Maternal mortality estimation at the subnational level: a model-based method with an application to Bangladesh

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Objective To provide a model-based method of estimating maternal mortality at the subnational level and illustrate its use in estimating maternal mortality rates (MMrates) and maternal mortality ratios (MMRs) in all 64 districts of Bangladesh.

Methods Knowing that mortality is more pronounced among the poorer segments of a population, in rural areas and in areas with poor availability and utilization of maternal care, we used an empirical Bayesian prediction method to estimate maternal mortality at the subnational level from the spatial distribution of such factors.

Findings MMRs varied significantly by district in Bangladesh, from 158 maternal deaths per 100 000 live births at Dhaka district to 782 in the northern coastal regions. Maternal mortality was consistently higher in the eastern and northern regions, which are known to be culturally conservative and to have poor transportation systems.

Conclusion Bangladesh has made noteworthy strides in reducing maternal mortality since 1990, even though the utilization of skilled birth attendants has increased very little. However, several areas still show alarmingly high maternal mortality figures and need to be prioritized and targeted by health administrators and policy-makers.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

The target of Millennium Development Goal 5 (MDG 5) is to reduce the maternal mortality ratio (MMR), defined as the number of maternal deaths per 100 000 live births, by three-quarters between 1990 and 2015. However, there are challenges involved in monitoring progress towards MDG 5 and in evaluating the impact of safe motherhood initiatives because accurately estimating maternal mortality is very difficult.[1] This is especially so in developing countries, where vital registration systems are usually incomplete.

In the absence of complete vital registration systems with accurate attribution of causes of death, the methods used most commonly to estimate maternal mortality are household surveys with direct death inquiry, indirect and direct sisterhood methods and reproductive age mortality surveys. However, none of these methods is suitable for measuring maternal mortality in small geographical areas, where safe motherhood programmes are often implemented. As a result, health administrators and programme managers working on local safe motherhood programmes are often unable to monitor progress towards reducing maternal mortality in their areas or to set a specific numeric objective. Good subnational estimates are also essential for setting priorities, allocating resources and targeting areas where maternal mortality is high.

For countries lacking maternal mortality data, regression-based methods are used to make estimates. Of the 198 countries and territories included in a study conducted in 1990 by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) to estimate maternal mortality, 114 countries (57.6%) had no nationally-representative data available and a regression model had to be used to estimate their maternal mortality figures.[2] Subsequent attempts to estimate maternal mortality globally have shown only modest improvements in data availability.[3,4]

Several factors explain the lack of national-level maternal mortality data. In statistical terms, maternal deaths are rare events and very large survey samples are needed to make estimates with reasonable confidence margins. As a case in point, the 2001 Bangladesh Maternal Health Services and Maternal Mortality Survey (BMMS), which was national in scope, comprised a sample of 104 323 households at a cost of about $US 1 million.[5] Yet despite the large sample size, the MMR estimates for the three years preceding the survey (382 per 100 000 live births) had 95% confidence intervals (CIs) of ± 15%. Similarly, accurate estimates of maternal mortality at the subnational level are not feasible with the estimation methods currently available.

Several experts have recommended using process indicators, such as the percentage of births attended by skilled providers, as proxies for maternal mortality.[6,7] However, process indicators are not suitable proxies because their frequency in relation to maternal mortality varies across different settings. Overall in Asian countries, for example, 34% of deliveries are attended by skilled birth attendants and the estimated MMR is 540 maternal deaths per 100 000 live births. In contrast, in sub-Saharan Africa about 35% of the deliveries are attended by skilled birth attendants, yet the MMR is almost twice as high as in Asia (920 per 100 000 live births).

In the late 1980s, Graham et al. proposed the indirect sisterhood method primarily to overcome the need for a large sample in household surveys, and several developing countries adopted it.[8] Rutenberg & Sullivan[9] later proposed a direct method entailing more detailed questions on the survival status of all siblings, not just sisters. In both methods, female respondents who report having dead sisters are asked about the timing of the deaths in relation to pregnancy, and the response is recorded. Piggyback-

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ing on existing surveys in this fashion makes for less costly maternal mortality estimates. However, sisterhood methods are not suitable for making subnational estimates because the location of the deaths is not recorded.

Some studies using reproductive age mortality surveys or case-finding approaches have been conducted to estimate subnational MMRs.[1,10,11] However, such approaches are very costly and seldom feasible. In this paper we propose a model-based approach that draws on the known distribution of certain population characteristics and contextual factors in a given area to estimate its MMR. This work is influenced by the literature of small area estimation methods based on generalized linear mixed models.[12] We illustrate the method by applying it to Bangladesh using data from the 2001 BMMS.[13]

Methods

Data

The 2001 BMMS was a nationally representative survey of 103 796 ever-married women of reproductive age (15–49 years). The household questionnaire collected data broken down by age and sex on the deaths that occurred over the three-year period immediately before the survey. If deaths in women of reproductive age were reported, their timing relative to pregnancy was determined through additional questions. We first estimated the maternal mortality rate (MMRate, defined as the number of maternal deaths per 100 000 women of reproductive age) for all 64 districts in Bangladesh independently, and then estimated the maternal mortality ratio (MMR) for each district *j* by dividing each district's MMRate by its general fertility rate (GFR, defined as the number of live births in a year per 1000 women of reproductive age):

$$MMRj = \frac{MMRatej}{GFRj} = \frac{deathsj}{womenj} \times \frac{womenj}{livebirthsj} = \frac{deathsj}{livebirthsj}$$

Our maternal mortality estimates are really pregnancy-related mortality ratios (PRMRs), as defined in WHO's *International statistical classification of diseases and related health problems, 10th revision*, since they include *all* deaths among women during pregnancy or within the 42 days following delivery, regardless of cause. In a standard household survey, true maternal deaths, which exclude deaths from incidental or accidental causes, cannot be distinguished from those that are pregnancy-related without additional information collected through verbal autopsy from close relatives of the deceased (e.g. mother, husband) about the signs and symptoms surrounding the death. All estimates of maternal mortality derived from sisterhood surveys are actually PRMRs, and historically-reported data are based primarily on PRMRs. To facilitate comparisons between our findings and those derived from other studies or available data sources, we included all pregnancy-related deaths as reported in the original BMMS and expressed maternal mortality in terms of MMRs. The true MMR based on BMMS and verbal autopsy is about 16% lower than the PRMR (e.g. 322 versus 382 maternal deaths per 100 000 live births).[5]

Statistical method

The maternal mortality rate can be estimated *directly* from a sample survey as

$$MMRate_{direct} = Y_{direct} = \sum_{i \in s} d_i / N_j$$

where d_i is the number of deaths and N_j is the number of women in area *j*. However, this direct method is not good for estimating maternal mortality at the subnational level. This is because in sample surveys, not all areas are represented in the sample, and samples from small geographical areas may not be large enough to provide a stable estimate.

Alternatively, maternal mortality can be estimated *indirectly* from the predicted values of the model as

$$Y_{indirect} = \bar{X}'\beta + \varepsilon$$

where ε is an error term and $\bar{X}$ is a vector of auxiliary variables that are mortality predictors measured as an average of the values at the subnational level. An advantage of the indirect regression method is that the estimation is based on all the data available in the sample, rather than just on data for area *j*. There are, however, two specific problems with the indirect method: the prediction with equation:

$$E(Y_{indirect}) = \bar{X}'\beta$$

which ignores the error term ε and thus the heterogeneity across areas, and it rests on the assumption that areas having similar characteristics have identical maternal mortality. In summary, the direct method provides unbiased estimates, but they have low precision (poor efficiency due to small sample size and large variance). Worse still, it cannot yield any estimate at all if the area is not included in the survey or no death is observed in it because of its small size. On the other hand, indirect (or synthetic) estimates with a regression method are more efficient and precise, but they are not free from bias.

Random-effects models,[14] also referred to as mixed models, are optimally based on both *direct* and *indirect* estimates and provide a balanced estimate. The prediction from the model, known as the best linear unbiased prediction (BLUP), is a weighted estimate of direct and indirect estimators and "borrows strength" (information) from related areas that also increase the effective sample size and thus increase precision.

In the random-effects (mixed) model,

$$y_{mixed} = \bar{X}'\beta + u_j + \varepsilon_{ij}$$

where u_j captures the heterogeneity across areas, $u_j \sim N(0, \sigma^2_u)$ and $\varepsilon_{ij} \sim N(0, \sigma^2_\varepsilon)$.

The BLUP from the model is:

Table 1. **Observed maternal mortality rates (MMRates) and maternal mortality ratios (MMRs) in all 64 districts of Bangladesh, 1997–2001**

District	Deaths (weighted no.)	Women person–years	GFR[a]	MMRate[b]	MMR[c]	MMR 95% CI
Bagerhat	6.8	5249	98	130	1329	383–1617
Bandarban	1.0	477	139	216	1558	–[d]
Barguna	0.8	2558	101	30	296	0–3418
Barisal	3.1	7258	119	42	354	588–1412
Bhola	2.1	4333	131	49	371	790–1210
Bogra	1.3	8743	91	15	159	739–1262
Brahmanbaria	7.2	6922	143	104	729	672–1328
Chanpur	4.7	6690	122	71	579	663–1337
Chittagong	3.9	18044	120	21	178	0–2226
Chuadanga	0.9	2853	83	32	389	500–1500
Comilla	5.8	12321	130	47	363	572–1429
Cox's Bazar	4.6	4084	162	114	701	975–1025
Dhaka	3.2	18361	96	18	184	0–2644
Dinajpur	4.3	8032	113	53	470	652–1348
Faridpur	0.0	5900	119	–	–	–
Feni	0.0	3184	121	–	–	–
Gaibandha	6.9	7400	100	93	930	749–1251
Gazirpur	2.4	5896	96	40	414	111–1889
Gopalganj	0.0	3725	118	–	–	–
Habiganj	4.3	5319	136	81	597	839–1161
Jamalpur	6.3	6571	109	95	870	552–1448
Jessore	2.8	7579	92	37	399	362–1638
Jhalokati	1.1	2157	94	53	559	373–1627
Jhenaidaha	1.0	4710	85	22	255	729–1270
Joypurhat	3.3	1806	86	182	2133	–
Khagrachhari	1.1	775	100	136	1351	0–2131
Khulna	0.7	7385	109	10	91	0–2049
Kishoreganj	3.7	8579	148	43	289	437–1564
Kurigram	1.8	4808	104	38	361	0–3409
Kushtia	0.9	5096	90	17	189	609–1392
Lakshmipur	2.0	4497	120	44	369	533–1467
Lalmonirhat	0.0	2922	108	–	–	–
Madaripur	0.8	3403	127	23	183	472–1528
Magura	1.5	2465	97	60	621	560–1440
Manikganj	2.5	4295	93	58	617	623–1377
Maulvi Bazar	1.8	5544	131	32	246	717–1283
Meherpur	0.0	1684	88	–	–	–
Munshiganj	1.4	4067	109	34	310	0–3303
Mymensingh	7.5	12639	131	59	452	665–1335
Naogaon	2.7	8044	85	34	402	0–3033
Narail	0.0	1955	122	–	–	–
Naratanganj	4.8	8055	116	59	510	377–1623
Narsingdi	0.0	6642	137	–	–	–
Natore	1.5	3933	89	38	429	–
Nawabganj	1.7	3998	99	43	429	297–1703
Netrokona	1.2	6442	142	19	134	434–1566
Nilphamari	1.3	4047	116	31	268	589–1411
Noakhali	1.0	7739	129	12	96	655–1346
Pabna	1.6	5660	99	28	282	520–1480
Panchagarh	0.0	2263	114	–	–	–
Patuakhali	3.7	3771	103	97	946	692–1308
Pirojpur	1.9	3155	107	59	554	551–1449
Rajbari	1.3	2389	99	56	562	–

$$
\begin{aligned}
y_{jBLUP} &= \bar{X}'_j\beta + \gamma(\bar{y}_j - \bar{X}_j'\beta) \\
&= \gamma\bar{y}_j + (1-\gamma)\bar{X}_j'\beta \\
&= (SF_j)\times direct\ \ estimator + \\
&\qquad (1-SF_j)\times indirect\ \ estimator
\end{aligned}
$$

where SF_j is the shrinkage factor for area j and *shrinkage* factor $\gamma_j = \sigma^2_{u(j)}/(\sigma^2_{u(j)} + \sigma^2_{\varepsilon})$.

A problem with the BLUP is that the estimators are dependent on the variance components, which are typically unknown in practice. The variances are commonly replaced with asymptotically consistent estimators from the fitted models, and the BLUP is referred to as an empirical best linear unbiased prediction (EBLUP). We used an empirical Bayesian method to predict MMRates.

We drew on our knowledge that maternal mortality is associated with certain individual and community characteristics to fit a random-effects Poisson regression model, under a generalized mixed model specification, in which maternal death counts were modelled to their proximate determinants.[15] All relevant variables available in the BMMS data, based on McCarthy & Maine's conceptual framework[15] for maternal mortality determinants, were included in the model. Regressor (X) variables were: urban/rural residence of women (RES), administrative division (DIV), socioeconomic status (SES), skilled birth attendants at delivery ($SBDA$) and distance of nearest health facilities (DIS). All covariates were measured at the aggregate level. The fitted random-effects Poisson model was:

$$
\begin{aligned}
log(y_{ij}) = \beta_0 &+ \beta_1 RES_j + \beta_2 DIV_j + \beta_3 SES_j \\
&+ \beta_4 SBDA_j + \beta_5 DIS_j + \nu_j \\
&+ log(py)
\end{aligned}
$$

where β_s are the model estimated coefficients, and $log(py)$ is the offset term – logarithm of exposure measured in women person–years (py) of exposure (for the year of death, a woman contributed 0.5 person–years, otherwise $py = 1$ for each year of observation [survival] during the study reference period), and ν_j is the residual error for area j. We used an empirical Bayesian method[16] to predict the MMRate for each district j from the above

District	Deaths (weighted no.)	Women person–years	GFR[a]	MMRate[b]	MMR[c]	MMR 95% CI
Rajshahi	0.0	6 948	91	–	–	–
Rangamati	0.9	1 387	124	65	525	572–1429
Rangpur	4.7	7 450	105	63	598	537–1463
Satkhira	2.7	5 432	103	49	477	633–1367
Shariatpur	2.3	3 425	130	66	506	401–1599
Sherpur	2.5	3 764	114	66	579	590–1410
Siraganj	0.0	7 207	118	–	–	–
Sunamganj	4.4	6 319	162	70	434	917–1083
Sylhet	9.6	7 596	151	126	835	889–1111
Tangail	0.0	11 424	88	–	–	–
Thakurgaon	0.0	3 485	125	–	–	–

CI, confidence interval; GFR, general fertility rate.
[a] Number of live births in a year to women of reproductive age.
[b] Number of maternal deaths per 100 000 women of reproductive age.
[c] Number of maternal deaths per 100 000 live births.
[d] Dashes indicate that no estimate could be obtained.

Table 2. **Estimated maternal mortality rates (MMRates) and maternal mortality ratios (MMRs) in all 64 districts of Bangladesh, 1997–2001**

District	MMRate	95% CI	MMR	95% CI
Bagerhat	76	49–104	782	503–1061
Bandarban	68	37–100	492	265–719
Barguna	50	35–66	499	342–655
Barisal	46	37–55	384	306–462
Bhola	54	38–70	411	288–534
Bogra	27	14–41	298	148–448
Brahmanbaria	73	50–97	515	348–682
Chanpur	54	36–72	442	292–593
Chittagong	25	15–36	211	124–299
Chuadanga	28	9–47	338	104–572
Comilla	46	34–58	354	262–446
Cox's Bazar	80	55–104	490	336–644
Dhaka	15	5–26	158	50–267
Dinajpur	34	20–49	303	175–431
Faridpur	29	12–45	239	98–381
Feni	35	15–55	291	128–455
Gaibandha	49	28–71	494	276–713
Gazirpur	31	19–42	318	201–435
Gopalganj	31	14–48	261	118–404
Habiganj	89	57–122	654	417–892
Jamalpur	66	38–93	600	348–853
Jessore	32	14–50	348	148–549
Jhalokati	47	32–62	501	342–661
Jhenaidaha	32	13–52	379	151–607
Joypurhat	36	18–54	421	213–629
Khagrachhari	60	30–90	597	297–897
Khulna	25	11–40	230	97–364
Kishoreganj	43	28–58	291	190–391
Kurigram	33	16–49	314	156–471
Kushtia	26	11–42	292	122–463
Lakshmipur	54	34–75	452	279–626
Lalmonirhat	36	14–58	335	127–542
Madaripur	40	22–58	317	171–462

model. The CIs for the predicted rates were based on the jackknife method.[17]

The estimation of the CIs for prediction is a challenging problem in the literature of mixed effects models because no closed formula for prediction error is available. Several approximate methods have been proposed for Gaussian linear mixed models, which are not suitable for count data fitted with random-effects Poisson regression models. Resampling procedures, bootstrapping and jackknife methods have been proposed to estimate the mean square error of BLUP for non-normal and nonlinear mixed models. We used a jackknife method to construct CIs for the EBLUP. The jackknife method is robust to misspecification and is commonly used in survey statistics to adjust variance estimation from complex survey data when the design effect > 1 owing to high intracluster correlation. All analyses were performed with Stata, version 10 (StataCorp LP, College Station, United States of America).

Results

Table 1 shows the observed MMRates and MMRs, with 95% CIs for all 64 districts in Bangladesh. The sample size at the district level, expressed in women person–years, ranged from 477 to 18 361. Such small samples are grossly inadequate for estimating maternal mortality. Furthermore, no maternal death was observed in 12 districts (19% of all districts). Thus, the estimated 95% CIs were either very wide or could not be estimated reliably. Such estimates are uninformative and useless for any practical purpose.

The model-based MMRates and MMRs are shown in Table 2. The estimated MMR ranged from 158 to 782 maternal deaths per 100 000 live births. In contrast, the observed MMR varied widely, from 91 to 2133 maternal deaths per 100 000 live births. The model-based 95% CIs were much narrower than the CIs of the observed estimates.

The MMR was lowest in the district of Dhaka, the capital of Bangladesh (158 100 000 per live births), and highest in the coastal districts, Bagerhat (782) and Patuakhali (712). High MMRs were found in most districts in Sylhet division, especially Sylhet and Habiganj (678 and 654, respectively). These two districts also had the highest MMRates (102 and 89

District	MMRate	95% CI	MMR	95% CI
Magura	41	12–69	424	129–718
Manikganj	38	24–53	412	257–567
Maulvi Bazar	51	29–74	392	221–562
Meherpur	22	4–41	255	42–469
Munshiganj	26	13–39	239	120–358
Mymensingh	49	36–62	375	277–473
Naogaon	32	18–47	383	213–552
Narail	33	11–54	269	94–444
Naratanganj	31	19–43	267	165–369
Narsingdi	30	13–47	218	91–344
Natore	33	17–49	369	186–552
Nawabganj	31	15–48	318	151–484
Netrokona	39	20–59	276	140–412
Nilphamari	32	16–48	278	140–417
Noakhali	35	19–52	273	144–401
Pabna	26	13–39	266	136–396
Panchagarh	35	15–56	312	135–489
Patuakhali	73	56–90	712	549–875
Pirojpur	53	40–66	495	371–620
Rajbari	40	22–58	402	224–581
Rajshahi	22	9–35	239	95–383
Rangamati	48	21–74	385	170–600
Rangpur	41	24–58	391	230–552
Satkhira	42	14–69	404	137–671
Shariatpur	47	26–68	360	201–518
Sherpur	48	29–68	425	251–600
Siraganj	29	13–45	243	108–377
Sunamganj	77	48–106	478	300–657
Sylhet	102	78–127	678	518–839
Tangail	24	10–38	270	112–428
Thakurgaon	33	15–52	268	116–419

CI, confidence interval.

maternal deaths per 100 000 women of reproductive age, respectively).

The spatial distribution of MMRs across Bangladesh is shown in Fig. 1. Maternal deaths were more highly concentrated in the districts of Sylhet division and in the hill tract areas of Chittagong division (a predominantly mountainous territory located in south-east Bangladesh and inhabited by a tribal population), as well as in coastal areas (southern region). In central coastal districts communication is primarily by boat and cyclones and floods are frequent.

Fig. 2 shows the districts ranked by MMR and the national MMR from the 2001 BMMS; details on BMMS maternal mortality estimates have been published by Hill et al.[5] In 28 (44%) districts, the MMR was higher than the national average.

A comparison of MMRates and MMRs across districts reveals some striking features. The MMR indicates the risk of death per pregnancy, whereas the MMRate indicates the overall (cumulative) risk of death per woman. In areas with a high GFR, MMR estimates can be comparatively low and therefore misleading. As an example, Bagerhat and Sunamganj have almost the same MMRate (76 and 77 per 100 000 women) but different GFRs (98 and 164 per 1000 women, respectively [not shown]). Women in Sunamganj misleadingly appear to have a substantially lower risk of maternal death than women in Bagerhat if we only look at MMRs (478 versus 782 per 100 000 live births, respectively).

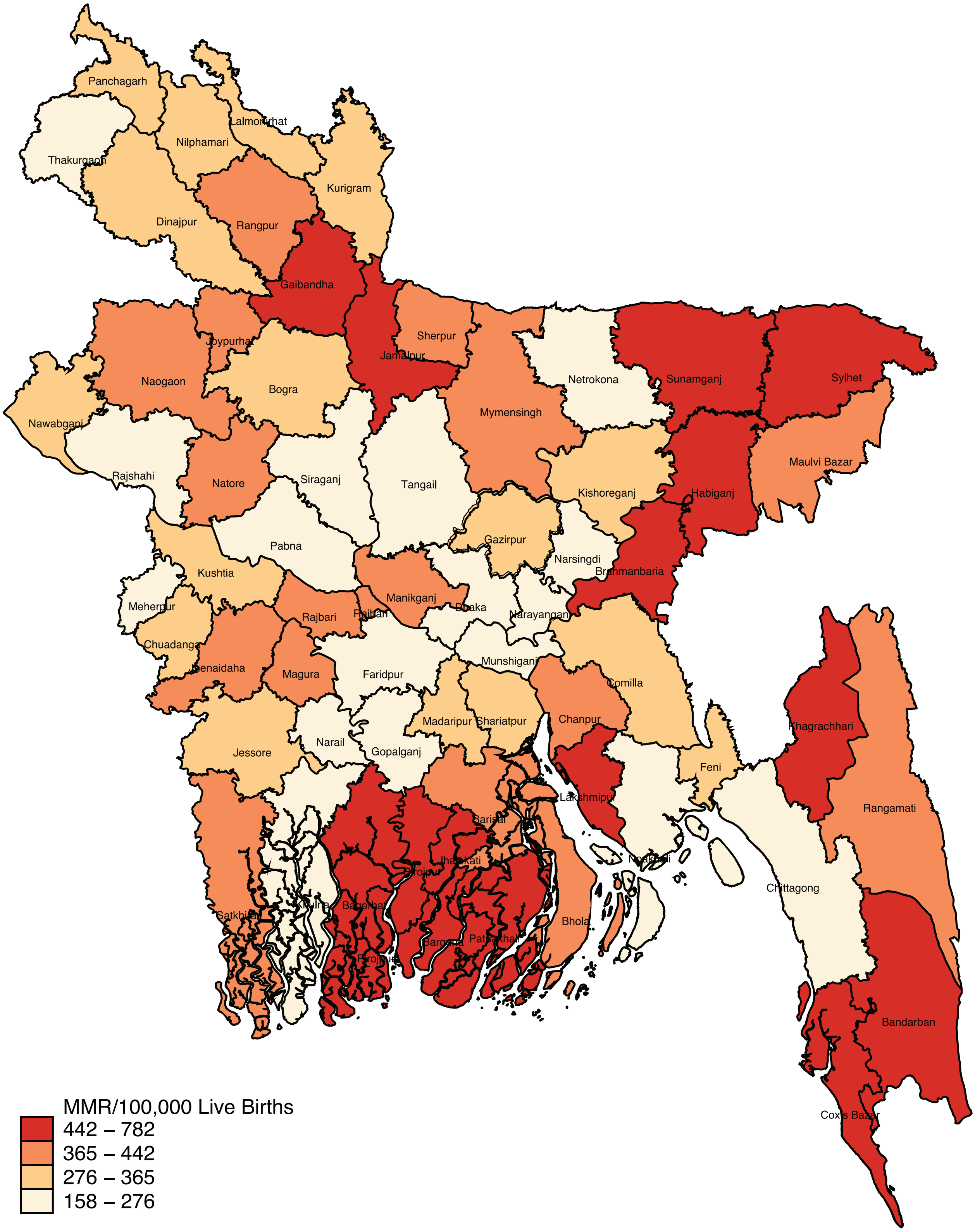
A comparison of our findings with those from an earlier study in Bangladesh by Rahman et al.,[10] in which a case-finding approach was used to identify deaths through hospital and community auditing, shows broad similarities in the spatial distribution of maternal deaths.

Conclusion

A maternal death is a rare event in the statistical sense and reliable estimates of maternal mortality call for population-based surveys with very large samples. It is not practical to estimate MMRs for small areas through sample surveys. A simple calculation can reveal, for example, that to estimate maternal mortality in 64 districts (as in Bangladesh) with an expected MMR of 500, a margin of error of 40%, a design effect of 1.2 and a GFR of 113 per 1000 women, based on a 3-year history of births, a sample of approximately 1.08 million women would be required. Such a requirement poses a major problem when undertaking a study of maternal mortality at the subnational level. We have presented an alternative, model-based method to estimate subnational maternal mortality from survey data derived from a much smaller sample.

The MMR in Bangladesh declined from 574 to 382 deaths per 100 000 (about 33%) in 1990–2000, even though the proportion of deliveries by skilled birth attendants increased very little over the period (in 2000 only 12% of births were delivered by skilled birth attendants). This rate of change indicates that the country is on its way to achieving the MDG 5 target of reducing the MMR by three-quarters between 1990 and 2015, but to attain the goal, it must further reduce the MMR to 143 deaths per 100 000 live births by 2015.[18] Our results suggest, quite reassuringly, that Dhaka district had already attained an MMR of 158 per 100 000 live births by the late 1990s. However, in 8 districts in Bangladesh MMRs are still greater than 500 deaths per 100 000 live births. These districts must reduce maternal mortality by more than 8.3% per year to achieve the MDG 5 target. In contrast, 21 districts (33%) have an MMR below 300 deaths per 100 000 live births, and these districts need to reduce maternal mortality by 5% per year to achieve the MDG 5 target. Stated differently, without an accelerated reduction in maternal deaths in areas of Bangladesh where maternal mortality is high, perhaps even twice as high as in low-mortality areas, the country may not achieve MDG 5. High maternal mortality districts were predominantly located in the coastal and hill tract regions, economically disadvantaged areas where

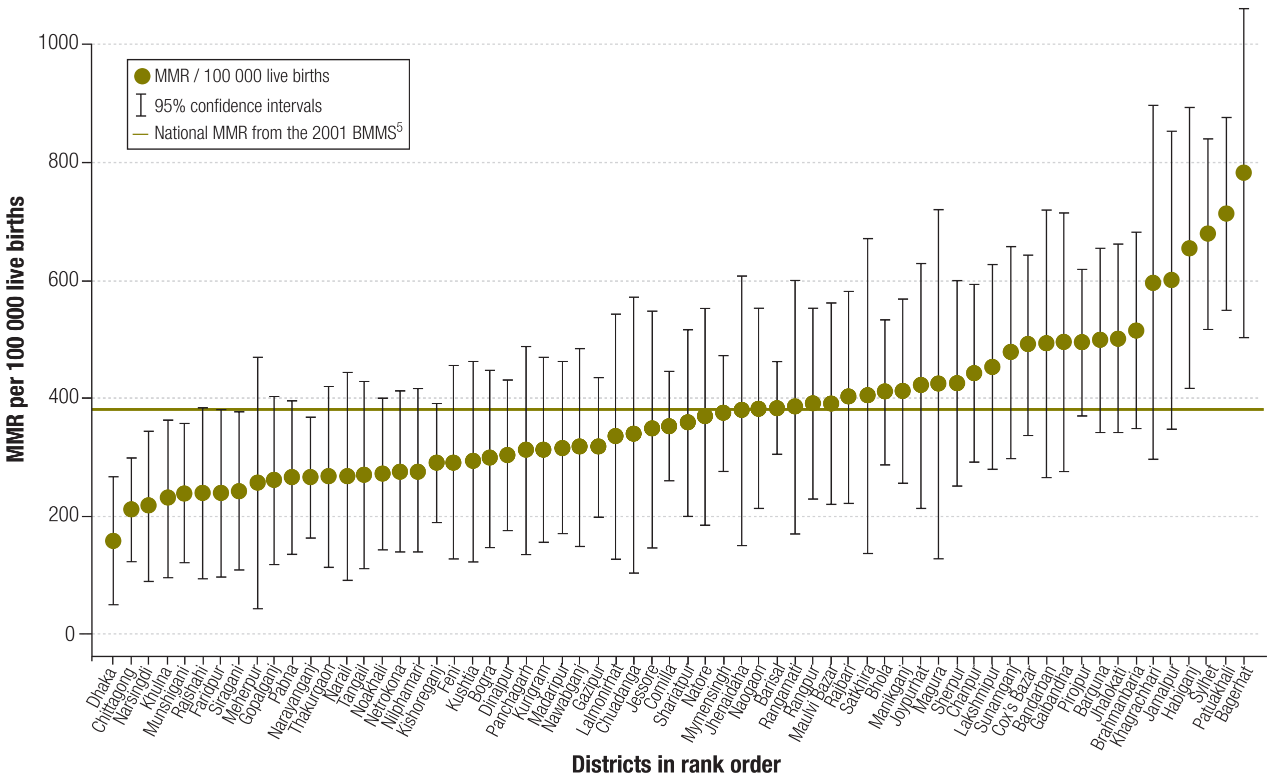
Fig. 1. **Map showing subnational maternal mortality ratio (MRR) estimates for the entire territory of Bangladesh, 1997–2000**



STATA

Source of map: Global Administrative Areas (http://www.gadm.org).

Fig. 2. **Maternal mortality ratio (MRR) estimates for all 64 districts of Bangladesh, 1997–2000**



road communication and transportation systems are weak. Maternal mortality was also pronounced in Sylhet division, a high-fertility area known to be socially conservative. Estimating MMRs at the district level will help health officials target these high-risk areas on a priority basis. Another BMMS survey round is taking place in 2010, and the data collected will make it possible to observe how maternal mortality has changed at the district level.

To allow estimates of maternal mortality at the subnational level, Stanton et al.[19] propose collecting maternal mortality data as part of the decennial census. In places where a vital registration system is not available, there is currently no other way to obtain data for estimating subnational level MMRs. However, the model-based approach presented in this paper offers a viable alternative. Random-effect Poisson models have been used in epidemiological studies, especially of cancer mortality.[20–27]

Reliable maternal mortality data are not available from a large number of countries, and WHO/UNICEF is currently using a regression method to indirectly estimate these countries' MMRs. The risk of bias implicit in such methods has already been discussed. The empirical Bayesian method, which gains strength by "borrowing information" from neighbouring countries, may also be used to estimate MMRs for countries lacking reliable data.

In this paper we have examined maternal mortality in Bangladesh and presented a new method that can help policy planners identify high-risk areas, efficiently allocate resources and prioritize target settings. Although the method does not always provide a precise estimate for each district, it does provide an overview of the spatial distribution of maternal mortality throughout Bangladesh, which will in turn be useful to health administrators and policy planners in prioritizing areas with high maternal mortality. ■

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ملخص

تقدير وفيات الأمهات على الصعيد دون الوطني: طريقة نموذجية للتطبيق في بنغلاديش

الغرض تقديم طريقة نموذجية لتقدير وفيات الأمهات على الصعيد دون الوطني وإظهار فائدة تقدير معدلات وفيات الأمهات في جميع مقاطعات بنغلاديش البالغ عددها 64 مقاطعة.

الطريقة حيث أن الوفيات أكثر حدوثاً بين الفئات السكانية الفقيرة، وفي المناطق الريفية، وفي المناطق التي تفتقر إلى رعاية الأمومة أو يصعب الاستفادة من خدماتها، لذا استخدم الباحثان طريقة عملية لتنبؤ بايز Bayesian prediction لتقدير وفيات الأمهات على الصعيد دون الوطني من حيز توزيع هذه العوامل.

الموجودات تباينت معدلات وفيات الأمهات تبايناً يُعتد به حسب مقاطعات بنغلاديش، فتراوحت من 158 وفاة للأمهات لكل 100 ألف مولود حي في مقاطعة دكا إلى 782 وفاة في المناطق الساحلية الشمالية. وكانت معدلات وفيات الأمهات أكثر باستمرار في المناطق الشرقية والشمالية، والتي تعد ثقافياً مناطق أكثر تحفظاً وتسوء فيها نظم الانتقال.

الاستنتاج لقد خطت بنغلاديش خطوة جديرة بالإشادة في خفض وفيات الأمهات منذ عام 1990، بالرغم من أن الاستفادة من المشرفات الماهرات على الولادة ازداد زيادة ضئيلة، لكن مازال هناك مناطق متعددة تثير معدلات وفيات الأمهات فيها القلق، وتحتاج إلى استهدافها واعتبارها أولوية من قبل الإداريين الصحيين وراسمي السياسات.

摘要

地方产妇死亡率估算：应用于孟加拉国的基于模型的方法

目的 旨在为估算地方产妇死亡率提供一个以模型为基础的方法并对其在估算孟加拉国64个区产妇死亡率（MMrates）和产妇死亡比（MMRs）上的应用进行了说明。

方法 鉴于死亡率在一个国家的贫困阶层、农村地区和孕产期保健可及性和利用率较差的地区更加显著，我们使用经验贝叶斯预测法，从这些因素的空间分布出发，估算地方产妇死亡率。

结果 孟加拉国的产妇死亡率因地区的差异差别很大，从达卡地区每十万婴儿安全出生中的158例产妇死亡到北部沿海地区的782例。东部和北部地区的产妇死亡率一直居高不下，众所周之这些地区在文化上保守并且交通不便利。

结论 尽管让熟练接生员进行接生增加有限，但自1990年以来孟加拉国在减少产妇死亡率上已经取得显著进步。然而，一些地区仍显示出高得惊人的产妇死亡率，因而仍需卫生管理人员和决策者的优先考虑和重视。

Résumé

Estimation de la mortalité maternelle au niveau sous-national: une méthode à base de modèles appliquée au Bangladesh

Objectif Fournir une méthode à base de modèles dans le cadre de l'estimation de la mortalité maternelle au niveau sous-national et illustrer son utilisation dans l'estimation des taux de mortalité maternelle (tauxMM) et des rapports de mortalité maternelle (RMM) dans les 64 districts du Bangladesh.

Méthodes Sachant que la mortalité est plus prononcée dans les segments plus pauvres d'une population, dans les régions rurales et les régions disposant de peu de soins aux mères et y ayant peu recours, nous avons utilisé une méthode de prédiction bayésienne empirique afin d'estimer la mortalité maternelle au niveau sous-national à partir de la distribution spatiale de ces facteurs.

Résultats Les RMM variaient considérablement par district au Bangladesh, de 158 décès maternels pour 100 000 naissances vivantes dans le district de Dhaka à 782 décès maternels dans les régions côtières du Nord. La mortalité maternelle était invariablement supérieure dans les régions de l'Est et du Nord, qui sont connues pour leurs systèmes de transport médiocres et pour être conservatives du point de vue culturel.

Conclusion Le Bangladesh a fait des progrès remarquables en termes de réduction de la mortalité maternelle depuis 1990, même si le recours à des sages-femmes compétentes n'a enregistré qu'une légère augmentation. Cependant, plusieurs régions montrent aujourd'hui encore des chiffres de mortalité maternelle alarmants, que les responsables politiques et les gestionnaires de la santé doivent cibler et traiter en priorité.

Резюме

Оценка материнской смертности на субнациональном уровне: метод, основанный на модели, и его применение на примере Бангладеш

Цель Предложить метод оценки материнской смертности на субнациональном уровне, основанный на модели, и проиллюстрировать его использование на примере оценки показателей материнской смертности (ПММ) и коэффициентов материнской смертности (КММ) в 64 округах Бангладеш.

Методы Сознавая, что смертность сильнее проявляется среди бедных слоев населения, в сельских районах и в районах с низкой доступностью и неудовлетворительным использованием медицинской помощи в области охраны здоровья матерей, мы использовали эмпирический байесовский метод прогнозирования для оценки материнской смертности на субнациональном уровне на основании процентного распределения этих факторов.

Результаты КММ значительно варьировались по округам Бангладеш, от 158 материнских смертей на 100 000 живорождений в Даккском округе до 782 в прибрежных северных районах. Материнская смертность была последовательно выше в восточных и северных районах, которые известны как консервативные в культурном отношении и имеют плохие транспортные системы.

Вывод С 1990 года Бангладеш заметно продвинулась вперед в снижении материнской смертности, даже несмотря на то, что использование квалифицированной акушерской помощи возросло очень незначительно. Тем не менее, ряд районов по-прежнему демонстрирует угрожающе высокую статистику материнской смертности. Администраторы здравоохранения и разработчики политики должны обратить первостепенное внимание на эти районы и усилить в них адресное воздействие.

Resumen

Estimaciones de la mortalidad materna a nivel regional: método basado en modelos con aplicación en Bangladesh

Objetivo Proporcionar un método basado en modelos para calcular la mortalidad materna a nivel regional y explicar su utilización en la estimación de las tasas de mortalidad materna (TMM) y las razones de mortalidad materna (RMM) en los 64 distritos de Bangladesh.

Métodos Para calcular la mortalidad materna a nivel regional y teniendo en cuenta que hay una mayor mortalidad en los sectores más desfavorecidos de la población, en las zonas rurales y en las áreas con una disponibilidad y utilización escasas de la asistencia materna, se utilizó un análisis bayesiano de predicción empírica a partir de la distribución espacial de dichos factores.

Resultados La RMM osciló de manera significativa en función del distrito de Bangladesh correspondiente: desde las 158 muertes maternas por 100 000 recién nacidos vivos en el distrito de Dhaka hasta las 782 de las regiones costeras del Norte. La mortalidad materna fue sistemáticamente superior en las regiones oriental y septentrional, conocidas por su cultura conservadora y por disponer de redes de transporte deficientes.

Conclusión Desde 1990 Bangladesh ha logrado avances notables en la reducción de la mortalidad materna, a pesar del escaso aumento de la asistencia por parte de matronas cualificadas. Sin embargo, algunas zonas siguen presentando unas cifras de mortalidad materna alarmantes y deben obtener prioridad y convertirse en el objetivo principal de los responsables sanitarios y políticos.

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