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An Indirect Method to Estimate Maternal Mortality Ratio: A Proposal and a First Approximation*

Introduction

MATERNAL mortality ranges from close to zero in highly developed countries to around 1,700 per 1,00,000 live births in countries lagging far behind in the developmental process. In the developing world though the level of maternal mortality is known to be alarmingly high and therefore a need for intervention is felt, data on maternal mortality are either not available or are of very poor quality (Bocma 1987). Faced with such situations demographers have often resorted to indirect estimation procedures (for methods of indirect estimation of measures of mortality, fertility and migration, see (Brass 1975; or United Nations 1983). Recently, two methods have been proposed for estimating the commonly used measure of maternal mortality, namely Maternal Mortality Ratio (MM/?), given as the number of maternal deaths per 1,00,000 live births, indirectly. Graham, Brass and Snow (1989) have proposed the use of what they call the 'sisterhood method' to estimate the MM/?. This method uses the proportion of adult sisters dying due to maternal mortality reported by adults in a survey or a census. The effectiveness of this method depends on the memory of the third party reporting the event. More recently, Blum and Fargues (1990) have demonstrated the use of two alternative procedures to estimate the MM/?. One of these uses the ratios of female and male age-specific mortality rates and the other uses the slope of only the female age-specific rates. In either case, fairly accurate information on age-specific mortality rates is required which may not be available in the case of many of the developing countries for which such methods are to be employed. Further, the use of sample surveys to estimate the MM/? has to be ruled out since the sample size would have to be enormous even if a moderately large error is allowed. For example, assuming that the MM/? is about 400 per 1,00,000 births, a sample of about 383 thousand births is required to obtain an estimate of MM/? within 20 points with 95 percent confidence. If the crude birth rate is 40 per 1000

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1. Often this is also termed as Maternal Mortality Rate. However, in the recent literature, the distinction between Maternal Mortality Rate and Maternal Mortality Ratio has been made as follows: Maternal Mortality Rate is the number of maternal deaths in a year per 1000 *women* and Maternal Mortality Ratio is the number of maternal deaths per 1,00,000 *births*; see, for example, Blum and Fargues (1990).

population, a population exceeding 9.6 million (or nearly 10 million) would have to be covered for one year. The costs of such surveys will be prohibitive. As such, an indirect approach to estimate *MMR* will be very useful. This paper is an attempt on these lines.

Since for large proportion of both maternal mortality and infant mortality, particularly perinatal mortality, the underlying predisposing causes are the same, infant and maternal mortality are expected to be highly associated at least statistically (Rinehart and Kols 1984). It has also been observed that high para women have a higher risk of maternal mortality (Trussell and Pebley 1984). Hence inclusion of total fertility rate in the procedure to estimate maternal mortality is expected to improve the estimate. Therefore, it is decided to use infant mortality rate and total fertility rate to estimate maternal mortality ratio in this paper. Besides, the estimation of infant mortality rate and total fertility rate requires relatively smaller samples than the estimation of maternal mortality ratio. Further, a number of indirect methods for obtaining reasonably accurate estimates of both the infant mortality rate and the total fertility rate from defective data are readily available. These facts justify the idea of using infant mortality rate (*IMR*) and total fertility rate (*TFR*) to estimate maternal mortality.

Data

The data on maternal mortality ratio, infant mortality rate and total fertility rate for the present work are drawn from a recent UNICEF publication (UNICEF 1989). Though the data for 131 countries, including developed and developing, are given, all the three measures are available only for 106 countries. A preliminary plotting on a graph sheet indicated that for seven countries the maternal mortality ratio is too high given the level of infant mortality. Hence they are treated as outliers, either because of doubtful quality or because of unusual conditions prevailing in these countries, and are dropped from the present analysis. The final analysis consisted of 99 countries. For a large number of developing countries the source of information is cited as UNICEF field office. As such it is very difficult to comment on the quality of data. However, the general remark that the quality of data from developing countries is poor may be accepted.

Findings

Regression curves of maternal mortality ratio (y) on *IMR* (x), square of *IMR* (x^2) and *TFR* (z) of the following forms are fitted for the above data set.

$$y = a_1 + b_1 \cdot x \quad (1)$$

$$y = a_2 + b_2 \cdot x + c_2 \cdot x^2 \quad (2)$$

$$y = a_3 + b_3 \cdot x + d_3 \cdot z \quad (3)$$

In the first regression, infant mortality rate explains 64 percent of variation in *MMR*. Almost nothing is added to the explained variation by a second degree curve, implying a linear relationship between *MMR* and *IMR*. Regression of *MMR* on *IMR* and *TFR* again

(equation 3 above) fails to show any improvement in the variation explained in *MMR* by the addition of *TFR* in the regression. It is possible that the effect of fertility on *MMR* is mediated through *IMR* and, therefore, the use of *TFR* in the prediction equation becomes redundant. This may be understood from the correlation coefficients between these variables. The correlations between these variables are given in Table 1 and the results of the regression on *MMR* in the first panel of Table 2.

TABLE 1 : CORRELATION MATRIX OF VARIABLES USED IN REGRESSION ANALYSIS

(i) Based on the data for 99 countries				
	<i>MMR</i>	<i>IMR</i>	<i>TFR</i>	
<i>MMR</i>	1.0			
<i>IMR</i>	0.803	1.0		
<i>TFR</i>	0.653	0.871	1.0	
(ii) Based on the data for 56 developing countries				
	<i>MMR</i>	<i>IMR</i>	<i>TFR</i>	
<i>MMR</i>	1.0			
<i>IMR</i>	0.659	1.0		
<i>TFR</i>	0.355	0.669	1.0	

TABLE 2 : RESULTS OF REGRESSION ANALYSIS OF MATERNAL MORTALITY RATIO ON *IMR* AND *TFR*

<i>Data used:</i>	<i>99 Countries</i>			<i>56 Developing Countries</i>		
	<i>Reg. Coefficients in eq.:</i>					
<i>Explanatory Variable</i>	(1)	(2)	(3)	(1)	(2)	(3)
<i>IMR</i>	3.287**	2.554**	3.965**	3.488**	2.096	4.040**
$(IMR)^2$	—	0.005	—	—	0.007	—
<i>TFR</i>	—	—	-18.497	—	—	-21.377
Intercept	-22.683	-8.516	11.024	-44.321	10.892	19.227
R^2	0.644	0.647	0.653	0.435	0.438	0.448

Notes : (i) — Indicates that the variable was not used in the equation.

(ii) *, ** Indicate that the regression coefficient is significant at the 5% and 1 % levels respectively.

Since any such procedure would be used for the developing countries, many of which would not have a direct estimate of the *MMR*, the regression analysis was repeated only for the data for the developing countries. In the data set used the relevant information for 56 countries in the developing world is available. The regression results show that it is primarily the *IMR* that explains a substantial proportion of the variation in the *MMR*, though the R^2 value (0.44) is lower than the value based on the entire data set; the R^2 in the larger data set

is high mainly due to the bunching of the developed countries at the lower range of *MMR* - *IMR* values. Given *IMR*, the other variables, *TFR* or *IMR*² add very little to the *R*² value (second panel of Table 2). Further, the regression coefficients vary only slightly, in relative terms, from the coefficients estimated from the complete data set. The predicted values of the *MMR* remain quite close to those by the earlier equation for values of *IMR* in the range 50-150, which would capture the *IMR* in most of the developing countries. Therefore, the equation (1) based on the larger data set may be used for estimating *MMR* from the *IMR*.

Expected values of the *MMR* for selected values of *IMR* over a plausible range, computed from regression equation (1), are given in Table 3. In addition, 95 percent confidence limits on these are also presented. This table may be used to obtain a quick estimate of the *MMR* if the value of *IMR* is known.

TABLE 3 : EXPECTED VALUES OF MATERNAL MORTALITY RATIO AND 95 PERCENT CONFIDENCE INTERVALS FOR SELECTED VALUES OF *IMR*

Value of <i>IMR</i>	Maternal Mortality Ratio		
	Expected value	95% of Confidence Limits on the estimate	
		Lower	Upper
20	43	14	72
30	76	50	102
40	109	85	133
50	142	119	165
60	175	152	198
70	207	184	231
80	240	215	266
90	273	245	302
100	306	274	338
125	388	347	429
150	470	419	522
175	553	490	615
200	635	560	709

Conclusion

The regression equation developed to estimate *MMR* from *IMR* indicates a reasonably high level of precision in predicting *MMR* (i.e. 64 percent of variation explained) in spite of low quality of input data. The results may, therefore, be considered only as a first approximation. With data of a better quality it would be possible to improve the prediction. Hence it is suggested that the prediction equation be reestimated when better quality data become available before using it for prediction purposes.

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