retained when the beta for each covariate was significant and in the direction allowed by previous evidence. The performance of each retained model was then assessed with half the held-out data in terms of the root-mean squared error of the prediction of the model compared with the data held out, and the root-mean squared error of the trend in the model compared with the trend in the data. Ensemble models were developed on the basis of the rankings of individual models and the performance of different ensembles assessed in the second half of the data held out of the regression (appendix). The best performing ensemble was selected and refitted to all data.

One of the strengths of the GBD is that all causes are simultaneously estimated. Estimates of every

cause-specific death rate are necessary to sum to all-cause mortality using the CoDCorrect algorithm.[16] To ensure they do sum to all-cause mortality, at the level of each draw from the posterior distribution of each cause of death for a specific country, year, and age group, the sum of all causes was rescaled to equal a draw taken from the uncertainty distribution of all-cause mortality for that country, year, and age group.

Causes of maternal death

We disaggregated maternal deaths into nine causes: maternal haemorrhage, maternal sepsis and other pregnancy-related infections, hypertensive disorders of pregnancy, obstructed labour, abortion, other direct maternal disorders, indirect maternal disorders, HIV, and late maternal deaths. To estimate the different causes of maternal death, we completed a systematic review (appendix) to identify data to inform which proportion of total maternal deaths is due to each cause. Additionally, we incorporated all vital registration and sample registration data that provided ICD-coded detail for maternal causes (appendix). We identified 61 studies and, after processing, included 943 site-years of vital registration, sample registration, and maternal mortality surveillance data.

We modelled the proportion of maternal deaths for all causes except HIV using DisMod-MR (version 2.0), which is a Bayesian meta-regression tool developed for the GBD (appendix). This version of DisMod-MR allows for two types of fixed effects (study attributes and country covariates) and includes nested random effects for super-region, region, and country. A key advantage of DisMod-MR is that it can handle data reported for any age interval. Predictions from DisMod-MR for each group divided by country, year, and age are based on the country covariates, reference values of the study level covariates, and hierarchical random effects. Point estimates with uncertainty were produced for six discrete points: 1990, 1995, 2000, 2005, 2010, and 2013. Each cause was modelled independently. Predicted cause fractions for each group were rescaled to equal 100% of the deaths not related to HIV. The rescaled cause fractions were then multiplied by the number of maternal deaths in each group (divided by country, year, and age) to obtain the number of deaths for each maternal cause, a sum to which the HIV deaths were added. The final result includes cause fraction and number of maternal deaths due to each cause, country, age group, and year.

Timing of maternal deaths

An important issue for planning of interventions is an understanding of the timing of maternal deaths with respect to labour and delivery.[47] We completed a systematic review to identify studies of the timing of maternal deaths (appendix). We identified 142 studies and used vital registration, sample registration, and surveillance data for late maternal death. Many studies combined the first 24 h postpartum (immediate or early postpartum) with the intrapartum period, because events of the immediate postpartum period are clinically related to events occurring during labour and delivery. Therefore, we also combined intrapartum and immediate postpartum periods. We followed this format to construct a dataset that included four different time windows: deaths occurring antepartum (before onset of labour), deaths occurring intrapartum or during the immediate postpartum period (up to 24 h after delivery), deaths occurring during the subacute and delayed postpartum periods (24 h to 42 days after delivery),[47] and late maternal deaths (43 days to 1 year after delivery). We modelled the proportion of maternal deaths in each of the four periods with DisMod-MR (version 2.0). The predicted proportions were scaled to 100% for each group.

2030 scenario and rate-of-change calculations

We developed a straightforward forecast scenario for the MMR for every country in 2030 by using the estimated

Metropolitana, Mexico City, Mexico (R Cárdenas ScD); **Colombian National Health Observatory, Instituto Nacional de Salud, Bogota, Colombia** (C A Castañeda-Orjuela MSc); **Universidad Diego Portales, Santiago, Chile** (R E Castro PhD); **College of Public Health** (H-H Lin ScD), **National Taiwan University, Taipei, Taiwan** (Prof J-C Chang PhD); **National Institutes of Health, Department of Health and Human Services, Bethesda, MD, USA** (X Che PhD); **Cyprus University of Technology, Limassol, Cyprus** (C A Christophi PhD); **Cedars-Sinai Medical Centre, Los Angeles, CA, USA** (Prof S S Chugh MD); **University of Salerno, Baronissi, Italy** (Prof M Cirillo MD); **Mayo Clinic, Rochester, MN, USA** (L T Cooper MD); **Medical**

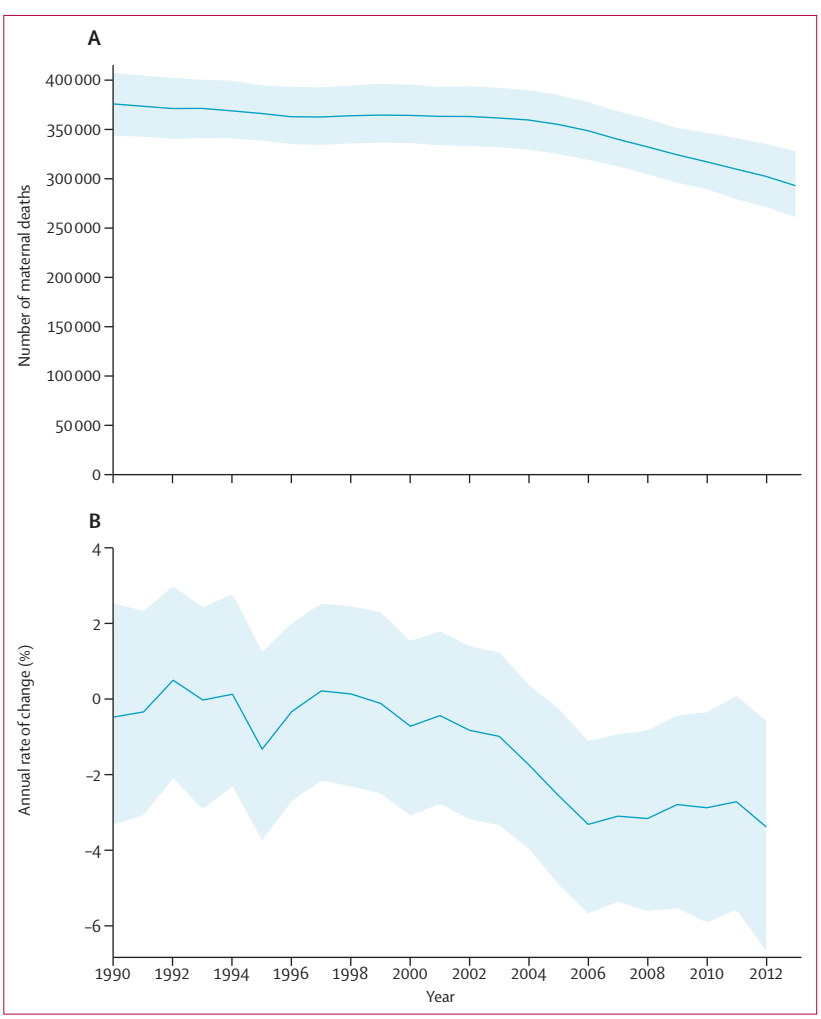

Figure 3: **Global maternal deaths (A) and annualised rate of change in maternal mortality ratio (B), 1990–2013**
Shaded areas show 95% uncertainty intervals.

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
Worldwide	283·2 (258·6 to 306·9)	273·4 (251·1 to 296·6)	209·1 (186·3 to 233·9)	376 034 (343 483 to 407 574)	361 706 (332 230 to 392 393)	292 982 (261 017 to 327 792)	−0·3% (−1·1 to 0·6)	−2·7% (−3·9 to −1·5)	−1·3% (−1·9 to −0·8)
Developed countries	24·5 (23·0 to 26·1)	16·0 (14·9 to 17·0)	12·1 (10·4 to 13·7)	3827 (3596 to 4076)	2341 (2178 to 2490)	1811 (1560 to 2053)	−3·3% (−3·8 to −2·8)	−2·9% (−4·2 to −1·5)	−3·1% (−3·7 to −2·5)
Developing countries	317·6 (289·9 to 344·5)	305·4 (280·3 to 331·5)	232·8 (207·3 to 260·6)	372 207 (339 780 to 403 753)	359 365 (329 892 to 390 100)	291 171 (259 299 to 325 923)	−0·3% (−1·2 to 0·6)	−2·7% (−4·0 to −1·5)	−1·4% (−1·9 to −0·8)
High-income Asia Pacific	16·4 (14·4 to 18·4)	10·3 (8·9 to 12·1)	7·9 (6·3 to 9·9)	325 (285 to 363)	173 (150 to 204)	128 (103 to 162)	−3·6% (−4·9 to −2·1)	−2·7% (−4·6 to −0·6)	−3·2% (−4·2 to −2·0)
Brunei	27·2 (18·9 to 39·0)	18·6 (13·8 to 24·6)	14·6 (9·8 to 21·1)	2 (1 to 3)	1 (1 to 2)	1 (1 to 1)	−2·9% (−6·3 to 0·4)	−2·5% (−6·7 to 1·9)	−2·7% (−5·0 to −0·4)
Japan	14·2 (12·2 to 16·2)	8·2 (6·8 to 9·8)	6·1 (4·7 to 7·9)	171 (148 to 195)	94 (78 to 113)	66 (51 to 86)	−4·3% (−5·7 to −2·6)	−2·9% (−5·7 to −0·2)	−3·7% (−4·9 to −2·3)
Singapore	10·4 (8·5 to 12·8)	8·8 (7·2 to 10·8)	4·5 (3·4 to 5·8)	6 (5 to 7)	4 (3 to 5)	2 (2 to 3)	−1·2% (−3·3 to 0·7)	−6·8% (−9·4 to −3·9)	−3·6% (−5·3 to −2·2)
South Korea	20·7 (17·5 to 23·9)	15·4 (12·8 to 19·0)	12·0 (8·7 to 16·7)	145 (123 to 168)	74 (61 to 91)	58 (42 to 81)	−2·3% (−4·3 to −0·1)	−2·6% (−5·7 to 0·4)	−2·4% (−3·9 to −0·7)
Central Asia	61·7 (58·0 to 65·6)	45·1 (41·6 to 49·0)	31·5 (27·0 to 37·0)	1188 (1119 to 1265)	724 (668 to 786)	569 (487 to 668)	−2·4% (−3·2 to −1·7)	−3·6% (−5·4 to −1·9)	−2·9% (−3·6 to −2·2)
Armenia	43·3 (36·0 to 51·3)	35·2 (29·1 to 42·5)	18·3 (13·9 to 23·4)	32 (26 to 38)	15 (13 to 19)	8 (6 to 10)	−1·6% (−3·5 to 0·4)	−6·6% (−9·7 to −3·6)	−3·8% (−5·1 to −2·4)
Azerbaijan	42·4 (36·6 to 49·0)	37·3 (31·4 to 44·2)	23·9 (17·1 to 33·9)	84 (72 to 97)	57 (48 to 67)	40 (29 to 57)	−1·0% (−2·8 to 0·8)	−4·6% (−8·2 to −0·4)	−2·5% (−4·0 to −1·0)
Georgia	42·0 (35·4 to 49·8)	31·7 (26·3 to 38·0)	31·1 (24·7 to 38·8)	37 (32 to 44)	19 (16 to 23)	18 (14 to 23)	−2·2% (−4·1 to −0·2)	−0·2% (−3·0 to 2·6)	−1·3% (−2·4 to −0·1)
Kazakhstan	70·9 (62·1 to 80·0)	36·0 (31·0 to 41·7)	27·0 (19·5 to 35·4)	247 (216 to 278)	105 (91 to 122)	90 (65 to 118)	−5·2% (−6·6 to −3·6)	−2·9% (−6·5 to 0·4)	−4·2% (−5·6 to −2·9)
Kyrgyzstan	62·5 (54·3 to 71·4)	58·3 (50·6 to 66·8)	46·8 (35·9 to 59·2)	84 (73 to 95)	66 (58 to 76)	69 (53 to 88)	−0·5% (−2·1 to 1·0)	−2·3% (−5·2 to 0·5)	−1·3% (−2·5 to −0·1)
Mongolia	180·2 (137·4 to 233·0)	96·3 (74·6 to 122·7)	51·3 (34·2 to 72·3)	108 (82 to 139)	50 (39 to 63)	33 (22 to 46)	−4·8% (−7·5 to −2·1)	−6·4% (−10·7 to −2·1)	−5·5% (−7·5 to −3·6)
Tajikistan	74·6 (65·3 to 86·4)	49·4 (42·2 to 57·8)	30·4 (22·2 to 39·3)	154 (135 to 178)	98 (84 to 115)	82 (60 to 106)	−3·2% (−4·9 to −1·6)	−4·9% (−8·2 to −1·9)	−3·9% (−5·4 to −2·7)
Turkmenistan	72·9 (63·2 to 83·1)	61·2 (41·1 to 83·7)	38·2 (22·9 to 55·5)	91 (79 to 103)	64 (43 to 88)	42 (25 to 61)	−1·4% (−4·6 to 1·3)	−4·8% (−9·7 to −0·1)	−2·9% (−5·0 to −1·1)
Uzbekistan	50·7 (45·4 to 56·8)	42·4 (36·6 to 48·9)	30·5 (21·0 to 42·6)	353 (315 to 395)	249 (215 to 287)	187 (129 to 262)	−1·4% (−2·8 to −0·1)	−3·4% (−6·8 to 0·4)	−2·3% (−3·9 to −0·7)
East Asia	139·5 (113·1 to 167·1)	63·9 (58·1 to 69·7)	18·2 (15·0 to 21·3)	31 690 (25 695 to 37 974)	11 084 (10 075 to 12 080)	3534 (2925 to 4135)	−6·0% (−7·6 to −4·3)	−12·6% (−14·5 to −10·7)	−8·9% (−10·1 to −7·6)
China	141·7 (114·4 to 170·8)	64·1 (58·2 to 70·1)	17·2 (14·0 to 20·3)	31 042 (25 074 to 37 428)	10 652 (9667 to 11 643)	3233 (2633 to 3815)	−6·1% (−7·8 to −4·3)	−13·2% (−15·2 to −11·1)	−9·2% (−10·4 to −7·8)
North Korea	136·3 (70·2 to 226·7)	100·5 (67·8 to 144·1)	77·4 (48·3 to 111·9)	546 (281 to 908)	386 (260 to 554)	275 (172 to 398)	−2·2% (−6·5 to 2·5)	−2·6% (−7·4 to 2·5)	−2·4% (−5·6 to 1·1)
Taiwan (Province of China)	24·9 (17·3 to 33·8)	13·5 (10·1 to 17·8)	7·9 (6·1 to 10·2)	102 (71 to 138)	46 (34 to 60)	26 (20 to 33)	−4·7% (−7·7 to −1·8)	−5·3% (−9·0 to −1·7)	−5·0% (−6·6 to −3·2)
South Asia	480·4 (407·4 to 558·3)	399·7 (345·8 to 467·6)	310·6 (252·4 to 383·4)	174 416 (147 914 to 202 689)	142 624 (123 413 to 166 876)	107 827 (87 629 to 133 087)	−1·4% (−3·0 to 0·3)	−2·6% (−5·1 to 0·0)	−1·9% (−3·0 to −0·8)
Afghanistan	501·0 (324·4 to 739·0)	716·3 (441·3 to 1123·4)	885·0 (508·7 to 1445·1)	3261 (2112 to 4811)	7726 (4760 to 12 117)	8794 (5055 to 14 360)	2·7% (−0·6 to 5·8)	2·1% (−1·8 to 5·4)	2·4% (0·1 to 4·7)
Bangladesh	551·9 (436·4 to 659·5)	333·1 (250·9 to 427·6)	242·7 (171·2 to 326·9)	20 669 (16 345 to 24 701)	11 327 (8532 to 14 541)	7737 (5459 to 10 422)	−3·9% (−6·4 to −1·3)	−3·2% (−7·0 to 0·8)	−3·6% (−5·1 to −1·9)
Bhutan	551·7 (275·0 to 846·5)	411·2 (204·9 to 651·7)	277·4 (136·7 to 469·2)	106 (53 to 162)	59 (30 to 94)	40 (20 to 68)	−2·3% (−6·4 to 1·5)	−4·0% (−8·1 to 0·9)	−3·0% (−5·8 to 0·2)
India	480·8 (384·9 to 583·6)	382·0 (315·3 to 472·8)	281·8 (207·0 to 371·2)	128 695 (103 026 to 156 193)	100 014 (82 553 to 123 801)	71 792 (52 723 to 94 564)	−1·8% (−4·0 to 0·6)	−3·1% (−6·6 to 0·3)	−2·3% (−3·9 to −0·8)
Nepal	417·4 (295·9 to 540·8)	365·0 (262·6 to 464·3)	272·3 (190·9 to 363·5)	3012 (2136 to 3903)	2623 (1886 to 3336)	1588 (1113 to 2119)	−1·0% (−3·6 to 1·5)	−3·0% (−6·0 to −0·1)	−1·9% (−3·7 to 0·1)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Pakistan	423·9 (317·2 to 521·6)	486·5 (360·7 to 595·6)	400·6 (233·0 to 560·8)	18 673 (13 973 to 22 976)	20 875 (15 477 to 25 557)	17 876 (10 397 to 25 026)	1·1% (–1·6 to 3·7)	–2·1% (–7·7 to 2·4)	–0·3% (–2·9 to 1·8)
Southeast Asia	295·0 (247·5 to 353·4)	217·4 (180·8 to 266·3)	154·9 (124·2 to 192·9)	35 339 (29 644 to 42 340)	25 637 (21 327 to 31 404)	18 028 (14 456 to 22 444)	–2·3% (–3·6 to –1·1)	–3·4% (–5·4 to –1·6)	–2·8% (–4·0 to –1·8)
Cambodia	355·9 (290·5 to 415·7)	399·0 (277·9 to 486·8)	220·9 (155·6 to 286·5)	1290 (1053 to 1507)	1355 (944 to 1654)	862 (607 to 1118)	0·8% (–1·8 to 2·8)	–5·9% (–9·3 to –2·9)	–2·1% (–3·6 to –0·6)
Indonesia	368·3 (311·6 to 432·9)	262·0 (224·3 to 308·2)	199·3 (149·4 to 257·4)	16 519 (13 975 to 19 416)	12 734 (10 902 to 14 982)	9352 7010 to 12 079)	–2·6% (–4·2 to –1·0)	–2·8% (–6·1 to 0·0)	–2·7% (–4·3 to –1·4)
Laos	514·4 (276·7 to 767·0)	490·7 (251·3 to 779·6)	303·8 (154·7 to 521·5)	942 (506 to 1404)	814 (417 to 1293)	543 (277 to 932)	–0·4% (–4·1 to 2·7)	–4·8% (–8·3 to –1·1)	–2·3% (–4·7 to 0·3)
Malaysia	101·6 (84·3 to 120·3)	78·4 (70·7 to 87·5)	55·7 (43·1 to 70·6)	522 (433 to 617)	364 (328 to 406)	291 (226 to 369)	–2·0% (–3·5 to –0·4)	–3·5% (–6·0 to –0·8)	–2·6% (–3·9 to –1·3)
Maldives	292·3 (240·8 to 355·1)	95·4 (78·7 to 111·6)	51·8 (38·6 to 67·0)	23 (19 to 28)	6 (5 to 7)	4 (3 to 5)	–8·6% (–10·3 to –6·7)	–6·2% (–9·5 to –3·0)	–7·5% (–9·1 to –6·0)
Myanmar	897·3 (513·3 to 1460·4)	645·6 (332·2 to 1145·2)	390·9 (196·3 to 731·7)	9465 (5414 to 15 405)	6108 (3144 to 10 835)	3531 (1773 to 6609)	–2·6% (–6·1 to 0·6)	–5·1% (–8·8 to –1·0)	–3·7% (–6·0 to –0·9)
Philippines	116·3 (103·4 to 130·2)	81·5 (72·0 to 91·5)	80·9 (54·9 to 115·0)	2374 (2112 to 2658)	1876 (1657 to 2105)	1959 (1328 to 2784)	–2·7% (–3·9 to –1·5)	–0·2% (–4·3 to 3·5)	–1·6% (–3·3 to –0·1)
Sri Lanka	73·6 (61·8 to 89·0)	47·9 (38·9 to 56·7)	30·9 (20·7 to 43·4)	257 (216 to 311)	178 (144 to 211)	116 (77 to 162)	–3·3% (–5·3 to –1·7)	–4·5% (–8·6 to –0·6)	–3·8% (–5·9 to –2·1)
Thailand	42·6 (36·1 to 50·3)	89·6 (75·9 to 104·4)	69·5 (47·3 to 98·7)	456 (386 to 538)	766 (648 to 892)	481 (328 to 684)	5·7% (3·8 to 7·5)	–2·7% (–6·6 to 1·4)	2·1% (0·3 to 3·9)
Timor-Leste	632·8 (490·8 to 781·3)	430·2 (361·6 to 498·6)	223·4 (175·5 to 275·9)	215 (167 to 266)	156 (131 to 181)	89 (70 to 110)	–2·9% (–4·9 to –0·9)	–6·6% (–9·0 to –4·2)	–4·5% (–6·0 to –3·1)
Vietnam	174·5 (124·5 to 239·1)	88·5 (59·4 to 122·0)	56·6 (34·1 to 89·5)	3275 (2337 to 4487)	1281 (860 to 1766)	800 (482 to 1265)	–5·2% (–8·3 to –2·2)	–4·6% (–9·1 to 0·0)	–5·0% (–7·5 to –2·3)
Australasia	8·1 (7·1 to 9·2)	5·9 (5·2 to 6·7)	5·5 (4·5 to 6·6)	26 (22 to 29)	19 (17 to 22)	21 (17 to 25)	–2·4% (–3·7 to –1·0)	–0·7% (–2·7 to 1·3)	–1·7% (–2·6 to –0·6)
Australia	7·0 (6·0 to 8·2)	5·1 (4·4 to 6·0)	4·8 (3·7 to 5·9)	18 (16 to 21)	14 (12 to 16)	15 (12 to 18)	–2·5% (–4·1 to –0·8)	–0·7% (–3·2 to 2·0)	–1·7% (–3·0 to –0·5)
New Zealand	12·6 (10·3 to 15·2)	9·4 (7·9 to 11·3)	9·3 (7·2 to 12·1)	7 (6 to 9)	6 (5 to 7)	6 (4 to 7)	–2·2% (–4·2 to –0·3)	–0·1% (–3·0 to 2·7)	–1·3% (–2·8 to 0·1)
Caribbean	208·3 (165·9 to 248·8)	213·1 (161·4 to 272·2)	150·0 (110·1 to 206·7)	1664 (1325 to 1987)	1602 (1214 to 2047)	1075 (788 to 1480)	0·1% (–1·5 to 1·7)	–3·5% (–6·1 to –1·0)	–1·5% (–2·6 to –0·1)
Antigua and Barbuda	54·4 (40·1 to 69·4)	50·8 (40·1 to 64·2)	42·0 (27·9 to 62·3)	1 (1 to 1)	1 (1 to 1)	1 (0 to 1)	–0·5% (–3·2 to 2·1)	–2·0% (–6·4 to 2·7)	–1·2% (–3·1 to 1·1)
Barbados	69·4 (54·8 to 87·4)	62·3 (50·4 to 75·0)	49·9 (34·3 to 70·7)	3 (2 to 4)	2 (2 to 3)	2 (1 to 3)	–0·8% (–3·0 to 1·4)	–2·3% (–6·2 to 1·7)	–1·5% (–3·2 to 0·4)
Belize	32·1 (26·2 to 39·5)	42·5 (34·9 to 51·6)	55·5 (37·6 to 78·9)	2 (2 to 3)	3 (2 to 4)	4 (3 to 6)	2·2% (0·1 to 4·2)	2·5% (–1·4 to 6·3)	2·3% (0·3 to 4·1)
Cuba	71·1 (59·6 to 87·0)	60·6 (52·4 to 70·2)	39·8 (31·5 to 49·5)	123 (103 to 150)	82 (71 to 95)	44 (35 to 54)	–1·2% (–3·0 to 0·4)	–4·3% (–6·9 to –1·6)	–2·5% (–3·8 to –1·2)
Dominica	50·2 (39·2 to 65·9)	41·4 (32·4 to 52·2)	36·1 (23·2 to 52·7)	1 (1 to 1)	1 (0 to 1)	0 (0 to 1)	–1·5% (–4·2 to 1·0)	–1·5% (–5·9 to 2·6)	–1·5% (–3·6 to 0·6)
Dominican Republic	73·8 (62·8 to 85·8)	60·5 (52·2 to 69·8)	40·8 (28·9 to 55·8)	164 (139 to 191)	138 (119 to 159)	90 (64 to 124)	–1·5% (–2·9 to 0·0)	–4·1% (–7·6 to –0·8)	–2·6% (–4·2 to –1·1)
Grenada	47·7 (37·6 to 62·4)	62·5 (50·6 to 76·6)	56·7 (41·0 to 76·9)	1 (1 to 2)	1 (1 to 1)	1 (1 to 2)	2·1% (–0·2 to 4·5)	–1·1% (–4·7 to 2·4)	0·7% (–1·0 to 2·4)
Guyana	118·8 (98·5 to 142·0)	138·9 (111·4 to 169·2)	118·1 (75·8 to 179·4)	21 (17 to 25)	25 (20 to 30)	20 (13 to 30)	1·2% (–1·0 to 3·3)	–1·8% (–6·1 to 2·4)	–0·1% (–2·1 to 2·0)
Haiti	492·4 (363·4 to 619·7)	495·7 (351·1 to 662·0)	333·0 (219·1 to 480·1)	1290 (952 to 1624)	1289 (913 to 1722)	868 (571 to 1251)	0·0% (–2·0 to 2·1)	–4·0% (–7·2 to –1·0)	–1·7% (–3·2 to –0·1)
Jamaica	44·0 (32·4 to 58·1)	59·4 (48·6 to 71·2)	44·7 (29·7 to 66·0)	27 (20 to 36)	33 (27 to 40)	23 (15 to 34)	2·3% (–0·2 to 5·0)	–3·0% (–7·0 to 1·2)	0·0% (–2·0 to 2·1)
Saint Lucia	52·0 (40·8 to 68·7)	44·4 (35·5 to 54·3)	41·0 (28·0 to 58·8)	2 (2 to 3)	1 (1 to 2)	1 (1 to 2)	–1·2% (–3·9 to 1·3)	–0·9% (–4·6 to 3·2)	–1·1% (–3·1 to 0·7)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Saint Vincent and the Grenadines	45·2 (33·3 to 60·8)	65·7 (54·0 to 81·7)	60·1 (43·7 to 80·8)	1 (1 to 2)	1 (1 to 2)	1 (1 to 1)	2·9% (0·2 to 5·7)	−1·0% (−4·6 to 2·3)	1·2% (−0·7 to 3·2)
Suriname	76·8 (62·3 to 93·2)	88·2 (71·3 to 106·5)	65·2 (44·2 to 91·3)	7 (6 to 9)	9 (7 to 11)	6 (4 to 9)	1·1% (−1·1 to 3·2)	−3·1% (−7·6 to 1·0)	−0·8% (−2·6 to 1·1)
The Bahamas	63·1 (48·0 to 84·0)	71·8 (57·5 to 90·2)	60·3 (38·8 to 91·2)	4 (3 to 5)	4 (3 to 5)	4 (2 to 5)	1·0% (−1·7 to 3·5)	−1·9% (−6·5 to 2·4)	−0·3% (−2·4 to 2·1)
Trinidad and Tobago	72·3 (61·5 to 84·3)	64·4 (54·1 to 75·8)	49·7 (36·4 to 65·6)	17 (14 to 20)	13 (11 to 15)	10 (7 to 13)	−0·9% (−2·6 to 0·9)	−2·7% (−5·8 to 0·5)	−1·7% (−3·1 to −0·2)
Central Europe	48·9 (45·4 to 53·0)	15·4 (14·1 to 16·5)	8·8 (7·5 to 10·1)	790 (734 to 856)	189 (173 to 203)	112 (95 to 128)	−8·9% (−9·7 to −8·2)	−5·6% (−7·1 to −4·1)	−7·4% (−8·2 to −6·8)
Albania	35·3 (29·5 to 41·6)	13·2 (10·8 to 16·1)	7·3 (4·9 to 10·2)	30 (25 to 35)	6 (5 to 8)	3 (2 to 4)	−7·6% (−9·7 to −5·5)	−6·1% (−10·4 to −2·2)	−6·9% (−8·7 to −5·2)
Bosnia and Herzegovina	38·8 (31·2 to 47·0)	20·4 (14·8 to 27·6)	11·0 (7·7 to 15·3)	23 (19 to 28)	7 (5 to 9)	4 (3 to 5)	−5·0% (−7·8 to −2·3)	−6·3% (−10·1 to −2·5)	−5·5% (−7·2 to −3·8)
Bulgaria	44·3 (38·8 to 50·7)	29·2 (24·9 to 33·7)	14·8 (12·0 to 18·2)	43 (37 to 49)	22 (18 to 25)	11 (9 to 13)	−3·2% (−4·8 to −1·7)	−6·8% (−9·0 to −4·5)	−4·8% (−5·7 to −3·8)
Croatia	16·9 (14·1 to 20·1)	12·7 (10·5 to 14·9)	9·9 (7·9 to 12·3)	9 (7 to 11)	5 (4 to 6)	4 (3 to 5)	−2·2% (−4·0 to −0·5)	−2·5% (−4·9 to 0·0)	−2·3% (−3·6 to −1·1)
Czech Republic	18·1 (15·2 to 21·4)	7·0 (5·8 to 8·4)	5·3 (4·1 to 6·7)	22 (18 to 26)	7 (6 to 9)	6 (5 to 8)	−7·3% (−9·2 to −5·4)	−2·8% (−5·6 to −0·2)	−5·3% (−6·6 to −4·1)
Hungary	19·0 (16·0 to 22·5)	9·2 (7·6 to 11·0)	8·5 (6·3 to 10·7)	24 (20 to 28)	9 (7 to 11)	9 (6 to 11)	−5·6% (−7·5 to −3·7)	−0·8% (−3·7 to 1·9)	−3·5% (−4·9 to −2·3)
Macedonia	25·1 (20·1 to 31·3)	17·7 (14·7 to 21·0)	10·5 (8·2 to 13·3)	9 (7 to 11)	4 (4 to 5)	2 (2 to 3)	−2·7% (−4·8 to −0·6)	−5·2% (−7·6 to −2·4)	−3·8% (−5·3 to −2·3)
Montenegro	15·9 (10·4 to 23·0)	18·6 (14·0 to 24·0)	12·3 (8·6 to 17·3)	1 (1 to 2)	1 (1 to 2)	1 (1 to 1)	1·3% (−2·2 to 4·7)	−4·2% (−7·8 to −0·2)	−1·1% (−3·3 to 1·1)
Poland	34·0 (30·3 to 38·2)	8·6 (7·4 to 9·9)	4·8 (3·8 to 6·1)	179 (159 to 201)	33 (28 to 37)	20 (16 to 26)	−10·6% (−12·0 to −9·3)	−5·8% (−8·5 to −3·4)	−8·5% (−9·6 to −7·4)
Romania	152·1 (137·4 to 169·5)	31·6 (27·9 to 35·5)	15·9 (12·2 to 19·9)	414 (374 to 462)	73 (65 to 82)	37 (28 to 46)	−12·1% (−13·3 to −10·9)	−6·9% (−9·6 to −4·3)	−9·8% (−11·1 to −8·7)
Serbia	15·8 (11·0 to 22·9)	12·1 (10·1 to 14·2)	10·6 (8·5 to 13·0)	22 (15 to 32)	13 (11 to 16)	10 (8 to 12)	−2·0% (−5·1 to 1·0)	−1·3% (−3·8 to 1·2)	−1·7% (−3·6 to 0·1)
Slovakia	15·9 (12·7 to 19·5)	9·5 (8·0 to 11·1)	6·2 (4·8 to 7·9)	12 (10 to 15)	5 (4 to 6)	4 (3 to 5)	−4·0% (−6·1 to −2·0)	−4·3% (−7·1 to −1·6)	−4·1% (−5·5 to −2·8)
Slovenia	12·9 (10·6 to 15·7)	11·0 (8·8 to 13·3)	7·4 (5·5 to 9·8)	3 (2 to 3)	2 (2 to 3)	2 (1 to 2)	−1·2% (−3·2 to 0·8)	−4·1% (−7·3 to −0·8)	−2·5% (−3·9 to −1·0)
Eastern Europe	60·1 (54·3 to 65·7)	36·3 (32·8 to 40·4)	17·6 (14·4 to 20·6)	1566 (1415 to 1714)	812 (733 to 904)	433 (354 to 507)	−3·9% (−4·9 to −2·8)	−7·3% (−9·4 to −5·4)	−5·3% (−6·1 to −4·6)
Belarus	40·5 (35·1 to 46·3)	25·0 (20·8 to 30·0)	10·6 (7·7 to 13·9)	53 (46 to 60)	25 (20 to 30)	11 (8 to 15)	−3·7% (−5·4 to −1·9)	−8·7% (−11·9 to −5·5)	−5·9% (−7·2 to −4·5)
Estonia	45·1 (37·4 to 54·1)	17·7 (14·7 to 21·5)	7·1 (4·9 to 9·5)	8 (7 to 10)	3 (2 to 3)	1 (1 to 1)	−7·2% (−9·2 to −5·3)	−9·2% (−12·7 to −5·8)	−8·1% (−9·9 to −6·6)
Latvia	49·7 (42·2 to 58·1)	20·8 (17·1 to 24·5)	8·5 (6·2 to 11·1)	16 (13 to 18)	5 (4 to 6)	2 (1 to 3)	−6·7% (−8·5 to −5·0)	−9·0% (−12·3 to −6·3)	−7·7% (−9·2 to −6·4)
Lithuania	29·6 (24·9 to 34·9)	13·7 (11·5 to 16·3)	6·1 (4·6 to 7·8)	15 (13 to 18)	5 (4 to 5)	2 (2 to 3)	−5·9% (−7·7 to −4·0)	−8·2% (−11·1 to −5·2)	−6·9% (−8·3 to −5·6)
Moldova	68·9 (59·7 to 79·6)	34·7 (28·5 to 41·3)	21·8 (16·0 to 28·2)	50 (43 to 57)	16 (13 to 19)	9 (7 to 12)	−5·3% (−7·2 to −3·4)	−4·7% (−7·7 to −1·8)	−5·0% (−6·6 to −3·7)
Russia	64·9 (57·7 to 72·6)	36·9 (32·5 to 42·0)	16·8 (13·5 to 20·2)	1099 (976 to 1229)	575 (507 to 655)	291 (234 to 351)	−4·4% (−5·7 to −2·9)	−7·9% (−10·5 to −5·6)	−5·9% (−6·8 to −5·0)
Ukraine	53·3 (46·3 to 60·8)	39·6 (34·5 to 45·4)	23·1 (17·5 to 29·2)	326 (283 to 372)	184 (161 to 211)	116 (88 to 147)	−2·3% (−3·7 to −0·8)	−5·4% (−8·4 to −2·7)	−3·7% (−4·9 to −2·5)
Western Europe	12·7 (11·7 to 13·8)	8·1 (7·3 to 8·6)	6·3 (5·3 to 7·1)	565 (522 to 615)	365 (330 to 390)	288 (243 to 326)	−3·5% (−4·2 to −2·9)	−2·5% (−3·8 to −1·4)	−3·1% (−3·8 to −2·5)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Andorra	5·5 (3·1 to 9·0)	3·1 (1·9 to 4·9)	3·0 (1·6 to 4·8)	0 (0 to 0)	0 (0 to 0)	0 (0 to 0)	−4·4% (−9·2 to 0·1)	−0·6% (−6·3 to 5·6)	−2·7% (−5·9 to 0·2)
Austria	10·3 (8·5 to 12·2)	5·0 (4·0 to 6·0)	3·2 (2·3 to 4·0)	9 (8 to 11)	4 (3 to 5)	3 (2 to 3)	−5·6% (−7·5 to −3·6)	−4·5% (−7·4 to −1·8)	−5·1% (−6·5 to −3·8)
Belgium	11·3 (9·4 to 13·3)	8·4 (6·9 to 10·1)	6·7 (5·0 to 8·6)	14 (12 to 16)	10 (8 to 12)	9 (7 to 11)	−2·2% (−4·0 to −0·5)	−2·3% (−5·2 to 0·5)	−2·3% (−3·6 to −1·0)
Cyprus	13·3 (9·6 to 17·7)	8·7 (6·7 to 11·0)	6·1 (4·4 to 8·1)	2 (1 to 3)	1 (1 to 1)	1 (1 to 1)	−3·2% (−6·0 to −0·4)	−3·6% (−7·4 to 0·1)	−3·4% (−5·2 to −1·6)
Denmark	7·4 (6·2 to 9·1)	5·8 (4·7 to 7·1)	4·8 (3·4 to 6·2)	5 (4 to 6)	4 (3 to 5)	3 (2 to 4)	−1·9% (−4·4 to 0·1)	−2·1% (−5·0 to 0·7)	−2·0% (−3·7 to −0·5)
Finland	7·2 (5·9 to 8·8)	6·4 (5·3 to 7·6)	3·9 (3·0 to 5·0)	5 (4 to 6)	4 (3 to 4)	2 (2 to 3)	−0·9% (−2·8 to 1·0)	−5·0% (−7·6 to −2·3)	−2·7% (−4·1 to −1·4)
France	15·6 (13·5 to 17·7)	11·0 (9·3 to 12·6)	8·8 (6·9 to 11·0)	116 (100 to 132)	87 (74 to 100)	70 (55 to 88)	−2·7% (−4·1 to −1·2)	−2·2% (−4·5 to 0·2)	−2·5% (−3·7 to −1·3)
Germany	18·0 (15·9 to 20·4)	8·3 (7·1 to 9·6)	6·5 (5·0 to 7·9)	146 (129 to 165)	62 (52 to 71)	46 (36 to 56)	−5·9% (−7·4 to −4·7)	−2·5% (−4·6 to −0·5)	−4·4% (−5·6 to −3·4)
Greece	9·5 (8·0 to 11·1)	7·9 (6·6 to 9·3)	9·1 (7·2 to 11·3)	10 (8 to 11)	9 (7 to 11)	10 (8 to 12)	−1·4% (−3·2 to 0·2)	1·4% (−1·0 to 4·0)	−0·2% (−1·3 to 1·0)
Iceland	7·1 (5·5 to 9·0)	4·2 (3·0 to 5·6)	2·4 (1·6 to 3·6)	0 (0 to 0)	0 (0 to 0)	0 (0 to 0)	−4·1% (−7·1 to −1·1)	−5·4% (−9·9 to −1·0)	−4·7% (−6·9 to −2·6)
Ireland	6·3 (5·2 to 7·6)	3·9 (3·1 to 4·7)	3·3 (2·3 to 4·4)	3 (3 to 4)	2 (2 to 3)	2 (2 to 3)	−3·7% (−5·6 to −1·9)	−1·7% (−5·0 to 1·7)	−2·8% (−4·4 to −1·3)
Israel	10·4 (8·8 to 12·5)	7·1 (5·9 to 8·5)	4·4 (3·2 to 5·5)	10 (9 to 12)	10 (8 to 12)	7 (5 to 9)	−2·9% (−4·8 to −1·1)	−4·9% (−8·2 to −2·2)	−3·8% (−5·4 to −2·4)
Italy	9·9 (8·6 to 11·4)	5·7 (4·7 to 6·7)	4·3 (3·2 to 5·5)	54 (47 to 63)	32 (27 to 38)	24 (18 to 32)	−4·3% (−5·8 to −2·7)	−2·8% (−5·7 to −0·2)	−3·7% (−5·0 to −2·4)
Luxembourg	5·0 (4·1 to 6·1)	7·0 (5·4 to 8·6)	6·1 (4·5 to 8·0)	0 (0 to 0)	0 (0 to 0)	0 (0 to 1)	2·6% (0·3 to 4·6)	−1·5% (−4·7 to 2·0)	0·8% (−0·8 to 2·4)
Malta	6·9 (5·5 to 8·4)	5·4 (4·2 to 6·9)	2·9 (2·0 to 3·9)	0 (0 to 1)	0 (0 to 0)	0 (0 to 0)	−1·8% (−4·3 to 0·5)	−6·5% (−10·4 to −2·8)	−3·8% (−5·6 to −2·1)
Netherlands	11·7 (9·8 to 13·9)	10·8 (8·9 to 12·7)	6·7 (5·1 to 8·3)	23 (19 to 27)	22 (18 to 25)	12 (9 to 15)	−0·6% (−2·3 to 1·0)	−4·8% (−7·4 to −2·1)	−2·5% (−3·7 to −1·3)
Norway	5·9 (4·9 to 7·1)	6·3 (5·1 to 7·7)	4·5 (3·5 to 5·6)	4 (3 to 4)	4 (3 to 5)	3 (2 to 4)	0·5% (−1·4 to 2·5)	−3·4% (−6·0 to −0·7)	−1·2% (−2·4 to 0·1)
Portugal	20·6 (17·7 to 24·1)	13·6 (11·5 to 16·0)	9·8 (7·7 to 12·2)	23 (20 to 27)	15 (13 to 17)	9 (7 to 11)	−3·2% (−4·9 to −1·5)	−3·3% (−6·0 to −0·8)	−3·3% (−4·4 to −2·1)
Spain	12·3 (10·7 to 14·3)	7·0 (6·0 to 8·2)	6·2 (4·8 to 7·6)	47 (41 to 54)	32 (28 to 37)	31 (24 to 38)	−4·3% (−5·8 to −2·8)	−1·4% (−3·8 to 1·2)	−3·0% (−4·2 to −1·9)
Sweden	7·0 (5·7 to 8·6)	4·9 (3·9 to 5·9)	3·7 (2·7 to 4·8)	8 (7 to 10)	5 (4 to 6)	4 (3 to 6)	−2·7% (−4·9 to −0·7)	−2·8% (−6·1 to 0·1)	−2·7% (−4·5 to −1·3)
Switzerland	6·7 (5·5 to 8·3)	5·8 (4·6 to 7·2)	3·9 (2·9 to 5·1)	5 (4 to 7)	4 (3 to 5)	3 (2 to 4)	−1·1% (−3·4 to 1·1)	−4·0% (−7·0 to −1·0)	−2·3% (−4·1 to −0·9)
UK	10·4 (9·4 to 11·1)	7·7 (7·0 to 8·3)	6·1 (5·2 to 6·9)	80 (73 to 86)	57 (52 to 62)	47 (40 to 54)	−2·3% (−2·9 to −1·7)	−2·4% (−3·8 to −1·0)	−2·3% (−3·0 to −1·7)
Andean Latin America	187·9 (169·5 to 208·7)	112·5 (99·7 to 125·1)	96·0 (75·3 to 117·2)	2249 (2028 to 2497)	1366 (1211 to 1520)	1164 (912 to 1421)	−4·0% (−5·2 to −2·8)	−1·6% (−4·0 to 0·6)	−2·9% (−4·1 to −2·0)
Bolivia	382·4 (312·1 to 458·1)	229·9 (178·7 to 281·9)	179·6 (110·4 to 257·2)	977 (798 to 1171)	616 (479 to 755)	499 (307 to 715)	−3·9% (−6·3 to −1·7)	−2·6% (−6·9 to 1·3)	−3·4% (−5·6 to −1·5)
Ecuador	142·7 (128·4 to 159·9)	86·0 (72·8 to 100·3)	84·6 (57·7 to 122·0)	430 (386 to 481)	282 (239 to 329)	282 (192 to 406)	−3·9% (−5·4 to −2·4)	−0·3% (−4·6 to 3·7)	−2·3% (−4·1 to −0·7)
Peru	131·5 (114·1 to 152·6)	75·7 (64·6 to 88·4)	63·7 (45·6 to 85·4)	842 (731 to 977)	468 (400 to 547)	383 (274 to 513)	−4·3% (−5·9 to −2·6)	−1·8% (−5·2 to 1·6)	−3·2% (−4·8 to −1·7)
Central Latin America	78·8 (74·9 to 82·3)	67·9 (63·7 to 72·6)	59·9 (53·8 to 66·7)	3884 (3690 to 4056)	3446 (3231 to 3683)	2950 (2649 to 3283)	−1·1% (−1·6 to −0·7)	−1·3% (−2·2 to −0·2)	−1·2% (−1·6 to −0·7)
Colombia	68·2 (60·7 to 76·7)	77·1 (67·2 to 87·7)	62·9 (44·1 to 85·2)	633 (563 to 712)	725 (632 to 824)	577 (405 to 782)	0·9% (−0·3 to 2·2)	−2·2% (−5·6 to 1·2)	−0·4% (−1·9 to 1·0)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Costa Rica	31·1 (26·9 to 36·0)	36·3 (31·7 to 41·5)	24·9 (20·1 to 30·3)	25 (22 to 29)	28 (24 to 31)	19 (15 to 23)	1·2% (–0·3 to 2·7)	–3·8% (–6·0 to –1·5)	–1·0% (–2·0 to 0·1)
El Salvador	105·5 (90·2 to 120·4)	57·5 (49·2 to 66·5)	65·8 (44·3 to 91·6)	181 (155 to 206)	77 (66 to 89)	86 (58 to 119)	–4·7% (–6·3 to –3·1)	1·2% (–2·6 to 4·9)	–2·1% (–3·8 to –0·4)
Guatemala	112·8 (101·0 to 126·2)	91·8 (81·2 to 104·2)	86·7 (65·8 to 110·8)	409 (367 to 458)	400 (353 to 454)	423 (321 to 541)	–1·6% (–2·8 to –0·4)	–0·6% (–3·5 to 2·0)	–1·2% (–2·4 to 0·0)
Honduras	153·1 (90·5 to 190·4)	119·5 (48·5 to 191·2)	72·0 (35·5 to 123·0)	295 (175 to 367)	238 (97 to 381)	153 (75 to 260)	–2·1% (–6·4 to 1·5)	–5·1% (–10·5 to 0·2)	–3·4% (–5·8 to –1·1)
Mexico	73·8 (70·4 to 77·1)	57·9 (55·0 to 60·5)	54·0 (50·3 to 58·2)	1774 (1691 to 1851)	1429 (1357 to 1493)	1224 (1139 to 1320)	–1·9% (–2·3 to –1·5)	–0·7% (–1·5 to 0·1)	–1·4% (–1·7 to –1·0)
Nicaragua	94·5 (81·2 to 109·4)	87·8 (76·7 to 101·0)	63·5 (49·0 to 80·0)	148 (127 to 171)	126 (110 to 145)	90 (69 to 113)	–0·6% (–2·1 to 1·0)	–3·3% (–6·2 to –0·7)	–1·8% (–3·0 to –0·5)
Panama	62·3 (53·0 to 72·7)	66·2 (57·2 to 76·3)	55·2 (40·6 to 73·2)	42 (35 to 49)	50 (44 to 58)	42 (31 to 56)	0·5% (–1·1 to 2·2)	–1·9% (–5·1 to 1·3)	–0·6% (–1·9 to 0·8)
Venezuela	66·6 (59·6 to 73·5)	62·0 (56·3 to 68·7)	54·7 (42·8 to 68·6)	377 (337 to 415)	373 (339 to 413)	336 (263 to 421)	–0·5% (–1·6 to 0·5)	–1·3% (–3·8 to 1·2)	–0·9% (–2·0 to 0·2)
Southern Latin America	55·5 (51·1 to 60·2)	51·2 (46·3 to 55·8)	44·2 (37·3 to 51·3)	603 (555 to 653)	513 (465 to 560)	445 (376 to 518)	–0·6% (–1·6 to 0·2)	–1·5% (–3·3 to 0·3)	–1·0% (–1·8 to –0·2)
Argentina	60·2 (54·9 to 66·0)	63·3 (57·0 to 69·7)	54·7 (45·3 to 64·6)	434 (396 to 476)	440 (396 to 484)	387 (320 to 456)	0·4% (–0·7 to 1·4)	–1·5% (–3·5 to 0·5)	–0·4% (–1·3 to 0·4)
Chile	47·8 (42·3 to 54·3)	22·0 (19·3 to 25·0)	18·7 (14·7 to 23·2)	146 (130 to 166)	56 (49 to 64)	47 (37 to 58)	–6·0% (–7·4 to –4·6)	–1·7% (–4·2 to 0·9)	–4·1% (–5·2 to –3·0)
Uruguay	38·7 (32·8 to 45·3)	32·5 (27·4 to 38·1)	22·9 (17·3 to 29·4)	23 (19 to 27)	17 (15 to 20)	12 (9 to 15)	–1·4% (–3·0 to 0·3)	–3·6% (–6·5 to –0·7)	–2·3% (–3·6 to –1·0)
Tropical Latin America	75·9 (68·0 to 84·6)	68·3 (60·9 to 75·6)	60·6 (47·5 to 75·6)	2818 (2522 to 3139)	2445 (2182 to 2708)	1969 (1542 to 2457)	–0·8% (–1·9 to 0·2)	–1·2% (–3·9 to 1·3)	–1·0% (–2·2 to 0·1)
Brazil	73·1 (65·0 to 82·0)	66·0 (58·4 to 73·7)	58·7 (45·8 to 73·5)	2609 (2320 to 2925)	2265 (2003 to 2530)	1813 (1414 to 2267)	–0·8% (–1·9 to 0·3)	–1·2% (–4·0 to 1·4)	–1·0% (–2·2 to 0·2)
Paraguay	145·6 (130·2 to 162·4)	119·8 (107·3 to 134·0)	95·2 (71·6 to 126·9)	209 (187 to 233)	181 (162 to 202)	156 (117 to 208)	–1·5% (–2·7 to –0·3)	–2·4% (–5·3 to 1·0)	–1·9% (–3·2 to –0·5)
North Africa and Middle East	131·0 (115·4 to 147·8)	101·8 (85·1 to 121·3)	78·1 (63·1 to 97·6)	13 106 (11 543 to 14 783)	10 370 (8672 to 12 351)	8907 (7204 to 11 135)	–2·0% (–3·2 to –0·9)	–2·7% (–4·3 to –1·0)	–2·3% (–3·2 to –1·3)
Algeria	126·1 (87·0 to 170·4)	81·0 (59·8 to 107·0)	51·5 (37·2 to 70·1)	949 (655 to 1283)	575 (424 to 759)	470 (340 to 641)	–3·4% (–6·5 to 0·1)	–4·5% (–8·6 to –0·5)	–3·9% (–5·8 to –2·0)
Bahrain	55·4 (40·7 to 73·4)	32·7 (24·9 to 41·9)	21·4 (15·5 to 29·0)	7 (5 to 10)	5 (4 to 6)	4 (3 to 6)	–4·0% (–6·9 to –1·1)	–4·3% (–8·0 to 0·1)	–4·2% (–6·1 to –2·2)
Egypt	83·7 (69·9 to 100·1)	44·8 (39·1 to 51·9)	32·6 (24·5 to 42·3)	1385 (1157 to 1656)	765 (668 to 888)	619 (465 to 803)	–4·8% (–6·5 to –3·0)	–3·2% (–6·2 to –0·3)	–4·1% (–5·5 to –2·8)
Iran	40·1 (27·0 to 57·2)	26·6 (21·9 to 31·6)	13·5 (9·4 to 18·3)	651 (439 to 929)	333 (275 to 396)	197 (137 to 266)	–3·1% (–6·2 to 0·2)	–6·9% (–10·9 to –3·1)	–4·7% (–7·0 to –2·6)
Iraq	110·6 (68·7 to 157·0)	88·0 (62·0 to 126·8)	65·8 (40·4 to 110·7)	736 (457 to 1045)	816 (574 to 1175)	695 (427 to 1170)	–1·7% (–5·6 to 2·5)	–3·1% (–8·1 to 2·3)	–2·3% (–4·8 to 0·7)
Jordan	102·2 (79·1 to 128·7)	60·2 (46·2 to 78·8)	29·8 (20·3 to 41·4)	112 (87 to 141)	92 (71 to 120)	57 (39 to 79)	–4·1% (–6·9 to –1·3)	–7·1% (–11·8 to –2·2)	–5·4% (–7·2 to –3·5)
Kuwait	17·8 (14·4 to 21·6)	11·4 (9·6 to 13·6)	9·5 (7·5 to 12·0)	6 (5 to 7)	5 (5 to 7)	7 (5 to 8)	–3·4% (–5·4 to –1·4)	–1·8% (–4·4 to 0·8)	–2·7% (–4·0 to –1·4)
Lebanon	101·4 (74·8 to 135·1)	42·4 (30·8 to 56·8)	18·1 (11·9 to 26·0)	65 (48 to 87)	23 (16 to 30)	12 (8 to 17)	–6·7% (–9·5 to –3·9)	–8·6% (–12·7 to –4·9)	–7·5% (–9·7 to –5·5)
Libya	41·8 (25·7 to 64·6)	30·7 (22·8 to 40·5)	27·0 (18·0 to 40·5)	46 (28 to 71)	37 (27 to 49)	33 (22 to 50)	–2·3% (–6·0 to 1·6)	–1·4% (–6·5 to 3·7)	–1·9% (–4·5 to 0·8)
Morocco	279·5 (236·0 to 338·9)	98·3 (75·2 to 120·8)	63·9 (45·1 to 85·8)	1971 (1664 to 2390)	603 (462 to 741)	472 (334 to 635)	–8·1% (–10·2 to –6·0)	–4·4% (–7·5 to –1·3)	–6·5% (–8·1 to –5·0)
Oman	47·0 (26·7 to 76·6)	20·4 (14·2 to 29·4)	12·8 (8·4 to 20·6)	30 (17 to 49)	11 (7 to 15)	9 (6 to 15)	–6·3% (–10·8 to –1·7)	–4·8% (–10·8 to 1·2)	–5·6% (–8·5 to –2·8)
Palestine	21·1 (12·3 to 34·3)	11·3 (8·7 to 14·4)	9·0 (5·5 to 13·2)	22 (13 to 35)	13 (10 to 17)	12 (7 to 17)	–4·6% (–9·0 to –0·4)	–2·5% (–7·5 to 2·3)	–3·7% (–6·8 to –0·7)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Qatar	50·4 (36·2 to 69·8)	38·9 (29·6 to 50·1)	18·7 (12·4 to 27·2)	5 (4 to 7)	4 (3 to 6)	4 (3 to 6)	−2·0% (−5·1 to 1·0)	−7·4% (−12·2 to −2·8)	−4·3% (−6·6 to −2·2)
Saudi Arabia	15·7 (9·1 to 25·2)	9·3 (7·6 to 11·1)	7·0 (5·2 to 9·2)	88 (51 to 140)	49 (41 to 59)	38 (28 to 50)	−3·8% (−7·9 to 0·6)	−2·8% (−6·2 to 0·5)	−3·4% (−5·8 to −0·8)
Sudan	407·8 (304·2 to 502·9)	356·5 (237·6 to 478·8)	275·2 (181·1 to 377·5)	3558 (2654 to 4388)	4193 (2794 to 5631)	3528 (2322 to 4840)	−1·1% (−3·5 to 1·1)	−2·6% (−5·4 to 0·2)	−1·8% (−3·3 to −0·2)
Syria	120·5 (86·0 to 158·8)	64·8 (49·1 to 80·9)	44·1 (31·1 to 60·3)	513 (367 to 676)	309 (235 to 386)	229 (161 to 313)	−4·7% (−7·7 to −1·8)	−3·9% (−7·7 to 0·1)	−4·4% (−6·4 to −2·4)
Tunisia	62·2 (44·4 to 82·7)	28·5 (18·4 to 42·3)	19·0 (11·6 to 28·5)	124 (88 to 164)	48 (31 to 72)	35 (21 to 53)	−6·1% (−9·7 to −2·4)	−4·1% (−9·1 to 0·7)	−5·2% (−7·6 to −3·0)
Turkey	48·5 (34·7 to 65·2)	23·1 (17·1 to 30·9)	15·0 (10·7 to 19·9)	664 (475 to 893)	304 (226 to 408)	188 (134 to 250)	−5·7% (−8·9 to −2·6)	−4·3% (−8·4 to −0·1)	−5·1% (−6·9 to −3·2)
United Arab Emirates	55·8 (31·0 to 112·1)	21·6 (14·1 to 33·7)	12·8 (7·7 to 21·4)	23 (13 to 47)	12 (8 to 18)	17 (10 to 29)	−7·1% (−11·9 to −2·4)	−5·3% (−10·2 to 1·0)	−6·3% (−9·5 to −3·0)
Yemen	342·6 (182·1 to 519·2)	322·2 (182·7 to 524·9)	308·8 (168·6 to 555·4)	2151 (1143 to 3260)	2172 (1232 to 3538)	2279 (1244 to 4099)	−0·5% (−3·5 to 2·7)	−0·5% (−3·8 to 3·3)	−0·5% (−2·8 to 2·2)
High-income North America	11·9 (10·7 to 13·3)	17·0 (15·1 to 18·8)	17·6 (14·3 to 21·6)	555 (499 to 621)	784 (697 to 867)	829 (672 to 1016)	2·7% (1·5 to 3·8)	0·3% (−1·8 to 2·6)	1·7% (0·7 to 2·6)
Canada	7·1 (6·0 to 8·3)	9·2 (7·6 to 10·7)	8·2 (6·3 to 10·3)	28 (24 to 33)	32 (27 to 37)	33 (25 to 42)	2·0% (0·2 to 3·6)	−1·2% (−3·7 to 1·3)	0·6% (−0·7 to 1·9)
USA	12·4 (11·1 to 13·9)	17·6 (15·7 to 19·5)	18·5 (14·8 to 22·9)	527 (472 to 592)	752 (669 to 833)	796 (638 to 985)	2·7% (1·4 to 3·8)	0·5% (−1·8 to 2·8)	1·7% (0·8 to 2·7)
Oceania	599·9 (365·3 to 972·5)	577·8 (331·4 to 976·3)	494·1 (264·4 to 849·3)	1234 (752 to 2001)	1461 (838 to 2469)	1325 (709 to 2278)	−0·3% (−3·3 to 2·7)	−1·6% (−5·2 to 2·4)	−0·9% (−3·2 to 1·7)
Federated States of Micronesia	170·3 (82·9 to 310·8)	130·5 (66·6 to 235·5)	87·9 (44·7 to 154·5)	6 (3 to 10)	4 (2 to 7)	2 (1 to 4)	−2·0% (−6·0 to 2·0)	−3·9% (−8·5 to 0·7)	−2·9% (−5·6 to 0·0)
Fiji	109·6 (68·4 to 165·2)	100·8 (72·0 to 135·5)	68·2 (43·7 to 102·8)	24 (15 to 36)	19 (14 to 26)	12 (8 to 18)	−0·6% (−4·4 to 3·6)	−4·0% (−9·0 to 0·8)	−2·1% (−4·9 to 0·7)
Kiribati	213·3 (153·9 to 296·9)	142·4 (97·1 to 216·5)	100·9 (57·4 to 169·1)	6 (4 to 8)	3 (2 to 5)	2 (1 to 4)	−3·2% (−7·1 to 0·8)	−3·6% (−9·0 to 1·8)	−3·4% (−6·2 to −0·6)
Marshall Islands	74·7 (46·2 to 111·8)	109·4 (66·3 to 167·8)	95·6 (51·9 to 164·9)	2 (1 to 2)	2 (1 to 3)	2 (1 to 3)	2·9% (−1·6 to 7·4)	−1·5% (−7·8 to 5·1)	1·0% (−2·0 to 4·0)
Papua New Guinea	765·9 (456·7 to 1255·9)	702·6 (396·4 to 1197·8)	594·2 (312·7 to 1030·8)	1148 (684 to 1882)	1382 (779 to 2355)	1260 (663 to 2187)	−0·7% (−3·8 to 2·4)	−1·7% (−5·4 to 2·3)	−1·1% (−3·6 to 1·5)
Samoa	61·1 (36·2 to 99·7)	51·2 (32·5 to 76·3)	41·4 (26·9 to 62·8)	3 (2 to 5)	3 (2 to 4)	2 (1 to 3)	−1·3% (−6·0 to 3·3)	−2·1% (−7·0 to 3·3)	−1·6% (−4·6 to 1·1)
Solomon Islands	254·0 (127·4 to 454·4)	214·5 (112·5 to 379·3)	183·0 (95·9 to 338·5)	32 (16 to 56)	34 (18 to 60)	32 (17 to 59)	−1·3% (−5·2 to 2·7)	−1·6% (−6·0 to 3·2)	−1·4% (−4·5 to 1·6)
Tonga	188·1 (118·8 to 286·9)	143·3 (108·8 to 185·6)	111·2 (68·2 to 172·2)	6 (4 to 9)	4 (3 to 5)	3 (2 to 5)	−2·0% (−6·0 to 1·8)	−2·7% (−7·8 to 2·3)	−2·3% (−5·0 to 0·4)
Vanuatu	176·3 (83·5 to 329·7)	174·8 (88·2 to 333·0)	139·2 (72·3 to 257·6)	10 (5 to 18)	10 (5 to 20)	9 (5 to 17)	−0·1% (−4·2 to 4·1)	−2·2% (−6·6 to 2·4)	−1·0% (−4·0 to 2·2)
Central sub-Saharan Africa	456·3 (366·2 to 546·7)	419·1 (341·2 to 499·8)	353·1 (279·9 to 434·1)	12 178 (9773 to 14 591)	15 191 (12 369 to 18 118)	15 355 (12 174 to 18 880)	−0·7% (−2·2 to 0·8)	−1·7% (−3·8 to 0·3)	−1·1% (−2·3 to 0·1)
Angola	510·6 (324·9 to 747·3)	451·1 (308·9 to 657·8)	310·1 (198·3 to 472·2)	2976 (1894 to 4356)	3672 (2515 to 5355)	3032 (1939 to 4618)	−0·9% (−3·7 to 1·8)	−3·8% (−7·1 to −0·5)	−2·2% (−4·0 to 0·0)
Central African Republic	788·7 (576·4 to 1020·1)	999·4 (636·2 to 1415·6)	910·5 (578·3 to 1293·2)	973 (711 to 1258)	1473 (937 to 2086)	1459 (926 to 2072)	1·8% (−0·7 to 3·9)	−0·9% (−3·8 to 1·7)	0·6% (−1·0 to 2·0)
Congo	397·2 (275·6 to 545·1)	482·8 (322·1 to 673·7)	287·3 (189·6 to 427·1)	379 (263 to 519)	678 (452 to 946)	494 (326 to 735)	1·5% (−1·1 to 3·9)	−5·2% (−8·5 to −2·0)	−1·4% (−3·4 to 0·4)
DR Congo	420·1 (323·5 to 521·5)	369·5 (295·0 to 451·4)	342·3 (251·4 to 446·7)	7616 (5865 to 9455)	9069 (7241 to 11 081)	10 125 (7437 to 13 213)	−1·0% (−3·1 to 1·3)	−0·8% (−3·7 to 1·8)	−0·9% (−2·6 to 0·7)
Equatorial Guinea	599·9 (376·2 to 897·0)	487·3 (280·4 to 736·7)	369·6 (199·8 to 620·0)	109 (68 to 163)	110 (63 to 166)	100 (54 to 168)	−1·6% (−5·4 to 2·3)	−2·9% (−6·9 to 1·4)	−2·2% (−4·9 to 0·9)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Gabon	345·7 (265·2 to 438·6)	413·0 (301·0 to 541·8)	267·3 (184·1 to 370·3)	126 (96 to 159)	189 (138 to 248)	144 (99 to 199)	1·3% (–1·3 to 4·0)	–4·4% (–7·9 to –1·3)	–1·2% (–2·9 to 0·6)
Eastern sub-Saharan Africa	511·7 (461·5 to 562·3)	564·7 (490·8 to 640·0)	387·2 (331·5 to 453·0)	45 250 (40 808 to 49 719)	65 050 (56 537 to 73 735)	52 269 (44 747 to 61 144)	0·7% (–0·3 to 1·9)	–3·8% (–5·1 to –2·4)	–1·2% (–1·8 to –0·6)
Burundi	757·1 (560·5 to 977·3)	712·3 (538·5 to 899·9)	370·8 (240·4 to 504·3)	2122 (1571 to 2739)	2240 (1693 to 2830)	1683 (1091 to 2289)	–0·5% (–3·0 to 1·9)	–6·6% (–10·2 to –3·7)	–3·1% (–5·1 to –1·4)
Comoros	527·4 (319·7 to 830·5)	383·0 (219·8 to 646·7)	329·2 (171·9 to 584·5)	82 (50 to 130)	88 (50 to 148)	85 (45 to 152)	–2·5% (–6·0 to 1·1)	–1·7% (–6·6 to 2·6)	–2·2% (–4·9 to 0·7)
Djibouti	526·3 (334·8 to 788·7)	629·3 (405·3 to 962·4)	523·5 (329·8 to 821·8)	124 (79 to 186)	138 (89 to 211)	123 (77 to 193)	1·4% (–1·9 to 4·6)	–1·9% (–5·2 to 1·5)	0·0% (–2·2 to 2·2)
Eritrea	614·2 (493·7 to 747·0)	679·9 (475·9 to 902·1)	566·0 (351·2 to 817·7)	949 (763 to 1154)	1241 (868 to 1646)	1313 (814 to 1896)	0·7% (–1·8 to 3·1)	–1·9% (–5·1 to 0·9)	–0·4% (–2·3 to 1·3)
Ethiopia	708·0 (600·4 to 815·0)	657·8 (486·3 to 839·6)	497·4 (371·5 to 648·8)	16 740 (14 197 to 19 271)	18 941 (14 001 to 24 173)	15 234 (11 378 to 19 871)	–0·6% (–3·1 to 1·4)	–2·8% (–5·2 to –0·2)	–1·6% (–2·8 to –0·3)
Kenya	315·5 (250·1 to 382·2)	559·2 (375·0 to 773·0)	277·2 (175·4 to 414·1)	3047 (2416 to 3692)	7628 (5115 to 10 543)	4361 (2759 to 6514)	4·3% (1·3 to 7·4)	–7·1% (–10·8 to –3·9)	–0·6% (–2·6 to 1·4)
Madagascar	314·0 (246·9 to 375·5)	378·0 (255·9 to 480·7)	297·7 (174·3 to 448·6)	1723 (1355 to 2061)	2610 (1766 to 3319)	2455 (1438 to 3699)	1·4% (–1·0 to 3·4)	–2·6% (–6·4 to 1·6)	–0·3% (–2·3 to 1·5)
Malawi	550·3 (440·5 to 669·6)	815·3 (567·4 to 1111·1)	334·7 (224·5 to 465·1)	2627 (2103 to 3197)	4542 (3161 to 6189)	2260 (1516 to 3140)	3·0% (0·7 to 5·3)	–8·9% (–12·5 to –6·1)	–2·2% (–3·8 to –0·6)
Mauritius	66·8 (56·8 to 79·1)	55·9 (47·8 to 65·8)	43·7 (34·4 to 54·7)	15 (13 to 18)	10 (8 to 12)	6 (5 to 8)	–1·4% (–3·0 to 0·4)	–2·5% (–5·1 to 0·0)	–1·9% (–3·0 to –0·6)
Mozambique	363·4 (262·6 to 463·2)	250·0 (184·3 to 322·0)	248·7 (151·4 to 365·4)	2190 (1583 to 2791)	2339 (1724 to 3012)	2574 (1567 to 3783)	–2·9% (–5·7 to 0·2)	–0·2% (–3·9 to 3·0)	–1·7% (–4·0 to 0·5)
Rwanda	656·1 (528·6 to 791·5)	612·6 (477·4 to 766·5)	291·0 (189·9 to 400·7)	2021 (1628 to 2438)	2142 (1669 to 2680)	1185 (773 to 1631)	–0·5% (–2·6 to 1·6)	–7·6% (–11·6 to –4·0)	–3·6% (–5·6 to –1·9)
Seychelles	21·2 (16·4 to 26·7)	14·9 (11·6 to 18·9)	15·7 (12·2 to 20·7)	0 (0 to 0)	0 (0 to 0)	0 (0 to 0)	–2·7% (–5·0 to –0·2)	0·5% (–2·8 to 4·0)	–1·3% (–2·8 to 0·3)
Somalia	486·9 (276·2 to 766·6)	422·4 (264·4 to 706·2)	407·7 (247·4 to 684·2)	1574 (893 to 2479)	1673 (1047 to 2797)	1903 (1155 to 3194)	–1·1% (–4·2 to 1·9)	–0·4% (–3·5 to 2·9)	–0·8% (–2·8 to 1·6)
South Sudan	763·8 (432·8 to 1129·7)	872·9 (602·8 to 1172·3)	956·8 (685·1 to 1262·8)	2138 (1211 to 3162)	2718 (1877 to 3650)	3912 (2801 to 5163)	1·2% (–2·3 to 4·9)	0·9% (–2·5 to 4·8)	1·1% (–1·2 to 3·8)
Tanzania	498·0 (399·2 to 593·4)	622·9 (449·6 to 812·0)	389·6 (266·5 to 548·7)	5814 (4661 to 6929)	10 148 (7324 to 13 228)	7745 (5298 to 10 908)	1·7% (–0·7 to 3·9)	–4·7% (–7·9 to –1·7)	–1·1% (–2·7 to 0·4)
Uganda	296·3 (215·6 to 392·4)	461·5 (319·6 to 615·9)	324·9 (213·8 to 450·2)	2800 (2037 to 3708)	6159 (4265 to 8219)	5385 (3544 to 7461)	3·4% (1·0 to 5·9)	–3·5% (–6·6 to –0·6)	0·4% (–1·4 to 2·2)
Zambia	354·6 (256·2 to 464·3)	475·1 (301·7 to 697·1)	315·1 (206·7 to 459·3)	1283 (927 to 1679)	2435 (1547 to 3574)	2044 (1341 to 2980)	2·2% (–0·5 to 4·5)	–4·1% (–7·3 to –0·7)	–0·6% (–2·1 to 1·0)
Southern sub-Saharan Africa	150·8 (115·9 to 182·6)	490·4 (367·8 to 626·1)	279·8 (202·6 to 381·5)	2455 (1886 to 2973)	8406 (6305 to 10 733)	4898 (3547 to 6679)	9·1% (6·5 to 11·8)	–5·6% (–8·1 to –3·0)	2·7% (1·2 to 4·4)
Botswana	205·8 (101·3 to 325·6)	1061·1 (523·3 to 1793·6)	480·8 (211·8 to 828·4)	95 (47 to 151)	504 (249 to 852)	228 (100 to 393)	12·6% (6·9 to 18·0)	–8·1% (–12·5 to –3·7)	3·6% (–0·1 to 6·7)
Lesotho	189·5 (130·9 to 255·2)	606·5 (419·2 to 849·2)	510·6 (303·5 to 772·7)	107 (74 to 144)	343 (237 to 480)	295 (175 to 446)	8·9% (5·5 to 12·7)	–1·8% (–5·1 to 1·5)	4·3% (1·9 to 6·6)
Namibia	165·2 (99·1 to 223·4)	307·5 (212·4 to 440·0)	149·6 (90·3 to 236·1)	89 (54 to 121)	184 (127 to 263)	89 (54 to 141)	4·8% (1·5 to 8·5)	–7·3% (–11·5 to –3·3)	–0·5% (–2·6 to 1·6)
South Africa	134·0 (93·3 to 175·2)	341·8 (227·8 to 481·0)	174·1 (96·3 to 274·9)	1403 (977 to 1835)	3739 (2492 to 5262)	1925 (1065 to 3041)	7·2% (3·3 to 11·1)	–6·9% (–11·1 to –2·7)	1·0% (–1·6 to 3·8)
Swaziland	111·2 (78·1 to 151·1)	272·9 (191·9 to 385·2)	148·5 (91·1 to 229·1)	41 (29 to 56)	97 (68 to 137)	55 (34 to 85)	6·9% (3·2 to 10·5)	–6·2% (–10·1 to –2·2)	1·2% (–1·3 to 3·6)
Zimbabwe	185·8 (143·8 to 232·9)	840·9 (490·4 to 1238·2)	520·7 (313·5 to 786·2)	719 (556 to 901)	3539 (2064 to 5212)	2306 (1388 to 3481)	11·5% (8·3 to 14·4)	–4·8% (–8·3 to –1·4)	4·4% (2·6 to 6·3)
Western sub-Saharan Africa	480·4 (419·0 to 544·8)	563·3 (489·7 to 639·1)	468·9 (385·4 to 564·0)	44 133 (38 493 to 50 052)	69 443 (60 370 to 78 794)	70 858 (58 231 to 85 221)	1·2% (–0·2 to 2·6)	–1·9% (–3·3 to –0·3)	–0·1% (–1·1 to 0·8)
Benin	523·5 (418·4 to 619·6)	415·8 (311·4 to 522·8)	328·6 (229·2 to 441·3)	1259 (1006 to 1490)	1347 (1009 to 1694)	1246 (869 to 1674)	–1·8% (–4·1 to 0·5)	–2·4% (–5·2 to 0·2)	–2·1% (–3·6 to –0·6)

(Table 1 continues on next page)

	Maternal mortality ratio (per 100 000 livebirths)			Number of maternal deaths			Annualised rate of change in maternal mortality ratio (%)		
	1990	2003	2013	1990	2003	2013	1990–2003	2003–13	1990–2013
(Continued from previous page)									
Burkina Faso	301·5 (224·9 to 383·1)	409·2 (307·2 to 517·5)	310·5 (223·1 to 406·2)	1325 (989 to 1684)	2443 (1834 to 3090)	2185 (1570 to 2858)	2·3% (0·1 to 4·6)	−2·8% (−6·1 to 0·3)	0·1% (−1·5 to 1·6)
Cameroon	436·4 (351·7 to 510·0)	614·4 (472·3 to 789·3)	564·6 (414·0 to 743·6)	2451 (1975 to 2865)	4476 (3441 to 5750)	4772 (3499 to 6285)	2·6% (0·5 to 5·0)	−0·9% (−3·4 to 1·4)	1·1% (−0·4 to 2·6)
Cape Verde	110·4 (83·5 to 138·3)	80·5 (47·8 to 128·1)	47·6 (27·9 to 76·2)	15 (11 to 19)	9 (5 to 15)	5 (3 to 8)	−2·6% (−6·6 to 1·2)	−5·3% (−11·2 to 0·4)	−3·8% (−6·2 to −1·4)
Chad	429·8 (352·9 to 510·2)	659·2 (506·9 to 808·4)	597·6 (408·4 to 809·5)	1424 (1170 to 1691)	3245 (2496 to 3980)	3593 (2456 to 4868)	3·3% (1·3 to 5·3)	−1·1% (−3·8 to 1·3)	1·4% (−0·3 to 2·9)
Côte d'Ivoire	496·9 (374·7 to 606·4)	729·8 (521·8 to 968·7)	501·5 (354·3 to 653·9)	2539 (1915 to 3099)	4771 (3411 to 6333)	3824 (2702 to 4987)	2·9% (0·5 to 5·2)	−3·7% (−6·8 to −0·9)	0·0% (−1·4 to 1·3)
Ghana	374·3 (247·7 to 528·1)	418·1 (309·6 to 532·9)	293·4 (193·5 to 410·4)	2143 (1418 to 3024)	2933 (2172 to 3739)	2343 (1545 to 3277)	0·9% (−2·6 to 4·7)	−3·6% (−7·3 to −0·3)	−1·1% (−3·6 to 1·4)
Guinea	660·4 (564·4 to 768·8)	676·3 (542·1 to 811·8)	615·4 (470·5 to 781·9)	1966 (1680 to 2289)	2642 (2118 to 3171)	2720 (2080 to 3457)	0·2% (−1·7 to 1·8)	−1·0% (−3·1 to 1·0)	−0·3% (−1·6 to 0·9)
Guinea-Bissau	708·1 (417·3 to 1052·9)	837·7 (573·6 to 1154·5)	885·3 (616·5 to 1230·2)	334 (197 to 497)	478 (327 to 659)	576 (401 to 800)	1·4% (−1·6 to 4·5)	0·6% (−2·3 to 3·5)	1·0% (−1·0 to 3·0)
Liberia	630·1 (487·9 to 782·0)	779·5 (605·3 to 962·1)	627·3 (467·5 to 793·2)	624 (483 to 775)	1038 (806 to 1281)	974 (726 to 1232)	1·6% (−0·8 to 4·1)	−2·2% (−4·6 to 0·1)	0·0% (−1·6 to 1·4)
Mali	573·0 (500·0 to 649·8)	506·7 (415·9 to 603·8)	388·3 (300·6 to 487·3)	2326 (2030 to 2638)	2936 (2410 to 3499)	2966 (2295 to 3722)	−1·0% (−2·5 to 0·7)	−2·7% (−5·0 to −0·5)	−1·7% (−2·9 to −0·5)
Mauritania	680·6 (585·6 to 789·8)	681·0 (501·2 to 856·1)	568·8 (363·6 to 793·6)	580 (499 to 673)	772 (568 to 971)	761 (487 to 1062)	0·0% (−2·4 to 1·8)	−1·9% (−4·6 to 0·6)	−0·8% (−2·7 to 0·7)
Niger	481·0 (394·4 to 567·6)	427·3 (348·3 to 523·0)	406·5 (308·2 to 505·0)	2217 (1818 to 2616)	2920 (2379 to 3573)	3873 (2936 to 4811)	−0·9% (−2·7 to 0·9)	−0·5% (−2·9 to 1·7)	−0·7% (−2·1 to 0·5)
Nigeria	483·2 (359·9 to 608·4)	585·7 (445·6 to 717·8)	496·4 (335·9 to 666·2)	21 233 (15 814 to 26 737)	34 810 (26 480 to 42 656)	36 698 (24 829 to 49 252)	1·5% (−1·2 to 4·0)	−1·7% (−4·4 to 0·9)	0·1% (−1·8 to 1·9)
São Tomé and Príncipe	297·5 (211·4 to 395·6)	195·7 (133·1 to 251·6)	134·9 (65·2 to 208·6)	13 (9 to 18)	11 (8 to 14)	9 (4 to 14)	−3·2% (−6·6 to −0·1)	−4·0% (−9·5 to 0·9)	−3·6% (−6·5 to −1·0)
Senegal	518·8 (441·9 to 601·7)	462·2 (366·1 to 557·3)	347·2 (249·2 to 455·2)	1727 (1471 to 2003)	2018 (1598 to 2433)	1881 (1350 to 2466)	−0·9% (−2·9 to 0·9)	−2·9% (−5·5 to −0·5)	−1·8% (−3·2 to −0·5)
Sierra Leone	521·4 (383·9 to 668·2)	665·1 (535·3 to 795·8)	622·6 (447·9 to 790·5)	943 (694 to 1209)	1360 (1095 to 1627)	1399 (1006 to 1776)	1·9% (−0·6 to 4·3)	−0·7% (−3·4 to 1·6)	0·8% (−1·0 to 2·3)
The Gambia	444·4 (230·1 to 685·5)	368·2 (191·4 to 580·8)	264·5 (135·5 to 434·7)	205 (106 to 316)	232 (121 to 366)	216 (111 to 356)	−1·4% (−5·0 to 2·4)	−3·3% (−6·9 to 0·6)	−2·2% (−5·0 to 0·6)
Togo	496·7 (407·1 to 603·8)	477·4 (332·4 to 644·0)	326·2 (210·7 to 473·0)	807 (662 to 981)	1001 (697 to 1350)	817 (528 to 1185)	−0·4% (−3·1 to 2·2)	−3·9% (−7·4 to −0·4)	−1·9% (−3·8 to −0·1)

Data in parentheses are 95% uncertainty intervals.

Table 1: **Maternal mortality ratio, numbers of maternal deaths, and annualised rates of change for 21 Global Burden of Disease regions and 188 countries**

annualised rate of change from 2003 to 2013 to predict the MMR for 2030. For countries with an increasing MMR in that period, we assumed that the MMR would remain constant. We used UN Population Division forecasts of the population aged 15–49 years and births to forecast the number of maternal deaths for each country. We calculated annualised rate of change for 1990–2013 using the continuous rate-of-change formula. Achievement of the MDG 5 target would be equivalent to a sustained 5·5% decrease per year from 1990 to 2015.

Uncertainty

We report 95% uncertainty intervals (UIs) for maternal deaths, the MMR, causes of maternal death, timing of maternal deaths, and annualised rates of change. The ensemble models for maternal mortality generate 1000 draws from the posterior distribution; the validity of the UIs was confirmed through 50 iterations of cross-validation with data held out during CODEm estimation. Additionally, DisMod-MR produced 1000 draws from the posterior distribution for the cause analysis and time-of-death analysis. We assumed uncertainty in the estimated fraction of maternal deaths due to each cause or the estimated fraction of maternal deaths in different timings to be independent of the uncertainty in the occurrence of maternal mortality. We calculated uncertainty with 1000 draws from the posterior distribution of every step of the estimation process, which allows for quantification and propagation of uncertainty associated with each of the epidemiological variables in the GBD framework. These UIs are different from confidence intervals, which would only quantify

Research Council Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK (Prof C Cooper FMedSci); **National School of Public Health (ENSP/Fiocruz), Rio de Janeiro, Brazil** (I da Costa Leite PhD); **Public Health Foundation of India, New Delhi, India** (Prof L Dandona, R Dandona PhD, G A Kumar PhD, R B Kumar MD); **Public Health England, London, UK** (Prof A Davis PhD); **School of Medicine** (A Dayama MD), **Emory University, Atlanta, GA, USA** (Prof Y Liu PhD, S B Omer PhD); **The Kirby Institute** (A J Vallely PhD), **University of New South Wales, Sydney, NSW, Australia**

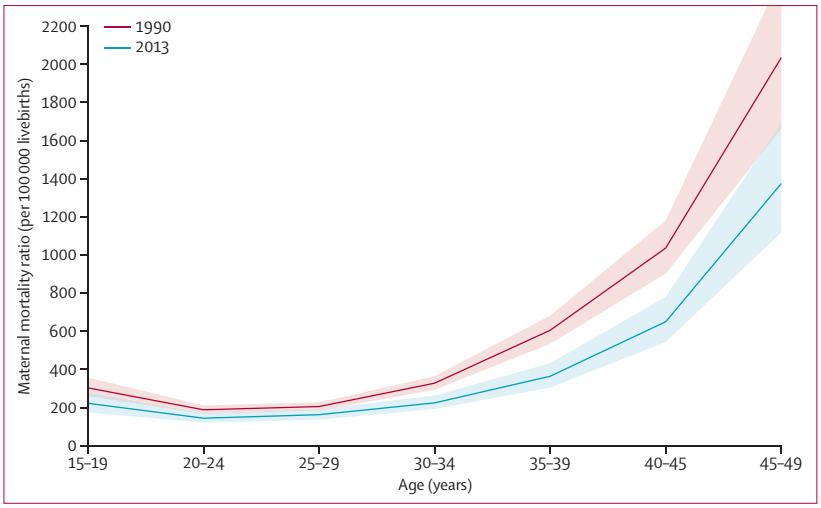

Figure 4: **Global maternal mortality ratio in 1990 and 2013, by age**
Shaded areas show 95% uncertainty intervals.

(Prof L Degenhardt PhD); **Griffith University, Brisbane, QLD, Australia** (Prof D De Leo DSc); **University of Auckland, Auckland, New Zealand** (B del Pozo-Cruz PhD); **Africa Medical and Research Foundation in Ethiopia, Addis Ababa, Ethiopia** (M Dessalegn MPH); **Hospital for Sick Children, University of Toronto, Toronto, ON, Canada** (G A deVeber MD); **University of Peradeniya, Peradeniya, Sri Lanka** (S D Dharmaratne MD); **Harvard School of Public Health** (E L Ding ScD), **Harvard University, Boston, MA, USA** (Prof J Salomon PhD); **Hatter Institute for Cardiovascular Research in Africa, Faculty of Health Sciences** (Prof K Sliwa PhD), **University of Cape Town, Cape Town, South Africa** (Prof R E Dorrington MPhil); **Sydney School of Public Health** (T R Driscoll PhD), **University of Sydney, NSW, Australia** (J Leigh PhD); **The Institute of Social and Economic Studies of Population at the Russian Academy of Sciences, Moscow, Russia** (Prof S P Ermakov DSc); **Non-Communicable Diseases Research Centre** (F Farzadfar MD), **Endocrinology and Metabolism Research Centre** (Prof A Esteghamati MD, N Hafezi-Nejad MD, S Sheikhbahaei MD), **Digestive Diseases Research Institute** (S G Sepanlou MD), **MS Research Centre** (M A Sahraian MD), **Tehran University of Medical Sciences, Tehran, Iran; Departamento de**

sampling uncertainty in the underlying data for a specific model.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The authors had access to the data in the study and had final responsibility for the decision to submit for publication.

Results

The total annual number of maternal deaths decreased from 376 034 (95% UI 343 483–407 574) in 1990, to 292 982 (261 017–327 792) in 2013 (figure 3A, table 1). The reduction accelerated steadily from 1990 to 2013 (figure 3B), with corresponding decreases in MMR (table 1). Between 2003 and 2013, the annual rate of change in MMR was greater than –1%, reaching –3·3% for 2012–13 (figure 3B).

MMR was highest in the oldest age groups and lowest in women aged 20–29 years in both 1990 and 2013 (figure 4). However, it decreased significantly between 1990 and 2013 for almost all age groups (figure 4). We used data for the proportions of births in different maternal age groups and calculated that 9·5% of maternal deaths are in the group aged 15–19 years, 43·1% in women aged 20–29 years, and 47·0% in those aged 30 years and older, with the remainder occurring in the group aged 10–14 years. Despite much higher rates of mortality in older age groups, the total number of deaths is roughly equal before and after the age of 30 years. The MMR in mothers aged 15–19 years in 2013 was 1·5 times higher than that in women aged 20–24 years, and 1·4 times higher than in those aged 25–29 years. In 2013, the MMR was 9·5 times higher for a woman aged 45–49 years (1374·4, 95% UI 1117·1–1694·9) than for a woman aged 20–24 years (144·1, 120·6–169·9).

We recorded substantial differences across the GBD regions in the trends in maternal deaths and the MMR (figure 5). Of the regions where the MMR was more than 300 in 1990, south Asia made the greatest progress by 2013 (figure 5A, table 1). In eastern and western sub-Saharan Africa, MMRs increased until 2005, but have since reduced substantially (figure 5A). The MMR in eastern sub-Saharan Africa has been changing at a rate of –4·5% per year (95% UI –6·0 to –2·8) since 2005.

Of regions that had MMRs of 100–300 in 1990, southeast Asia has had the most notable decreases (figure 5B). The MMR in the Caribbean has followed a similar trend to eastern and western sub-Saharan Africa—ie, increasing to 2005, before falling—and it has improved only slightly in north Africa and the Middle East (figure 5B). The MMR in southern sub-Saharan Africa increased greatly between 1990 and 2006, rising from 150·8 (95% UI 115·9–182·6) to 565·7 (420·1–737·2), but then fell to 279·8 (202·6–381·5) in 2013 (figure 5B).

We recorded decreases in MMRs in all regions that had an MMR of 30–100 in 1990 (figure 5C, table 1). This reduction is particularly evident in east Asia (figure 5C, table 1). The rates of change in southern Latin America and central Latin America since 2000 seem to have been slower than those before 2000 (figure 5C). In regions with low MMR in 1990 (<30), the MMR has continued to reduce slowly, except for in the high-income region of North America (figure 5D, table 1).

Except for late maternal deaths and HIV-related deaths, the absolute numbers of deaths due to every cause decreased significantly (p<0·001) from 1990 to 2013 (table 2, appendix). However, in sub-Saharan Africa, the number of deaths due to all causes increased from 1990 to 2013 (table 1). Globally, the biggest absolute reduction was in deaths due to maternal haemorrhage: from 71 295 (95% UI 64 562–78 329) in 1990, to 44 190 (38 273–50 819) in 2013. The biggest percentage decrease was in maternal sepsis, which caused 11·6% (11·4–11·8) of all maternal deaths in 1990, but 9·7% (9·5–9·9) in 2013 (figure 6A). The proportion of maternal deaths due to indirect causes increased slightly from 9·1% (95% UI 8·9–9·4) in 1990, to 10·2% (10·0–10·5) in 2013 (figure 6A). Additionally, the proportion of maternal deaths due to other direct causes rose from 16·5% (95% UI 16·3–16·8) in 1990, to 17·0% (16·7–17·3) in 2013 (figure 6A). The number of late maternal deaths decreased globally by 3·0%, from 44 814 (95% UI 36 414–53 106) in 1990, to 43 507 (35 667–52 395) deaths in 2013. In 2013, HIV accounted for 1·5% (0·9–2·0) of all maternal deaths in sub-Saharan Africa, but only 0·4% (0·2–0·6) worldwide. The number of abortion-related deaths decreased significantly at the global level (p=0·002; figure 6A) and in all regions other than Oceania, where no significant change occurred (p=0·35), and sub-Saharan Africa, where the number of deaths increased significantly after abortion (p<0·001).

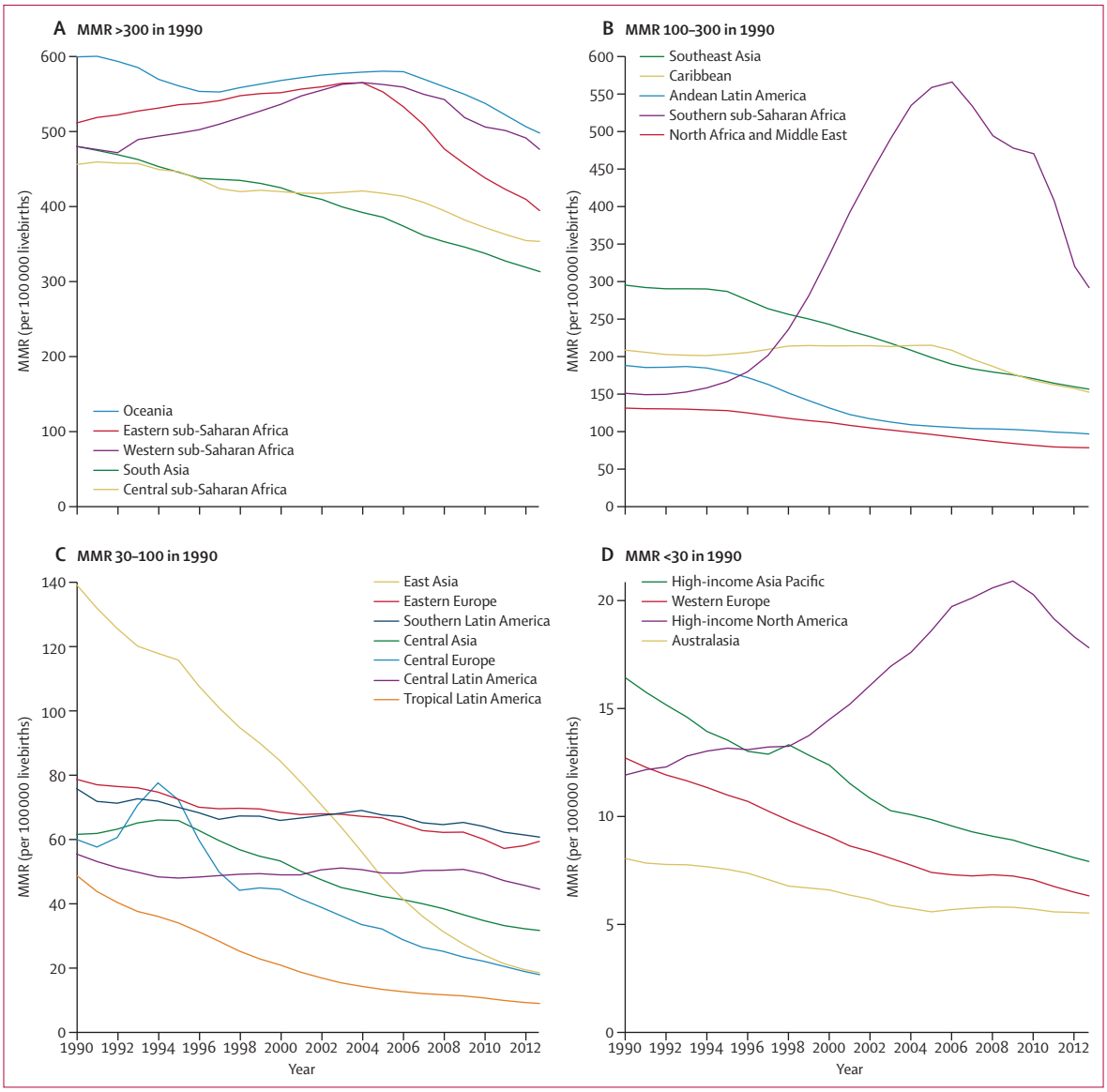

Figure 5: **Change in MMR between 1990 and 2013, by region**
MMR=maternal mortality ratio.

Cause patterns vary by regions. The two most important causes of maternal death in high-income regions in 2013 were indirect and other direct causes (figure 6B), owing largely to a decrease in abortion-related deaths, which was the most important cause of maternal mortality in high-income regions in 1990. The number of deaths due to haemorrhage, hypertension, and maternal sepsis have also decreased significantly, whereas the numbers of deaths due to indirect and late maternal causes have increased since 1990 (figure 6B, appendix). By contrast, the most important causes in low-income countries—other direct, abortion, and haemorrhage—have not changed between 1990 and 2013, although different trends are apparent in different regions. For example, east Asia had significant decreases in all causes except HIV (which was estimated to be the cause of 0·003% of all maternal deaths in 2013; appendix). The total global number of HIV-related maternal deaths in 2013 was 2070 (95% UI 1290–2866), reduced from a peak of 3280 (2041–4403) in 2004. The increase in proportion of deaths due to indirect maternal causes was most notable in Latin America and the Caribbean, where the proportion increased from 9·2% (95% UI 8·8–9·8) in 1990, to 11·5% (10·9–12·2) in 2013.

In 2013, on average, nearly a quarter of deaths occurred antepartum (24·6%, 24·1–25·2), a quarter intrapartum and immediately postpartum (27·7%, 27·1–28·2), a third

Saúde Pública, ARS Norte IP, Porto, Portugal (M M Felicio MD, C M Teixeira MD)**; Department of Medical Epidemiology and Biostatistics** (E Weiderpass PhD)**, Karolinska Institutet, Stockholm, Sweden** (S-M Fereshtehnejad MD, R Havmoeller MD)**; Northern Region Health Administration** (V M P Machado MSc)**, Public Health Department, Unidade Local de Saúde de Matosinhos, Porto, Portugal** (G M Ferreira de Lima BSC)**; Federal University of Minas Gerais, Belo Horizonte, Brazil** (E B Franca PhD)**; National Centre for Disease Control and Public Health of Georgia, Tbilisi, Georgia** (K Gambashidze MS, K Kazanjan MS, M Kereselidze MD, M Shakh-Nazarova MS, L Sturua PhD)**; Clinique Coopérative de Parakou, Parakou, Borgou, Benin** (F G Gankpé MD)**; Public Health Unit of Primary Health Care Group of Almada-Seixal, Almada, Setúbal, Portugal** (A C Garcia MPH)**; Division of Human Nutrition, Wageningen University, Wageningen, Netherlands** (J M Geleijnse PhD)**; Monash University, Melbourne, VIC, Australia** (K B Gibney MBBS, B K Lloyd PhD)**; University Hospital of Dijon, Dijon, France** (Prof M Giroud MD)**; Heller School for Social Policy and Management** (E L Glaser MA)**, Brandeis University, Waltham, MA, USA** (B T Idrisov MD, E A Undurraga PhD)**; Ministry of Labour, Health and Social Affairs, Tbilisi, Georgia** (K Goginashvili MPH)**; University of Massachusetts Medical School, Worcester, MA, USA** (Prof P Gona PhD)**; National Institute of Public Health, Cuernavaca, Mexico** (D González-Castell MSc, I B Heredia Pi PhD, F Mejia-Rodriguez MSc, J C Montañez Hernandez MSc, T G Sánchez Pimienta MSc, E E Servan-Mori MSc, S Villalpando PhD, Prof R Lozano)**; Department of Diabetes Research, National Centre for Global Health and Medicine, Tokyo, Japan** (A Goto PhD)**; School of Population Health** (D G Hoy PhD)**, University of Queensland, Brisbane, QLD, Australia** (H N Gouda PhD, L Knibbs PhD)**; Saint James School of Medicine, Kralendijk, Bonaire, Netherlands** (Prof H C Gugnani PhD)**; Kanawha**

Charleston Health Department, Charleston, WV, USA (Rahul Gupta MD); **Fortis Escorts Hospital, Jaipur, India** (Rajeev Gupta PhD); **Arabian Gulf**

subacute and delayed postpartum (35·6%, 34·9–36·2), and 12·1% (11·9–12·5) late. The biggest absolute change was in intrapartum deaths (table 2, appendix), which decreased by more than 35%, but equally notable was that despite a decrease in the mean fraction of postpartum deaths, the proportion of total deaths occurring postpartum and late actually increased at the global level (p<0·001).

	Cause of death									Timing of death			
	Abortion	Haem-orrhage	Hyper-tension	Obstructed labour	Sepsis	Late	Other direct	Indirect	HIV	Ante-partum	Intra-partum*	Postpartum†	Late
Worldwide	43 684 (38 336–49 843)	44 190 (38 275–50 819)	29 275 (25 664–33 376)	18 789 (16 281–21 747)	23 717 (20 045–27 993)	43 507 (35 667–52 395)	56 114 (48 671–64 245)	31 058 (26 818–35 679)	2070 (1290–2866)	61 176 (52 959–70 010)	64 823 (55 562–74 856)	123 476 (109 051–139 584)	43 507 (35 667–52 395)
Andean Latin America	160 (115–215)	165 (126–211)	174 (131–217)	64 (46–84)	128 (98–163)	260 (194–331)	125 (95–158)	85 (65–109)	0 (0–0)	154 (114–204)	285 (210–370)	465 (348–590)	260 (194–331)
Australasia	2 (2–3)	2 (2–3)	3 (2–4)	2 (2–3)	2 (1–2)	2 (1–2)	5 (4–6)	3 (2–4)	0 (0–0)	6 (4–8)	6 (5–8)	7 (5–9)	2 (1–2)
Caribbean	132 (83–195)	146 (90–228)	284 (198–415)	73 (43–111)	119 (80–175)	92 (50–146)	129 (81–194)	90 (53–140)	7 (4–11)	272 (168–419)	300 (163–480)	410 (276–612)	92 (50–146)
Central Asia	58 (47–72)	84 (69–100)	55 (45–67)	52 (41–67)	64 (50–80)	81 (66–100)	107 (86–133)	67 (55–83)	0 (0–0)	174 (139–215)	114 (92–141)	199 (164–242)	81 (66–100)
Central Europe	24 (20–28)	15 (12–18)	12 (10–14)	11 (9–14)	9 (7–11)	11 (8–13)	17 (14–20)	13 (10–16)	0 (0–0)	24 (19–27)	40 (33–48)	38 (31–45)	11 (8–13)
Central Latin America	331 (294–376)	478 (426–537)	563 (495–635)	196 (173–223)	227 (198–261)	215 (177–251)	446 (394–505)	486 (428–546)	1 (1–2)	513 (392–672)	1112 (917–1347)	1110 (858–1354)	215 (177–251)
Central sub-Saharan Africa	2679 (2031–3491)	2233 (1663–3018)	1645 (1215–2197)	863 (652–1106)	1386 (1010–1870)	2350 (1664–3154)	2831 (2078–3712)	1222 (823–1629)	114 (62–167)	4805 (3654–6210)	1298 (815–1876)	6902 (5184–8723)	2350 (1664–3154)
East Asia	395 (324–467)	709 (578–854)	322 (260–385)	365 (292–443)	298 (246–356)	376 (305–458)	545 (446–643)	518 (414–614)	0 (0–0)	725 (503–976)	1780 (1369–2213)	654 (439–899)	376 (305–458)
Eastern Europe	66 (54–80)	50 (39–60)	34 (26–42)	46 (34–60)	26 (20–33)	39 (27–53)	93 (75–112)	78 (62–95)	0 (0–0)	192 (150–235)	44 (28–63)	159 (127–195)	39 (27–53)
Eastern sub-Saharan Africa	10 142 (8413–12 152)	6276 (5228–7707)	5286 (4327–6467)	2718 (2248–3261)	4908 (3967–5996)	4702 (3732–5807)	13 312 (11 350–15 591)	3976 (3237–5126)	844 (524–1144)	13 429 (11 038–16 452)	9176 (7334–11 319)	24 962 (20 629–30 208)	4702 (3732–5807)
High-income Asia Pacific	17 (13–22)	22 (17–29)	12 (9–17)	10 (7–13)	13 (9–18)	7 (5–10)	26 (20–35)	21 (16–27)	0 (0–0)	51 (37–68)	33 (24–48)	37 (24–50)	7 (5–10)
High-income North America	97 (76–122)	44 (33–57)	64 (48–83)	51 (31–78)	63 (49–78)	143 (112–178)	224 (176–280)	143 (112–178)	0 (0–0)	120 (72–176)	254 (180–341)	313 (224–411)	143 (112–178)
North Africa and Middle East	1130 (843–1500)	1831 (1421–2415)	1294 (1008–1713)	838 (632–1095)	809 (610–1084)	836 (556–1206)	1300 (996–1741)	847 (616–1171)	3 (2–5)	2129 (1620–2907)	2692 (1950–3638)	3249 (2384–4402)	836 (556–1206)
Oceania	212 (108–363)	244 (123–437)	136 (68–249)	117 (59–203)	102 (53–185)	180 (92–335)	212 (111–379)	116 (58–205)	2 (1–3)	297 (151–543)	583 (308–1035)	264 (129–484)	180 (92–335)
South Asia	12 074 (9081–15 883)	16 453 (11 957–22 330)	10 656 (7805–14 072)	7099 (5425–9206)	9382 (6734–12 841)	19 900 (14 138–27 257)	19 433 (14 257–26 136)	12 601 (9303–16 472)	26 (13–43)	21 202 (15 555–27 811)	23 518 (17 274–30 621)	43 207 (32 787–55 636)	19 900 (14 138–27 257)
Southeast Asia	2638 (1964–3459)	2656 (1968–3460)	2388 (1718–3144)	1346 (941–1855)	1460 (1044–1935)	2274 (1672–3009)	3217 (2348–4232)	2001 (1498–2654)	9 (5–14)	4007 (2980–5262)	8039 (6154–10 319)	3708 (2836–4927)	2274 (1672–3009)
Southern Latin America	94 (77–115)	44 (35–54)	45 (36–56)	28 (20–37)	73 (59–88)	29 (22–36)	51 (41–61)	80 (66–98)	0 (0–1)	196 (151–246)	107 (73–150)	114 (69–158)	29 (22–36)
Southern sub-Saharan Africa	718 (488–1026)	517 (360–714)	624 (428–868)	298 (197–437)	627 (430–914)	604 (376–914)	463 (313–662)	657 (435–942)	381 (217–563)	1059 (660–1542)	1014 (571–1662)	2221 (1471–3256)	604 (376–914)
Tropical Latin America	225 (171–287)	196 (147–253)	341 (259–435)	69 (51–92)	249 (192–317)	272 (178–378)	279 (214–356)	332 (253–426)	1 (1–2)	295 (191–418)	544 (349–776)	858 (623–1158)	272 (178–378)
Western Europe	55 (45–62)	35 (29–41)	34 (28–39)	23 (19–27)	24 (20–29)	23 (18–28)	60 (50–68)	34 (28–40)	0 (0–0)	65 (52–78)	89 (74–104)	112 (92–132)	23 (18–28)
Western sub-Saharan Africa	12 436 (10 015–15 401)	11 990 (9449–15 320)	5301 (4139–6773)	4521 (3382–5992)	3749 (2745–4945)	11 114 (8229–14 535)	13 239 (10 539–16 609)	7687 (5894–9976)	680 (372–1039)	11 460 (8923–14 807)	13 795 (10 460–18 323)	34 489 (27 764–42 248)	11 114 (8229–14 535)

*Intrapartum and immediate postpartum. †Subacute and delayed postpartum.

Table 2: **Global and regional maternal deaths in 2013, by cause and timing**

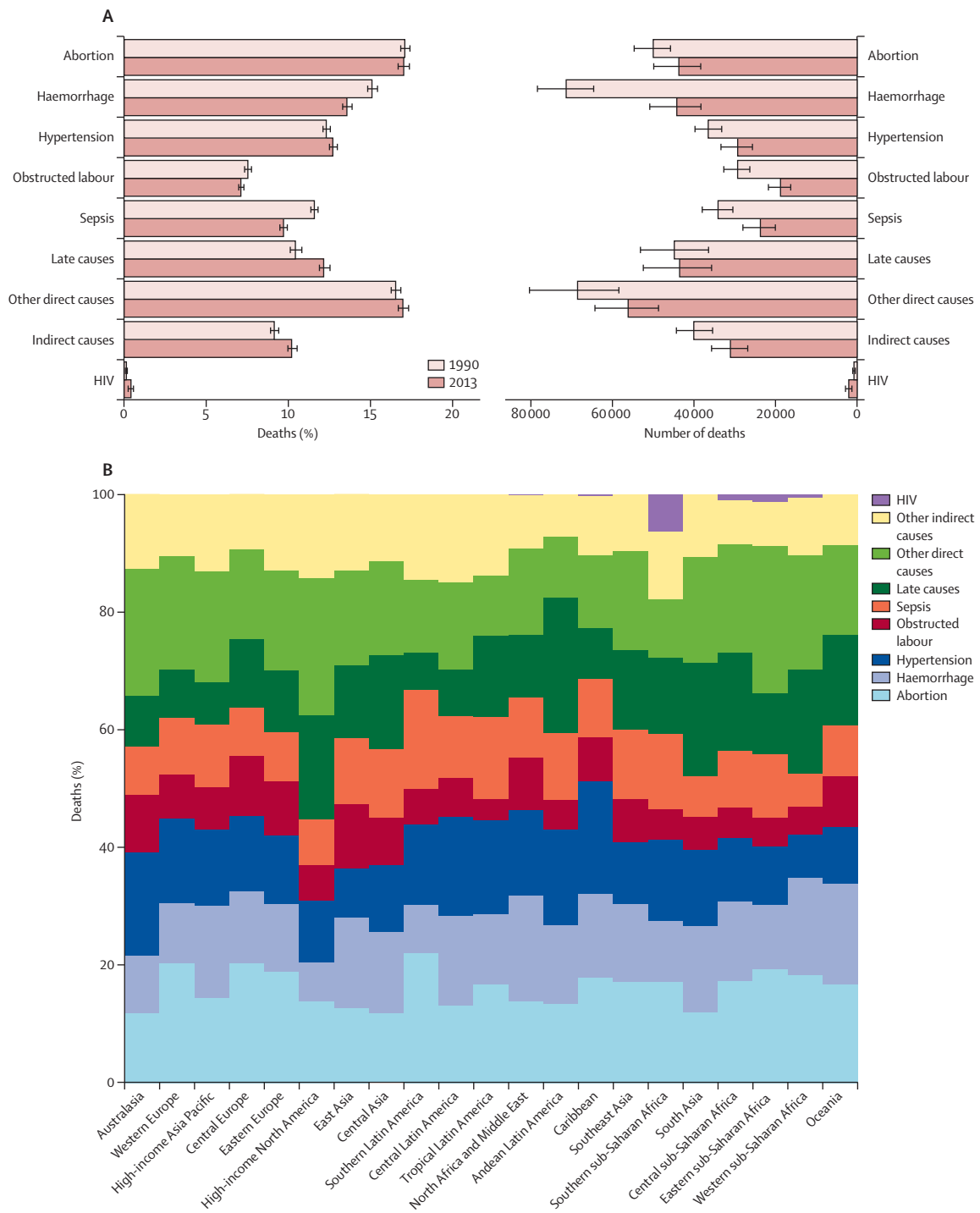

Figure 6: **Causes of maternal death**
(A) Mean proportion (left) and total number (right) of maternal deaths due to different causes in 1990 and 2013. Error bars show 95% uncertainty intervals. (B) Proportion of maternal deaths due to different causes in 2013, by region.

In 2013, 16 countries had MMRs of between 500 and 1000: Afghanistan, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Djibouti, Eritrea, Guinea, Guinea-Bissau, Liberia, Lesotho, Mauritania, Papua New Guinea, Sierra Leone, South Sudan, and Zimbabwe (figure 7, table 1). 15 countries had MMRs of less than 5: Andorra,

University, Manama, Bahrain (Prof R R Hamadeh DPhil); **Wayne County Department of Health and Human Services, Detroit, MI, USA** (M Hammami MD); **School of Medicine and Pharmacology, University of Western Australia, Perth, WA, Australia** (Prof G J Hankey MD); **Parnassia Psychiatric Institute, The Hague, Netherlands** (H W Hoek MD); **Albert Einstein College of Medicine, Bronx, NY, USA** (Prof H D Hosgood PhD); **Public Health Division, Secretariat of the Pacific Community, Noumea, New Caledonia** (D G Hoy); **Birzeit University, Birzeit, Ramallah, Palestine** (A Husseini PhD); **National Institute for Health Development, Tallinn, Estonia** (K Innos PhD, M Leinsalu PhD); **School of Public Health** (Prof N Kawakami MD), **Graduate School of Medicine** (M Inoue PhD), **University of Tokyo, Tokyo, Japan** (K Shibuya MD); **George Mason University, Fairfax, VA, USA** (K H Jacobsen PhD); **Ochsner Medical Centre, New Orleans, LA, USA** (E Jahangir MD); **Graduate School of Public Health, Yonsei University, Seoul, South Korea** (Prof S H Jee PhD); **Postgraduate Institute of Medical Education and Research, Chandigarh, India** (Prof V Jha DM); **Tianjin Centres for Diseases Control and Prevention, Tianjin, China** (G Jiang MD); **National Institute of Public Health, Copenhagen, Denmark** (Prof K Juel PhD); **Vanderbilt University, Nashville, TN, USA** (E K Kabagambe PhD, U Sampson MD); **Fudan University, Shanghai, China** (H Kan MD); **University of Balamand, Beirut, Lebanon** (N E Karam MD); **Helmholtz Centre for Infection Research, Braunschweig, Germany** (A Karch MD); **Malaria and Other Parasitic Diseases Division** (C K Karema MSc), **Ministry of Health, Kigali, Rwanda** (F Sayinzoga MD); **Oklahoma State University, Tulsa, OK, USA** (A Kaul MD); **University of California San Francisco, San Francisco, CA, USA** (D S Kazi MD); **University of São Paulo, São Paulo, Brazil** (Prof A G Kemp PhD, Prof P A Lotufo DrPH, Prof G V Polanczyk PhD, Prof I S Santos PhD); **South African Medical Research Council, Cape Town, South Africa** (A P Kengne PhD); **Jordan University of Science and Technology, Al-Ramtha, Jordan**

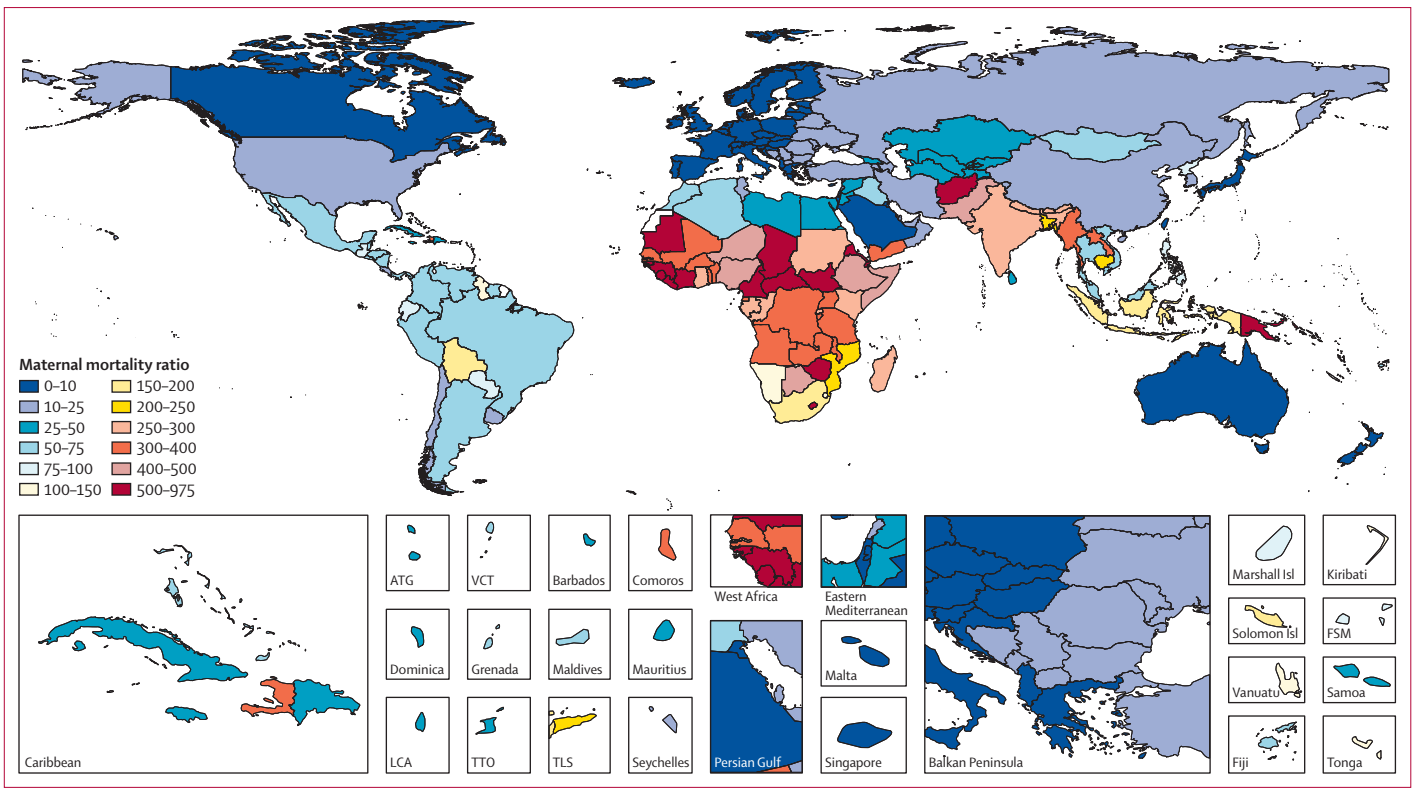

Figure 7: **Maternal mortality ratio in 2013**
ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. Isl=Islands. FSM=Federated States of Micronesia. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste.

(Prof Y S Khader ScD); **Supreme Council of Health, Doha, Qatar** (S E A H Khalifa MSc); **Health Services Academy, Islamabad, Pakistan** (E A Khan MPH); **Institute of Health Policy and Management, Seoul National University College of Medicine, Seoul, South Korea** (Prof Y-H Khang PhD); **Department of Preventive Cardiology, Department of Preventive Medicine and Epidemiologic Informatics, National Cerebral and Cardiovascular Centre, Suita, Japan** (Y Kokubo PhD); **Centre for Community Empowerment, Health Policy and Humanities, National Institute of Health Research and Development, Jakarta, Indonesia** (S Kosen MD); **University of Montreal, Montreal, QC, Canada** (Prof B Kuate Defo PhD); **Rajrajeshwari Medical College and Hospital, Bangalore, India** (Prof C Kulkarni PhD); **Arkansas State University, Jonesboro, AR, USA** (V S Kulkarni PhD); **International Institute for Population Sciences, Mumbai, India** (K Kumar MPS); **Indian**

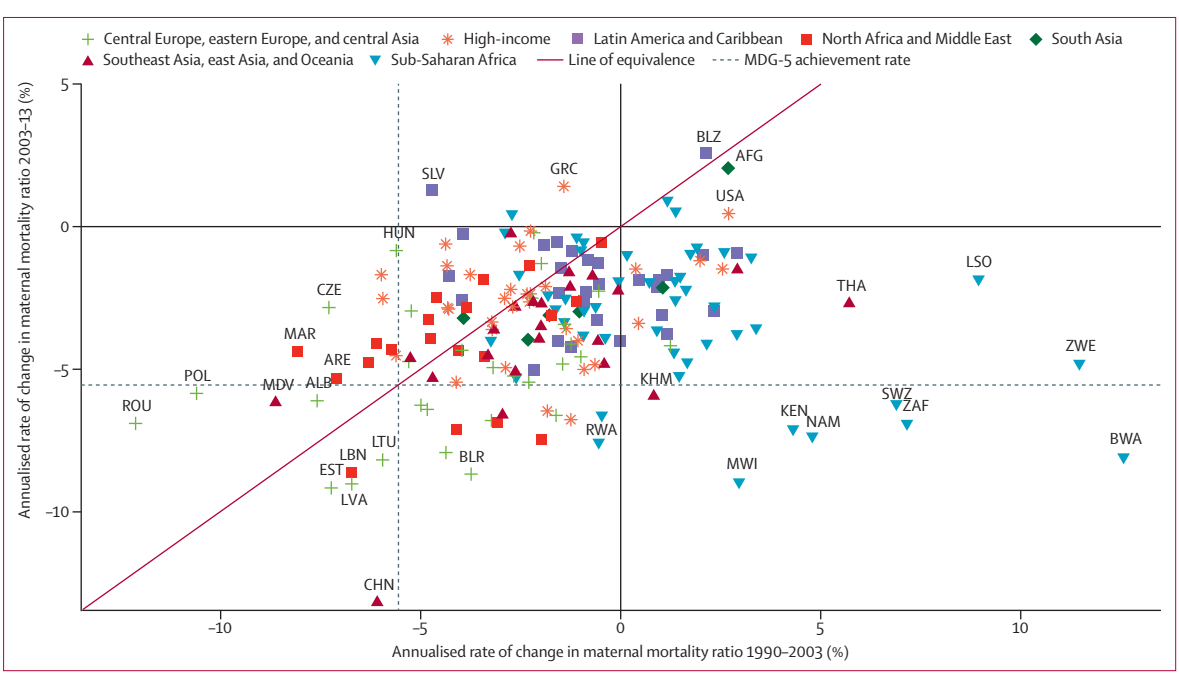

Figure 8: **Annualised rate of change in maternal mortality ratio in 1990–2003 and 2003–13**
Countries are grouped by Global Burden of Disease super-region. Countries are labelled when at or near the MDG5 achievement rate, or if they had large increases in either period. MDG=Millennium Development Goal. ROU=Romania. POL=Poland. MDV=Maldives. MAR=Morocco. ALB=Albania. CZE=Czech Republic. ARE=United Arab Emirates. EST=Estonia. LBN=Lebanon. LVA=Latvia. CHN=China. LTU=Lithuania. HUN=Hungary. SLV=El Salvador. BLR=Belarus. GRC=Greece. RWA=Rwanda. KHM=Cambodia. BLZ=Belize. AFG=Afghanistan. MWI=Malawi. KEN=Kenya. NAM=Namibia. THA=Thailand. SWZ=Swaziland. ZAF=South Africa. LSO=Lesotho. ZWE=Zimbabwe. BWA=Botswana.

Australia, Austria, Denmark, Finland, Iceland, Ireland, Israel, Italy, Malta, Norway, Poland, Singapore, Sweden, and Switzerland (table 1). Some countries had noticeably higher MMRs than neighbouring countries did (figure 7). In the Caribbean, only Guyana and Haiti had MMRs of more than 100 in 2013 (figure 7, table 1). Similarly, in South America, only Bolivia had an MMR of more than 100 (figure 7, table 1). Afghanistan had the highest MMR in south Asia, Yemen had the highest MMR in north Africa and the Middle East, and Papua New Guinea had the largest value in southeast Asia and Oceania in 2013 (figure 7, table 1). The MMR in China was 17·2 (95% UI 14·0–20·3) compared with 18·5 (14·8–22·9) in the USA. In sub-Saharan Africa, Mauritius, Seychelles, Namibia, Swaziland, Cape Verde, and São Tomé and Príncipe have MMRs of less than 150 (figure 7, table 1).

137 countries had higher annualised rates of change in MMR between 2003 and 2013 than between 1990 and 2003 (figure 8). Nevertheless, only 40 countries have achieved the MDG 5 decrease of 5·5% per year in either time interval (figure 8). From 1990 to 2013, Albania, United Arab Emirates, Bosnia and Herzegovina, Belarus, China, Estonia, Lebanon, Lithuania, Latvia, Morocco, Maldives, Mongolia, Oman, Poland, Romania, and Russia had reductions of greater than 5·5% (table 1). These countries—which represent 5·1% of all developing nations—are likely to achieve the MDG 5 target of a reduction in the MMR of three-quarters. 30 countries had annual reductions in the MMR of MDG 5 pace or better from 2003 to 2013, eight of which were in sub-Saharan Africa (Botswana, Burundi, Kenya, Malawi, Namibia, Rwanda, South Africa, and Swaziland) and ten in central and eastern Europe (Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Estonia, Latvia, Lithuania, Poland, Romania, and Russia; table 1). Between 2003 and 2013, eight countries had annualised rates of change of more than 8%: Belarus, Botswana, China, Estonia, Latvia, Lebanon, Lithuania, and Malawi (figure 8, table 1). From 1990 to 2003, MMR increased in 50 countries, 27 of which were in sub-Saharan Africa (table 1). Between 2003 and 2013, only eight countries had increases: Afghanistan, Belize, El Salvador, Guinea-Bissau, Greece, Seychelles, South Sudan, and the USA (figure 8, table 1).

In our fairly optimistic forecast scenario for 2030, we would expect 184 100 (95% UI 133 600–244 700) maternal deaths worldwide in 2030. 53 countries—all of which are in sub-Saharan Africa, except for Afghanistan, Bangladesh, Bhutan, Bolivia, Haiti, India, Indonesia, Laos, Myanmar, Nepal, Pakistan, Papua New Guinea, Solomon Islands, and Yemen—will still have MMRs of more than 100 (figure 9). Despite accelerated reductions in many countries, our simple forecasts suggest that in 2030, 74 countries are likely to still have a MMR of more

Institute of Public Health, Public Health Foundation of India, Gurgaon, India (R B Kumar); **Boston Medical Centre, Boston, MA, USA** (G Kwan MD); **Fourth View Consulting, Tallinn, Estonia** (T Lai PhD); **Australian Research Centre for Population Oral Health (ARCPOH), School of Dentistry, University of Adelaide, Adelaide, SA, Australia** (Prof R Lalloo PhD); **Institute of Health Policy and Development Studies, National Institutes of Health, Manila, Philippines** (Prof H Lam PhD); **International Agency for the Prevention of Blindness and Vision 2020, Weston, FL, USA** (V C Lansingh PhD); **Korea University, Seoul, South Korea** (Prof J-T Lee PhD, S-J Yoon PhD); **University at Albany, Rensselaer, NY, USA** (R Leung PhD); **National Centre for Birth Defects Monitoring of China, Chengdu, China** (X Li MD); **National Centre for Chronic and Non-Communicable Disease Control and Prevention** (Yichong Li MPH, S Liu PhD, J Ma PhD, Prof L Wang MD, Prof M Zhou PhD), **National Institute of Occupational Health**

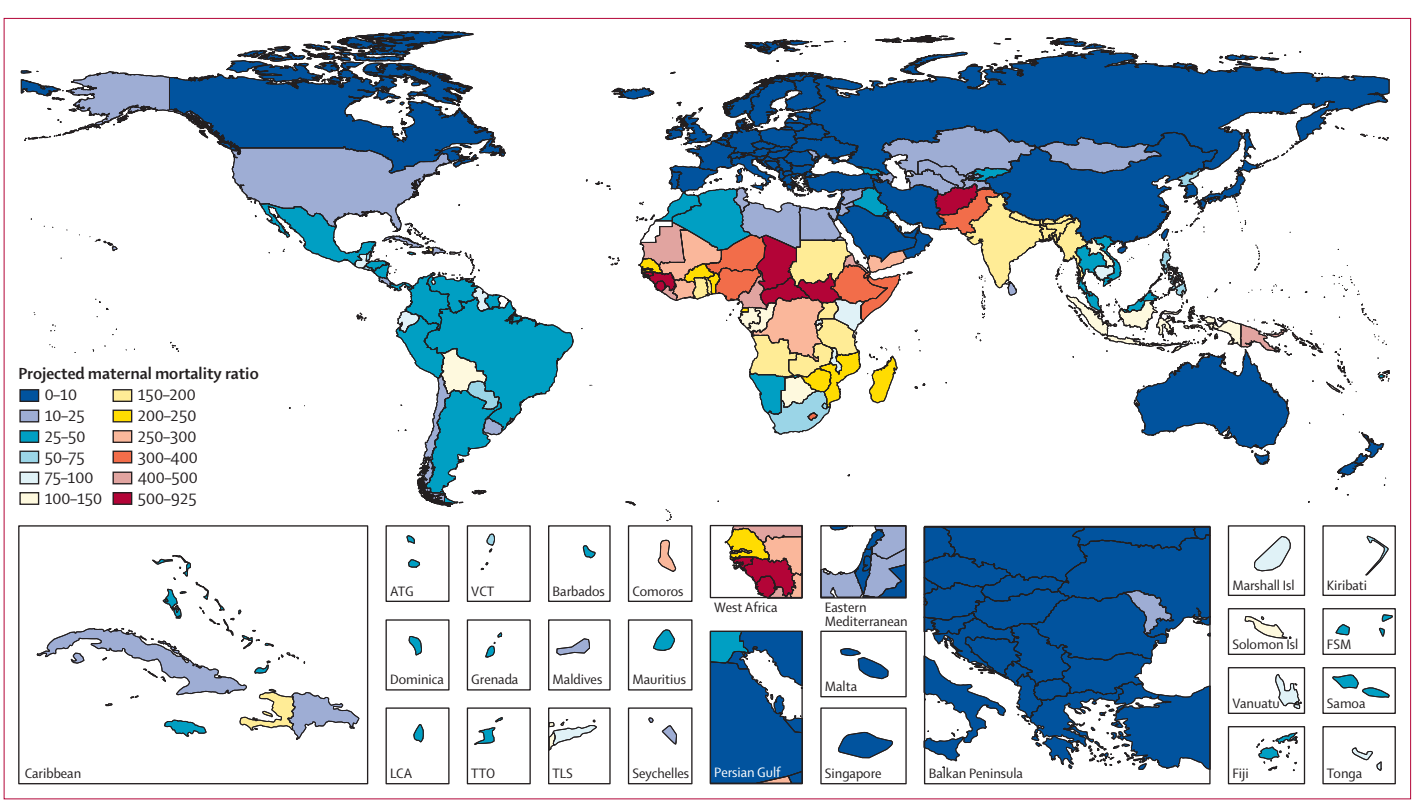

Figure 9: **Projected maternal mortality ratio in 2030**
ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. Isl=Islands. FSM=Federated States of Micronesia. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste.

and Poison Control (Prof F Tan MD), Chinese Centre for Disease Control and Prevention, Beijing, China (X Liang PhD); Genentech, South San Francisco, CA, USA (Yongmei Li PhD); National Office for Maternal and Child Health Surveillance, West China Second University Hospital, Sichuan University, Chengdu, China (Prof J Liang MD, Prof Y Wang MS, Prof J Zhu MD); Wayne State University, Miami, FL, USA (S E Lipshultz MD); National Institute of Environmental Health Sciences, Research Triangle Park, NC, USA (S J London MD); Ministry of Health Singapore, Singapore, Singapore (S Ma PhD); Xpharmconsult, Kumasi, Ghana (N K Mainoo MMRCB); Department of Public Health, Faculty of Health Sciences and Social Work, Trnava University, Trnava, Slovakia (M Majdan PhD); University of Zambia, Lusaka, Zambia (C C Mapoma PhD); Queen Mary University of London, London, UK (Prof W Marcenes PhD); University of the East Ramon Magsaysay Memorial Medical Centre, Quezon City, Philippines (M B Marzan MSPH); University of York, York, UK (A J Mason-Jones PhD); Janakpuri Super Specialty Hospital, New Delhi, India (Prof M M Mehndiratta MD); UN Population Fund, Lima, Peru (W Mendoza MD); Pacific Institute for Research and Evaluation, Calverton, MD, USA (T R Miller PhD); University of Ottawa, Ottawa, ON, Canada (E J Mills PhD); University of Papua New Guinea, Port Moresby, Papua New Guinea (Prof G L Mola MD); Institute for Maternal and Child Health Istituto di Ricovero e Cura a Carattere Scientifico Burlo Garofolo, Trieste, Italy (L Monasta DSc, L Ronfani PhD); Bureau of International Health Cooperation, Manila City, Philippines (J de la Cruz Monis MSc); University of North Texas, Denton, TX, USA (Prof A R Moore PhD); National Centre for Child Health and Development, Setagaya, Tokyo, Japan (R Mori PhD); Philipps-University Marburg, Marburg, Germany (Prof U O Mueller PhD, R Westerman PhD); Tokyo Medical and Dental University,

than 50, and 89 countries will have MMRs of less than 30, compared with 72 countries in 2013.

Discussion

On the basis of recent data and a refined understanding of the association between HIV and maternal mortality, we have shown that worldwide maternal mortality has decreased by 1·3% per year since 1990. Despite reductions in the number of maternal deaths—from about 376 000 in 1990 to about 293 000 in 2013—only 16 countries, seven of which are developing countries, are expected to achieve the MDG 5 target of a 75% reduction in the MMR by 2015. We noted two different patterns in developing countries: sustained substantial decreases in most of Asia and Latin America, and stagnation or increases from 1990 to 2003 in sub-Saharan Africa and Oceania. Increases in some high-income countries such as the USA are a deviation from the general trend downwards in developed countries. However, the substantial acceleration in the decreases since 2003—especially in sub-Saharan Africa—provides hope that more countries can achieve rapid and sustained reductions.

Ambitious calls for progress in maternal mortality in the next 15–20 years and reductions in MMRs to less than 30 in all countries have been deemed financially and technically feasible.[48] Our finding that rates of change in maternal mortality in some developing countries have exceeded 8% in the past decade (eg, in China) lends support to ambitious aspirational goals. However, on the accelerated trajectory from 2003 to 2013, MMRs will still be high in several countries in west and central Africa, and in the Horn of Africa. Unsurprisingly, projections for child mortality in 2030 are also high in these areas of the world. A focus on levels of maternal mortality equivalent to those in high-income nations in all countries will need special policy attention, national action, and global investment in the countries that are predicted to be left far behind a grand convergence. Many of the countries in central and west Africa that will present the greatest challenge to achievement of low MMRs have historically received less development assistance for health than have other low-income countries.[49] Although development assistance for maternal, newborn, and child health has been increasing at a pace faster than that for most thematic areas, excluding HIV, especially since 2009, increases in central and west Africa have not been as large as in other regions. A new focus on these countries will probably need action by multilateral, bilateral, and private global health funders, and shifts in the historical allocation of funds across low-income countries.

The drivers of improvement (or lack thereof) in underlying causes of maternal deaths have important clinical, public health, and policy implications. Maternal mortality has been successfully reduced in many countries. Although the absolute numbers of deaths due to abortion, maternal haemorrhage, and hypertensive disorders of pregnancy have decreased in real terms, these causes remain important, collectively accounting for nearly 50% of all deaths. Continued promotion of policies to reduce anaemia and malnutrition, prevent malaria in pregnancy, provide calcium and micronutrient supplementation, encourage skilled birth attendance and in-facility delivery, discourage early motherhood, and reduce unsafe abortion should lead to sustained dividends.[50–52] Such focus should be expected to reduce the risk of life-threatening complications of pregnancy, but the complications will not be eliminated altogether. Increased coverage of skilled birth attendance and delivery in facilities properly resourced for emergency obstetric care is essential for prevention of these deaths.

Health-system re-engineering is necessary to begin preparations for the new challenges that lie ahead. The increasing relative importance of other direct, indirect, and late maternal causes of death is consistent with global epidemiological transition, and suggests that many health systems are inadequate to meet the needs of an increasing number of pregnant women with pre-existing conditions and high-risk pregnancies. The risks of sepsis-related deaths are known to be increased by the prevalence of obesity and diabetes in women of reproductive age.[53] Moreover, because of the inherent difficulty in diagnosis of maternal sepsis, the problem could be larger than we have estimated in countries with high overall maternal mortality. Therefore, prevention of sepsis will need not only a focus on medical management of comorbidities, but also improved sanitation and access to routine prophylactic antibiotics during caesarean section for facilities that intend to provide such a service, both of which have been shown to be effective and cost-effective strategies to reduce maternal death.[54,55]

Many diseases—eg, sickle-cell anaemia, obesity, diabetes, hypertension, and chronic kidney conditions—confer increased mortality risk during pregnancy. These indirect causes of maternal death are likely to continue increasing in importance where they are commonly encountered.[56–60] A focus on health-system strengthening will be needed to reduce the effect of other direct causes of maternal death, because the most likely underlying aetiologies are complications of anaesthesia, embolism (air, amniotic fluid, and blood clot), and the less common but often fatal condition of peripartum cardiomyopathy.[61–64] Health systems must begin to plan for these changes through increasing the size and training of the perioperative workforce and investment in family planning services, adequate infrastructural resources for facilities, and systems to identify and follow women who are at risk of life-threatening puerperial and postpartum complications.

In 2013, HIV accounted for 1·5% of maternal deaths in sub-Saharan Africa, rising to 6·2% in southern sub-Saharan Africa. However, HIV infection is associated with the smallest number of deaths worldwide of any of the causes we examined. Increased ART coverage has led to reduced HIV-related mortality in sub-Saharan Africa and

has been associated with decreased mortality in HIV-positive women during pregnancy.[45,65] Nevertheless, the increase in maternal mortality during the mid-2000s in southern Africa is well in excess of the number of HIV-associated maternal deaths. There are at least four possible explanations for this finding. First, we could have underestimated the RR of death for a pregnant woman with HIV infection compared with a pregnant woman without HIV infection. Our meta-analysis results are consistent with previous studies, but the RR could be biased downwards if included studies are from areas with better care or access to ART.[22,34] Second, we could have overestimated maternal mortality if the UNAIDS Spectrum estimates of HIV prevalence in pregnancy are underestimates. These values suggest that age-specific fertility rates decrease by 24% in HIV-positive women compared with HIV-negative women when aged 20–24 years, but fertility decreases by 56% by age 45–49 years.[66] Third, we assume the RR is generalisable across different levels of HIV prevalence in pregnant women, which might not be true. Fourth, the HIV epidemic could be diverting resources from maternal care because of a huge demand for care. Although this situation is theoretically possible, several studies and reports have not shown this relation; indeed, there could be synergies between ART scale-up and clinic and hospital productivity.[67] Perhaps the most important finding is that with the scale-up of ART, MMR seems to decrease rapidly (eg, in Malawi).[68]

In our study, we have not tested the association between development assistance for maternal health programmes and MMR. However, accelerated decreases occurred in 106 of 138 developing countries in 2003—3 years after the Millennium Declaration—coinciding with the scale-up of development assistance for maternal and child health programmes.[49] Rigorous testing of the hypothesis that global priority setting and investments in maternal health programmes have had an important role in the acceleration of progress is needed. This research is important because it could strengthen the basis on which post-2015 requests for funding of continued expansion of maternal health services are made. Because we have reported much slower rates of change than the UN has,[6] the importance of establishing the case for continued investment in maternal health programmes is even greater; ambitious goals for regions such as sub-Saharan Africa will probably need major investments.

We compared our estimates of maternal mortality with those from the GBD 2010 and the 2012 UN estimates.[6] The correlation between our MMR estimates and those of GBD 2010 for 1990 was 0·96, and for 2010 was 0·89. The correlation figures with the UN analysis for the same two periods were 0·88 and 0·85. Perhaps the most notable difference between the UN 2012 analysis and ours is the number of maternal deaths in 1990: 543 000 compared with 376 000. The difference in numbers for 2010 is smaller: 287 000 deaths compared with 317 300. The much higher number from the UN for 1990 raises the estimated annualised rate of change in the MMR from 1990 to 2010 substantially, to –3·1% per year compared with –1·1% per year in our study. One of the most important differences between our assessment and the UN's seems to be related to the WHO estimates of reproductive-age mortality in some

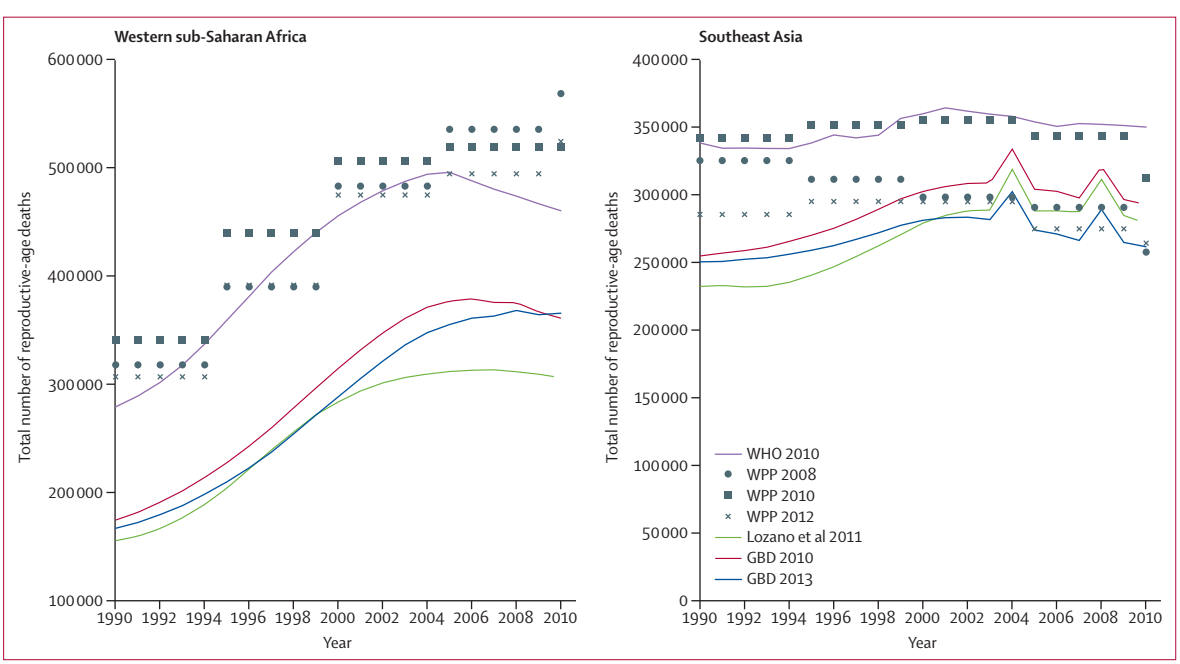

Figure 10: **Comparison of all-cause reproductive-age mortality envelopes between 1990 and 2010**
WPP=World Population Prospects. GBD=Global Burden of Disease Study.

Tokyo, Japan (M Mukaigawara MD); **International Centre for Diarrhoeal Diseases Research, Dhaka, Bangladesh** (A Naheed PhD); **University of KwaZulu-Natal, Durban, South Africa** (Prof K S Naidoo PhD); **Ministry of Health Fiji, Suva, Fiji** (D Nand MPH); **Suraj Eye Institute, Nagpur, India** (Prof V Nangia MD); **School of Public Health, State University of New York, New York, NY, USA** (D Nash PhD); **Faculty of Medicine, Fez, Morocco** (Prof C Nejjari PhD); **National Institute of Diabetes and Digestive and Kidney Diseases, Phoenix, AZ, USA** (R G Nelson PhD); **Norwegian Centre for Addiction Research (SERAF), University of Oslo, Oslo, Norway** (S P Neupane MBBS); **Kenya Medical Research Institute Wellcome Trust Programme, Kilifi, Kenya** (Prof C R Newton MD); **Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain** (M J Nieuwenhuijsen PhD); **University of Bergen, Bergen, Norway** (Prof O F Norheim PhD); **Kyung Hee Unversity, Seoul, South Korea** (I-H Oh PhD); **Teikyo University School of Medicine, Tokyo, Japan** (Prof T Ohkubo MD); **Centre for Healthy Start Initiative, Lagos, Nigeria** (B O Olusanya PhD); **Lira District Local Government, Lira Municipal Council, Lira, Uganda** (J N Opio MPH); **Toxicology Unit, Faculty of Pharmacy, University of Port Harcourt, Port Harcourt, Nigeria** (Prof O E Orisakwe PhD); **Christian Medical College Ludhiana, Ludhiana, India** (J D Pandian MD); **Sungkyunkwan University School of Medicine, Suwon, South Korea** (Prof J-H Park MPH); **Universidad de Cartagena, Cartagena, Colombia** (A J Paternina Caicedo MSc); **University of Calgary, Calgary, AB, Canada** (Prof S B Patten PhD); **All India Institute of Medical Sciences (AIIMS), New Delhi, India** (Prof V K Paul MD); **WHO, Waigani, Papua New Guinea** (B I Pavlin MD); **London School of Hygiene & Tropical Medicine, London, UK** (Prof N Pearce PhD); **3B's Research Group in Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and**

Regenerative Medicine, and ICVS/3B's PT Government Associate Laboratory, Braga Portugal (Prof D M Pereira PhD); Flinders University, Adelaide, SA, Australia (Prof K Pesudovs PhD); Centre for Applied Biostatistics, Sahlgrenska Academy, University of Gothenburg, Sweden (Prof M Petzold PhD); McMaster University, Hamilton, ON, Canada (D Poenaru MD); Erasmus Medical Center, Department of Public Health, Rotterdam, Netherlands (S Polinder PhD); University of Liverpool, Liverpool, UK (D Pope PhD); University of British Columbia, Vancouver, BC, Canada (F Pourmalek PhD); College of Pharmacy (D Qato PhD), University of Illinois, Chicago, IL, USA (K M Tabb PhD); Contech International, Lahore, Pakistan (A Rafay MS); Sina Trauma and Surgery Research Centre, Department of Neurosurgery, Shariati Hospital and Research Centre for Neural Repair, University of Tehran, Tehran, Iran (Prof V Rahimi-Movaghar MD); Hamad Medical Corporation, Doha, Qatar

regions with high fractions of reproductive-age mortality due to maternal causes. These estimates are substantially higher than the GBD 2013 estimates for west Africa, north Africa and the Middle East, and southeast Asia in 1990, ranging from 7% higher in Ghana to 58% higher in Nigeria. The differences between estimates of reproductive-age mortality in western sub-Saharan Africa and southeast Asia are large (figure 10). In some cases, the most recent UN Population Division estimates (World Population Prospects 2012) converge towards the GBD estimates, although WHO estimates are substantially higher (figure 10). The UN Population Division and WHO almost exclusively predict levels of adult mortality in west Africa on the basis of child mortality, whereas we make substantial use of survey and census data from the region in our GBD analysis.[69] The reasons for the changes between successive revisions of maternal mortality estimates depend on the country, but are driven both by new data for levels of reproductive-age mortality and maternal causes or the fraction of deaths that are related to pregnancy.

Our study, which brings together a wide array of data sources for the levels, causes, and timing of maternal deaths for many countries, has important limitations. First, although ICD-coded vital registration systems have clear rules for assignment of causes of death, we used census and survey data for the fraction of deaths to distinguish explicitly between deaths caused by pregnancy (maternal deaths) and those that were incidental (pregnancy-related deaths). We made adjustments for incidental deaths related to HIV, but have not made similar adjustments for other types of incidental deaths due to causes such as injuries. Studies[70,71] suggest that deaths due to injury are less common in non-pregnant women than in pregnant women of the same age, but they do occur in both groups, which leads to a bias upwards in our assessment. That bias must be tempered with the potential bias that sibling and household reports of pregnancy-related deaths could lead to selective under-reporting of abortion-related deaths.[72] Second, uncertainty in the estimates of maternal death in many countries is substantial.[73] Within the same country, sources can differ widely. For example, we used many different types of sources in India: in rural regions, data are largely from the Survey of Causes of Death-Rural, the Sample Registration System, and verbal autopsy studies, whereas Medical Certification of Causes of Death covers largely urban populations.[4]

Third, there is still no definitive way to estimate the interaction of HIV and pregnancy in death. Only 21 studies were available for estimation of the excess risk of death during pregnancy in women with HIV. Only two studies[44,45] inform the excess risk of death during pregnancy in women with HIV. These two studies provide widely divergent findings and could reflect the complex interaction between ART (and the associated greater care received by women taking it) and pregnancy as much as the effect of pregnancy on the progression of HIV. As such data continue to be developed and because of the important implications for policy making, we will continue to work to find new data sources, improve data quality, and incorporate updated methods as necessary to continue providing updates for global, regional, and national maternal mortality.

Fourth, because of sparse data, we could not quantify the contributions of other infections, such as influenza (eg, H1N1), malaria, tuberculosis, and hepatitis, to maternal mortality at the population level.[74] Fifth, our method of estimating the detailed causes of maternal death used all available data, but such specific data are not available for many countries, or, if they are available, are coarse with respect to age. Therefore, we might have underestimated the true extent of the interplay between cause and age in maternal mortality and differences between countries in the same region.

Sixth, we have estimated UIs for each component of the analysis. CODEm provides confirmation that the UIs for the maternal mortality model have a data coverage of 97·9%, so they could be slightly overestimated. Finally, our estimates of maternal mortality are affected by estimates in each age group of other causes of death developed for the GBD 2013 because of the requirement that cause-specific mortality must sum to all-cause

Panel: Research in context

Our analysis continues a body of analytical work into levels and trends in maternal mortality that began with Hogan and colleagues' report[4] and was followed by that by Lozano and colleagues[5] and the Global Burden of Disease Study 2010 (GBD 2010).[16] With each subsequent study, there have been important advances in the data available for analysis and the methods of analysis. Lozano and colleagues[5] moved from one preferred regression model, as used by Hogan and colleagues and the UN measurement efforts,[6,20] to an ensemble of multiple models developed through rigorous out-of-sample predictive validity testing. The maternal mortality analysis included in GBD 2010 extended the analysis in two important ways: maternal mortality was assessed with all other causes of death subject to the constraint that sum of individual causes of death equalled the demographic assessment of all-cause mortality in each age group of reproductive-age women, and it included estimates of the major causes of maternal mortality. In our study, in addition to 2421 site-years of new data, several important methodological innovations improve the estimation of maternal mortality. First, we have analysed sibling history data for the fraction of reproductive-age deaths that are related to pregnancy by calendar year for each 5-year age group of mothers, pooling data from several surveys when events for the same calendar year were recorded. Second, we have substantially revised the approach to understand the effect of HIV on maternal mortality. We did a systematic review and used relative risks from cohort studies to accurately assign a fairly small fraction of HIV-related deaths during pregnancy or the puerperium to be maternal deaths. Third, we have quantified other direct maternal causes, indirect maternal causes, and late maternal death for the first time. Fourth, we have analysed previous reports and other sources about the timing of maternal deaths to provide guidance on when most deaths occur. Our data and improved methods have led to a different understanding of the evolution of global maternal deaths with important implications for target setting in the post-MDG era.

mortality. Errors in the estimates for other causes of death could bias upwards or downwards our assessments of maternal mortality.

An important part of improved measurement in the future is a recommendation that surveillance of late maternal mortality (>42 days but <1 year) be included in surveys and censuses. With the assumption that maternal mortality will continue to decrease, severe maternal morbidity or so-called near miss cases are likely to increase, some of which might be expected to lead to increased late maternal death.[54] Perhaps more importantly for some regions, HIV has been described by some as being a risk factor for late maternal death. If this description is true, these deaths might not be captured appropriately, because neither reproductive health surveys nor demographic and health surveys quantify late maternal death. In view of the major dependency on sibling histories and the recall of pregnancy-related deaths in household surveys, major changes would be necessary to track late maternal deaths through these instruments.

Measurement of maternal mortality remains challenging (panel). It depends both on robust demographic assessment of reproductive-age mortality rates and data for the fraction of deaths in each age group that are maternal or related to pregnancy. Changes between systematic analyses in the levels and trends in maternal mortality are larger than for child mortality. As a result, users of any assessment of maternal mortality need to recognise that assessments could change as new data are identified or obtained. Despite continuing measurement challenges, there are strong reasons to continue a global focus on reductions in maternal death in the next 15–20 years. An important adjunct to both the framing of new goals and mobilisation of action for them will be regular updates about the evidence in the trends for maternal mortality by age, cause, and timing. We believe that it is this evidence that should fuel and inspire debates and policies to reduce maternal deaths. We believe the evidence is convincing that decreases in the MMR have accelerated in several countries since 2003. These accelerations should be carefully studied to provide qualitative insights into what has worked in different settings. As new global targets for maternal mortality are developed, it will be important to take lessons from these insights, but also begin planning for the evolving health and health-care needs of women of reproductive age. Achievement (or not) of arbitrary goals established without proper regard to the distribution of rates of change prevailing at the time is a political construct that obscures knowledge and praise for the substantial progress that has been made to reduce maternal mortality in the past decade. Furthermore, accelerated decreases in maternal mortality will be more likely if the evidence from policy responses in these countries is widely and effectively disseminated and implemented.

Contributors

NJK and CJLM prepared the first draft. NJK, CS, ADL, CJLM, and RL finalised the draft on the basis of comments from other authors and reviewer feedback. NJK, ADL, CJLM, and RL conceived the study and provided overall guidance. NJK completed all modelling. NJK, AB-V, and MSC did the statistical analysis of model results. All other authors provided data, developed models, reviewed results, initiated modelling infrastructure, and reviewed the report.

Declaration of interests

Cyrus Cooper has received consultancy fees, lecture fees, and honoraria from Amgen, GlaxoSmithKline, Alliance for Better Bone Health, Merck Sharp and Dohme, Eli Lilly, Pfizer, Novartis, Servier, Medtronic, and Roche. Katherine B Gibney received the National Health and Medical Research Council Gustav Nossal scholarship sponsored by CSL in 2012; this award is peer-reviewed through the standard National Health and Medical Research Countil peer-review process, and CSL does not play any part in selection of the awardee. Norito Kawakami has received fees from Meiji, Otsuka, EAP Consulting, Fujitsu Software Technologies, Japan Productivity Center, Occupational Health Foundation, Japan Housing Finance Agency, Aishin-Seiki, and the Japan Dental Association; consultancy fees from Sekisui Chemicals, Junpukai Health Care Center, and Osaka Chamber of Commerce and Industry; and royalties from Igaku-Shoin, Taisha-kan, Nanko-do, Nanzan-do, PHP Publication, and Fujitsu Software Technologies. Norito Kawakami has also received research grants from the Japanese Ministry of Education, Science, and Technology; the Japanese Ministry of Health, Labor and Welfare; Fujitsu Software Technologies; Softbank; and Japan Management Association. Guilherme V Polanczyk has received grants or research support from the National Council for Scientific and Technological Development, the São Paulo Research Foundation, and the University of São Paulo; has served as a paid consultant to Shire; has served on the speakers' bureau of Shire; and has received royalties from Editora Manole. Jasvinder A Singh has received research grants from Takeda and Savient; has received consultant fees from Savient, Takeda, Regeneron, and Allergan; is a member of the executive of OMERACT, an organisation that develops outcome measures in rheumatology and receives arms-length funding from 36 companies; is a member of the American College of Rheumatology's Guidelines Subcommittee of the Quality of Care Committee; and is a member of the Veterans Affairs Rheumatology Field Advisory Committee. The other authors declare no competing interests.

Acknowledgments

We thank the countless individuals who have contributed to the Global Burden of Disease Study 2013 in various capacities. We would like to acknowledge the extensive support from all staff members at the Institute for Health Metrics and Evaluation and specifically thank: Michael F MacIntyre, Peter Speyer, and Summer Lockett Ohno for their management of the Global Burden of Disease Study 2013; Kelsey Pierce for her valuable guidance; Peter Speyer, James Bullard, Serkan Yalcin, Edgar Sioson, Evan Laurie, Charles Atkinson, and Andrew Ernst for their tireless support of the computational infrastructure necessary to produce the results; Linda A Ettinger for her expert administrative support; Peter Speyer, Abigail McLain, Marissa Iannarone, and Eden Stork for their persistent and invaluable work to gain access to and catalogue as much data as possible to inform the estimates; Emily A Dansereau, D Allen Roberts, Katrina Ortblad, Herbert C Duber, Elizabeth K Johnson, and Jonathan C Brown for their efforts in developing and improving the HIV modeling process; Nicholas Graetz for computational support; Madeline L Moyer, Bryan K Phillips, Lee Richardson, Logan Sandar, and Stan Biryukov for data extraction and processing; Christopher Margono for assistance with referencing and submission; Thomas D Fleming for covariates and literature references support; and Meghan D Mooney for coordination of all-cause mortality estimates. No individuals acknowledged received additional compensation for their efforts.

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(S ur Rahman FRCPCH)**; University of Missouri, Columbia, MO, USA** (M Raju PhD)**; Department of Public Health, University of the Punjab, Lahore, Pakistan** (S M Rana PhD)**; Walden University, Minneapolis, MN, USA** (Prof A Refaat PhD)**; Bhaba Atomic Research Center Hospital, Mumbai, India** (N Roy MD)**; Marshall University, Huntington, WV, USA** (M Sawhney PhD)**; Federal University of Santa Catarina, Florianópolis, Brazil** (I J C Schneider PhD)**; University of Alabama at Birmingham, Birmingham, AL, USA** (D C Schwebel PhD, J A Singh MD)**; Stellenbosch University, Cape Town, South Africa** (Prof S Seedat PhD)**; Health Canada, Ottawa, ON, Canada** (H H Shin PhD, S Weichenthal PhD)**; Heriot-Watt University, Edinburgh, UK** (I Shiue PhD)**; Reykjavik University, Reykjavik, Iceland** (I D Sigfusdottir PhD)**; University of Pennsylvania, Philadelphia, PA, USA** (Prof D H Silberberg MD)**; Instituto Nacional de Epidemiología Dr Juan H Jara, Mar del Plata, Buenos Aires, Argentina** (A P Silva MgSc)**; Norwegian Institute of Public Health, Oslo, Norway** (Prof V Skirbekk PhD)**; Federal Research Institute for Health Organisation and Informatics of Ministry of Health of the Russian Federation, Moscow, Russia** (S S Soshnikov PhD)**; Department of Clinical Neurological Sciences, Western University, London, ON, Canada** (L A Sposato MD)**; University Tunku Abdul Rahman, Kajang, Malaysia** (C T Sreeramareddy MD)**; Hellenic Centre for Disease Control and Prevention (KEELPNO) Greece, Athens, Greece** (K Stroumpoulis PhD)**; Department of Criminology, Law and Society (and Sociology), University of California Irvine, Irvine, CA, USA** (B L Sykes PhD)**; Ministry of Public Health, Yaounde, Cameroon** (R T Talongwa MD)**; Memorial University, St John's, NL, Canada** (E Y Tenkorang PhD)**; Department of Anesthesiology, University of Virginia, Charlottesville, VA, USA** (A S Terkawi MD)**; Department of Anesthesiology, King Fahad Medical City, Riyadh, Saudi Arabia** (A S Terkawi)**; The Earth Institute, Columbia University, New York, NY, USA** (A L Thorne-Lyman ScD)**;**

Cincinnati Children's Hospital Medical Centre, Cincinnati, OH, USA (Prof J A Towbin MD)**; Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA** (B X Tran PhD)**; Department of Medicine, University of Crete, Heraklion, Greece** (Prof M Tsilimbaris PhD)**; Department of Veterans Affairs, Washington, DC, USA** (U S Uchendu MD)**; Department of Internal Medicine, Federal Teaching Hospital Abakaliki, Abakaliki, Nigeria** (K N Ukwaja MD)**; National Institute for Public Health and the Environment, Bilthoven, Netherlands** (C H van Gool PhD)**; UKK Institute for Health Promotion Research, Tampere, Finland** (Prof T J Vasankari PhD)**; Neuroscience Centre, Raffles Hospital, Singapore** (N Venketasubramanian MD)**; University of Bologna, Bologna, Italy** (Prof F S Violante MD)**; Higher School of Economics, Moscow, Russia** (Prof V V Vlassov MD)**; Uniformed Services University of Health Sciences, Bethesda, MD, USA** (S Waller MD)**; Jinan Institute of Research on Aging, Jinan, China** (S X Wang PhD)**; Murdoch Children's Research Institute, Royal Children's Hospital, Melbourne, VIC, Australia** (R G Weintraub)**; University of Miami, Miami, FL, USA** (J D Wilkinson MD)**; Institute of Public Health, University of Gondar, Gondar, Ethiopia** (S M Woldeyohannes MPH)**; Ateneo School of Medicine and Public Health, City of Pasig, Manila, Philippines** (J Q Wong MD)**; Jimma University, Jimma, Ethiopia** (M A Wordofa MPH)**; Nanjing University School of Medicine, Jinling Hospital, Nanjing, China** (Prof G Xu PhD)**; University of North Carolina at Chapel Hill, Chapel Hill, NC, USA** (Y C Yang PhD)**; Division of Cardiovascular Medicine, Jichi Medical University School of Medicine, Shimotsuke, Japan** (Y Yano MD)**; University of Hong Kong, Hong Kong Special Administrative Region, China** (Prof P Yip PhD)**; National Centre of Neurology and Psychiatry, Kodaira, Japan** (N Yonemoto MPH)**; Jackson State University, Jackson, MS, USA** (Prof M Z Younis PhD)**; Department of Epidemiology and Biostatistics, Global Health**

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Institute, School of Public Health, Wuhan University, Wuhan, China (Prof C Yu PhD)**; TCM Medical Tk, Nusajaya, Johor Bahru, Malaysia** (K Yun Jin PhD)**; Mansoura Faculty of Medicine, Mansoura, Egypt** (Prof M E S Zaki MD)**; Chongqing Medical University, Chongqing, China** (Prof Y Zhao MD)**; Zhongshan Ophthalmic Centre, Sun Yat-sen University, Guangzhou, China** (Y Zheng PhD)**; and Cancer Institute and Hospital, Chinese Academy of Medical Sciences, Beijing, China** (Prof X N Zou MD)

Correspondence to:
Dr Nicholas J Kassebaum, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Avenue, Suite 600, Seattle, WA 98121, USA
nickjk@uw.edu

See **Online** for appendix