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HOW CONTRACEPTIVE USE AFFECTS MATERNAL MORTALITY

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ABSTRACT

Introduction. It is widely recognized that family planning contributes to reducing maternal mortality by reducing the number of births that expose women to mortality risk. There is also evidence that increases in contraceptive use may reduce the risk per birth by eliminating the highest risk births.

Methods and data. We use a demographic projection package and estimates from the United Nations Population Division to estimate the impact of the decline in the total fertility rate in the developing world on the number of births and the number of maternal deaths. We use data from 146 Demographic and Health Surveys on the distribution of births by risk factor and special country data sets on the maternal mortality ratio (MMR) by parity and age to explore the impacts of contraceptive use on at-risk births and on the MMR.

Results. More than 1 million maternal deaths were averted from 1990–2005 because of declines in the total fertility rate in developing countries. Increasing contraceptive use contributes to a decline in demographically at-risk births, particularly high parity births that carry an elevated risk of maternal mortality. This effect can reduce the MMR by an estimated 450 points during the transition from low to high contraceptive use.

Conclusions. Family planning programs that raise the use of modern contraceptives can make an important contribution to the overall efforts to reduce maternal mortality in the developing world.

INTRODUCTION

Maternal mortality levels are high in much of the developing world, and any declines over the 15-year period from 1990 to 2005 have been small—both in terms of the maternal mortality ratio (MMR—the number of maternal deaths per 100,000 live births) and in absolute numbers of deaths. Family planning programs that support increases in the use of modern contraceptives can affect the number of maternal deaths in two ways. The most direct effect comes from the reduction in the number of births that occurs as contraceptive use increases. With fewer births, the risk of maternal death is lower and the total number of deaths is lower. Increasing contraceptive use may also have indirect benefits that reduce the average risk of mortality associated with each birth as a result of a change in the distribution of births toward fewer at-risk births. This brief considers both ways and estimates the magnitude of the effects. By reducing unintended pregnancies, contraception can also result in fewer abortions, which can carry a high mortality risk when there are complications.

METHODS AND MATERIALS

International trends for numbers of deaths, the MMR, and the lifetime risk of death have been compiled for 1990, 1995, 2000, and 2005.[1] The most recent estimates for 2005 also include a re-estimation of MMR in 1990. The examination shows that, in the developing world, the MMR declined from 480 in 1990 to 450 in 2005.

No international data sets exist on MMR by mother's age and parity, but we located 13 data sets for age-specific MMRs and five data sets for parity-specific MMRs from Bangladesh,[2] Honduras,[3] Guatemala,[4] Burkina Faso,[5] and Sri Lanka,[6] as well as MMRs by age for 42 countries[7] in a 1974 compilation.

Data from 146 Demographic and Health Surveys (DHS) provided information on the distribution of births by risk factor.

We estimated the global impacts of contraceptive use on the MMR in two steps: first, the impact of contraceptive use on the percentage of demographically high-risk births, and second, the effect of fewer at-risk births on the MMR.

We use these data to conduct three separate analyses of the impacts of contraceptive use on maternal deaths. First, we look at the global effects by estimating the number of maternal deaths that would have occurred if contraceptive use had not increased between 1980 and 2005 and if the MMR had not declined. We use a demographic projection model[8] to estimate the number of births that would have occurred if fertility had not fallen from 1990 to 2005 and apply the MMR to those births to calculate the number of maternal deaths. While increases in contraceptive use are not the only factor that can lead to a decline in the total fertility rate (TFR), it is the dominant one—far more important in regression comparisons than the net effects of later marriage and age-sex distributions. A simple cross-section correlation between the TFR and the contraceptive prevalence rate (CPR) from 135 DHS data sets yields an R2 correlation of 0.76 (0.73 between the general fertility rate and the CPR, and 0.69 between the crude birth rate and the CPR). We focus this part of the analysis on changes in TFR and assume that changes in CPR are the major influence.

Second, in a two-stage analysis we look at the relationship between contraceptive use and the distribution of births by demographic factor and then the relationship between demographically at-risk births and the MMR. It has been shown that births that are spaced too closely (less than 24 months apart), mothers giving birth at too young an age (under 18) or too old an age (35 and over), and high-parity births (parity

4 and higher) have an elevated risk of infant and child mortality.[9] We examine whether these same risk factors also affect maternal mortality. There is supportive evidence from Bangladesh.[10] Matlab data for more than 20,000 births from 1968–1970 showed the classic J-shaped curve for the MMR, with the highest rates at ages 10–19 and 40–44, and similarly, high rates at zero parity and at parities 7 and above. The J-shaped pattern also appeared in a comprehensive review by Nortman of 1964–1966 data from 42 countries, showing maternal mortality following a sharp upward incline by mother's age. The elevated risk of death with age occurred in each of three sub-groups of countries where the prevailing average risk was low, medium, and high. "If women had births only in the age interval 20–34, maternal mortality would come down by 19 percent in Mexico, Thailand, Venezuela, and the United States; by 23 percent in Colombia and France; and by 25 percent in the Philippines."[11]

We use data from DHS[12] on contraceptive use and the distribution of births by risk factor. This data set contains 146 surveys from 68 countries: 33 from sub-Saharan Africa, 13 from Latin America and the Caribbean, 10 from Asia, 6 from North Africa and the Middle East, and 6 from Eastern Europe. To capture all at-risk births, we employ the DHS variable "any risk," which includes all births exclusive of first births and births free of any of the specific risks. Depending on the country, births with "any risk" vary from a low of 25 percent in Viet Nam in 2002 to a high of 79 percent in Yemen in 1991/92. In the first stage of analysis, we used time trends for data from countries with more than one survey to estimate the change in the percentage of all births with any demographic risk and compare it to the change in the proportion of women of reproductive age using contraception (CPR). By using the change in both factors between two surveys, usually spaced about five years apart, we control for social, cultural, and economic net differences across countries that are not likely to change substantially in such a short time. In the second stage of analysis, we looked at the relationship between the percentage of births with a demographic risk and the MMR. Country-specific estimates of the MMR do not have enough precision to measure changes over short periods, so we used a cross-section analysis to compare the levels of MMR with the levels of at-risk births. We used this two-stage process to relate CPR to MMR rather than analyze the direct relationship between the two, in order to control for social, cultural, and economic differences between countries and to focus on a key pathway by which contraceptive use affects the MMR.

In our third stage of analysis, we used data on variations in MMR by age of mother and parity to estimate the expected changes in the MMR if those patterns remained the same but the distribution of births by age and parity was modified by contraceptive use. We used DHS data to estimate how the distribution of births by mother's age and parity changes as CPR increases.

RESULTS

Direct effect on numbers of births

We can estimate the number of maternal deaths averted *directly* from the increase in contraceptive use by using demographic data from the United Nations and a population projection program. According to the United Nations Population Division,[13] the TFR in all developing countries declined from 3.63 births per woman in 1990 to 2.83 in 2005. The declining fertility rate and rising numbers of women of reproductive age meant that the annual number of births remained roughly constant at about 122 million from 1990 to 2005, and the number of maternal deaths declined slightly from 588,000 in 1990 to 550,000 in 2005 (multiplying 122 million by the MMRs of 480 and 450 noted earlier). If there were no change in contraceptive use, the TFR would have remained roughly constant from 1990 to 2005. In that case, the annual number of births would have risen to 157 million by 2005 and the number of maternal deaths would have been 705,000—155,000 more maternal deaths in 2005 than the actual estimate. For the period 1990–2005, the drop in TFR resulted in 1.2 million fewer maternal deaths (9.73–8.50, see Table 1).

Table 1. Estimated number of annual maternal deaths in low- and middle-income countries under alternative scenarios (in millions)

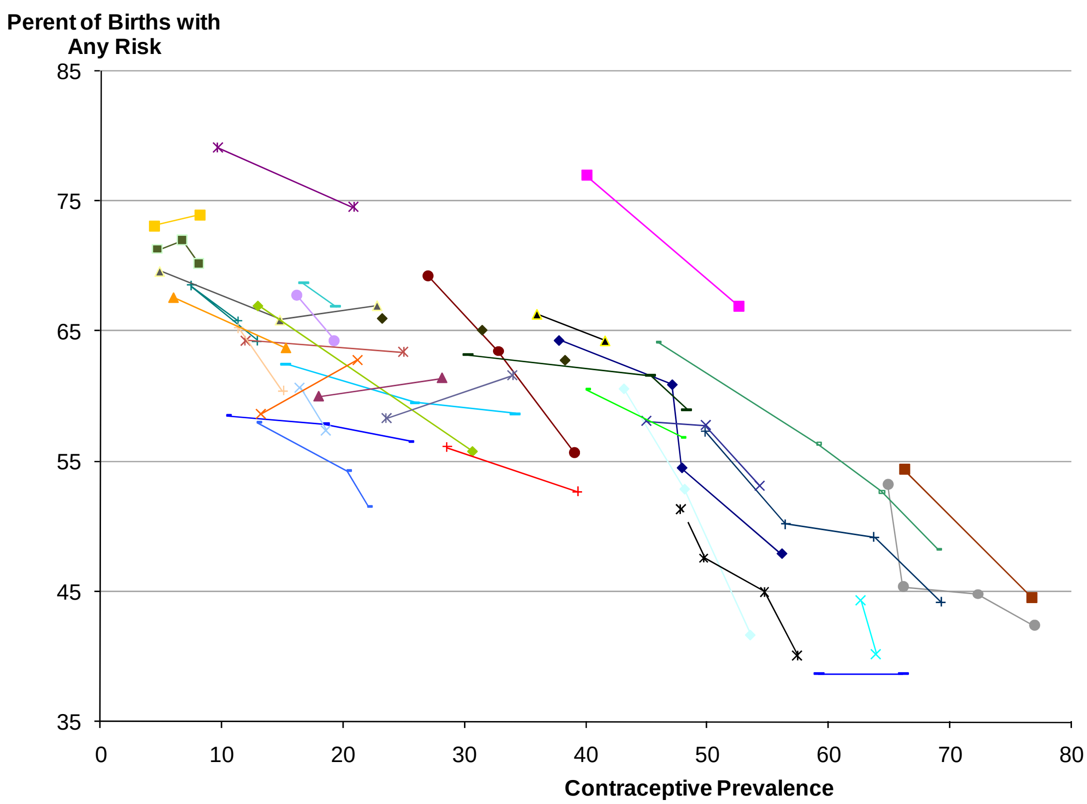
Period	Actual	Constant TFR	Constant MMR	Both TFR and MMR Constant
1990–95	2.91	3.04	2.93	3.07
1995–00	2.83	3.26	2.91	3.36
2000–05	2.76	3.43	2.91	3.61
1990–2005	8.50	9.73	8.87	10.04

If the MMR had remained rather constant over this period, there would have been 250,000 more maternal deaths (8.87–8.50). The combined effect of both changes in TFR and MMR was 1.5 million fewer maternal deaths from 1990–2005 (10.04–8.50).

Indirect Effect on MMR

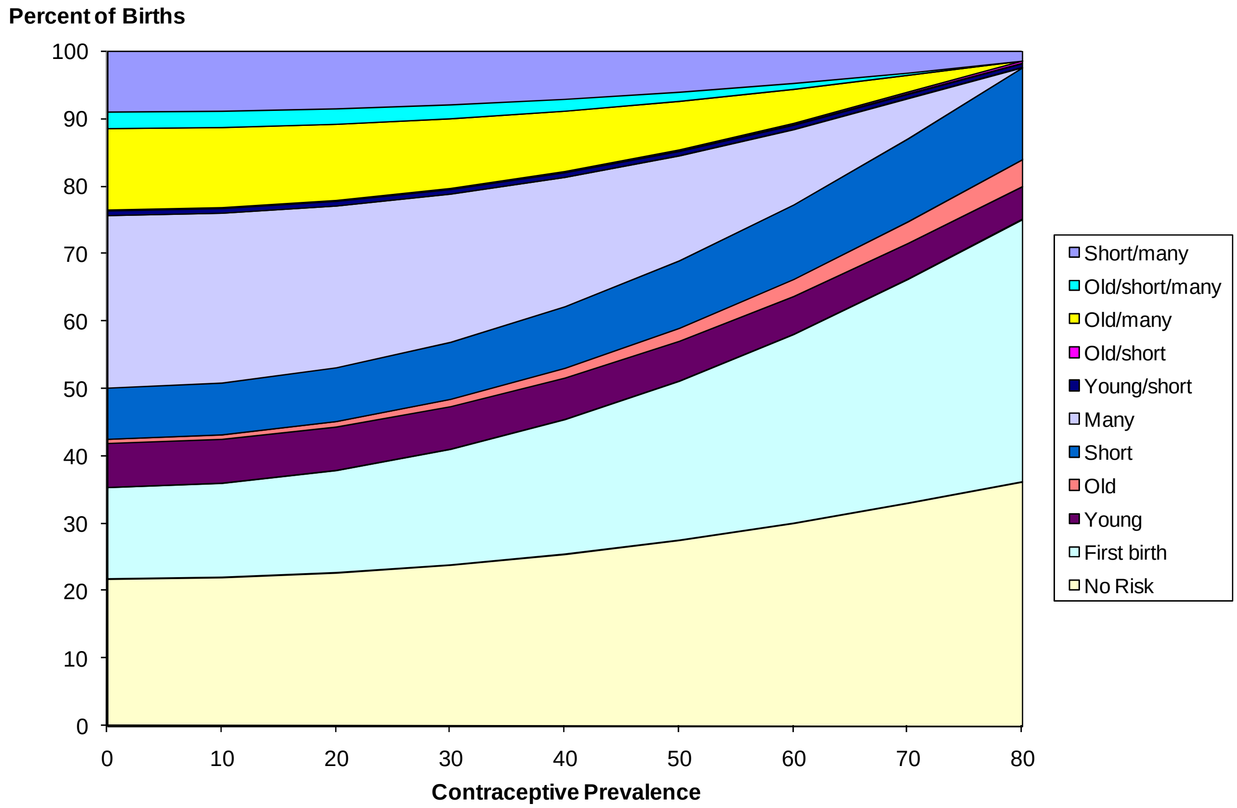
The relationship between changes in CPR and changes in the percentage of births with any risk factor is shown in Figure 1. The data clearly show that the distribution of births by risk factor changes as the use of family planning changes. The average slope of all the survey pairs is -0.55, meaning that for each 10 percent increase in CPR, the percentage of births with any risk drops by 5.5 percent.

Figure 1. The relationship between changes in contraceptive use and changes in the percentage of births with any demographic risk



At low levels of contraceptive prevalence, around 70 percent of all births will have one or more of the demographic risk factors. As prevalence increases toward 80 percent, the percentage of births with any risk drops to around 35 percent. The main cause of this drop is the virtual elimination of high-parity births and births with multiple risk factors. At very low levels of contraceptive use, about half of all births are parity four and higher, but as contraceptive use increases to 80 percent, this percentage shrinks to almost zero. Figure 2 shows the smoothed relationship that results from ordering all the DHS data sets from lowest CPR to highest and smoothing the curves across surveys.

Figure 2. The smoothed pattern in the distribution of births by contraceptive prevalence



The cross-section comparison of the percentage of births with any risk and the estimated MMR for the date closest to the date of the DHS are shown in Figure 3. To adjust the relationship for economic and social factors, we included two control variables in the regression analysis: female primary school enrollment and the Gross National Income per capita expressed in purchasing power parity. The results are shown in Table 2. The coefficient of 11.3 on at-risk births means that for each reduction of 10 percent in the percentage of births with a demographic risk, the MMR falls by 113 points.

Figure 3. Relationship between MMR and the percent of births in any risk category

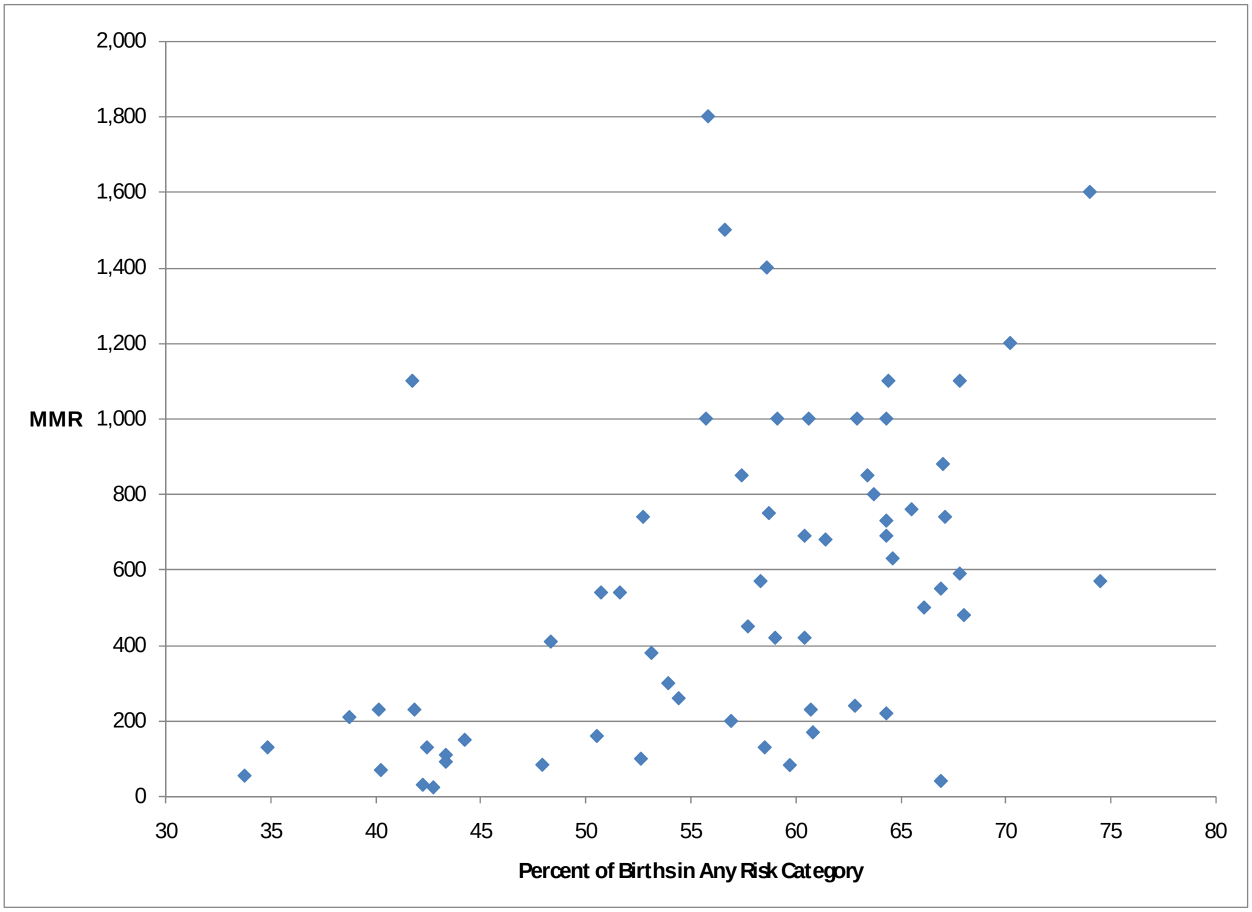


Table 2. Regression results to estimate the MMR

Variable	Coefficient	Range of Coefficient	P value
Intercept	202.664	-521,926	0.578
GNP PPP per capita	-0.067	-0.095, -0.039	0.000
Female primary school enrollment	-0.313	-3.973, 3.347	0.865
% births with any risk	11.319	2.108, 20.530	0.017

By using both stages of this analysis, we can estimate the combined effects of contraceptive use on the percentage of births that are at-risk and then on the MMR. As a country transitions from a very low CPR to a high CPR, the percentage of at-risk births can be expected to drop from around 75 percent to around 35 percent (see previous Figure 1). As a result of the change in at-risk births, the MMR is expected to drop by about 450 points (40% decline in at-risk births multiplied by the regression coefficient of 11.3) due solely to the effects of contraceptive use.

Country-specific Patterns of MMR by Parity

The most important impact of increasing contraceptive use on at-risk births is the reduction in high-parity births. Figure 4 shows the relationship between MMR and parity for four locations: Bangladesh, Guatemala, Honduras, and New York State (1936–38) in the United States. The patterns are similar, except that Bangladesh has such a high risk at parity 1 that the other risks are all lower. The elevated MMR at parities 5 and above is important because across all the DHS data sets used here, 29 percent of births are in this category. Even a partial shift away from the highest order can be important for changes in the overall MMR.

Figure 4. The relationship between the MMR and parity with MMR values normalized to 1 at parity 1

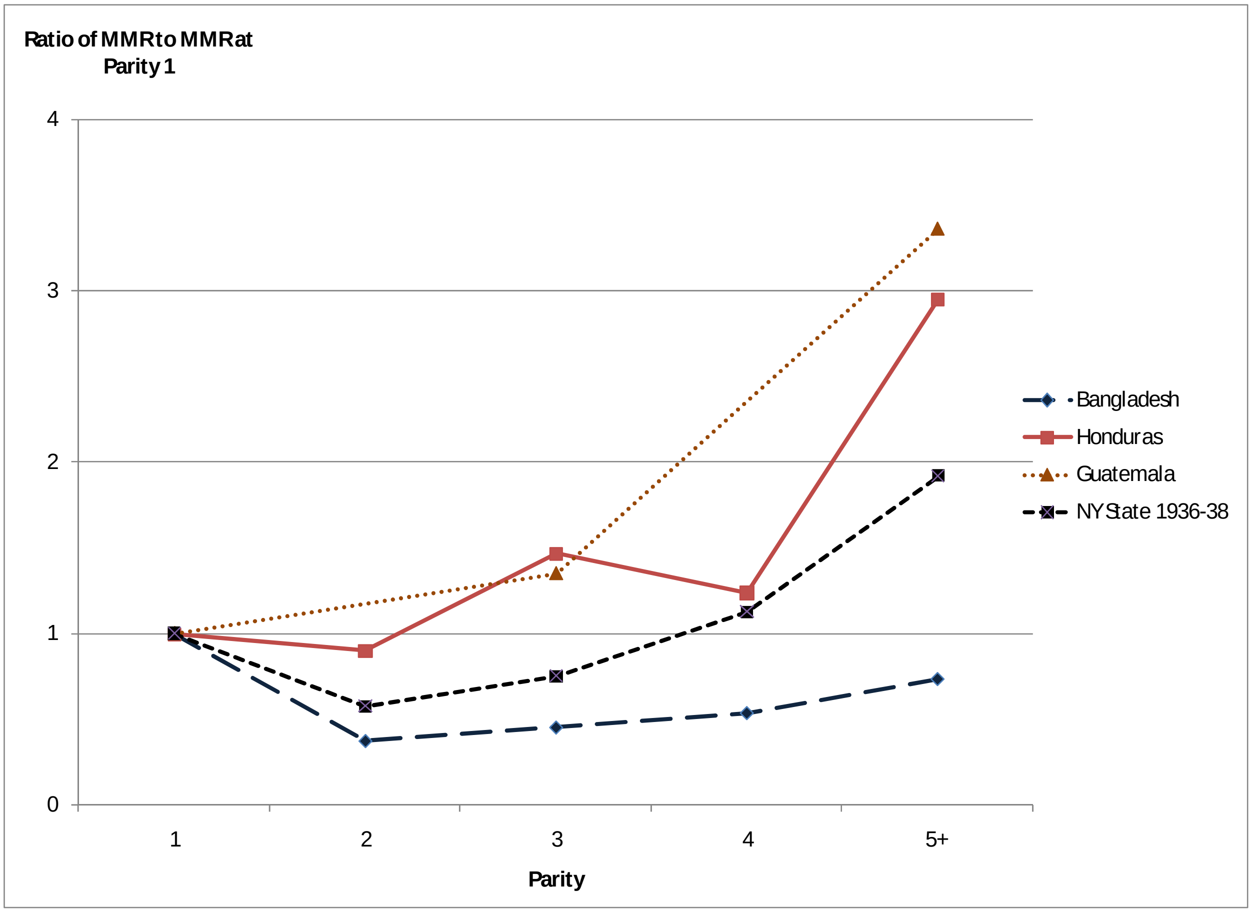


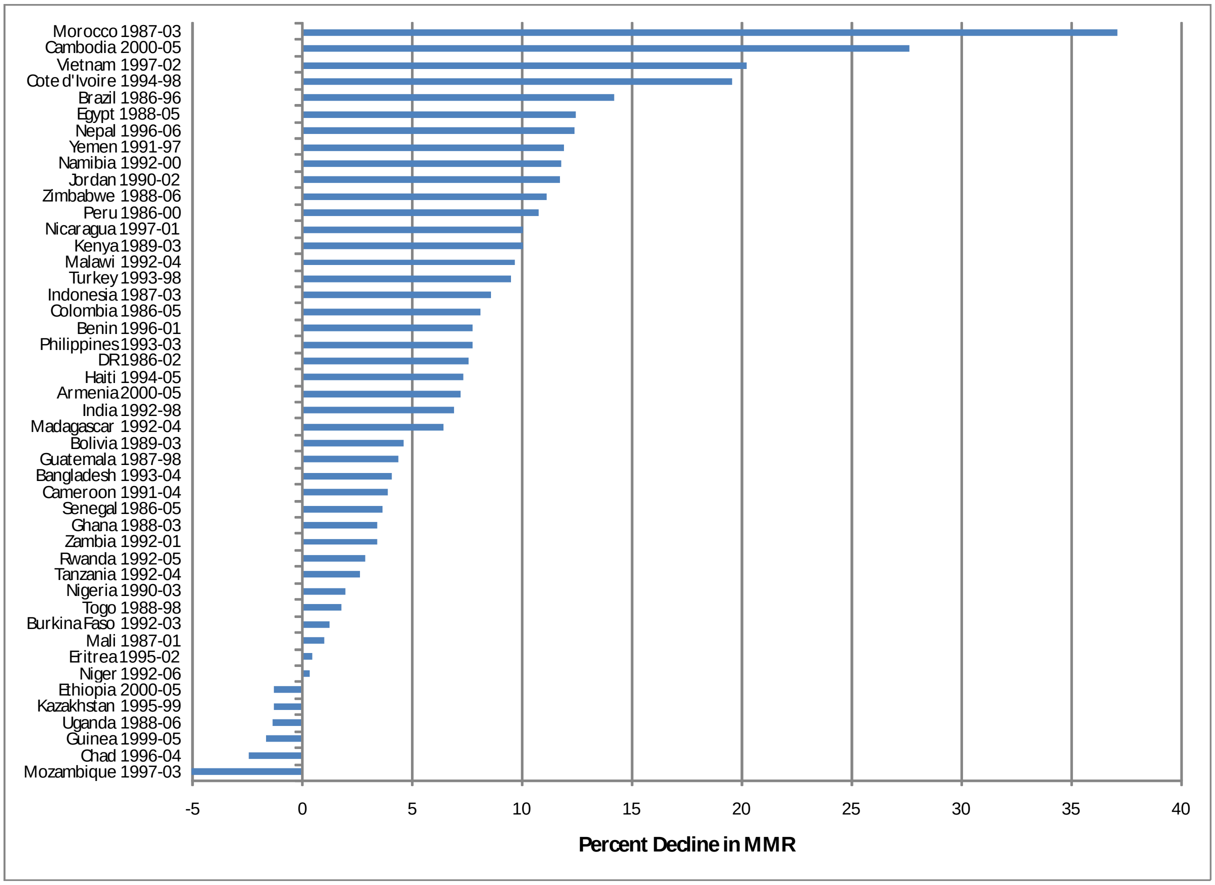
Table 3 illustrates this effect for Honduras. Currently, 11 percent of births are parity 4 and 28 percent are parity 5+. Using the patterns in Figure 2, we can estimate that 50 percent of births would be high parity (4+) if contraceptive prevalence were only 10 percent and that just 10 percent would be high parity if contraceptive use were 70 percent. Applying these illustrative birth distributions to the pattern of MMR by parity for Honduras shows that the MMR for all births would fall by 30 percent—from 110 at 10 percent contraceptive use to 76 at 70 percent. The current 39 percent of high-parity births in Honduras is similar to the average across all DHS data sets. To the extent that the Honduras pattern of MMR by parity is similar elsewhere, increasing contraceptive use to a high level in all developing countries could result in a 25 percent decrease in the global MMR.

Table 3. MMR by Parity for Honduras showing current values and illustrative values for lower and higher values of contraceptive prevalence

	Parity					Resulting MMR
	1	2	3	4	5+	
MMR by Parity	62	56	91	77	183	
% of births, current	25%	21%	15%	11%	28%	101
% births with CPR = 10%	20%	17%	12%	14%	36%	110
% births with CPR = 70%	37%	31%	22%	3%	7%	76

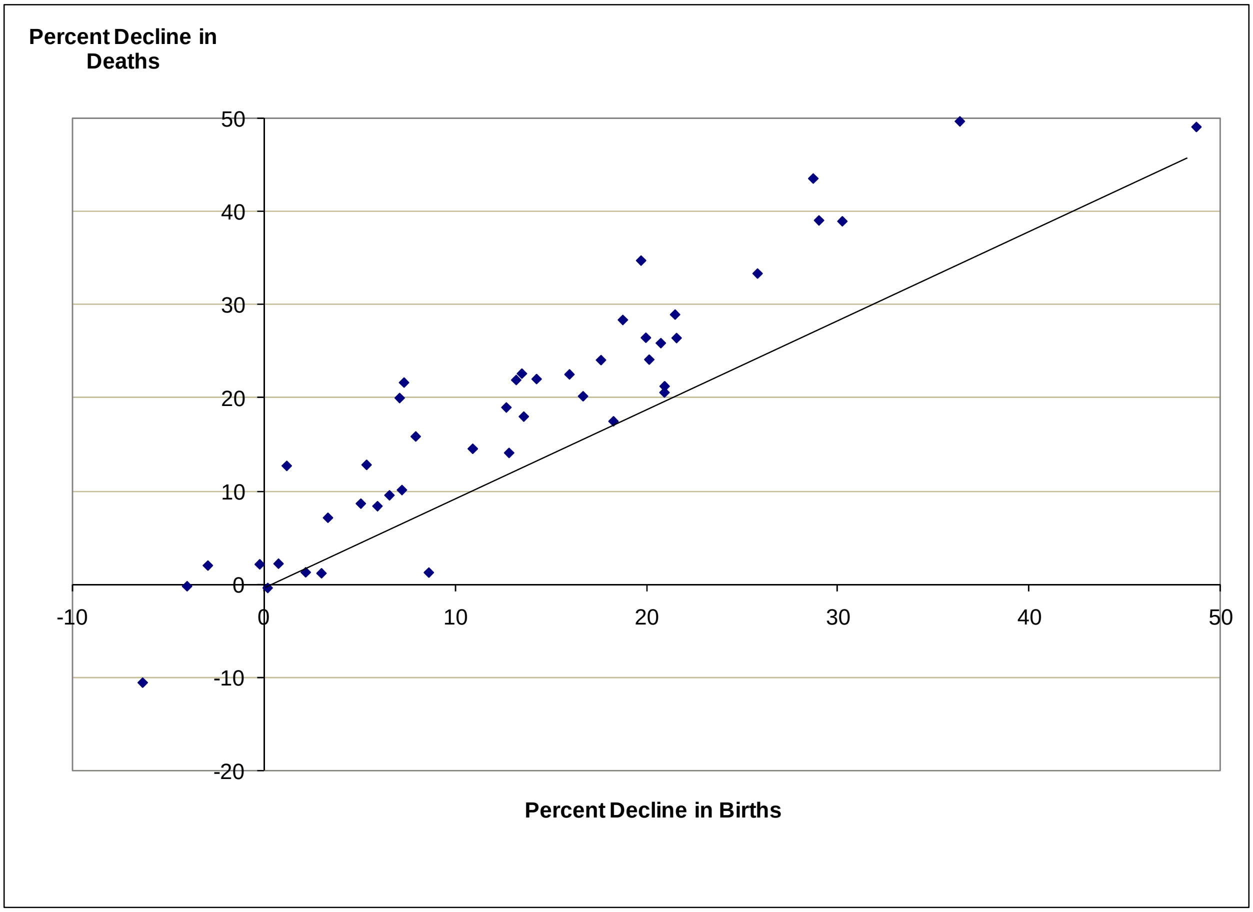
The effect of changing parity distributions on the MMR can also be seen by examining recent DHS data on births by parity. For 46 countries with DHS data available, we calculated the change in the parity distribution of births between the earliest and latest surveys. By applying a fixed schedule of MMR by parity (using the Honduras schedule in Table 3) to these parity distributions, we calculated how the MMR would change solely because of the way the parity distribution changed. The results—expressed as the expected decline in a 10-year period—show small increases (negative declines) for six countries and positive effects for the rest ranging up to more than 35 percent with an average of 7.3 percent (see Figure 5). These are reasonably impressive declines, achieved only by changing the distribution of births by parity. Actual declines in MMRs can be larger where health system improvements have lowered the parity-specific risks.

Figure 5. Percentage declines in MMRs expected over a 10-year period due to improved parity distributions of births using a fixed (Honduras) schedule of MMR by parity



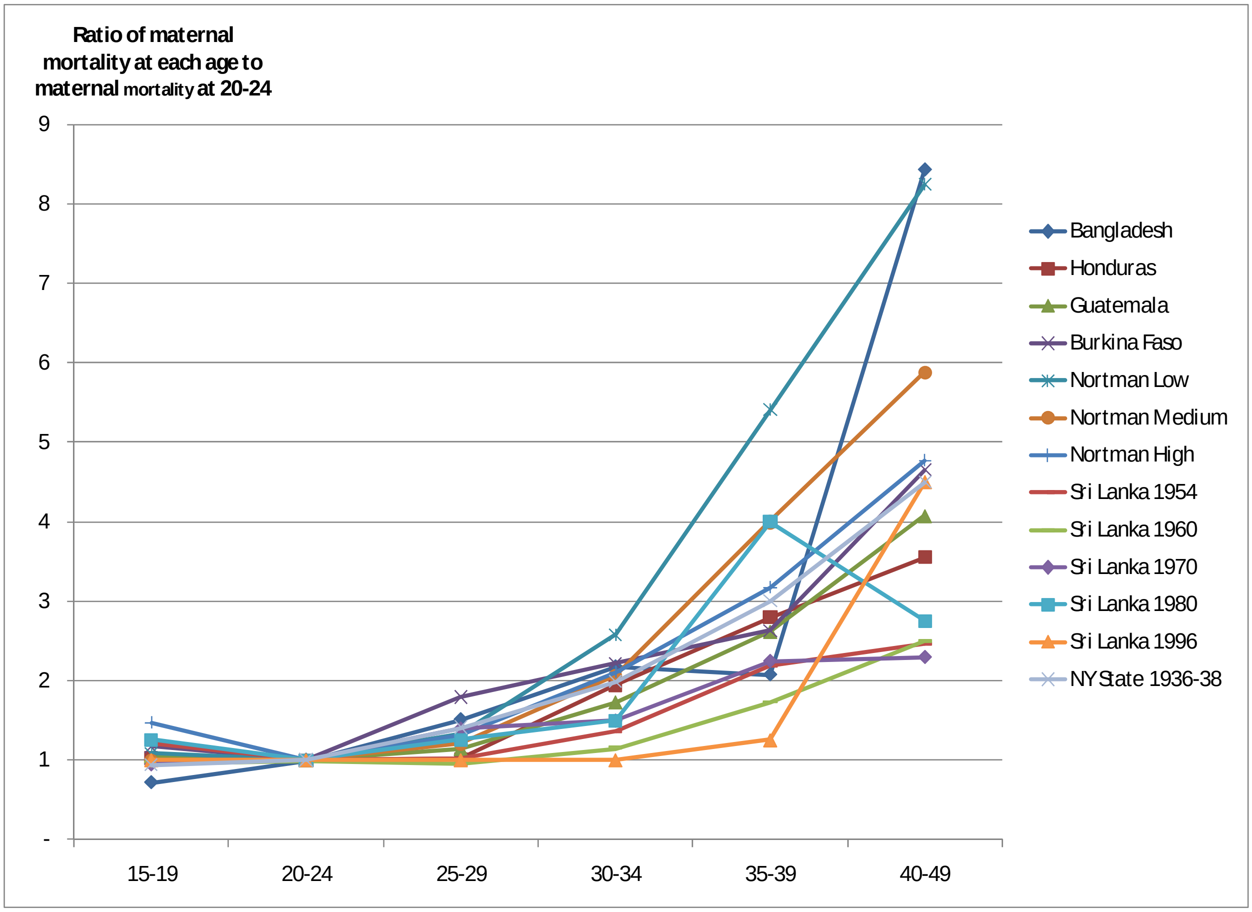
Another way to look at the same phenomenon is to compare the change in numbers of births expected by the changing parity distribution to the change in the numbers of maternal deaths. The decline in births is selective by parity, so by holding the parity-specific risk constant, the percentage decline in deaths should exceed the percentage decline in births. That indeed occurs in almost all countries (see Figure 6.) Most countries lie above the diagonal line, meaning that the shift in parity distributions would cause the number of maternal deaths to fall more than the drop in the number of births, leading to a drop in the overall MMR.

Figure 6. Comparison of the expected decline in deaths and births due to changes in the parity distribution of births between earliest and latest DHS



Finally, regarding mortality patterns by age rather than by parity, we compiled the schedules of MMR by the age of the mother at the time of birth from the scarce examples available (see Figure 7). The risk at ages above 35 is at least double that at ages 20–24 in most data sets, and in half of the cases, it rises to 4.5 to 8 times higher. We conducted parallel analyses to those above—for the impact on mortality of changing age distributions of births between two surveys—and found the impacts to be much smaller than those for changing parity distributions. The reasons are two-fold: first, as contraceptive use increases, the changes in age distributions are much less than changes in parity distributions, particularly as rising use especially drives out high parity births; and second, births at high ages are always relatively few, whereas births at the higher parities are numerous as contraceptive use starts its rise from low levels.

Figure 7. Age-specific MMR values in relation to the MMR at ages 20–24



CONCLUSION

This article has explored the effects of increasing contraceptive use on maternal mortality. The direct effects are clear and large. The drop in the TFR from 1990–2005, due primarily to increasing contraceptive use, resulted in 1.2 million fewer maternal deaths (15% less) than would have occurred with no fertility decline. Future increases in contraceptive use will reduce women's exposure to the risks associated with pregnancy and will keep many more mothers alive.

There is strong evidence that contraceptive use also affects the mortality rate. Time series survey data show a clear pattern of smaller percentages of at-risk births as contraceptive use increases. The greatest effect is the reduction of high-parity births, which are virtually eliminated at high levels of contraceptive use. Cross-national data show that the MMR is highly correlated with the percentage of at-risk births, even with controls for differences in economic and social conditions. In addition, declines in maternal deaths are greater than the corresponding declines in births in nearly all countries, due to the selective effect of births shifting to lower parities that carry lower risks. Together, all this evidence suggests that the reduction in at-risk births brought about by contraceptive use leads to lower levels of the MMR.

Other interventions also reduce maternal mortality by directly addressing the causes of mortality, such as severe bleeding, infection, consequences of abortion complications, hypertensive disorders such as preeclampsia and eclampsia, and obstructed labor. Clearly, there is a need to improve the coverage and quality of all safe motherhood services, as no single intervention will be sufficient. This paper has tried to bring attention to the role that family planning can play in the broader effort to reduce maternal mortality in developing countries—not only through a reduction in the number of births but also through a reduction in the MMR as a result of better distributions of births to lower risk categories, primarily lower parities.

APPENDIX I. MMR VALUES AND PATTERNS, BY AGE

	MMR Values by Age					
	15–19	**20–24**	**25–29**	**30–34**	**35–39**	**40–49**
Bangladesh	170	237	358	516	492	2000
Honduras	76	74	75	144	207	263
Guatemala	110	107	122	185	280	436
Burkina Faso	317	271	487	601	714	1262
Nortman Low	13	12	16	31	65	99
Nortman Medium	34	34	41	70	136	200
Nortman High	134	91	119	192	289	434
Sri Lanka 1954	440	365	370	500	800	900
Sri Lanka 1960	250	260	250	300	450	650
Sri Lanka 1970	95	100	140	150	225	230
Sri Lanka 1980	50	40	50	60	160	110
Sri Lanka 1996	20	20	20	20	25	90
NY State 1936–38	156	166	234	329	499	747

ENDNOTES

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