Do Health Services Reduce Maternal Mortality? Evidence from Ratings of Maternal Health Programs

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June 2001

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WP-01-39

The research upon which this paper is based was sponsored by the MEASURE *Evaluation* Project with support from the United States Agency for International Development (USAID) under Contract No. HRN-A-00-97-00018-00.

The working paper series is made possible by support from USAID under the terms of Cooperative Agreement HRN-A-00-97-00018-00. The opinions expressed are those of the authors, and do not necessarily reflect the views of USAID.

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Abstract

Objectives. The study investigates whether maternal mortality ratios in developing countries are related to health service adequacy.

Methods. Service ratings were obtained from an average of 17 experts in each of 49 developing countries and used in cross-national regressions for alternative measures of maternal mortality.

Results. The rated adequacy of access to services was one of two significant predictors, the other being national per capita income. Among services, those involving emergency treatment and avoidance of births (abortion and family planning) had stronger relationships with maternal mortality than those involving prevention (antenatal care) and risk identification (general delivery care).

Conclusions. Besides socioeconomic development, health services can contribute to lower maternal mortality, and more narrowly targeted services have a greater statistical effect.

Do Health Services Reduce Maternal Mortality?

Evidence from Ratings of Maternal Health Programs

Maternal deaths in developing countries, at around 510,000 a year or about 99.4 percent of all maternal deaths in the world,[1] are a major public health problem. Various programs have been proposed to reduce this human cost, involving a multitude of interventions to deal, at different stages, with the life-threatening conditions related to pregnancy and delivery.[2] While some rationale and evidence for the effectiveness of specific interventions may exist, systematic comparison of approaches is difficult, often relying on arbitrarily specified models.[3]

We essay in this paper a small step toward clarifying the relative importance of broad classes of maternal health services. We look at maternal mortality across countries and attempt to relate it to expert ratings of services. We confirm that services appear to make a difference, and that different classes of services are not of equal significance.

Maternal mortality levels are difficult to determine accurately. As rare events occurring, virtually everywhere, in connection with fewer (often far fewer) than 1 in 50 live births, maternal deaths are difficult to pick up in sample surveys. Picking them up instead when deaths are registered by cause is unreliable with the weak civil registration systems in most developing countries, and even in developed countries, problems of classification can skew the reports. We do not attempt to determine maternal mortality ratios here, but we do use alternative measures of them to see if some consistency may emerge about the effects of services.

Ratings of services

Maternal and neonatal health services were rated for 49 developing countries in 1999-2000, using an average of 17 experts per country knowledgeable about the national program. The experts made judgments on a questionnaire labeled the Maternal and Neonatal Program Index (MNPI), indicating their assessments of how adequate a program was on 81 items. Such items were included as access to

treatment for abortion complications and reasonable policies about which personnel can provide maternal services. Using the expert ratings to describe services across developing countries, Bulatao and Ross[4] note the wide cross-national variation in access to services. For instance, access tends to be very limited in the majority of African countries. Variation was also demonstrated across types of service. For instance, antenatal care was rated much more adequate cross-nationally than safe abortion services.

The items rated were grouped as follows:

Facility capacity: Health centers/District hospitals

Access to services: Rural access/Urban access

Care received: Antenatal care/Delivery care

Other items covered newborn care and policy and support services, but we do not consider these here on the assumption that their impact on maternal mortality, if any, is indirect, through actual services. Factor analysis confirmed that the groupings of items above were coherent. Each group, however, involves various specific services, some more directly relevant to mortality than others.

The services most proximate to the outcome of survival or death should be of greatest relevance. It may be argued that interventions closer in time to the resolution of a life-threatening event must be more powerful and may be more determinative of the outcome. Whether accurate or not, this is *not* the argument we depend on. Instead, we argue that proximate interventions are more likely to be well targeted, and for that reason could have a greater statistical effect on outcomes. The selectivity in the application of these interventions should mean that substantial effort on them could have a disproportionate effect.

We distinguish four types of services by proximity to the resolution of life-threatening maternal conditions: treatment, risk identification, prevention, and avoidance. Treatment could be provided for such conditions as postpartum hemorrhage, obstructed labor, and abortion complications. Risk identification involves services that lead to identifying such cases, without necessarily having the capacity to treat them effectively. Prevention is more general: providing interventions that are potentially

useful against these conditions, but on a broader scale to pregnant women who may or may not be at risk. Avoidance means avoiding the pregnancy entirely, or avoiding carrying it to term through abortion.

Table 1 identifies service items in the questionnaire by type. These items are also classified by the level at which they have been rated (such as health centers, hospitals, or general access), given that factor analysis effectively distinguished such groupings. A grouping concerning family planning provision is also included. We expect ratings of the services in the last column to have a stronger negative relationship to maternal mortality than ratings of the services in preceding columns.

Method and data

We analyze the link between expert ratings of services and maternal mortality ratios cross-nationally, running multiple regressions to predict maternal mortality ratios.

Services are rated from 0 to 100, with higher scores indicating greater service adequacy. The means across countries for the major groups of items are 51.0 for facility capacity, 51.3 for access, and 62.4 for care received--indicating relatively weak services overall. The care-received items have higher scores on average than the other groups possibly because they include fewer items relating to emergency care as opposed to routine care. The access items, it should be noted, were rated for the proportion of women, rural and urban separately, with adequate access. Rural and urban ratings are combined here, weighted by the percentage of the population in each sector.

National maternal mortality ratios are taken from three main sources: ratios for 1990 estimated for UNICEF and WHO;[5,6] similar estimates for 1995 reported by Hill et al.,[7] also developed for WHO and UNICEF;[1] and a compilation of estimates covering the period 1990-98 reported by the World Bank.[8] Maternal mortality data may be good in some countries but are weak in many others. We use these alternative sets of estimates looking for consistent patterns that might indicate some underlying reality.

The 1990 and 1995 estimates involved similar methodology. Where good data were available, registration or survey-based estimates were used, often with some adjustment. Estimates for other countries were obtained through regression analysis. The dependent variable for these regressions was

not the maternal mortality ratio itself but the proportion maternal among female deaths in reproductive ages. The estimates for 1990 and 1995 are strongly but not perfectly correlated at 0.80. The differences are unlikely to be due to actual changes over five years, given that the 1995 estimate is almost as often higher than lower than the 1990 estimate. The 1995 estimates are based on more data, involve somewhat more refined methodology, and pertain to a date closer in time to the 1999 service ratings we use. Nevertheless, we also use the 1990 estimates to provide a further point of comparison.

Both 1990 and 1995 estimates have a key drawback. Being largely regression-based, they may include systematic errors that could bias regressions predicting them. We therefore also consider the set of maternal mortality ratios reported in the 2000 World Development Indicators.[8] These data are "official estimates [for the latest year between 1990 and 1998] based on national surveys or derived from official community and hospital records."[8:101] These ratios are considerably lower than the 1995 ratios but tend to parallel them, being correlated with them slightly more strongly (at 0.86) than are the 1990 ratios. The main advantage of these 1990-98 ratios is their varied sources, which militates against, though it does not exclude, systematic biases.

Two other sets of maternal mortality estimates might be considered. First, in the course of an interagency review of the UNICEF-WHO estimates, Hakkert[9] produced alternative estimates using a different regression approach. These were never officially adopted, but we use them to confirm regression results. Second, Schiffman[10] made his own selection of maternal mortality ratios based only on Reproductive Age Mortality Surveys, Demographic and Health Surveys, and developed-country vital registration. For the countries we consider, these estimates are few and almost identical to the World Bank estimates. We nevertheless report limited regressions with them.

Other predictors

In attempting to predict maternal mortality ratios from ratings of services, we need to control for various socioeconomic and demographic factors. Maternal mortality may be affected by such factors as income, education, and the proportion of the population urban. Various arguments for such relationships

might be made. For instance, if preventing maternal deaths requires relatively expensive hospital-based interventions, national income may be crucial, not only for its effect on public investment in medical facilities but also because it allows greater investment in such things as a better transport system and permits individuals to pay more easily for essential care or its components, such as needed drugs. Higher levels of education, on the other hand, could mean greater awareness of the risks of pregnancy and a better informed approach to dealing with them. And a more urban population might be more easily served than a more rural one by a network of emergency care centers.

Besides these socioeconomic factors, we consider two other possible determinants of maternal mortality ratios: the crude birth rate and the proportion of deliveries involving a trained attendant. Since the maternal mortality ratio is a ratio of deaths to births, one might expect it to be unaffected by number of births. However, if maternal survival depends on relatively scarce medical resources, a larger number of births could aggravate any medical shortages. Having a trained attendant at a birth should reduce risk, or at least help in identifying critical cases. This is indeed one of the aspects of services in our ratings, but household data on this are also available from Demographic and Health and other surveys. A previous report[4] has shown some consistency between Demographic and Health survey estimates and the expert ratings. We include the household-based estimates in the regressions to determine if the expert ratings add any predictive power to them.

Both Hill et al.[7] and WHO and UNICEF[5,6] produced many of their estimates of maternal mortality through regression, using a different but related dependent variable. Their aim was not to explain maternal mortality but to find an equation to use in estimating it where actual data were unavailable. One has to worry about whether using such maternal mortality estimates will merely reproduce their regression results. The variables of income and education were in their analysis but were dropped as not being significant. Fertility (the general fertility rate) and trained attendants at delivery were significant and were used in estimation. If we find the latter two variables to have significant effects, particularly if these effects apply only to 1990 and 1995 ratios and not to the World Bank 1990-

98 ratios, we would have to treat such results with some skepticism.

Table 2 lists the variables reviewed, giving their means and standard deviations. The logit is taken for maternal mortality ratios and the natural log for per capita income to normalize distributions to the extent possible. Of the 49 countries covered by expert ratings, all have estimates for maternal mortality ratios in 1995, but only 30 have such estimates for 1990-98. Various other data, especially the percentage of deliveries with a trained attendant, are missing for blocks of countries. The table also gives mean service ratings for the main groups of items and for the smaller groups distinguished in Table 1.

Given the relatively small number of cases, we run regressions stepwise to eliminate predictors that are not useful. We then repeat the regressions with as many cases as possible. It is impractical to include all the service ratings in this analysis, given both the small number of cases and the high intercorrelations among ratings demonstrated through factor analysis. We will instead use the aggregate indices for the larger groups of items and examine separately the correlations with maternal mortality of the more disaggregated indices, controlling for any socioeconomic or demographic variables that appear important in the regression analysis.

Results

Stepwise regression results in Table 3 indicate only two important predictors of maternal mortality ratios: per capita GNP and adequacy of access to maternal health services, both of which reduce mortality. Income and access are the only variables that enter each regression, and both are consistently significant in their effects. None of the other socioeconomic or demographic variables, nor the other aggregate rating indices, has a significant effect.

The 1990-98 ratios include one country for which data may have been obtained from the 1990 regression estimates. Leaving it out, however, does not affect the results. Similarly, leaving out of the 1995 data all those countries for which estimates are based on a regression model (estimates of type E in Hill et al.[7]) does not alter the conclusions, as Table 3 also shows. When the equations are reestimated with slightly larger samples (equation 3)--which is possible because the variables dropped tend to have

more missing data--the coefficients are essentially unchanged but tend to become more significant. Except for the constant term, the coefficients in this equation change little when different maternal mortality estimates (and therefore slightly different samples) are used.

Of the variables not in the equations, the crude birth rate comes closest to having a significant effect. It is added to the final regressions in equation 4, and, with more cases, proves to be significant in one instance. However, this is for the 1995 ratio, which is partly based on fertility estimates. A similar effect is clearly not present when regression-based estimates are excluded, nor with the 1990-98 World Bank ratios, so this effect could be artifactual.

Equations 3 and 4 were reestimated using the Hakkert and Schiffman estimates of maternal mortality. Results are essentially the same with the Hakkert estimates. With the Schiffman estimates, results are slightly weaker but still comparable to previous results. Most of the coefficients are close to but not significant, partly because of the smaller number of cases.

The equations imply that services make a difference to maternal mortality regardless of income. Mean access ratings for the countries considered range from 17 to 83, meaning that for each country this proportion of women is reported to have adequate access to the average service item on the questionnaire. If a typical upper-middle income country (similar to Chile) were to move from one extreme of access to the other, the maternal mortality ratio would fall 200 points (per 100,000). For a lower-middle income country (similar to the Philippines), the fall would be 330 points, and for a low-income country (such as Ghana), the fall would be 560 points.

That only one index from the expert ratings enters the equations is not surprising given the fairly strong intercorrelations among various ratings. To try to differentiate among them, we consider correlations (both zero-order and partials controlling for per capita GNP) of the more disaggregated indices pertaining to the groupings of items in Table 1.

The pattern of these correlations tends to be consistent regardless of which set of maternal mortality ratios is considered (Table 4; note that the major divisions match those in Table 1). Close to

half the correlations are significant even when per capita income is controlled. As already indicated by the regressions, the correlations are strongest with the indices of service access. In general, correlations also tend to be stronger for indices reflecting services more proximate to the outcome: for indices relating to treatment rather than to risk identification, and for risk identification rather than for prevention. This is true, however, only within levels (within rows of the table) rather than across levels.

There are two important exceptions to the pattern. Where health center capacity is concerned, the effect of the treatment index, though slightly more negative than that of the risk identification index, is insignificant and quite small. In fact, if the two items making up the risk identification index are distinguished, we find that the item relating to having transport for obstructed labor has as strong a negative relationship to maternal mortality as any item in the treatment index. This may suggest that any treatment at the health center level is fairly limited and, in critical cases, no more than a prelude to needed further treatment at a referral facility.

The second anomaly involves indices related to avoidance--presumably the least proximate type of service--which instead have the strongest relationship of all to maternal mortality. The avoidance indices can be broken down into the component services, which involve abortion and various family planning methods. Among these, adequate access to safe abortion services has the strongest relationship to lower maternal mortality; the partial correlations with income controlled range from -0.54 to -0.58. Access to postpartum family planning has almost as strong an effect, but an effect considerably reduced when access to safe abortion services is controlled. Both safe abortion and family planning avert further unwanted pregnancies, many of them at high parities carrying exceptionally high risks. Over time this tends to reduce the MMR.

The effect of family planning provision appears to vary by contraceptive method. Having contraceptive pills available has little if any effect on maternal mortality, and routinely offering family planning postpartum or postabortion also has negligible effect once per capita income is controlled. However, even with income controlled, provision of sterilization and provision of IUDs still have a

significant effect. These often hospital-based services may be related to access to other more critical hospital services. We therefore control for access to safe abortion, and find that female sterilization still has a significant effect on maternal mortality. All these results suggest that ratings for access to treatment, combined with ratings for access to safe abortions and possibly sterilization, may be the most sensitive indicators for services that affect maternal mortality.

Discussion

We have shown that ratings of maternal health services have a substantial and significant relationship to maternal mortality ratios that does not disappear with socioeconomic and demographic controls. Given the uncertainty about precise maternal mortality levels across countries, we have used alternative sets of estimates of levels, but regardless of the estimates used, cross-national regressions show that per capita income and access to services are the most important factors.

Other factors such as education and urbanization, which might be expected to affect maternal mortality, do not have a significant effect once income and service access are controlled. Nor is a significant effect shown either for fertility level or proportion of deliveries with a trained attendant. These last two factors were previously used in predicting the proportion maternal among deaths to reproductive-age women,[6,7] which was in turn the basis for estimating maternal mortality for many developing countries. One might therefore have expected them to have strong effects, but this was not the case.

Part of the explanation for the unimportance of these other variables is the collinearity among predictors, especially given the relatively small number of developing countries--49 at most, down to 25 in some regressions--that we analyze. Another part of the explanation may be the greater importance of relatively expensive health services in reducing maternal mortality, which could translate into making national income more important than either education or urbanization. However, attempts to verify this using health expenditure estimates were unsuccessful, possibly because expenditures are not always properly applied or because they are not directed to the specific services needed. Income, then, may

reflect more than simply the ability to pay for care and may be effectively, in this context, a broader indicator of development.

These results are broadly similar to those of Schiffman,[10] whose regressions show that services and socioeconomic factors affect maternal mortality. However, many details of the results are different. Schiffman's regressions were across 64 countries at all levels of development, whereas we show the capacity of these factors to distinguish within a set of developing countries. The socioeconomic factors performed differently in Schiffman's regressions, with female education being more important than income, whereas we show the reverse. Perhaps most important, Schiffman's measure of services, household-survey estimates of proportion of deliveries with a trained attendant, is less important in our regressions than expert ratings of access to services.

The importance of access to services is striking. Our access index does include deliveries with a trained attendant, but it also includes other services possibly more crucial to maternal survival. The statistical effect of access does not guarantee that simply increasing access will always be adequate in reducing maternal mortality. We do not necessarily identify a causal relationship here, nor can we entirely exclude the possibility that some raters, having some knowledge of maternal mortality levels, assign higher access scores when mortality is low. The weakness of maternal mortality data generally and the limited country coverage of the access ratings suggest the need for further investigation.

We also looked at correlations of maternal mortality ratios with ratings for specific service items. These correlations demonstrate that it matters which level of service is being rated. Health center capacity and hospital capacity, for instance, have limited direct relevance for maternal mortality. One reason is that their ratings necessarily apply to existing facilities. Where facilities are few and maldistributed they can be highly rated while having little population impact.

On the other hand, access to services tends to have a similar, strong relationship to maternal mortality regardless of the specific service rated. Distinctions can nevertheless be made, particularly between services involving treatment of complications and the avoidance of them (particularly through

provision of safe abortions) versus services involving prevention or the identification of those at risk. More adequate treatment and avoidance services have a stronger relationship to lower maternal mortality than do more adequate prevention and risk-avoidance activities.

Ratings for the care received by pregnant women have a weaker and more variable relationship to mortality than access ratings do. Why this is so is not entirely clear. One possibility is methodological: when asked to estimate the (quantitative) proportion of women with good access, raters may think concretely, but find it more complex to judge the degree to which all women receive adequate care. Also, some raters may consider the services received by all pregnant women, while others may focus only on those in need of emergency services.

We also found that family planning provision relates to lower maternal mortality ratios. This relationship is clearer for sterilization and IUD insertion than for pills. The explanation is partly that having more adequate services in these areas is related to having more adequate services in such other areas as safe abortion services. This is not, however, the full explanation where female sterilization is concerned. Perhaps an element of selectivity is involved in female sterilization that leads to reductions in risky pregnancies even beyond its being more common for women at higher parities.

Finally, the effects of antenatal services are not strong. They are more weakly related to lower maternal mortality than are such other services as treatment for postpartum hemorrhage, management of obstructed labor, and treatment of abortion complications.

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Table 1. Rated features of maternal health services, classified by type and level of measurement			
Avoidance	*Prevention*	*Risk identification*	*Treatment*
..... Health center capacity: Health centers have trained staff who can			
		• Use partograph to determine when to refer • Have transport arranged for obstructed labor	• Manage postpartum hemorrhage • Administer antibiotics intravenously • Manually remove retained placenta • Perform manual vacuum aspiration or electric suction • Have adequate antibiotic supplies
.....Hospital capacity: Hospitals have trained staff who can.....			
		• Provide all functions listed for health centers	• Perform blood transfusions • Perform Cesarean section or other operative delivery
..... Access to services: Pregnant rural and urban women have adequate access to			
• Provision of safe abortion services • Postpartum family planning services	• Antenatal care	• Delivery care by trained professional attendant	• Treatment for postpartum hemorrhage • Management of obstructed labor • Treatment of abortion complications
..... Antenatal care: At antenatal visits, pregnant women			
	• Receive iron folate tablets for anemia • Receive needed tetanus injections	• Are examined for hypertension and treated • Are informed about danger signs	
.....Delivery care: At delivery, women.....			
		• Are seen by trained professional attendant • Have labor monitored • Are checked for hypertension, anemia, infection • Are scheduled for a checkup in 48 hours	• Can receive emergency obstetric care
.....Family planning provision: Health centers and hospitals have trained staff who.....			
• Routinely offer family planning postabortion • Routinely offer family planning postpartum • Can offer sterilization to females, males (hospitals) • Can insert intrauterine devices • Have contraceptive pills regularly in stock			
Note: Various other items were also rated, including newborn care and policy and support services. These are not included in the table.			

Table 2. Means and standard deviations for variables in the analysis

Variable	*Mean*	*S.d.*	*N*[a]
Maternal mortality			
1990 ratio[5]	661	470	48
Logit	-5.3	0.9	48
1995 ratio[7]	630	512	49
Logit	-5.4	1.0	49
1990-98 ratio[8]	341	190	30
Logit	-5.9	0.8	30
Socioeconomic and demographic indicators			
GNP per capita: purchasing power parity 1999[11]	2,378	1,898	46
Natural log	7.5	0.8	46
Net primary female enrolment ratio 1997[8]	77.5	23.5	41
Urban percentage of the population[8]	40.5	18.2	49
Crude birth rate 1995-2000[12]	31.8	8.9	49
Percentage of deliveries with a trained attendant[13,7]	56.6	21.3	33
Aggregate expert ratings[4]			
Facility capacity	51.0	10.1	49
National access	51.3	16.1	49
Care received	62.4	9.5	49
Disaggregated expert ratings[4]			
Health center capacity: risk identification	44.4	14.5	49
Health center capacity: treatment	47.6	10.8	49
Hospital capacity: risk identification	66.8	10.3	49
Hospital capacity: treatment	58.3	12.7	49
Access to services: avoidance	38.7	19.1	49
Access to services: prevention	65.7	15.7	49
Access to services: risk identification	56.8	18.5	49
Access to services: treatment	47.5	17.9	49
Antenatal care: prevention	72.1	11.3	49
Antenatal care: risk identification	64.9	10.3	49
Delivery care: risk identification	52.4	11.8	49
Delivery care: treatment	55.5	12.0	49
Family planning: avoidance	58.6	11.9	49

[a] The maximum number of cases is 49, the number of countries in the study.

Table 3. Cross-national regressions for alternative maternal mortality ratios

Dependent variable and predictors	*Stepwise regressions* (1) *B*	*t*	(2) *B*	*t*	*Final regressions* (3) *B*	*t*	(4) *B*	*t*
1990 ratio								
GNP per capita (log)	-0.883	-6.31**	-0.567	-3.80**	-0.584	-4.73**	-0.405	-2.56*
Access to services			-0.025	-3.43*	-0.024	-4.07**	-0.021	-3.55**
Crude birth rate							0.024	1.75
Constant	1.112	1.04	0.072	0.08	0.222	0.29	-2.016	-1.36
R^2 (n)	0.61	(28)	0.73	(28)	0.73	(46)	0.75	(46)
1995 ratio								
GNP per capita (log)	-0.874	-6.75**	-0.592	-4.22**	-0.673	-4.80**	-0.426	-2.41*
Access to services			-0.022	-3.26*	-0.018	-2.72*	-0.014	-2.15*
Crude birth rate							0.033	2.16*
Constant	0.992	1.01	0.062	0.07	0.539	0.62	-2.560	-1.55
R^2 (n)	0.64	(28)	0.75	(28)	0.67	(46)	0.70	(46)
1990-98 ratio								
GNP per capita (log)	-0.804	-6.66**	-0.629	-4.58**	-0.596	-4.09**	-0.591	-3.10*
Access to services			-0.015	-2.18*	-0.016	-2.28*	-0.016	-2.11*
Crude birth rate							0.001	0.04
Constant	0.192	0.21	-0.316	-0.36	-0.553	-0.60	-0.615	-0.34
R^2 (n)	0.66	(25)	0.72	(25)	0.68	(29)	0.68	(29)
1995 ratio excluding regression estimates								
GNP per capita (log)	-0.759	-5.66**	-0.517	-3.51*	-0.541	-3.04*	-0.392	-1.57
Access to services			-0.019	-2.68*	-0.022	-2.71*	-0.020	-2.29*
Crude birth rate							0.017	0.85
Constant	0.240	0.24	-0.568	-0.61	-0.214	-0.20	-1.984	-0.84
R^2 (n)	0.63	(21)	0.73	(21)	0.68	(26)	0.69	(26)
Hakkert ratios								
GNP per capita (log)					-0.648	-5.11**	-0.450	-2.79*
Access to services					-0.026	-4.32**	-0.023	-3.78**
Crude birth rate							0.027	1.89
Constant					0.659	0.84	-1.821	-1.20
R^2 (n)					0.76	(46)	0.78	(46)
Schiffman ratios								
GNP per capita (log)					-0.516	-2.91*	-0.380	-1.55
Access to services					-0.013	-1.90	-0.012	-1.66
Crude birth rate							0.014	0.82
Constant					-1.160	-1.07	-2.679	-1.24
R^2 (n)					0.70	(22)	0.71	(22)

Note: Other variables that did not enter the stepwise regressions were the urban percentage of the population, the net primary female enrolment ratio, the crude birth rate, the household survey-based percentage of births delivered by a trained attendant, and the mean ratings for health facility capacity and for maternal health care received.

* $p < .05$.

** $p < .001$.

Table 4. Cross-national correlations between item indices and maternal mortality ratio

	Bivariate correlations				*Partial correlations, controlling per capita GNP*			
Indices	*Avoid-ance*	*Preven-tion*	*Risk identi-fication*	*Treat-ment*	*Avoid-ance*	*Preven-tion*	*Risk identi-fication*	*Treat-ment*
With 1990 ratio								
Health center capacity			-0.13	-0.16			0.10	-0.03
Hospital capacity			-0.25*	-0.43*			-0.14	-0.27*
Access to services	-0.78**	-0.46**	-0.66**	-0.76**	-0.60**	-0.21	-0.35*	-0.51**
Antenatal care		0.10	-0.34*			0.10	-0.26*	
Delivery care			-0.46**	-0.53**			-0.27*	-0.30*
Family planning	-0.49**				-0.30*			
With 1995 ratio								
Health center capacity			-0.07	-0.16			0.15	-0.02
Hospital capacity			-0.23	-0.37*			-0.07	-0.11
Access to services	-0.77**	-0.36*	-0.58**	-0.69**	-0.59**	-0.04	-0.21	-0.37*
Antenatal care		0.09	-0.28*			0.14	-0.16	
Delivery care			-0.46**	-0.52**			-0.25*	-0.26*
Family planning	-0.46**				-0.32*			
With 1990-98 ratio								
Health center capacity			-0.02	-0.12			0.23	0.04
Hospital capacity			-0.28	-0.34*			-0.12	-0.14
Access to services	-0.70**	-0.27	-0.57**	-0.70**	-0.58**	-0.11	-0.31	-0.48*
Antenatal care		0.04	-0.39*			-0.30	-0.32*	
Delivery care			-0.44*	-0.51*			-0.21	-0.29
Family planning	-0.42*				-0.34*			

Note: Correlations of the indices in each cell are with the logit of the maternal mortality ratio, controlling where indicated for the log of per capita 1999 GNP using purchasing power parity.

* $p < .05$, one-tailed.

** $p < .001$, one-tailed.