Maternal Mortality and Its Correlates: Practical Implications of Data Analysis Across Multiple Countries

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Abstract

Objective: Studies of maternal mortality that use data from multiple countries often identify statistically significant correlates and interpret them as factors relevant to policy. This study was designed to address the fragility of a statistical association between the maternal mortality rate and its main correlates, and to assess the relevance of multi-country data analysis for policy making.

Methods: Patterns of variation in the maternal mortality rate associated with the fertility rate, income per capita, primary and secondary school enrolment, institutional quality, women's participation in politics, and health systems indicators across 111 countries in 2000 and 128 countries in 2005 were investigated using a linear multilevel modelling approach.

Results: The fertility rate and income per capita were the only robust predictors of the maternal mortality rate. Health systems indicators and school enrolment, after controlling for the effect of the fertility rate, income per capita, and region-specific contextual factors, were found to be unstable direct predictors of the maternal mortality rate.

Conclusion: Although multi-country comparative studies can identify key correlates of the maternal mortality rate, policy recommendations to reduce maternal mortality should be based on causal models that take contextual factors into account.

Résumé

Objectif : Les études portant sur la mortalité maternelle qui utilisent des données issues de multiples pays en viennent souvent à repérer des corrélats significatifs sur le plan statistique et à les interpréter comme étant des facteurs pertinents en matière de politique. Cette étude a été conçue pour traiter de la fragilité d'une association statistique entre le taux de mortalité maternelle et ses principaux corrélats, ainsi que pour évaluer la pertinence de l'analyse de données issues de multiples pays à des fins d'élaboration de politiques.

Méthodes : Les tendances de la variation du taux de mortalité maternelle associées au taux de fertilité, au revenu par habitant, à l'inscription aux écoles primaires et secondaires, à la qualité institutionnelle, à la participation des femmes à la politique et aux indicateurs des systèmes de santé dans 111 pays en 2000 et dans 128 pays en 2005 ont été explorées au moyen d'une approche de modélisation linéaire à niveaux multiples.

Résultats : Le taux de fertilité et le revenu par habitant ont été les seuls facteurs prédictifs robustes du taux de mortalité maternelle. À la suite de la neutralisation des effets du taux de fertilité, du revenu par habitant et des facteurs contextuels propres à chacune des régions, nous avons constaté que les indicateurs des systèmes de santé et l'inscription scolaire étaient des facteurs prédictifs directs instables du taux de mortalité maternelle.

Conclusion : Bien que les études comparatives multipays puissent identifier des corrélats clés en ce qui concerne le taux de mortalité maternelle, les recommandations en matière de politique visant la réduction de ce taux devraient être fondées sur des modèles causaux qui tiennent compte des facteurs contextuels.

INTRODUCTION

The United Nations set an ambitious goal to reduce the global maternal mortality rate by 75% between 1990 and 2015. As noted in this Journal, the 2010 United Nations Millennium Development Goals report indicates only 13% of countries in the sample were on track to meet the goal.[1] The variation in maternal mortality rates across income and geographic regions is staggering. In 2010, the maternal mortality rate in Sub-Saharan Africa was 15 times higher than that observed in developed countries.[2] Of an estimated 287 000 maternal deaths in 2010, 85% occurred in Sub-Saharan and Southern Asian countries.[3]

The causes of maternal mortality and ways to effectively prevent it are well understood by health professionals, and this understanding is supported by a large body of

evidence. An overwhelming share of deaths associated with complications during pregnancy and childbirth can be averted by creating access to a skilled attendant at birth and effective obstetric care, and by preventing unwanted pregnancy and unsafe abortions.[4] Poverty, gender inequalities, lack of political commitment, and cultural barriers further hinder the ability of women at risk to benefit from the essential services.[5]

Translating knowledge into effective policies, however, is not simple. Should the countries with the highest maternal mortality rates spend more on health care, specifically on skilled birth attendants and physicians? Should the focus be on improving per person income to reduce the incidence of poverty? Should spending on education increase and enrolment numbers improve? Academic papers seem to imply that the answer is "yes" to all of the above.[6–9] Although the link between more expenditures on health care and more effective health services for women is intuitively valid, the strength of this link in the real world depends on a myriad of factors. Furthermore, a country's federal budget is limited, and socially prudent action requires that money be allocated to programs that generate visible and substantive gains.

A common approach used by health and social science scholars to determine which factors exert greater influence on the maternal mortality rate and to estimate the magnitude of each factor's influence is to perform linear regression analysis of multi-country data. A bivariate analysis helps provide an understanding of the overall pattern of association, but it fails to capture the net effect of one variable on another. Independent variables cannot be ranked in terms of their influence on the maternal mortality rate using a bivariate statistical association, because such an approach fails to take into account confounding factors.

McAlister and Baskett[10] investigated how socioeconomic and health indicators influence the maternal mortality rate using the 2003 United Nations Human Development Report data for 148 countries. After carrying out a bivariate polynomial regression analysis, they concluded that improving female education is the best policy to reduce the maternal mortality rate. As noted, a bivariate polynomial regression analysis cannot identify which variables exert greater influence on the maternal mortality rate. Although no causal statement can be made on the basis of bivariate regression analysis, the results reported by McAlister and Baskett[10] provide strong indication of a *potential* causal link between education and the maternal mortality rate.

A better approach to estimate the net association of socioeconomic and health indicators with the maternal mortality rate is a multiple regression analysis, because it generates partial correlation estimates as opposed to a simple correlation that ignores confounding factors. A multiple regression analysis, however, also faces severe problems if data exhibit strong clustering or if it has a nested structure; it ignores regional clustering and subsequently the estimates of partial correlations are imprecise.

An approach using a multilevel model decomposes the model's error term into a random effect component attributable to specific regions and a fixed effect attributable to all countries. In addition to capturing region specificities, a multilevel model provides the flexibility to obtain meaningful answers to complex questions. For example, it is possible to estimate how much of the variation in the maternal mortality rate across countries is attributable to region-specific factors. It is also possible to estimate the impact of contextual variables specific to regions on any given country's maternal mortality rate. Perhaps the most appealing aspect of a multilevel model is its ability to generate superior in-sample as well as out-of-sample predictions.[11]

METHODS

All data used in the statistical analysis are public access. Health-related variables (shown in the Table) were obtained from the World Health Organization's Global Health Observatory Data Repository, and socioeconomic variables were obtained from the World Bank's World Development Indicators.[12,13] The key variables included in the analysis were chosen to be consistent with the model used by the Maternal Mortality Estimation Inter-Agency Group (MMEIG), a task force consisting of experts from the World Health Organization, the United Nations Children's Fund, the United Nations Population Fund, the World Bank, and a team at the University of California at Berkeley. The MMEIG model uses income per capita, general fertility rate, and the presence or absence of a skilled attendant at birth as key explanatory variables for the maternal mortality rate. Many countries in this dataset have missing values for the skilled attendant at birth variable. As a result proxy measures such as health expenditure per capita, nurses per 100 000 population, and physicians per 100 000 population are used to capture the availability and provision of essential health services for women. In contrast to the MMEIG model, the present study used gross national income per capita instead of gross domestic product per capita to measure income, because gross national income focuses on income and gross domestic product focuses on production. To capture gender inequality, the proportion of women in government was included in the model. A successful implementation of policies aiming to reduce maternal mortality also requires a political environment free from corruption, concentration