Background: *The development of the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5) and ICD-11 has led to reconsideration of diagnostic criteria for posttraumatic stress disorder (PTSD). The World Mental Health (WMH) Surveys allow investigation of the implications of the changing criteria compared to DSM-IV and ICD-10.* Methods: *WMH Surveys in 13 countries asked respondents to enumerate all their lifetime traumatic events (TEs) and randomly selected one TE per respondent for PTSD assessment. DSM-IV and ICD-10 PTSD were assessed for the 23,936 respondents who reported lifetime TEs in these surveys with the fully structured Composite International Diagnostic Interview (CIDI). DSM-5 and proposed ICD-11 criteria were approximated. Associations of the different criteria sets with indicators of clinical severity (distress-impairment, suicidality, comorbid fear-distress disorders, PTSD symptom duration) were examined to investigate the implications of using the different systems.* Results: *A total of 5.6% of respondents met criteria for "broadly defined" PTSD (i.e., full criteria in at least one diagnostic system), with prevalence ranging from 3.0% with DSM-5 to 4.4% with ICD-10. Only one-third of broadly defined cases met criteria in all four systems and another one third in only one system (narrowly defined cases). Between-system differences in indicators of clinical severity suggest that ICD-10 criteria are least strict and DSM-IV criteria most strict. The more striking result, though, is that significantly elevated indicators of clinical significance were found even for narrowly defined cases for each of the four diagnostic systems.* Conclusions: *These results argue for a broad definition of PTSD defined by any one of the different systems to capture all clinically significant cases of PTSD in future studies. Depression and Anxiety 31:494–505, 2014.*

Key words: *Posttraumatic stress disorder; World Mental Health Surveys; epidemiology; nosology; DSM-IV; DSM-5; ICD-10; ICD-11*

INTRODUCTION

Diagnostic criteria for posttraumatic stress disorder (PTSD) have changed with each edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM), including the recent release of DSM-5, reflecting in part debates about the distinctions between normal responses to traumatic stressors versus maladaptive reactions[1] and the potential for inappropriate medicalization of suffering.[2] The diagnostic criteria for PTSD have also varied across editions of the International Classification of Diseases (ICD), with anticipated tightening of criteria in the forthcoming 11th edition in order to emphasize the importance of avoiding overdiagnosis of PTSD.[3] These changes to the PTSD diagnosis, evident in DSM-5 and anticipated in ICD-11, have reinvigorated debate about the appropriate criteria for PTSD and the implications of differences in diagnostic criteria across each of the diagnostic systems.[4–8]

DSM-IV and ICD-10 criteria for PTSD differ in multiple ways (Appendix, Table A1). First, DSM-IV defined the traumatic event (TE) as one that causes threat to the integrity of the person or others (A1 criterion), with the reaction of the individual characterized by intense fear, helplessness, or horror (A2 criterion),[9] whereas ICD-10 Diagnostic Criteria for Research (ICD-10-DCR) refer to the importance of events that precipitate distress in almost anyone.[10] Second, although DSM-IV criteria include both avoidance and numbing symptoms, ICD-10-DCR includes only the presence of avoidance symptoms.

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Third, DSM-IV requires the presence of clinically significant distress or impairment, whereas ICD-10-DCR does not. Fourth, DSM-IV requires that symptoms continue for at least 1 month, whereas ICD-10-DCR emphasizes that symptoms begin within 6 months of the event and that some persist, but does not specify a minimum required duration.

Two important changes to the definition of a traumatic stressor and the associated symptoms needed to qualify for a PTSD diagnosis have been made in DSM-5[11] (Appendix, Table A1). First, based on evidence that the A2 criterion had insufficient clinical utility, the requirement of a subjective response of fear, helplessness, or horror to the event was eliminated.[4] By eliminating A2, DSM-5 expanded the context of PTSD from exclusively a fear-based anxiety disorder to a disorder that also included anhedonic/dysphoric and externalizing phenotypes. Second, based on factor analyses of PTSD symptoms,[4] the number of clusters of PTSD symptoms required to qualify for a diagnosis was increased from 3 to 4, with avoidance and numbing symptoms split into separate clusters and expanded to represent avoidance and persistent negative alterations in cognitions and mood. The expanded symptoms include persistent negative evaluation of self or others, elevated self-blame, a negative emotional state, and reckless or self-destructive behavior.

Anticipated revisions to the PTSD diagnosis in ICD-11[3,12,13] emphasize that the construct of PTSD should have both global applicability and clinical utility,[14] reflecting concerns about the potential overuse of PTSD in disaster-exposed populations[15] (Appendix, Table A1). In keeping with previous recommendations,[16,17] the ICD-11 workgroup has recommended including three core symptom clusters (re-experiencing, avoidance of traumatic reminders, and hyperarousal) and removing nonspecific symptoms that are also found in other conditions (e.g., trouble concentrating, sleep problems). Re-experiencing the TE refers not only to remembering the event, but also to experiencing the event as occurring again, as in nightmares and flashbacks. Duration of required symptoms and degree of functional impairment are used to differentiate normal reactions to traumatic stressors from PTSD, and PTSD is differentiated from complex PTSD that is also characterized by a range of other disturbances.[12] By using a narrower and briefer ICD-11 set of symptoms, ICD-11 aims to better differentiate PTSD from often comorbid conditions.

Several questions about these changes and differences deserve further consideration. First, is the DSM-5 suggestion of four symptom clusters supported by investigation of symptom structure in a cross-national sample? Second, what is the impact of changes in the diagnostic criteria sets on PTSD prevalence cross-nationally? Third, to what extent do the diagnostic criteria identify overlapping populations of individuals? Previous evidence suggests that prevalence estimates of DSM-IV and ICD-10 PTSD are similar but that the systems identify somewhat distinct sets of individuals, although this research is based only on data from one country.[18] Fourth, do individuals diagnosed with PTSD using each of the diagnostic criteria sets exhibit similar clinical characteristics, including distress, impairment, suicidality, and comorbidity? Given that ICD-10 does not require distress and impairment for diagnosis, it is likely that ICD-10 cases on average are associated with lower levels of such outcomes. Again, prior comparison of DSM-IV and ICD-10 PTSD has shown that absence of the distress/impairment criterion results in higher PTSD prevalence in ICD-10.[18] Fifth, as part of a broader concern with implications of differences among systems, is PTSD differentially associated with sociodemographic factors, TE types, and prior lifetime history of mental disorder across the systems?

Answering these questions is key to understanding the global impact of changes to the diagnostic criteria sets for PTSD. The World Mental Health (WMH) Surveys, a dataset comprising thousands of respondents from around the globe, and employing a diagnostic instrument with both DSM and ICD criteria for PTSD, provides an important opportunity for beginning to do so.

METHODS

SAMPLES

Interviews were administered in 13 countries, including eight classified by the World Bank[19] as high income (Belgium, Germany, Italy, Japan, Netherlands, New Zealand, Spain, United States), four upper-middle income (São Paulo in Brazil, Bulgaria, Mexico, Romania), and one lower-middle income (Colombia). Most surveys were based on nationally representative household samples, the exceptions being surveys of all urbanized areas in Colombia and Mexico and of specific Metropolitan areas in Brazil (São Paulo) and a series of cities in Japan. Response rates ranged from 55.1% (Japan) to 87.7% (Colombia). The weighted (by sample size) mean response rate across surveys was 70.3%. Interviews were in two parts. Part I, administered to all respondents, assessed core DSM-IV mental disorders ($n = 67,652$ respondents across all 13 surveys). Part II assessed additional disorders and correlates. Questions about PTSD were included in Part II, which was administered to 100% of Part I respondents who met lifetime criteria for any Part I disorder and a probability subsample of other Part I respondents ($n = 34,321$ across all 13 surveys). Part II respondents were weighted by the inverse of their probability of selection from Part I to adjust for differential probabilities of selection. Additional weights adjusted for differential within and between household selection and deviations between the sample and population demographic–geographic distributions. More details about WMH sample design and weighting are presented elsewhere.[20]

MEASURES

Interview Procedures. Interviews were administered face-to-face in respondent homes after obtaining informed consent using procedures approved by local Institutional Review Boards. The interview schedule was developed in English and translated into other languages using a standardized WHO translation, back-translation, and harmonization protocol.[21] The full text of the interview schedule is available at www.hcp.med.harvard.edu/wmh.

TEs. The WMH interview assessed lifetime exposure to 29 TEs, including seven war-related (e.g., combatant, civilian in a war zone), five types of physical assault (e.g., beaten by a caregiver as a child, mugged), three types of sexual assault (e.g., stalked, attempted rape, rape), six involving threats to physical integrity excluding violence (e.g., life-threatening accidents, natural disasters), five involving threats to loved ones (e.g., life-threatening illness/injury), and traumatic death of loved one. Two additional open-ended questions asked about TEs not included on the list and TEs respondents did not wish to describe concretely. Respondents were probed separately about number of lifetime occurrences and age at first occurrence of each reported TE type. PTSD was assessed in relation to a *randomly selected* lifetime TE to produce a population-level representative sample of TEs.[22] This was done by numbering each occurrence of each reported TE for each respondent, then selecting one numbered instance, and then weighting that report by the probability of selection of that particular TE for that respondent. This approach produces a weighted dataset representative of all lifetime TEs occurring to all respondents. Twenty-three thousand nine hundred thirty-six Part II respondents (67.1%) reported one or more TEs, with 24.6% of those with TEs reporting exactly one and the others reporting a mean of 6.0 (range 2–160; interquartile range 3–6), for approximately 114,000 TEs. Although PTSD was assessed only for one TE per respondent, the sum of weights of these 23,936 respondents was equal to the total number of TEs rather than the number of respondents.

PTSD. Mental disorders were assessed with the Composite International Diagnostic Interview (CIDI),[22] a fully structured interview administered by trained lay interviewers, to assess DSM-IV and ICD-10 disorders. The CIDI assessment of PTSD began with questions to operationalize the DSM-IV Criterion A2 requirement that the person's response to the focal TE involve intense fear, helplessness, or horror. However, rather than requiring responses of this time, all respondents with qualifying TEs were additionally asked about DSM-IV Criterion B symptoms of persistent re-experiencing, Criterion C symptoms of persistent avoidance, and Criterion D symptoms of persistent symptoms of increased arousal. Respondents who reported any of these symptoms were then asked about the DSM-IV Criterion E requirement that symptoms persist more than 1 month and the Criterion F requirement that these symptoms cause clinically significant distress or impairment.

As detailed elsewhere,[23] blinded clinical reappraisal interviews with the Structured Clinical Interview for DSM-IV (SCID) were conducted in four WMH countries. CIDI–SCID concordance for DSM-IV PTSD was moderate[24] (κ = .49; area under the curve (AUC) = .69). The two components of AUC, sensitivity and specificity, were 38.3 and 99.1, respectively, resulting in a likelihood ratio positive (LR+) of 42.0, which is well above the threshold of 10 typically used to consider screening scale diagnoses definitive.[25] Consistent with the high LR+, the proportion of CIDI cases confirmed by the SCID was 86.1%, suggesting that the vast majority CIDI cases of DSM-IV PTSD would independently be judged to have DSM-IV PTSD by trained clinicians.

ICD-10 criteria were also fully operationalized in the CIDI, as ICD-10 Criteria B–D are a subset of the DSM-IV criteria. DSM-5 criteria (11) were approximated by fully operationalizing DSM-5 Criteria B (one or more of five symptoms of intrusive recollection), C (one or both of two symptoms of avoidance), F (duration of more than 1 month), and G (clinically significant distress or impairment), and partially operationalizing Criteria D (two or more of four symptoms of negative alterations in cognitions and mood, three of which were not assessed in the CIDI) and E (two or more of five symptoms of marked alterations in arousal and reactivity, one of which was not assessed in the CIDI). Proposed ICD-11 diagnostic guidelines (3) were approximated by operationalizing the requirements of (1) avoidance of thoughts–memories of the TE or of activities–situations reminiscent of the TE, (2) excessive hypervigilance or enhanced startle reactions, and (3) significant impairment in functioning, while closely approximating the requirement of (4) re-experiencing the TE in the form of either vivid intrusive memories, flashbacks, or nightmares accompanied by fear or horror.

Other Mental Disorders. In addition to PTSD, the CIDI assessed five DSM-IV fear disorders (panic disorder without agoraphobia, specific phobia, social phobia, agoraphobia without history of panic disorder, obsessive compulsive disorder), three distress disorders (major depressive disorder/dysthymia, generalized anxiety disorder, bipolar disorders [I-II and subthreshold BPD]), three disruptive behavior disorders (oppositional defiant disorder [ODD], conduct disorder [CD], intermittent explosive disorder), and two substance disorders (alcohol and drug abuse with or without dependence). Age-of-onset of each disorder was assessed using special probing techniques shown experimentally to improve recall accuracy.[26] DSM-IV organic exclusion rules and diagnostic hierarchy rules were used (other than for ODD, which was defined with or without CD, and substance abuse, which was defined with or without dependence). As detailed elsewhere,[23] generally good concordance was found between these CIDI diagnoses and blinded clinical diagnoses based on clinical reappraisal interviews with the SCID.[27]

Other Predictors. Differential predictors of the different types of PTSD were investigated. The predictors included gender, age at TE exposure, TE type (war-related, other interpersonal violence, intimate/sexual violence, accidents, death of loved one, other network TEs, and other TEs), numbers of temporally prior lifetime fear/distress disorders (anxiety and mood disorders), and number of temporally prior lifetime behavior/substance disorders.

Outcomes. The following four outcomes are considered here: severe distress or impairment associated with symptoms of PTSD, as assessed by CIDI questions requiring first lifetime onset of suicidal ideation in conjunction with the focal TE in the subsample of respondents with no prior lifetime history of suicidality; and first lifetime onset of any fear disorders or any distress disorder in the subsample of respondents with no prior lifetime history of those disorders. Suicidality was assessed with the CIDI suicidal behavior module.[22]

ANALYSIS METHODS

Multivariate additive associations among PTSD symptoms were examined with exploratory factor analysis (EFA) of the tetrachoric correlation matrix between all logically possible pairs of dichotomously scored symptoms. The parallel analysis simulation method[28] was used to select the number of factors to retain in the analysis, whereas promax rotation was used to improve our ability to interpret the solution. Prevalence estimates of PTSD based on each of the four diagnostic systems, on any of the four systems (referred to below as *broadly defined* PTSD), and on multisystem profiles were then estimated with cross-tabulations.

Regression analysis was then used to examine the associations of PTSD according to the different diagnostic systems with each of the four outcomes. As the cross-tabulations showed that the numbers of cases in some of the 15 logically possible multivariate profiles of diagnoses across the four systems (i.e., 2^4–1) were too small to allow completely disaggregated comparisons, we made only three comparisons for each of the four diagnostic systems for each outcome: (1) between *narrow* cases within the diagnostic system (i.e., cases that met criteria for PTSD according to the criteria of the system but not according to the criteria of any of the other three systems) and broadly defined noncases (i.e., respondents that did not meet criteria for PTSD according to the criteria of any of the four systems); (2) between *total* cases within the diagnostic system (i.e., cases that met criteria for PTSD according to the criteria of the system whether or not they also

TABLE 1. Rotated (promax) standardized regression coefficients based on EFA of CIDI PTSD symptom questions (n = 23,936)[a]

	I	II	III	IV
I. Re-experiencing				
Repeated unwanted memories of random event	.84	.11	.00	.03
Repeated unpleasant dreams about random event	.79	.06	−.02	.05
Flashbacks of random event happening	.84	.06	−.07	.05
Get very upset when reminded of random event	.87	.00	.10	−.05
Have physical reactions when reminded of random event	.59	−.05	.16	.20
II. Avoidance				
Try not to think about random event	.13	.82	−.05	.10
Purposely stay away from things that remind of random event	−.03	.75	.28	.05
III. Numbing				
Unable to remember important parts of random event	−.01	.48	.46	−.10
Lose interest in things used to enjoy	.14	.09	.84	−.11
Feel emotionally distant/cut-off from people	.08	.14	.84	−.03
Trouble feeling love/happiness toward others	−.06	.12	.87	.08
Feel no reason to plan for the future	−.07	.09	.79	.11
IV. Arousal				
Trouble falling asleep during random event	.32	−.12	.18	.50
More irritable than usual during random event	.09	−.17	.37	.55
More trouble concentrating during random event	.21	−.20	.50	.39
Much more alert/watchful with no real need	−.03	.22	−.14	.94
More easily startled by ordinary noises	.08	.11	−.01	.83

[a]Principal axis factor analysis of weighted (see the text for a discussion of weighting) tetrachoric correlation matrix of responses to dichotomous symptom questions.

meet criteria in any of the other three systems) and broadly defined non-cases; and (3) between *other* cases (i.e., cases that did meet criteria for PTSD according to the criteria of the system but did meet criteria for at least one of the other three systems) and broadly defined non-cases.

The equations to predict comorbid fear and distress disorders predicted lifetime first onset of each such disorder in the year of TE exposure in the subsample of respondents without a prior lifetime history of the outcome disorder. These equations to predict comorbidity were based on a combined person-disorder data array. For example, a separate sample of eligible respondents was defined for each of the five fear disorders depending on prior lifetime history of that disorder, these five datasets were then combined, and a single logistic regression equation was estimated in this combined dataset (with four dummy control variables to distinguish among the five disorders) to estimate a single set of predictor coefficients constrained to be equal across all five outcomes.

We then used logistic regression to examine differences in the sociodemographic, trauma-related, and psychopathological predictors of PTSD in the four different types of PTSD. This was done by estimating four logistic regression equations, one for PTSD diagnoses in each system, that used information about gender, age at TE exposure, type of TE (using the seven-category classification scheme described above with traumatic death of a loved one serving as the reference category), and prior (to the age of TE exposure) lifetime history of fear/distress and behavior/substance disorders (dummy variables for exactly one and more than one disorder of each type) to distinguish between *total* cases according to the focal system and *other* cases. Logistic regression coefficients and their standard errors were exponentiated and are reported here as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was consistently evaluated using .05-level two-sided tests. The design-based Taylor series method implemented in the SAS software system[29] was used to adjust for the weighting and clustering of observations.

RESULTS

EFA

EFA was carried out on the matrix of tetrachoric correlations among the 17 DSM-IV Criterion B–D symptoms of PTSD assessed in the WMH surveys. Parallel analysis showed that four meaningful factors exist in the data (Table 1). Promax rotation lead to a solution that corresponded closely to the DSM-5 symptom dimensions of re-experiencing, avoidance, numbing, and arousal.

PREVALENCE

A total of 5.6% of respondents meet criteria for PTSD in at least one of the four systems (Table 2). We refer to these cases below as having *broadly defined* PTSD. The system with the highest prevalence (standard error in parentheses) is ICD-10 (4.4% [0.3], including 79.4% of all broadly defined cases), followed by DSM-IV and ICD-11 (3.3 [0.2] and 3.2% [0.2], including 58.4 and 57.4%, respectively, of all broadly defined cases), and the lowest is DSM-5 (3.0% [0.2], including 53.5% of all broadly defined cases; (Table 3). One-third of broadly defined cases (1.8% of all respondents) meet criteria in all four systems, an additional one-third of broadly defined cases in either three (0.9% of all respondents) or two (an additional 0.9% of all respondents) systems, and the final one-third of broadly defined cases (1.9% of all respondents) in only one of the four systems. The much higher prevalence of cases based on ICD-10 than the other systems is reflected in the fact that narrow ICD-10

TABLE 2. Prevalence of PTSD according to the criteria of each and any of the four diagnostic systems (n = 23,936)

	Total sample		Among respondents with broadly defined PTSD[a]	
	Percentage	(*SE*)	Percentage	(*SE*)
DSM-IV	3.3	(0.2)	58.4	(2.5)
DSM-5	3.0	(0.2)	53.5	(2.5)
ICD-10	4.4	(0.3)	79.4	(2.2)
ICD-11	3.2	(0.2)	57.4	(2.7)
Any	5.6	(0.3)	100.0	–
n	23,936		1,581	

[a]Broadly defined PTSD = PTSD according to the criteria of any of the four systems.

PTSD is the second most common profile (22.1% of all broadly defined cases), the most common being cases meeting criteria in all four systems, while the other narrowly defined types are quite uncommon (1.5–6.3% of all broadly defined cases).

VARIATION IN ADVERSE OUTCOMES ASSOCIATED WITH THE DIFFERENT TYPES OF PTSD

The vast majority (95%) of the 44 ORs that compare outcomes among respondents with PTSD to outcomes among respondents classified as broadly defined noncases are greater than 1.0 and statistically significant (89%; Table 4). The same is true of all four ORs associated with narrowly defined DSM-IV PTSD, all four of those associated with narrowly defined DSM-5 PTSD, three of the four ORs associated with narrowly defined ICD-10 PTSD, and one of the four ORs associated with narrowly defined ICD-11 PTSD. These results suggest that each of the four diagnostic systems detects at least some clinically significant cases that are missed by all the other systems. Narrowly defined DSM-IV cases tend to be more severe than DSM-IV cases that also meet criteria for PTSD in any of the other systems. The opposite is true for narrowly defined ICD-10 and ICD-11 cases, both of which have consistently lower severity scores than total cases. The number of narrowly defined DSM-5 cases is so small that comparisons between narrowly defined and total DSM-5 cases cannot be made. Total DSM-IV and DSM-5 cases are consistently more severe than other cases, while total ICD-10 and ICD-11 cases are for the most part less severe than other cases.

DIFFERENTIAL PREDICTORS

The associations of age of TE exposure and gender with PTSD risk do not vary significantly across the four diagnostic systems (Table 5). However, there is some variation in the differential risk of PTSD across

TABLE 3. The cross-classification of PTSD prevalence across the four diagnostic systems (n = 23,936)

	Total sample		Among respondents with broadly defined PTSD	
	Percentage	(SE)	Percentage	(SE)
I. Meets criteria in all four systems				
DSM-IV, DSM-5, ICD-10,ICD-11	1.8	(0.2)	33.1	(2.2)
II. Meets criteria in three systems				
DSM-IV, DSM-5, ICD-10	0.4	(0.1)	7.7	(1.2)
DSM-IV, DSM-5, ICD-11	0.3	(0.1)	5.8	(1.3)
DSM-IV, ICD-10, ICD-11	0.1	(0.0)	2.6	(0.5)
DSM-5, ICD-10, ICD-11	0.0	(0.0)	0.8	(0.5)
Any three systems	0.9	(0.1)	16.8	(1.8)
III. Meets criteria in two systems				
DSM-IV, DSM-5	0.1	(0.0)	0.9	(0.3)
DSM-IV, ICD-10	0.2	(0.1)	2.8	(0.8)
DSM-IV, ICD-11	0.1	(0.1)	1.4	(1.1)
DSM-5, ICD-10	0.2	(0.1)	3.3	(1.0)
DSM-5, ICD-11	0.0	(0.0)	0.5	(0.3)
ICD-10, ICD-11	0.4	(0.1)	7.0	(1.2)
Any two systems	0.9	(0.1)	15.8	(1.8)
IV. Meets criteria in one system				
DSM-IV	0.2	(0.0)	4.4	(0.8)
DSM-5	0.1	(0.0)	1.5	(0.7)
ICD-10	1.2	(0.2)	22.1	(2.4)
ICD-11	0.4	(0.1)	6.3	(1.2)
Any one system	1.9	(0.2)	34.3	(2.4)
V. Meet criteria in any of the four systems				
Any	5.6	(0.3)	100.00	–
n	23,936		1,581	

TABLE 4. Associations of PTSD classified by only one ("narrow" cases) versus more than one ("all other" cases) diagnostic system with indicators of clinical significance among respondents exposed to a traumatic experience

	Severe distress or impairment				Suicidality				Comorbid disorders: Distress				Comorbid disorders: Fear			
	Percentage	(SE)	OR	(95% CI)	Percentage	(SE)	OR	(95% CI)	Percentage	(SE)	OR	(95% CI)	Percentage	(SE)	OR	(95% CI)
I. DSM-IV																
Narrow[a]	90.9	(3.7)	497.7*	(177.2→999)	15.5	(8.6)	12.9*	(3.5–47.9)	7.9	(2.2)	11.1*	(5.9–20.8)	2.9	(1.6)	13.7*	(4.3–44.0)
Total[a]	83.3	(2.9)	321.7*	(202.0–512.4)	7.4	(1.3)	4.5*	(2.7–7.5)	5.1	(0.7)	6.8*	(4.6–9.9)	1.8	(0.5)	5.1*	(2.6–9.9)
All others	62.0	(4.1)	96.1*	(63.4–145.5)	3.0	(1.7)	1.9	(0.6–6.1)	2.6	(0.7)	3.7*	(2.0–7.0)	1.3	(0.4)	4.4*	(2.2–8.6)
No PTSD	2.2	(0.4)	1.0	–	1.2	(0.1)	1.0	–	0.7	(0.1)	1.0	–	0.3	(0.0)	1.0	–
II. DSM-5																
Narrow[a,b]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total[a]	87.5	(2.4)	492.7*	(289.9–837.5)	8.2	(1.8)	5.3*	(2.9–9.4)	5.5	(0.8)	7.8*	(5.2–11.7)	2.0	(0.5)	5.6*	(3.0–10.4)
All others	59.4	(3.9)	82.1*	(56.7–118.8)	2.5	(0.9)	1.5	(0.6–3.5)	2.4	(0.5)	3.2*	(1.8–5.5)	1.1	(0.3)	3.8*	(1.9–7.4)
No PTSD	2.2	(0.4)	1.0	–	1.2	(0.1)	1.0	–	0.7	(0.1)	1.0	–	0.3	(0.03)	1.0	–
III. ICD-10																
Narrow[a]	52.0	(6.1)	52.9*	(28.1–95.7)	1.6	(0.9)	1.0	(0.3–3.6)	2.4	(0.9)	3.6*	(1.5–8.5)	1.1	(0.5)	4.7*	(1.8–12.2)
Total[a]	73.4	(2.8)	164.3*	(114.2–236.3)	4.6	(0.8)	2.9*	(1.8–4.6)	4.0	(0.5)	5.4*	(3.7–7.9)	1.5	(0.4)	4.8*	(2.6–8.9)
All others	78.7	(6.1)	273.4*	(135.9–550.2)	8.6	(4.1)	5.2*	(1.7–15.4)	4.2	(1.2)	5.7*	(2.8–11.5)	1.7	(0.6)	4.8*	(2.4–9.5)
No PTSD	2.2	(0.4)	1.0	–	1.2	(0.1)	1.0	–	0.7	(0.1)	1.0	–	0.3	(0.03)	1.0	–
IV. ICD-11																
Narrow[a]	57.2	(10.5)	89.1*	(32.9–241.4)	1.1	(1.0)	0.4	(0.1–3.0)	0.5	(0.2)	0.5	(0.2–1.5)	0.8	(0.4)	2.4	(0.7–8.0)
Total[a]	82.4	(3.1)	346.1*	(211.3–566.7)	5.5	(1.1)	3.1*	(1.8–5.4)	4.0	(0.6)	5.3*	(3.5–8.0)	1.6	(0.5)	4.2*	(2.0–8.9)
All others	63.8	(4.1)	93.3*	(61.5–141.6)	5.3	(2.0)	3.6*	(1.7–8.0)	4.0	(0.8)	5.8*	(3.5–9.4)	1.5	(0.4)	5.7*	(3.2–10.0)
No PTSD	2.2	(0.4)	1.0	–	1.2	(0.1)	1.0	–	0.7	(0.1)	1.0	–	0.3	(0.03)	1.0	–
n			23,936				(22,030)[c]				(79,836)[d]				(112,460)[e]	

*Significantly different from respondents who did not meet criteria for PTSD in any of the four diagnostic systems at the .05 level, two-sided test.

[a]*Narrow* cases are those that meet criteria for PTSD in the one diagnostic system represented in the subheading but in none of the other three systems. *Total* cases, in comparison, are all those who meet criteria for PTSD in the diagnostic system represented in the subheading whether or not they also meet criteria in one or more of the other three systems. *All others*, finally, are all those who do not meet criteria for PTSD in the diagnostic system represented in the subheading but do meet criteria in one or more of the three other systems. All three groups are contrasted with respondents who had a traumatic experience but did not develop PTSD according to the criteria of any of the four systems.

[b]Respondents with narrow DSM-5 PTSD were excluded from analysis due to their small number.

[c]Respondents with a history of suicidal ideation at an earlier age than when they experienced the focal TE were excluded.

[d]Four distress disorders were included in the analysis (major depressive disorder, bipolar disorder, generalized anxiety disorder, and obsessive-compulsive disorder). A separate observational file was created for each of these disorders excluding respondents with a lifetime history of this disorder at an earlier age than when they experienced the focal TE. The four data files were then stacked and a single set of coefficients was estimated for the pooled within-disorder odds of onset in the year of TE exposure. The sample size given here is for the stacked dataset. Disorder-specific samples ranged in size from 11,925 for obsessive-compulsive disorder (OCD) to 23,500 for bipolar disorder. The small sample size for OCD is due to the fact that OCD was assessed in only a subsample of cases in a subset of countries.

[e]Five fear disorders were included in the analysis (agoraphobia, panic disorder, separation anxiety disorder, social phobia, and specific phobia). A separate observational file was created for each of these disorders, excluding respondents with a lifetime history of this disorder at an earlier age than when they experienced the focal TE. The four data files were then stacked and a single set of coefficients was estimated for the pooled within-disorder odds of onset in the year of TE exposure. The sample size given here is for the stacked dataset. Disorder-specific samples ranged in size from 20,429 for specific disorder to 23,629 for agoraphobic.

TABLE 5. Sociodemographic and trauma-related predictors of broadly defined PTSD and PTSD based on each of the diagnostic systems

			Among respondents with broadly defined PTSD							
	Broadly defined PTSD versus noncases		Narrow[a] DSM-IV versus Others		Total[b] DSM-5 versus others		Narrow[a] ICD-10 versus others		Narrow[a] ICD-11 versus others	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
I. Sociodemographic										
Age of traumatic exposure										
Age in decades	1.0	(0.9–1.1)	0.9	(0.7–1.1)	0.9	(0.7–1.0)	1.2	(1.0–1.5)	1.1	(0.8–1.5)
χ^2_1	0.1		1.5		2.2		3.5		0.6	
Sex										
Female	1.8[c]	(1.3–2.4)	1.7	(0.7–4.1)	0.9	(0.6–1.5)	0.8	(0.4–1.5)	1.2	(0.6–2.8)
Male			1.0	–	1.0	–	1.0	–	1.0	–
χ^2_1	15.4[c]		1.2		0.0		0.7		0.3	
II. Trauma type										
War events	0.7	(0.3–1.4)	0.0[c]	(0.0–0.0)	0.4	(0.1–1.2)	1.3	(0.3–6.3)	6.1	(1.0–38.1)
Other interpersonal violence	0.9	(0.6–1.4)	0.1[c]	(0.0–0.4)	0.8	(0.4–1.7)	0.9	(0.4–2.4)	5.8[c]	(1.6–21.7)
Intimate/sexual violence	2.6[c]	(1.9–3.8)	0.0[c]	(0.0–0.2)	1.3	(0.6–2.5)	0.4	(0.2–1.1)	4.5[c]	(1.2–17.0)
Accident	0.6[c]	(0.4–0.8)	0.0[c]	(0.0–0.2)	0.8	(0.4–1.6)	1.7	(0.4–6.4)	0.4	(0.1–1.9)
Network events	0.8	(0.5–1.2)	0.5	(0.2–1.5)	0.5[c]	(0.3–1.0)	1.5	(0.7–3.4)	0.8	(0.3–2.6)
Death	1.0	–	1.0	–	1.0	–	1.0	–	1.0	–
Other	2.0[c]	(1.4–3.0)	0.1[c]	(0.0–0.4)	0.9	(0.4–2.0)	1.5	(0.5–4.6)	0.8	(0.2–3.3)
χ^2_6	88.1[c]		913.3[c]		9.9		9.0		16.3*	
III. Lifetime prior history of mental disorders										
Fear/distress disorders										
0	1.0	–	1.0	–	1.0	–	1.0	–	1.0	–
1	2.0[c]	(1.5–2.7)	0.7	(0.3–1.8)	1.3	(0.8–2.2)	1.2	(0.6–2.2)	0.6	(0.2–1.7)
2+	4.3[c]	(3.1–5.9)	1.6	(0.5–5.2)	1.2	(0.8–1.9)	1.0	(0.5–2.2)	1.1	(0.4–3.2)
χ^2_2	83.7[c]		2.5		1.7		0.3		1.4	
Behavioral/substance disorders										
0	1.0	–	1.0	–	1.0	–	1.0	–	1.0	–
1	1.2	(0.8–1.8)	5.5[c]	(1.7–17.4)	1.1	(0.6–2.1)	0.8	(0.3–1.9)	0.6	(0.2–2.3)
2+	2.1[c]	(1.6–2.9)	1.1	(0.2–6.1)	1.6	(0.7–3.7)	1.4	(0.3–6.3)	0.2[c]	(0.0–1.0)
χ^2_2	24.1[c]		8.7[c]		1.0		0.5		4.2	
n	23,936		728		1,581		669		796	

[a]*Narrow* cases are those that meet criteria for PTSD in the one diagnostic system represented in the column heading but in none of the other three systems.

[b]*Total* cases are all those who meet criteria for DSM-5 PTSD whether or not they also meet criteria in one or more of the other three systems. Total cases were used instead of narrow cases of DSM-5 PTSD because of the rarity of narrow DSM-5 PTSD.

[c]Significant difference between PTSD according to the diagnostic system indicated by the column heading and one or more of the other three diagnostic systems.

TE types depending on the diagnostic system used to define PTSD. The most important source of this variation is that interpersonal violence is associated with significantly higher PTSD risk relative to traumatic death of a loved one when PTSD is defined using ICD-11 criteria (which is true for 57.4% of respondents with broadly defined PTSD) rather than criteria based on any of the other diagnostic systems (which is true for the remaining 42.6% of respondents with broadly defined PTSD). There is also evidence that traumatic death of a loved one is associated with significantly higher PTSD risk relative to a number of other TEs when PTSD is defined using narrowly defined DSM-IV criteria rather than other criteria. However, given that only 4.4% of respondents with broadly defined PTSD have narrowly defined DSM-IV PTSD, these differences are not as important as those associated with ICD-11 PTSD. The associations of prior lifetime DSM-IV fear/distress and behavior/substance disorders with PTSD risk do not vary significantly across the four diagnostic systems other than for a greater importance of having exactly one prior externalizing disorder in the small proportion of cases where PTSD is defined using narrowly defined DSM-IV criteria rather than other criteria. Finally,

predictors of broadly defined PTSD include female gender (OR = 1.8), sexual assault (OR = 2.6), and prior history of fear/distress (OR = 2.0–4.3) or behavior/substance (OR = 2.0–4.3) disorders.

DISCUSSION

This analysis has a number of limitations, the most important being that PTSD was assessed using fully structured lay-administered interviews rather than semistructured clinical interviews, that the interviews were based on retrospective reports about lifetime rather than recent TEs, that DSM-5 criteria were incompletely operationalized (in particular the newly added DSM-5 symptoms were not assessed), and that the proposed ICD-11 diagnostic guidelines are not written as research criteria and needed to be approximated. As a consequence, the results reported here are likely imprecise, and possibly biased (e.g., with underestimation of DSM-5 PTSD prevalence). Nevertheless, the analysis is valuable insofar as these are the first large-scale cross-national data comparing DSM-IV, DSM-5, ICD-10, and ICD-11 PTSD.

Five findings are noteworthy. The first is that the EFA reported here mirrors the DSM-5 approach of distinguishing four PTSD symptom clusters.[11] Although a number of previous analyses have also yielded a four-factor solution,[4,30] there has been debate about whether the fourth factor should be limited to numbing or should include nonspecific arousal symptoms.[31,32] The current findings are the first based on a large cross-national sample and support a model in which the factors are re-experiencing, avoidance, numbing, and arousal. However, further work, for example, with confirmatory factor analyses, is needed to address fully ongoing debates in the literature about the structure of PTSD symptoms.[33]

Second, although 5.6% of respondents met criteria for "broadly defined" PTSD (in which PTSD criteria for any diagnostic system are met), a similar proportion of these broadly defined cases met criteria for DSM-5 (53.5 or 3% of total sample) and ICD-11 (57.4 or 3.2% of total sample). These diagnostic systems are likely to have similar clinical utility in terms of identifying similar proportions of the population. A larger proportion of respondents with broadly defined PTSD met ICD-10 diagnostic criteria, consistent with the more stringent, conservative approach to PTSD diagnosis taken by DSM-5 and ICD-11.

Third, the different diagnostic systems detect populations of PTSD that show only partial overlap. One-third of broadly defined cases (1.8% of all respondents) meet criteria in all four systems, an additional one-third in either three (0.9% of all respondents) or two (an additional 0.9% of all respondents) systems, and the final one-third (1.9% of all respondents) in only one of the four systems. Narrowly defined ICD-10 PTSD comprises 22.1% of all broadly defined cases, but other narrowly defined types are quite uncommon (1.5–6.3% of all broadly defined cases).

Fourth, while differences in associations with indicators of clinical severity are consistent with ICD-10 criteria being least strict and DSM-IV criteria most strict (and as intended, ICD-11 PTSD is associated with less comorbidity), the more striking result is that indicators of clinical significance are found even for narrowly defined cases across all four diagnostic systems. Thus, the use of any one diagnostic system will overlook many individuals who suffer from clinically significant symptoms, including distress and impairment.

Fifth, little evidence could be found for significant differences in sociodemographic, trauma-related, or prior lifetime psychopathological (including both fear/distress and behavioral/substance disorders) predictors of PTSD across the different systems, indicating that there is a similar underlying risk profile for PTSD irrespective of the definition. This general pattern, and especially the finding that the associations of prior psychopathology with PTSD are indistinguishable across the four diagnostic systems, adds support to the argument above that all four definitions are providing information on unique clinically significant cases that are omitted from the other systems.

These findings extend previous work comparing different diagnostic criteria sets for PTSD,[18,34–37] and are consistent with the argument that refinements to DSM-IV aimed at removing symptoms that overlap with those of other mood and anxiety disorders, are not associated with a major change in prevalence of PTSD, nor with evidence of a change in disability, comorbidity, or structural validity.[38–41] Based on these findings, we suggest that broadly defined PTSD may be a particularly useful additional construct in future epidemiological studies of PTSD.

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APPENDIX

TABLE A1. TABLE A1. PTSD criteria in DSM-IV, DSM-5, ICD-10, and ICD-11

	Symptoms required
DSM-IV criteria	
A1. Exposure to actual or threatened death, serious injury, or a threat to physical integrity of oneself or others	
A2. Response to the event involved fear, helplessness, or horror	
B. Persistent re-experiencing	One of five
C. Persistent avoidance and numbing	Three of seven
D. Persistent hyperarousal	Two of five
E. Duration of at least 1 month	
F. Clinically significant distress/impairment	
DSM-5 criteria	
A. Exposure to actual or threatened death, serious injury, or sexual violence	
B. Persistent re-experiencing	One of five
C. Persistent avoidance	One of two
D. Persistent numbing	Two of four
E. Persistent hyperarousal	Two of five
F. Duration of at least 1 month	
G. Clinically significant distress/impairment	
ICD-10 criteria	
A. Exposure to a stressful event or situation of exceptionally threatening or catastrophic nature likely to cause pervasive distress in almost anyone	
B. Persistent re-experiencing	
C. Avoidance	
D. Either (1) or (2) below:	
1. Inability to recall important aspects of the stressor	
2. Persistent hyperarousal	Two of five
E. Criteria B, C, and D must all be met within 6 months of the stressful event	
ICD-11 criteria	
A. Exposure to a stressful event or situation of exceptionally threatening or horrific nature likely to cause pervasive distress in almost anyone	
B. Persistent re-experiencing that involves not only remembering the TE, but also experiencing it as occurring again	
C. Avoidance	
D. Persistent hyperarousal (i.e., heightened perception of current threat)	
E. Clinically significant functional impairment	

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

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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

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.

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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

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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.

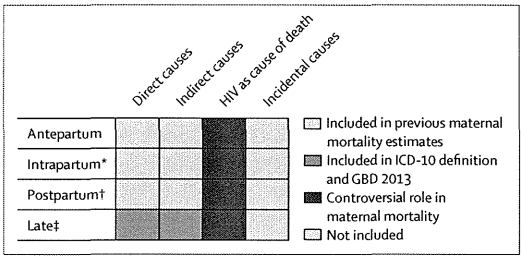

Figure 1: **Definitions of maternal death**
ICD-10=International Classification of Diseases, version 10. *During labour and up to 24 h after delivery. †Between 24 h and 6 weeks after delivery. ‡Between 6 weeks and 1 year after delivery.

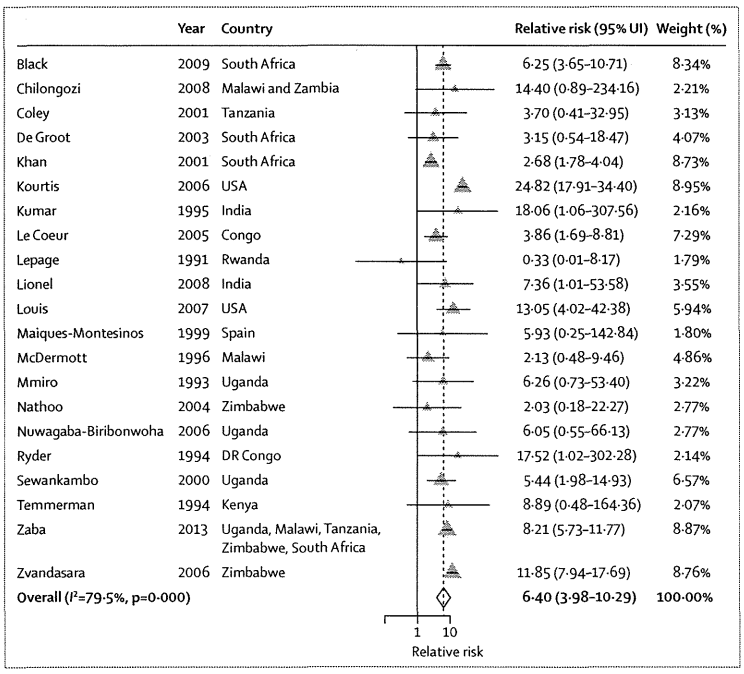

Figure 2: **Forest plot of the relative risk of death during pregnancy for women with HIV infection compared with women without HIV infection**
Weights are from random effects analysis. Size of the triangles is proportional to the weighting of each study in the meta-analysis. UI=uncertainty interval.

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

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

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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.

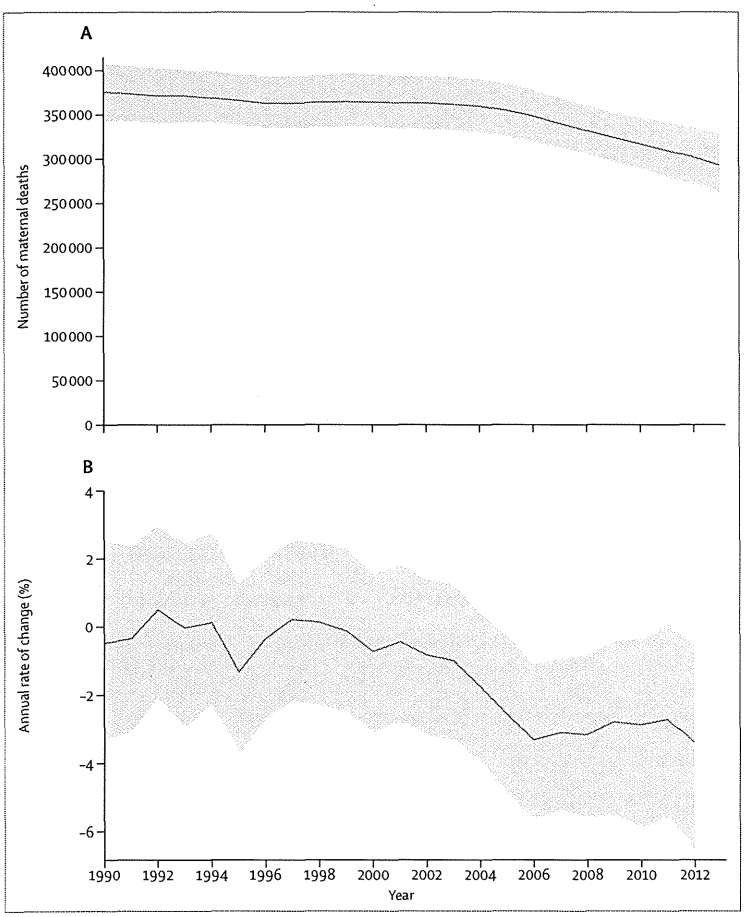

Figure 3: Global maternal deaths (A) and annualised rate of change in maternal mortality ratio (B), 1990–2013
Shaded areas show 95% uncertainty intervals.

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

	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)