Risk factors of maternal mortality in Pakistan: Preliminary results from the Demographic and Health Survey (DHS), 2006-2007.

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Introduction

Immediately after independence in 1947, the Government of Pakistan focused its efforts on improving the health of the mothers and children. Pakistan was among the pioneers in the developing world to introduce national programs in maternal and child health (MCH) and family planning. However, the pace of development in the social sector could not be maintained over decades of political instability within the country and perpetually volatile geopolitical situation outside the country. Paucity of sincere leadership at the national and local levels, bad governance and accountability in the public sector and flawed planning are the most important reasons for Pakistan's lagging behind in terms of social development. Health and education sectors seem to be the most affected of all.

Pakistan's population currently is about 160 million and the annual population growth rate is estimated at 1.8% (Statistics Division, Government of Pakistan, 2007). About 60% of population lives in under-served rural areas. With a current fertility rate of nearly 4.0 per woman, and contraceptive prevalence rate of 30%, it seems unlikely that population growth rate would decline significantly in the near future.

Since 1990, progress in the health indicators has slowed down considerably. Pakistan is lagging behind its neighbors in terms of health and social indicators. Pakistan's current neonatal mortality rate is 56 per 1000 live births, compared with 36 in Bangladesh and 39 in India. Results of the recent Demographic and Health Survey (DHS) [National Institute of Population Studies, Pakistan & Macro International, USA, 2007] indicate that progress in the MCH indicators over the past decade has been particularly slow. It seems unlikely that Pakistan will meet its targets with regard to the Millennium Development Goals (MDGs), especially in maternal health. Pakistan's target is to reduce MMR to 140 or less, and to increase skilled birth attendance to 90%, by 2015 [Ministry of Health, Government of Pakistan, 2005].

The DHS measured, for the first time in Pakistan, the levels and determinants of maternal mortality from a nationally representative sample of more than 95,000 households. The estimated maternal mortality ratio (MMR) is 276 per 100,000 live births; however, the MMR is significantly higher in the rural areas and highest in the remote and under-developed Balochistan province.

In this paper, we present preliminary results from an in-depth analysis of the Pakistan DHS data on maternal mortality. A comparison of maternal mortality between provinces, urban and rural areas, and by socioeconomic status of the household is presented. In addition, we quantify the major risk factors of maternal mortality, both at the woman/household level and the community level.

Methods

The DHS was a household survey capturing 3-years recall of the births and deaths occurring in households. Details of the design and sampling methodology of the survey are already published in a report (National Institute of Population Studies Pakistan and Macro International, USA, 2007) where the methodology for identifying maternal deaths in the sample is described in detail. Briefly, all births and deaths during the preceding 3 years in each household were identified by the interviewer and all female deaths in the 15-49 years age bracket were further investigated using a validated verbal autopsy (VA) questionnaire. The validation process of the VA questionnaire involved investigating the cause of death among women in the 15-49 years age-cohorts occurring in two tertiary care hospitals in the public sector and for which a hospital diagnosis was available. In correctly predicting the category of death (maternal or non-maternal), the VA had a positive predictive value of 78% and negative predictive value of 95% (Midhet and Hosang, 2007).

The design of Pakistan DHS (2006) was such that the births and deaths occurring during the recall period were recorded in the entire sample (approximately 95,000 households). However, detailed birth histories from ever-married women were obtained in only about 10% of households (approximately 10,000 women). Hence, it is not possible to directly estimate the relative risk of maternal mortality for the risk factors at the household and community level.

In this report, we present the results of a nested case-control study, designed to compare the women who died of maternal causes with those surviving a pregnancy in the same sampling clusters and during the same time period. All maternal deaths identified in the Pakistan DHS (2006) are regarded as cases, while the controls are randomly selected from the women reporting a live birth during the 3 years before the survey. Cases and controls are not matched. The ratio between cases and controls is 1:10. All female deaths in the reproductive ages that were classified as maternal deaths are included in the study as cases (n = 230, sampling fraction for cases = 1.00). All of these maternal deaths occurred during 2003-206. Correspondingly, the controls are randomly selected from 5,444 women who reported a live birth during the same period and about whom the desired information on the risk factors was available (n = 2,300, sampling fraction for controls = 0.42). The sample size for the nested case-control study was computed using Epi-Info and according to the following specifications: confidence level = 95%; Power = 90%; assumed rate of exposure among controls = 20%; case to control ratio =1:10; minimum level of risk (odds ratio) to be estimated = 1.75.

The primary objective of the present study is to identify – indirectly from the Pakistan DHS 2006 – the important risk factors associated with maternal mortality in Pakistan, including biological and socioeconomic risk factors. In addition, the effect of community-level variables (such as accessibility of healthcare, transport and telecommunication) on the risk of maternal mortality is also estimated.

Basic results of the DHS are reported in the Pakistan DHS Report 2006-2007 (National Institute of Population Studies, Pakistan, and Macro International, USA). Using the data provided in the Report, we computed 95% confidence limits around the MMR estimates for urban and rural areas and separately for each of the four provinces.

The risk factors at the woman/household level include age at birth, parity, past history of pregnancy loss, antenatal care in this pregnancy, skilled birth attendance at last delivery, socioeconomic status of the household, education levels of the woman and her husband and residence (major urban, other urban, rural and province). For deaths occurring in the rural areas, community-level risk factors will be included in the analysis: distance to the nearest primary health facility, secondary/tertiary hospital, motorized public transport; mobile phone coverage and presence of a Lady Health Worker (LHW) in the village. The study tests the hypothesis that the risk of maternal mortality attached to known biological risk factors (particularly age, parity, past obstetric history) is multiplied due to lack of access to health services, transport and telecommunication. However, the primary purpose of the study is to identify the community-level risk factors having the greatest impact on maternal mortality.

We estimate unadjusted and adjusted odds ratios (OR) for the above risk factors. Adjusted OR are derived from logistic regression models (SPSS version 11.5) to control for the effects of known biological and socioeconomic variables.

The DHS used two-staged cluster sampling method. However, the number of sampling clusters was large (945). In sampling each cluster, approximately 10 ever-married women were interviewed while the total number of maternal deaths in the 945 clusters is 230. As a result, the number of cases and controls per cluster, as included in our study, is very small. Approximately 60% of sampling clusters have reported no maternal death during the 3 years recall period (and hence the number of cases in these clusters is 0). The average number of observations per cluster (both cases and controls) in our study is 2.9. Therefore, we do not make an attempt to adjust for the clustering effect of observations.

Results

The overall MMR was 276 maternal deaths per 100,000 live births; maternal deaths constituted approximately 20% of all female deaths in the reproductive age (15-49 years). The MMR was significantly higher in the rural areas (320, compared to 177 in urban areas; $P < 0.05$). The MMR is also significantly higher in the province of Balochistan (765, compared to 227, 311 and 272 in Punjab, Sindh and NWFP, respectively).

The maternal mortality rate was 40 per 100,000 person-years lived by women in the reproductive age (15-49 years).

MMR was slightly higher among women < 20 years and the lowest among women 20-24 years; the MMR increased sharply among women 35-39 years – altogether forming a J-shaped curve. The lifetime risk of death from pregnancy related causes was estimated as 1.1% (1 in 89).

Postpartum hemorrhage was the commonest cause of maternal deaths (27.2%), followed by puerperal sepsis (13.7%), eclampsia (10.4%) and obstetric embolism (6%). About 8% of all maternal deaths were attributed to 'iatrogenic causes', reflecting that these death occurred primarily due to incompetence and/or negligence of the hospital staff; 5.6% deaths were attributed to the complications of abortion and 5.5% to antepartum hemorrhage. All other direct causes of maternal deaths constituted 10.5%, while 13% maternal deaths were attributed to indirect maternal causes (ICD-10: International Classification of Diseases, 10^{th} version - revised; WHO 2007).

Table 1 Adjusted and unadjusted odds ratios (OR) for woman/household level risk factors

Risk Factor	Unadjusted OR (95% confidence limits)	Adjusted OR* (95% confidence limits)
Woman's age at birth:		
< 20 years	2.0 (1.2, 3.8)	1.5 (0.8, 2.7)
20-34 years (Ref.)	1.0	1.0
≥ 35 years	1.6 (1.2, 2.2)	1.8 (1.2, 2.7)
Parity:		
Primiparous women	2.4 (1.6, 3.5)	1.8 (1.1, 2.7)
1-2 previous live births (Ref.)	1.0	1.0
3-4 previous live births	1.3 (0.9, 2.0)	1.2 (0.8, 1.9)
≥ 5 previous live births	1.8 (1.2, 2.7)	1.1 (0.7, 1.8)
Prior history of pregnancy loss:		
None (Ref.)	1.0	1.0
1 or more	1.2 (0.9, 1.7)	1.3 (1.0, 1.9)
Ever used family planning:		
No (Ref.)	1.0	1.0
Yes	0.3 (0.2, 0.4)	0.3 (0.2, 0.5)
Woman's education level:		
No schooling	3.6 (1.9, 6.8)	3.6 (1.5, 8.8)
Less than secondary school	2.3 (1.1, 4.7)	3.2 (1.3, 7.4)
Secondary school and above (Ref.)	1.0	1.0
Husband's education level:		
No schooling	1.9 (1.4, 2.6)	1.4 (1.0, 2.1)
Less than secondary school	1.2 (0.8, 1.7)	0.9 (0.6, 1.4)
Secondary school and above (Ref.)	1.0	1.0
Socioeconomic status:		
Highest 20% (Ref.)	1.0	1.0
Middle 60%	1.5 (1.0. 2.4)	0.8 (0.5, 1.3)
Lowest 20%	1.9 (1.2, 3.1)	0.7 (0.4, 1.3)
Residence:		
Urban (Ref.)	1.0	1.0
Rural	1.5 (1.1, 2.1)	1.2 (0.8, 1.7)
Antenatal care in last pregnancy**:		
None (Ref.)	1.0	1.0
Yes	0.3 (0.2, 0.4)	0.2 (0.1, 0.4)
Skilled birth attendance in last delivery**:		
No (Ref.)	1.0	1.0
Yes	1.3 (0.8, 1.9)	2.2 (1.3, 3.6)

*Each variable is adjusted for all other variables shown in table except antenatal care and skilled birth attendance; a separate model estimated for antenatal care and skilled birth attendance, including all other variables shown in table and excluding pregnancies not resulting into a live birth. **Excludes pregnancies not resulting into a live birth.

Table 1 presents crude and adjusted odds ratios for selected biological and socioeconomic risk factors of maternal mortality. The common risk factors having a significant association with maternal mortality are: Woman's age at pregnancy (those younger than 20 years and older than 35 years are at a significantly greater risk than the women in the 20-34 years age group). Parity (primiparous women and those having five or more live births previously are at a significantly greater risk compared to the women having 1-4 previous live births). Woman's education (women having no schooling and those having less than secondary school education are at a greater risk than the women having secondary level education or above). Similarly, women in the lowest wealth quintile are at a greater risk of maternal mortality than the women in the highest wealth quintile. Finally, it appears that the deceased women were significantly less likely to have used family planning prior to their last pregnancy, compared to the controls.

More interestingly, however, pregnant women who received prenatal care during their last pregnancy are at a lower risk of maternal mortality. The women who were delivered by a skilled birth attendant were not at a lesser or greater risk than the women not delivered by a skilled birth attendant.

After adjusting for the variables shown in the table, age at birth of 35 years or older, nulliparity, family planning use and woman's education emerge as significant risk factors of maternal mortality. Among women who had a pregnancy resulting into a live birth, both antenatal care and skilled birth attendance are significantly associated with maternal mortality. The deceased women were less likely to receive antenatal care but more likely to have skilled birth attendance at delivery.

Table 2 presents the crude and adjusted OR for selected community-level variables. Estimates for the first five variables are only for the rural areas. Those for the last two variables are for the entire sample. In the rural clusters, a distance of 40 kilometers or more to any of the three facilities (primary health facility, hospital and transport) is a clear risk factor for maternal mortality. Similarly, women residing in villages where mobile phone service is available are at a lower risk of maternal mortality. Presence of an LHW in the village, however, does not seem to have an effect on the risk of maternal mortality. Finally, a greater percentage of women delivered by a skilled birth attendant and a higher rate of secondary school education (among women residing in the sampling cluster) are also associated with a lower risk of maternal mortality.

After adjusting for individual level variables (age, parity, past history of pregnancy loss, woman's education level, husband's education level, family planning use before last pregnancy and socioeconomic status), distance to hospital and public transport retain their rather strong association with maternal mortality. The association between maternal mortality and mobile phone services and presence of Lady Health Worker (LHW) do not seem to change after adjusting for the individual level variables. The effect of skilled birth attendance rate and secondary school education rate among women in the village disappears when adjusted for the individual level variables.

Table 2 Adjusted and unadjusted odds ratios (OR) for community level risk factors*

Risk Factor	Unadjusted OR (95% confidence limits)	Adjusted OR** (95% confidence limits)
Distance to primary health facility:		
< 10 Kilometer (Ref.)	1.0	1.0
10 – 39 Kilometers	1.2 (0.8, 1.7)	1.2 (0.8, 1.7)
≥ 40 Kilometers	2.2 (1.1, 4.2)	1.9 (0.9, 3.8)
Distance to hospital:		
< 10 Kilometer (Ref.)	1.0	1.0
10 – 39 Kilometers	1.1 (0.7, 1.6)	1.1 (0.8, 1.7)
≥ 40 Kilometers	2.2 (1.4, 3.3)	2.4 (1.5, 4.0)
Distance to public transport:		
< 10 Kilometer (Ref.)	1.0	1.0
10 – 39 Kilometers	1.6 (0.9, 3.0)	1.8 (0.9, 3.7)
≥ 40 Kilometers	3.1 (1.4, 7.0)	3.6 (1.5, 9.1)
Mobile telephone coverage:		
No (Ref.)	1.0	1.0
Yes	0.6 (0.4, 0.9)	0.6 (0.4, 0.9)
Lady Health Worker in village:		
No (Ref.)	1.0	1.0
Yes	0.8 (0.6, 1.1)	0.9 (0.6, 1.3)
Percent of deliveries by SBA***:		
< 10% (Ref.)	1.0	1.0
10% - 20%	0.6 (0.4, 0.9)	0.8 (0.5, 1.2)
>20%	0.5 (0.2, 0.9)	0.7 (0.3, 1.4)
Percent of women with secondary school education****:		
< 10% (Ref.)	1.0	1.0
10% - 20%	0.9 (0.6, 1.3)	1.4 (0.9, 2.1)
>20%	0.5 (0.3, 0.8)	0.8 (0.4, 1.4)

*For rural sampling clusters only, except for the last two variables. ** Each variable adjusted for age, parity, past history of pregnancy loss, woman's education level, husband's education level, family planning use before last pregnancy and socioeconomic status; models for first five variables exclude urban areas. ***Percent of deliveries in the cluster by skilled birth attendant (SBA) during last 3 years; includes both urban and rural sampling clusters. ****Percent of ever-married women in the sampling cluster having secondary school education or above; includes both urban and rural sampling clusters.

Discussion

This paper is a first attempt at analyze the extremely rich and multi-dimensional data on maternal mortality from the Pakistan DHS (2006-2007). Some of the obvious constraints to this study related to the fact that the DHS is usually not designed to allow carving out a nested case-control study. The major difficulty that we encountered in designing this study was that the information on the cases and controls was not necessarily comparable. For obvious reasons, the reliability and precision, as well as the quality, of the data arising from the verbal autopsy interviews were poorer than comparable data extracted from the ever-married women's interviews and birth history records. However, every single one of the detailed verbal autopsy interviews was scrutinized by a panel of experts, who were aided by an open-ended verbatim story of the death, recorded in the respondents' own words. The panelists also recorded their opinion about the quality of the data contained in the VA questionnaire, which was found to be satisfactory in the vast majority of cases included in this study.

An important difficulty encountered during data analysis was the co-linearity between the independent variables. Information is available on a large number of independent variables, both at the woman/household level and the community level. However, selection of the right variables for inclusion into the logistic regression was a major problem. We tried to include as few variables as possible, and our selection was based upon a preliminary analysis through 2 by 2 tables, as well as our judgment of the practical importance of the risk factors.

The findings from this exercise are largely as expected: Older women (age 35 years and above), nulliparous women and those having no schooling are at a significantly greater risk of dying of complications of pregnancy and childbirth. In the logistic regression model, women's education status emerges as a more important socioeconomic variable than the socioeconomic status (measured in terms of wealth quintiles) and the husband's education.

Women residing in remote rural villages and having no access to transport and telecommunication are also more likely to die of such complications. Since high-risk pregnancies and women having complications are more likely to be referred to skilled birth attendants, the risk of maternal death is higher among births delivered in hospitals and/or by trained health professionals. We also found that women who were using a family planning method before their last pregnancy were less likely to die of maternal complications. Another somewhat puzzling finding is that the women who received prenatal care during the last pregnancy were much less likely to die of maternal complications. Both of these findings could theoretically be attributed to underreporting of family planning use and prenatal care among the deceased women. However, we have examined the verbal autopsy data very carefully and believe that the information on the deceased women is sufficiently complete and reliable. Disregarding these two findings completely would be unjustifiable.

Our study reinforces the importance of accessibility of maternal health services, particularly emergency obstetric care. We feel that these data are telling us the following:

1. Family planning proves to be an important and significant protection against maternal mortality. In particular, women in the latter years of their reproductive life should be encouraged to use safe and reliable methods to avoid a pregnancy.
2. Prenatal care, although not directly related with maternal complications, could provide the women an opportunity to be introduced to the health system. Information and advice provided by a trained healthcare provider during a routine prenatal visit may prepare the woman and her family to face the unpredictable yet sometimes inevitable complications during pregnancy and childbirth. Similarly, pregnancy risk assessment and appropriate advice may persuade the woman and her family to use a health facility for delivery.
3. The maternal mortality in Pakistan is highest in the remote and under-served areas. Bringing the health services closer to the woman and making them more effective and attractive for the woman and her family would go a long way in reducing maternal mortality in Pakistan. Availability of transport and telecommunication systems stands out to be the most significant factor in this regard.

Further analysis of the DHS data with regard to maternal mortality is needed. The authors are currently developing a dossier for the Ministry of Health to list a number of evidence-based interventions that can be implemented at the community level and in the primary health facilities. Pakistan has recently introduced the community midwives – a new cadre of health workers who would provide skilled birth attendance at the community level. The community midwives should be trained in obstetric first-aid, making use of a number of interventions that have recently been developed for which sufficient evidence is now available. Examples are the use of misoprostol or oxytocin during third stage of labor, active management of third stage of labor and use of magnesium sulphate for eclampsia. Our analysis of the DHS data on maternal mortality suggests, both directly and indirectly, that such interventions might be instrumental in bringing a significant decline in maternal mortality in Pakistan.