Interagency Maternal Mortality Estimates 1990-2008: methods and findings

Maternal Mortality Estimation Inter-Agency Group (MMEIG: UNICEF, UNFPA, World Bank, WHO – H4)

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Training course in sexual and reproductive health research
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Background

- Updates every 5 year since 1990 by WHO, UNICEF, UNFPA – The World Bank joined in 2005 updates

- 2008 update – An academic team at University of Berkeley developed/applied in collaboration with MMEIG

- Reviewed by the technical advisory group with experts from academic institutions: Berkeley, Harvard, Hopkins, Texas, Aberdeen, Umea, Statistics Norway – in current update

- Countries consulted for comments on methodology and additional input

General framework of the maternal mortality estimates 1990-2008

- Levels and trends of maternal mortality between 1990 and 2008 for 172 countries
- Hierarchical/multilevel linear regression model
- The input data is the PMDF (proportion maternal among all female deaths 15-49) adjusted for completeness and definition
- Covariates being the log(GDP), log(GFR) and SAB
- The final output takes into account the maternal mortality related with the HIV/AIDS

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Definition used

- => <u>Maternal death</u>: "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes." ICD-10, WHO,1994

- <u>Pregnancy-related death</u>: "the death of a woman while pregnant or within 42 days of termination of pregnancy"

Estimated measures

- <u>Maternal Mortality Ratio (MMR)</u>: Ratio of maternal deaths in a period to live births (proxy for risky events) in the same period (x 100,000).

- <u>Number of maternal deaths</u>

- <u>PMDF</u>: Proportion of maternal among female deaths 15-49

- <u>Lifetime risk</u> of a maternal death: An estimate of the likelihood that a woman who survives to age 15 will die of maternal causes
  - proportion of women reaching reproductive age who would die of maternal causes, taking into account competing causes

Input database

- Database of 172 countries, from 1985 onwards
- Nationally representative data

  => focusing on sources where PMDF is possible to compute

Data on maternal mortality: availability

Sources	Number of surveys	Number of country-years
Civil Registration	1891	1891
Surveys with Sibling Histories	105	819
Population Censuses	18	19
Other (eg special surveys, verbal autopsies, surveillance)	80	113
Total	2094	2842

24 countries had no nationally representative data that met inclusion criteria

UNDP · UNFPA · WHO · World Bank
Special Programme of Research, Development
and Research Training in Human Reproduction

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Input data to the model: PMDF

- PMDF is considered less subject to under-reporting than MMR (maternal and non-maternal deaths likely to be under-reported to similar degree)

- Maternal deaths as defined by ICD is difficult to capture – usually all deaths in pregnancy measured

- Efforts have been made to adjust for:
  - under reporting
  - definition

- For the model the HIV/AIDS component was taken out from the PMDF; the HIV/AIDS component is added back after the model fitting

Input data to the model: Adjustment by type of source

- Adjustment for completeness of reporting specified in relation to the type of data
  - CR system: Review of recent literature on underestimation of maternal deaths in CR systems – adjustment by a factor of 1.5
  - Sibling histories: age-standardization, 1.1 upward adjustment (underestimation of early pregnancy deaths); 0.9, 0.85 downward adjustment (remove accidental deaths)
  - Other special studies (e.g., RAMOS): 1.1 upward adjustment

Input data to the model:
Definition and HIV/AIDS adjustment

- Observed PMDF were grouped into 3 categories according to the definition
  - Maternal mortality
  - Pregnancy-related
  - Pregnancy-related without accident

Maternal,
    non-AIDS-related
	Maternal,
	    AIDS-related

Accidental/incidental,
    non-AIDS-related
	Accidental/incidental,
	    AIDS-related

Input data to the model: Addressing HIV/AIDS

- The fraction of AIDS deaths among women aged 15-49 that occur during pregnancy (v) :

$$v = c*k*GFR / (1 + c*(k-1)*GFR)$$

- c = average period of exposure-to-risk associated with each live birth

- k = relative risk of dying from HIV/AIDS for a pregnant versus non-pregnant woman

- $\tilde{u}$ = the fraction of AIDS deaths that were presumably included in a PMDF or MMR observation.

  - = 1 if "pregnancy-related" definition (with or without accidents)
  - = 0.5 otherwise

- *PMDF observations adjusted to remove estimated included AIDS deaths before running regression:*

  PMDF – $\tilde{u}$ * v * a

  where a = proportion of AIDS deaths among all deaths in age range 15-49 for women

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Covariates

- GDP: gross domestic product PPP per capita, in constant 2005 international dollar; the World Bank series, complemented by other sources

- GFR: general fertility rate, the number of births in a population divided by the number of women at reproductive ages; UNPD World Population Prospects the 2008 revision

- SAB: the proportion of deliveries with a skilled attendant at birth from UNICEF database

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Covariates and the model

- A time series of these three covariates were constructed for the 1985-2008 period

- Time-matched average values of the covariates for time intervals corresponding to the period of each observation of the dependent variable PMDF were computed

- A hierarchical/multilevel model with three main covariates, plus random effects for countries and regions and an offset which will adjust the denominator of PMDF for AIDS.

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Fitting and add back HIV/AIDS

- The model fitted to the complete set of observations for 172 countries

- Add back a fraction, u, of the total number of AIDS deaths estimated to have occurred during pregnancy

$$\text{est.}\, PMDF_i = \text{est.}\, PMDF_i^{na} + uv_i a_i$$

- Predicted PMDF converted to MMRs:

MMR = PMDF(D/B)

  - D= N female deaths 15-49 estimated from WHO life tables
  - B = N live births from UN Population Division estimates

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Uncertainty

Components of uncertainty include:

- Any remaining bias in adjusted PMDF values
- Uncertainty in model parameters (c, k, u, and pi)
- Regression prediction uncertainty within the PMDF model
- Possible error in MMR conversion (estimated births and deaths)
- Alternative models, covariates, etc.

Maternal mortality in 2008 and average annual change between 1990 and 2008

	MMR	Lower estimate	Upper estimate	Maternal deaths	Average annual change %
WORLD TOTAL	**260**	**200**	**370**	**358,000**	**-2.3**
DEVELOPED REG.	14	13	16	1700	-0.8
COUNTRIES OF THE CIS	40	34	48	1500	-3.0
DEVELOPING REG.	290	220	410	355,000	-2.3
North Africa	92	60	140	3400	-5.0
Sub-Saharan Africa	640	470	930	204,000	-1.7
Asia	190	130	270	139,000	-4.0
Latin America and the Caribbean	85	72	100	9200	-2.9
Oceania	230	100	500	550	-1.4

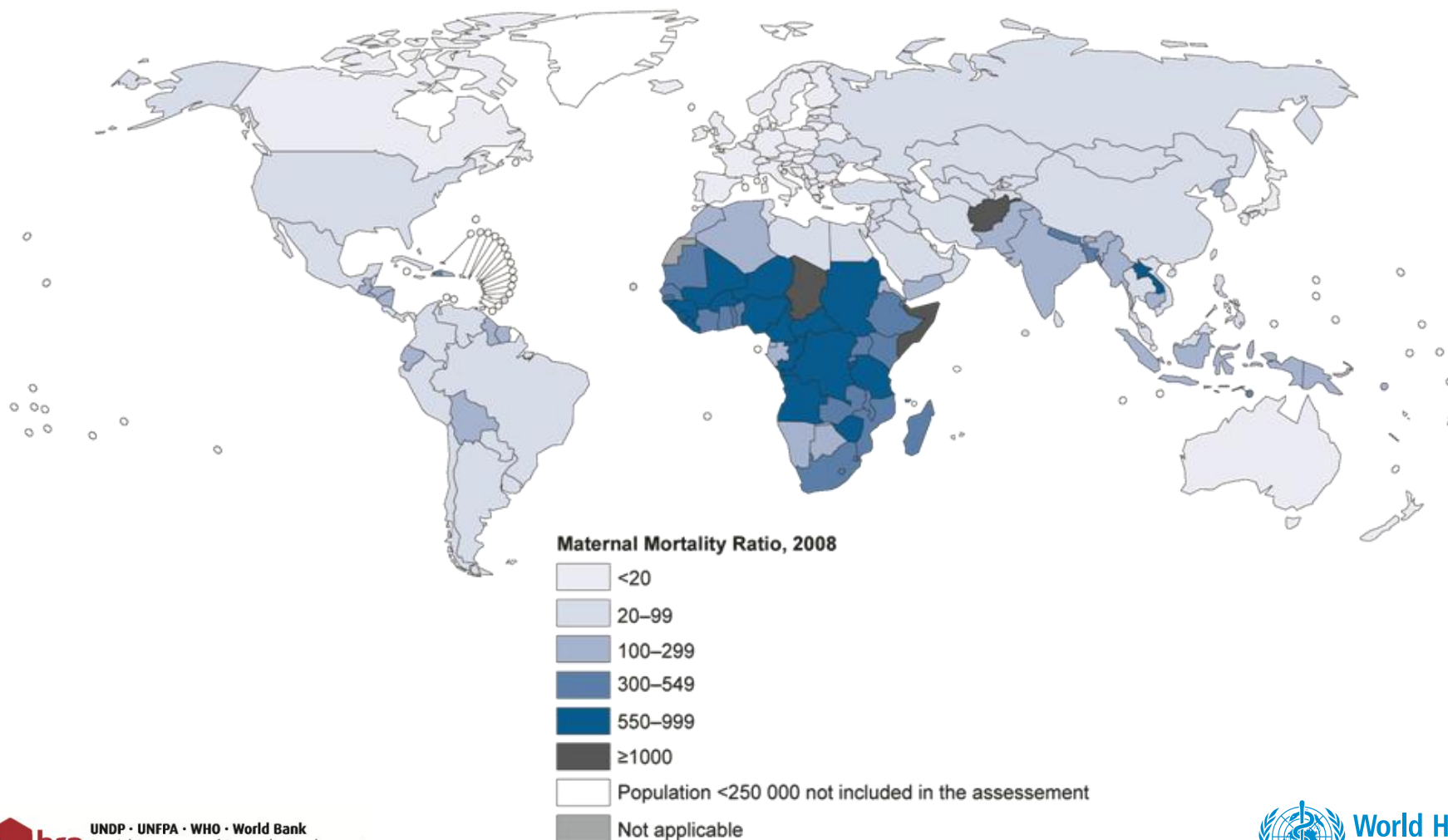* Numbers are rounded

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Maternal mortality ratios 1990-2008
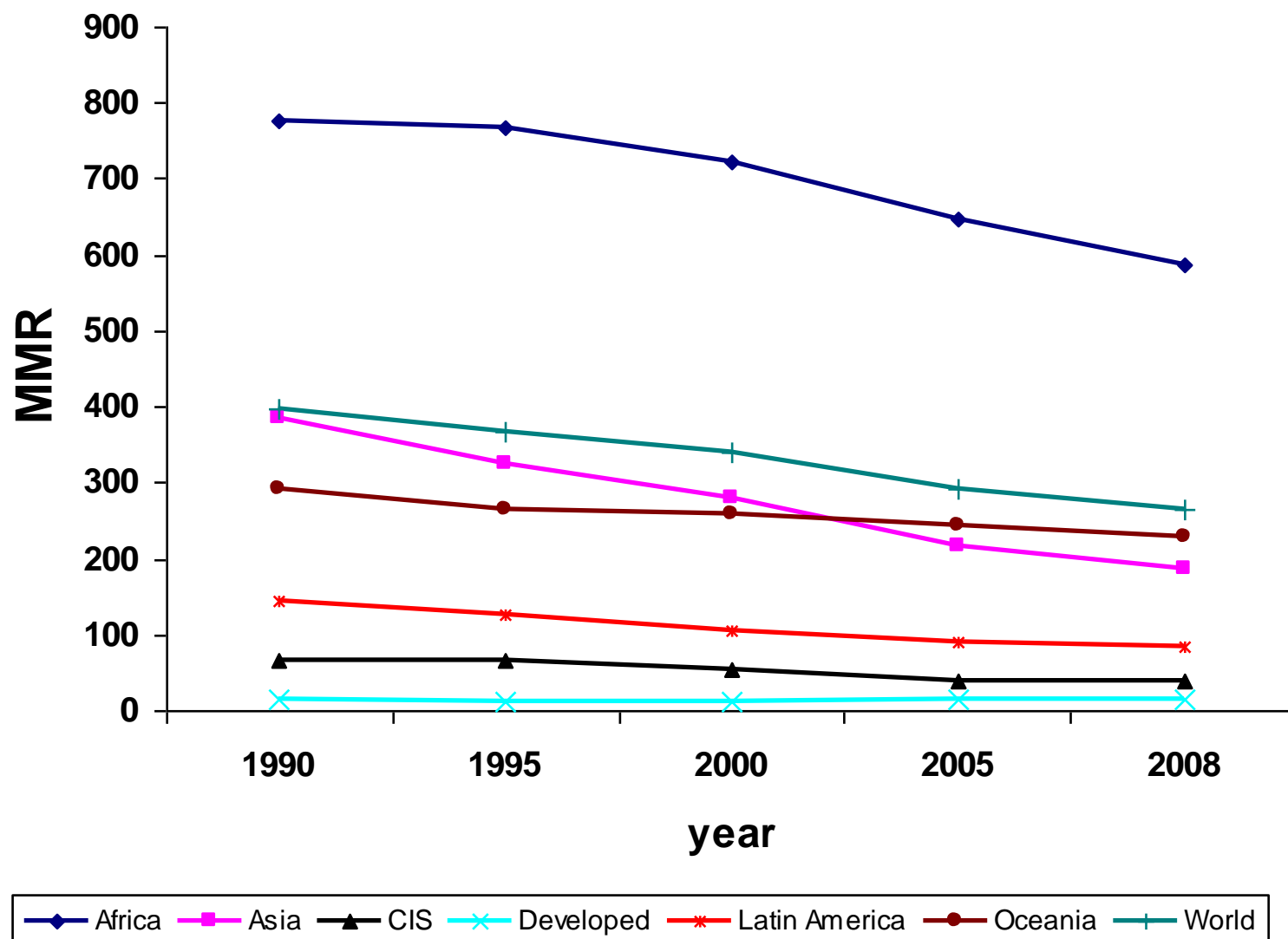
Maternal deaths due to HIV/AIDS

- Overall, it was estimated that there were 42 000 deaths due to HIV/AIDS among pregnant women in 2008

- About half of those were assumed to be maternal
  - The contribution of HIV/AIDS was highest in sub-Saharan Africa where 9% of all maternal deaths were estimated to be due to HIV/AIDS
  - Globally, 6% of maternal deaths estimated to be due to HIV/AIDS

Maternal mortality ratios at country level

Maternal Mortality Ratio, 2008
- <20
- 20–99
- 100–299
- 300–549
- 550–999
- ≥1000
- Population <250 000 not included in the assessement
- Not applicable

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What is new compared with the 2005 analysis

- Trend estimates for countries

  => bigger database

- Definition issue addressed

- Maternal deaths related with HIV/AIDS taken into account

- Statistical model – more detailed

Next steps

- Database and the statistical programme available on web

www.who.int/reproductivehealth/publications/monitoring/9789241500265/en/index.html

- January: TAG meeting – call for inputs and collaboration

- Review feedback and continuous interaction with countries in:
  - strengthening capacity in using the model
  - reviewing data quality
  - updating the database
  - supporting the use of data for decision making

- Regional workshops

Conclusion

- Gradual – but variable decline of maternal mortality, globally off the pace required by the MDG 5 target

- Preventable maternal deaths occur every day

- Need for real and better numbers:

  – Maternal deaths must be counted to guide action and monitoring progress

  – Estimates are imprecise, but important as a means to assess progress and engage countries

  – Not knowing the exact numbers of women dying should not deflect anyone's attention from stepping up our efforts to reduce maternal mortality