Changing epidemiology of maternal mortality in rural India: time to reset strategies for MDG-5

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Abstract

OBJECTIVE To understand changes in epidemiology of maternal mortality in rural India in the context of increasing institutional deliveries and implementation of community-based interventions that can inform policies to reach MDG-5.

METHODS This study is a secondary analysis of prospectively collected community-based data of every pregnancy and its outcomes from 2002 to 2011 in a rural, tribal area of Gujarat, India as part of safe-motherhood programme implemented by voluntary organisation, SEWA Rural. The programme consisted of community-based interventions supported by a first referral unit, and promotion of institutional deliveries. For every maternal death, a verbal autopsy was conducted. The incidence rates for maternal mortality according to place, cause and timing of maternal deaths in relation to pregnancy were computed. Annual incidence rate ratios (IRR) and 95% confidence intervals, adjusted for caste and maternal education, were estimated using Poisson regression to test for linear trend in reduction in mortality during the study period.

RESULTS Thirty-two thousand eight hundred and ninety-three pregnancies, 29,817 live births and 80 maternal deaths were recorded. Maternal mortality ratio improved from 607 (19 deaths) in 2002–2003 to 161 (five deaths) in 2010–2011. The institutional delivery rate increased from 23% to 65%. The trend of falling maternal deaths was significant over time, with an annual reduction of 17% (adjusted IRR 0.83 CI 0.75–0.91, P-value < 0.001). There were significant reductions in adjusted incidence rate of maternal deaths due to direct causes, during intrapartum and post-partum periods, and those which occurred at home. However, reductions in incidence of maternal deaths due to indirect causes, at hospital and during antepartum period were not statistically significant. Most maternal deaths are now occurring at hospitals and due to indirect causes.

CONCLUSION Gains in institutional deliveries and community-based interventions resulting in fewer maternal deaths due to direct causes should be maintained. However, it would be essential to now prioritise management of indirect causes of maternal mortality during pregnancy at community and hospitals for further reduction in maternal deaths to achieve MDG-5.

keywords skilled birth attendance, maternal mortality ratio, epidemiology, institutional delivery, Millennium Development Goal-5

Introduction

The epidemiology of maternal mortality is well known (Ronsman et al. 2006). Most maternal deaths occur in poor countries and are clustered around delivery and the immediate post-partum period, although there are variations depending upon the population. The majority of deaths occur due to direct causes such as bleeding, hypertensive disorders and infections (Ronsman et al. 2006). Guided by epidemiology of maternal mortality, institutional delivery has been promoted to prevent maternal deaths at the time of delivery (Bale et al. 2003; WHO 2005; Campbell & Graham 2006). India launched Janani Suraksha Yojana (JSY) in 2005–2006, a conditional cash-transfer programme to promote institutional deliveries. Under JSY, a woman living below the poverty line is entitled to Rs. 700 (US $ 14) in rural areas and Rs. 600 in urban areas if she delivers in a public or accredited private health facility. JSY is implemented through community-based front-line workers who also are incentivised for motivating women for delivering in a health facility (Ministry of Health & Family Welfare 2005). Some state
governments in India initiated their own schemes, such as free emergency transportation for women in labour to reach a hospital and innovative public–private partnership (called Chiranjeevi scheme in Gujarat) to involve obstetricians from private sector (Mavalankar et al. 2009). At the same time, cadres of village-based frontline workers were established in all villages to motivate women to deliver at health facilities and facilitate delivery of community-based-interventions (National Rural Health Mission 2013). These efforts have resulted in a significant increase in the institutional delivery rate from 24.4% in 2005 to 61% in 2010 (Office of Registrar General, India 2008, 2010). The maternal mortality ratio (MMR) has fallen from 407 deaths per 100 000 live births in 1997–1998 to 212 in 2007–2009 (Sample registration system, Office of Registrar General, India 1998, 2012). The increase in institutional deliveries with improved referral linkages is one of the important reasons thought to have resulted in reduction in MMR in India (Kumar et al. 2010).

Despite these achievements, India is not on track to reach the Millennium Development Goal-5 (MDG-5), which is to reduce number of maternal deaths by 75% between 1990 and 2015 (United Nations 2012). At this critical juncture, it is important to understand changes in epidemiology of maternal deaths to evaluate current strategies and guide development of new ones to achieve MDG-5. The objective of this study was to examine changes in epidemiology of maternal mortality in context of increasing institutional deliveries and implementation of community-based interventions in a rural block of Gujarat, India from 2002 to 2011. We tested the hypothesis that there was no change in incidence of maternal deaths, its causes, time and place in this population before and after 2004.

Methods

Study setting

This study is based on prospectively collected community-based data by field-based front-line workers (FLWs) of SEWA Rural. SEWA Rural (SR) is a voluntary organisation in Jhagadia block of Gujarat state in western India. The population of Gujarat was almost 60 million in 2011, and per capita annual income was Rs. 22 553 (US $ 450) (Government of Gujarat 2010, 2012). Gujarat’s MMR was 148 and infant mortality rate was 50/1000 live births with institution delivery rate of 56% in 2007–2009 (Ministry of Health & Family Welfare 2010, 2012; Office of Registrar General, India 2012). After collecting baseline information for 2 years from 1 April 2002 to 30 March 2004, SEWA Rural implemented a family-centred safe-motherhood and new-born survival project for 7 years from 1 April 2004 to 31 March 2011 which catered to the entire Jhagadia block consisting of 168 villages with a population of 175 000, which is mainly tribal, rural and poor (SEWA Rural 2011; Kutty et al. 2013).

Community-level interventions were implemented by FLWs and traditional birth attendants (TBAs) to provide antepartum, intrapartum and post-partum care. The following method was used to ensure completeness of pregnancy registration: The FLWs conducted house-to-house visits in her village every week and registered all new pregnancies. Additionally, two cluster supervisors made monthly door-to-door field visits in all villages to find and register any remaining new pregnancies, which might have been missed by FLWs. This resulted in more than 90% complete pregnancy registration of the expected number of registration based on birth rate of Gujarat. The FLW visited a pregnant woman five times antepartum and nine times post-partum. During home visits, FLW’s responsibility was to ensure early registration of pregnancy, satisfactory birth-preparedness and complication-readiness, complete antepartum check-up, identification and referral of high-risk mothers, counselling of woman and her family in case of unintended pregnancy with availability of referral services for termination of pregnancy, motivate the mother for delivery at hospital, safe delivery by trained TBA in case of home delivery, immediate newborn care and post-partum follow-up of mothers and neonates up to 6 weeks after delivery. Complicated cases were referred to the SEWA Rural hospital, which is a government and UNICEF approved first referral unit (FRU) providing Comprehensive Emergency Obstetrics and Newborn Care attending to almost 2400 deliveries every year. Along with SEWA Rural’s efforts, Governments of India and Gujarat introduced various schemes during the same time period to promote institutional deliveries as described above.

Data collection

Front-line workers used a data collection card to record information related to demographics, risk factors, delivery of services, place of delivery, pregnancy outcome and survival status at 6 weeks post-partum. FLWs also recorded every maternal death and all female deaths in their village. Maternal death was defined as ‘[t]he death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes’ (WHO/UNICEF/UNFPA/
World Bank 2010). A verbal autopsy tool, consisting of open and close ended questions, was developed by SEWA Rural based on prevalent WHO guidelines for conducting verbal autopsy for maternal deaths (WHO 1994). An experienced supervisor visited the deceased woman’s home within 1 month of death and conducted a verbal autopsy by interviewing close family members, TBA and those who were present at the time of death. Once the field team confirmed occurrence of maternal death, a team consisting of a senior obstetrician–gynecologist, public health professionals and field staff discussed every maternal death to ascertain cause of death. A primary and secondary cause of death was assigned and coded by the team based on International Classification of Diseases-10. The information from the verbal autopsy tool was entered into a database at headquarters. Quality and completeness of data were monitored by programme managers, obstetricians and statisticians during weekly meetings, field visits and by comparing field-level data with SEWA Rural hospital records.

Variables of interest and statistical analysis
Statistical software ‘R’ and STATA 10 were used for analysis and creating figures (StataCorp 2007; R Core Team 2012). Information about all pregnancies, pregnancy outcomes and maternal deaths among all women who were resident of the project areas was included for this study. Every primary cause of death was categorised in one of two categories: direct and indirect causes. Deaths from direct causes were defined as ‘those resulting from obstetric complications of the pregnant state (i.e. pregnancy, labour and the puerperium), from interventions, omissions or incorrect treatment, or from a chain of events resulting from any of the above’. Deaths from indirect causes were defined as ‘those resulting from a previously existing disease or a disease that developed during pregnancy and which was not due to direct obstetric causes but which was aggravated by the physiological effects of pregnancy’ (WHO/UNICEF/UNFPA/World Bank 2010). Intrapartum period was considered from onset of labour to end of third stage of labour (Stedman’s medical dictionary 2005). Institutional delivery rate was defined as number of deliveries in institution per 100 deliveries including live and still births.

We chose incidence rate of maternal deaths per 100 000 pregnancies for the analysis instead of MMR. Because a large proportion of maternal deaths occurred during antepartum period and was due to unsafe abortion where delivery did not take place, MMR (which is number of maternal deaths per 100 000 live births) was not sufficient to capture these deaths for analysis. The incidence rate of maternal deaths per 100 000 pregnancies was estimated by dividing the number of maternal deaths by total number of pregnancies according to place, cause and timing of maternal death in relation to pregnancy. The trend in reduction in maternal deaths over the study period was tested using Poisson regression with calendar year entered in the model as a single, continuous variable while adjusting for maternal education and caste. Annual incidence rate ratios (IRR) covering 2002–2011 with 95% confidence intervals are reported for each type of maternal death. Changes in proportion of maternal deaths according to its time, place and cause were also displayed in form of a bar diagram.

Ethical considerations
This study is based on secondary analysis of data collected for project monitoring; thus, ethical review was not sought. Permission from the scientific committee of SEWA Rural was obtained as it hosts the data.

Results
In total, 32.893 pregnancies were registered from 2002 to 2011. There were 29,837 (90.7%) live births, 613 (1.9%) still births, 827 (2.5%) surgical terminations of pregnancies and 1616 (4.9%) spontaneous abortions. Eighty maternal deaths were recorded from 2002 to 2011. As seen in Table 1, characteristics of women who had live births during baseline and project periods were similar, except literacy, caste and institutional delivery rate improved during project period. Information about covariates such as maternal age, caste and maternal education was missing from 177 (0.5%), 253 (0.7%) and 1493 (4.5%) pregnant women, respectively. Mean age of deceased women was 26 years, 10 (13%) had unwanted pregnancy and 70 (87%) of women belonged to a scheduled tribe. Only 18 (22%) women who suffered maternal death delivered at hospital. There were 36 deaths (45%), which occurred before delivery either during antepartum period or due to unsafe abortion practices. Twenty-three (28.8%) women had to seek care at two or more hospitals. Figure 1 shows the reduction in MMR over time against the institutional delivery rate. MMR declined sharply during first 4 years of project; however, a plateau was observed afterwards. The initial sharp reduction was due to fewer women dying from haemorrhage (from 11 to 1) and unsafe abortion (from five to one). The trend in fall of number of maternal deaths over the study period was significant (P < 0.001).

Figure 2(a) shows primary causes of all 80 maternal deaths. Of all 41 maternal deaths due to indirect causes, 21 occurred antepartum, two intrapartum and 18...
post-partum. Sickle cell anaemia, severe anaemia, malaria and ectopic pregnancy were some of the most common causes of maternal deaths, which occurred during antepartum period. Eighty-four per cent of the deaths, which occurred antepartum, were due to indirect causes. Of 11 deaths due to unsafe abortion practices, eight occurred during first 4 years and only three deaths occurred in last 5 years.

The proportion of deaths, which occurred antepartum, at hospitals and due to indirect causes has increased (Figure 3). Major causes of maternal deaths occurring in hospital were sickle cell disease (21%) and haemorrhage (21%). Of 38 maternal deaths at hospital, 60% occurred on the day of admission. Most maternal deaths are now occurring because of indirect causes and at hospitals throughout pregnancy.

As seen in Table 2, there was a 17% reduction in adjusted incidence rate of maternal deaths annually (IRR 0.83, CI 0.75–0.91, \( P < 0.001 \)). There were significant reductions in adjusted incidence rate of maternal deaths every year due to direct causes, during intrapartum, post-partum period and those which occurred at home. However, annual reductions in incidence rate of maternal deaths occurring during the antenatal period (adjusted IRR 0.89, CI 0.76–1.05, \( P \)-value 0.16), at hospital (adjusted IRR 0.92, CI 0.81–1.05, \( P \)-value 0.22) and due to indirect causes (adjusted IRR 0.93, CI 0.82–1.05, \( P \)-value 0.23) were not significant.

Discussion

The epidemiology of maternal mortality underwent a major shift in Jhagadia block during last decade. Understanding of this change in epidemiology provides important lessons for way forward to reach MDG-5 in India. There is a reduction in overall, time, cause and place-specific incidence rate of maternal deaths.
Reduction in maternal deaths due to direct causes after promotion of institutional deliveries has been observed in other countries (Cross et al. 2010). Two separate estimates from the Government of India stated that direct causes were responsible for 73% and 66% of deaths, though this was before a sharp increase in institutional...
delivery rate (Ministry of statistics & programme implementation, Government of India 2005; Office of Registrar General 2008). Two hospital-based studies in North India reported that indirect causes were responsible for 18% (total number of maternal deaths in study = 1223) and 51% (total number of maternal deaths in study = 76) of deaths, respectively (Bhattacharyya et al. 2008; Jain et al. 2009). A nationwide sample survey in India observed that 23.4% deaths occurred during antepartum period, 21% deaths were due to indirect causes, and 59.1% deaths occurred in health facilities in 2003 (Institute of research in medical statistics, Indian council of Medical research 2003).

The trend observed in this study might be due to reduction in deaths due to direct causes occurring around the time of delivery because of increase in institutional delivery (or skilled birth attendance) (UNFPA & University of Aberdeen 2004). Community-based efforts aimed at early identification of unintended pregnancies followed by sensitive counselling might have helped pregnant women and their families to make the right decisions and avoid unsafe abortions. Large reduction in number of deaths at home and increase in institutional deliveries might have contributed towards increase in proportion of maternal deaths at hospital; however, absolute risk of dying at hospital has fallen.

The findings of this study are important for planning, implementing and evaluating current and future safe-motherhood interventions and research. Existing efforts to promote institutional and safe deliveries along with increasing coverage and quality of community-based interventions should continue. However, study of maternal deaths in Jhagadia block provides a ‘best case scenario’ for maternal mortality with high coverage of community-based interventions and increase in institutional deliveries supported by referral linkages with functional FRU. Even with that, MMR in Jhagadia (161) was slightly more than the India’s MDG-5 target (MMR of 109 deaths/100 000 live births) (Sample Registration Survey 2011). Therefore, it might be essential to prioritise management of indirect causes of maternal mortality during pregnancy for further reduction in maternal deaths now if India is to achieve MDG-5.

There is increasing concern regarding the ‘third delay’, which occurs after a woman reaches a health facility, especially now as institutional deliveries and proportion of maternal deaths in hospitals are increasing.

### Table 2 Maternal deaths in Jhagadia block, by cause, time and place: 2002–2011* (number and incidence per 100 000 pregnancies)

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<tbody>
<tr>
<td>Maternal deaths (overall)</td>
<td>35 (520)</td>
<td>15 (186)</td>
<td>16 (218)</td>
<td>9 (122)</td>
<td>5 (146)</td>
<td>0.83 (0.75–0.91)</td>
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<tr>
<td>Maternal deaths due to direct causes</td>
<td>25 (372)</td>
<td>6 (74)</td>
<td>5 (68)</td>
<td>3 (41)</td>
<td>2 (58)</td>
<td>0.72 (0.61–0.83)</td>
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<tr>
<td>Maternal deaths due to indirect causes</td>
<td>12 (178)</td>
<td>9 (112)</td>
<td>11 (150)</td>
<td>6 (81)</td>
<td>3 (88)</td>
<td>0.92 (0.81–1.05)</td>
</tr>
<tr>
<td>Maternal deaths during antenatal period</td>
<td>10 (149)</td>
<td>2 (25)</td>
<td>7 (95)</td>
<td>3 (41)</td>
<td>3 (88)</td>
<td>0.89 (0.75–1.04)</td>
</tr>
<tr>
<td>Maternal deaths during intranatal and post-natal period</td>
<td>25 (371)</td>
<td>13 (161)</td>
<td>9 (123)</td>
<td>6 (81)</td>
<td>2 (58)</td>
<td>0.79 (0.7–0.9)</td>
</tr>
<tr>
<td>Maternal deaths at home and on the way</td>
<td>21 (312)</td>
<td>9 (112)</td>
<td>8 (109)</td>
<td>3 (41)</td>
<td>1 (29)</td>
<td>0.74 (0.64–0.85)</td>
</tr>
<tr>
<td>Maternal deaths at hospital</td>
<td>14 (208)</td>
<td>6 (74)</td>
<td>8 (109)</td>
<td>6 (81)</td>
<td>4 (117)</td>
<td>0.91 (0.81–1.05)</td>
</tr>
<tr>
<td>Total number of pregnancies</td>
<td>6730</td>
<td>8048</td>
<td>7331</td>
<td>7362</td>
<td>3422</td>
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†Estimate is based on the Poisson model treating calendar year as a single linear variable, adjusted for caste and education.
diagnoses and its dependence on quality of data collection and standardisation (Garenne & Fauveau 2006).

Conclusion
Since 2004, there has been large reduction in number of maternal deaths due to direct causes. However, it would be essential to prioritise management of indirect causes of maternal mortality during pregnancy at community level and hospitals for further reduction in maternal deaths so that MDG-5 can be achieved in India.

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