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The effects of skilled health attendants on reducing maternal deaths in developing countries: testing the medical model

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Abstract

More than 500 000 women die each year from pregnancy related causes. Ninety-nine percent of these deaths occur in developing countries. This study examines the statistical relationship between maternal deaths and skilled health attendants. A skilled health attendant is a medical doctor, nurse, trained midwife, primary healthcare worker, or trained traditional birth attendant. A cross-national study was conducted using World Bank and United Nations data. A Medical Model was developed and tested using 100 countries identified as developing. The model consisted of the number of medical doctors in the country, number of nurses in the country, and the percentage of births attended by a skilled health attendant; the dependent variable was the maternal mortality ratio. Beta coefficients from multiple regression analysis indicated a strong association between maternal deaths and skilled health attendant. In addition, the Medical Model was capable of explaining 75% of maternal deaths. Future studies should focus on identifying ancillary or midlevel health care professionals, included in the skilled health attendant category, to ascertain their impact on maternal deaths in developing countries.

Keywords: Maternal health; Maternal mortality; Demography; Women studies; Global studies

1. Introduction

More than 500 000 women die each year from pregnancy-related causes. Ninety-nine percent of these deaths occur in developing countries; almost all are preventable. Causes of maternal deaths include hemorrhage, infection, hypertension, obstructed labor, and complications from unsafe abortions. With adequate medical care, these conditions are not fatal. However, in developing countries inadequate or no medical care is a major factor leading to maternal deaths. Most women in developing countries depend on traditional birth attendants who, for the most part, have had no formal midwifery training. Therefore, when complications arise, a trained medical professional is not available.

Maternal deaths are defined as those deaths that occur during pregnancy, within 42 days after pregnancy termination, regardless of pregnancy duration and site, from any cause related to or aggravated by the pregnancy, but not from accidental or incidental causes (CDC, 1999a). However, many maternal deaths are not recorded because many developing countries lack vital statistics registration systems.

The World Bank (1999) has determined that medical intervention before, during, and after childbirth is essential for reducing maternal deaths. Medical intervention is defined as having a skilled health attendant care for the pregnant woman. A skilled health attendant is defined as a personnel who is trained to give the necessary supervision, care, and advice to women during pregnancy, labor, and the postpartum period, to conduct deliveries on their own, and to care for newborns (The World Bank, 2000). In the developing countries, a skilled health attendant can be a medical doctor, nurse, trained midwife, primary health care worker, or trained traditional birth attendant (The World Bank, 2001a,b).

There are on average only 76 medical doctors per 100 000 population in developing countries; the statistics for the industrialized countries is 253 per 100 000 population (UNDP, 1999). The number of nurses in the developing countries is slightly higher at 85 per 100 000 population (UNDP, 1999). Not all nurses or medical doctors are available to provide maternal and child health services. Data on the number of midwives, primary health care workers, and trained traditional birth attendants are not available. It is estimated that 53% of births in developing countries are delivered with a skilled health attendant present (WHO/UNFPA/UNICEF, 1999). Although an increase in skilled

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health attendants is a long-term process, it is possible to augment the number of skilled health attendants in developing countries through midwifery training to traditional birth attendants. Some might have reservations about the earlier assertion because the World Health Organization has stated that there is no evidence that such training leads to a reduction in maternal deaths (WHO/UNFPA/UNICEF, 1999). Yet, it has been strongly suggested that there is a relationship between reduction of maternal deaths and timely and adequate medical services for problem pregnancies (Barnes-Josiah, Myntti, & Augustin, 1998; Prendiville, 1998; Thaddeus & Maine, 1994). The World Health Organization (WHO/UNIFPA/UNICEF, 1999) estimates that 15% of all births are complicated by potentially fatal conditions; that 25% of all maternal deaths are due to postpartum hemorrhaging, and that these deaths occur because adequate medical services are not available.

In this paper the relationship between skilled health attendants and maternal deaths is explored. The paper focuses on the Medical Model, one of the four models developed by the author to explain maternal mortality from a social and economic perspective.[1] The Medical Model seeks to determine which type of health provider or skilled health attendant has the greatest impact on reducing maternal deaths. Two hypotheses are being tested: (1) as the level of care increases from a skilled health attendant to a medical doctor and/or nurse, the maternal mortality ratio (MMR) decreases and (2) as the percentage of birth attendants who are skilled health attendants increases, the MMR decreases.

2. Background information

Maternal deaths are a social problem. They are measured by the MMR that predicts the risk of death to pregnant women. The ratio is the number of maternal deaths divided by the number of live births multiplied by 100 000 (Weeks, 1999). In the United States, the MMR has been 7 to 8 deaths per 100 000 live births since 1982; the average for the industrialized world is 13. In the developing world the MMR is 491 per 100 000 live births (UNDP, 1999).

The leading cause for teen deaths is pregnancy-related complications (Safe Motherhood Fact Sheet, 1998). Teen girls aged 15–19 are twice as likely to die from childbirth than older mothers. It is estimated that 50% of maternal deaths in Nigeria are to adolescent girls (WIN News, 2000), many of these deaths are due to unsafe abortions. Between 13 and 20% of maternal deaths are due to unsafe abortions (Duke & Speidel, 1991; Safe Motherhood Fact Sheet, 1998; Shane, 1997). The facts suggest that safe abortion is one of the most predictable means of reducing maternal deaths.

It has also been suggested that if women who wish to delay or limit births used effective contraceptives, maternal deaths would drop by an estimated 17–35% (Ashford, 1995). Furthermore, if all women delayed their first birth until after age 20, at least 25% of pregnancy-related deaths could be prevented (Gelbard, Haub, & Kent, 1999). Family planning may be an important method for reducing maternal deaths. Sub-Saharan Africa has the lowest rate of contraceptive use and the highest MMR (Goliber, 1997; UNDP, 1999), suggesting that adequate medical care and family counseling may reduce maternal as well as infant mortality rates.

The traditional medical model recognizes the physician, nurse, and trained midwife as competent individuals to care for the pregnant woman. In the United States, the physician is the primary care giver for most pregnancies; in developing countries, it is a nurse, midwife, primary healthcare worker, and trained or untrained traditional birth attendant. Most of the 585 000 women who die each year from pregnancy related causes receive inadequate or no medical care prior to, during, or after childbirth.

Inadequate medical care means that essential obstetric services or the proper medical professionals, i.e. medical doctor or obstetrician, were not available. One of the questions being asked in this study is whether the level of health care provided has an effect on the MMR. That is, which skilled health attendant will make the greatest impact on reducing maternal deaths in the developing world. A skilled health attendant refers to health care providers with midwifery skills; for example, medical doctor, nurse, midwife, primary health care worker, or trained traditional birth attendant (The World Bank, 2001a,b). The term medical doctor can refer to a qualified medical doctor or someone who performs the same function as a medical doctor but has not had the same intensive training, i.e. physician assistant. The term nurse can refer to a licensed practical nurse, registered nurse, or nurse-midwife. The term trained-midwife is often used synonymously with trained traditional birth attendant. However, a trained-midwife is usually a professional nurse (i.e. nurse-midwife) who has had additional training in childbirth or midwifery. A primary health care worker can be a physician assistant or some other ancillary personnel who has been trained to care for pregnant women (this category does not include trained traditional birth attendants).

An untrained traditional birth attendant is usually a woman with no formal midwifery training who may be a relative or friend of the family and/or feels obligated to care for the pregnant women in her community. A trained traditional birth attendant, on the other hand, is usually a traditional birth attendant who has had formal midwifery training sponsored by a government or a non-governmental organization and may or may not be considered a skilled health

[1] The other three models are: the Public Health Model which tests the impact of an adequate diet and family planning services on reducing maternal deaths; the Demographic Transition Model, which tests the impact of economic development on maternal deaths; and the Modernization Model, a synthesis of the three (Medical, Public Health and Demographic Transition Model), which tests the impact of modernity and the status of women on maternal deaths. Manuscript in preparation.

attendant (WHO/UNFPA/UNICEF, 1999; The World Bank, 2000). Lack of wider recognition of trained traditional birth attendants as skilled health attendants is due to a World Health Organization (WHO/UNFPA/UNICEF, 1999) conclusion that they do not reduce maternal deaths. Although this conclusion is not universal (Greenwood et al., 1990; McLean, 2000; Walraven, Telfer, Rowley, & Ronsmans, 2000).

The controversy over their effectiveness may be related to their variations in training, support, prior education, and/or faulty research methods. Kamal (1998) conducted a study on traditional birth attendants in over 70 countries. He found that without proper supervision and support, trained traditional birth attendants are not effective; an unsupported, trained traditional birth attendant is helpless when there are complications during childbirth. A Canadian–Nigerian Safe Motherhood initiative program in southeastern Nigeria provided support and supervision for its trained traditional birth attendants. During the study period, the MMR dropped from 1450 per 100 000 live birth to 245 per 100 000 (McLean, 2000). However, Dehne, Wacker, and Cowley (1995) found no noticeable difference in maternal health indicators after training 18 illiterate traditional birth attendants in Burkina Faso, and another Nigerian study found that, trained illiterate traditional birth attendants only referred one-quarter of at risk pregnant women to health centers (Matthews et al., 1995). In order to reduce maternal deaths, trained traditional birth attendants must be able to refer complicated cases to trained medical professionals, who must be accessible, available, and affordable. If the medical facilities and services are not available, the trained traditional birth attendant is ineffective.

The unstandardized training of traditional birth attendants may also affect their performance. The training can range from as small as 38 hours (Schaider, Ngonyani, Tomlin, Rydman, & Roberts, 1999) to 2 years (Itina, 1997). Traditional birth attendant training in Somalia usually last 2 weeks and includes anatomy, physiology, antenatal care, normal and complicated pregnancy, labor and puerperium, and management of the newborn. However, there is usually no supervision or support after training (Prendiville, 1998). Jowett (2000) says that the most important function that traditional birth attendants can perform is to identify, and help the pregnant woman to identify, complications that arise during pregnancy. The next step is to encourage the women with complications to seek essential obstetric services. However, the services have to be available; and traditional birth attendants have no control over that.

Developing countries are chronically medically understaffed. Governments are often not able or willing to allocate the necessary funds for the training of medical doctors or obstetricians; yet skilled medical personnel are needed to provide care before, during, and after childbirth. The original purpose of the Medical Model developed for this study was to statistically test the impact of physicians, nurses, and/or trained traditional birth attendants on the MMR. However, since trained traditional birth attendants are usually excluded from the skilled health attendant category in most data sources, the model is only capable of testing the impact of medical doctors, nurses, and ancillary health personnel.

3. Methodology

3.1. Data and variables

The Medical Model is tested using data from Human Development Report 1999 (UNDP, 1999) and Maternal Health Around the World Website (World Health Organization and World Bank, 1997). The unit of analysis for this study is the individual developing countries. A developing country is defined as one with a gross national product (GNP) per capita that is $14 000 or less. This classification includes 25 Eastern European countries and 125 countries located in Africa, Asia, Latin America, and the Caribbean (see Table 1 for the list of developing countries with their MMR). Unfortunately, the number of countries included in this study is only 100 due to missing data.

The dependent variable for the Medical Model is MMR. The MMR (the number of maternal deaths per 100 000 live births) is being used to measure the risk of a woman dying from childbirth. The MMR is for the year 1990 and is taken from the Human Development Report 1999. The independent variables that comprise the model are number of medical doctors (MDs) per 100 000 population, number of nurses (RNs)[2] per 100 000 population, and the percentage of births that are attended by a skilled health attendant (SKHA). The data for SKHA are taken from the Maternal Health Around the World Website 1997. Eleven of the 150 developing countries had no data listed for SKHA. The data for medical doctors (MDs) and nurses (RN) are taken from the Human Development Report 1999 and are for the year 1993. Of the 150 developing countries reported for that year, 24 reported no data for nurses, and 16 reported no data for medical doctors.

3.2. Analysis

This cross-national study utilized SPSS bivariate and multiple regression analyses to test the model. Test of significance and frequency distributions were performed to identify important relationships among the variables. In addition, initial tolerance statistics indicated multi-collinearity for two independent variables. However, multi-collinearity was expected since these two variables, number of medical doctors and number of nurses, identify the number of healthcare personnel that may be available to provide maternal and child care services. Both numbers are consistently low for developing countries. The third independent

[2] The 1999 Human Development Report does not indicate whether nurse refers to registered nurse, licensed practical nurse, or nurse-midwife.

Table 1
Developing countries in ascending order by MMR

Country	MMR	Country	MMR
Greece	10	Libya	220
Slovenia	13	Brazil	220
Portugal	15	Honduras	220
Czech Republic	15	South Africa	230
Poland[a]	19	Botswana[a]	250
Macedonia, TFYR	22	Philippines	280
Azerbaijan	22	Peru	280
United Arab Emirate	26	Lebanon	300
Bulgaria	27	El Salvador	300
Kuwait	29	Iraq	310
Hungary[a]	30	Pakistan	340
Georgia	33	Namibia	370
Lithuania	36	Madagascar	490
Belarus	37	Gabon	500
Latvia	40	Cameroon[a]	550
Estonia	41	Malawi	560
Armenia	50	Zimbabwe	570
Ukraine	50	India[a]	570
Panama	55	Myanmar	580
Uzbekistan	55	Morocco	610
Turkmenistan	55	Lesotho	610
Costa Rica	60	Togo	640
Moldova	60	Indonesia	650
Chile	65	Bolivia	650
Albania	65	Kenya	650
Mongolia	65	Lao, People's Dem[a]	650
Russian Federation	75	Sudan	660
Malaysia	80	Central African Rep	700
Kazakhstan	80	Ghana[a]	740
Uruguay	85	Tanzania	770
Trinidad and Tobago	90	Cot d'Ivoire[a]	810
Cuba	95	Bangladesh	850
China	95	Congo, Dem. Rep[a]	870
Argentina	100	Congo	890
Columbia	100	Cambodia	900
Mexico	110	Guinea-Bissau[a]	910
Dominican Republic	110	Papua New Guinea	930
Kyrgyzstan	110	Mauritania	930
Venezuela	120	Burkina Faso[a]	930
Mauritius	120	Zambia[a]	940
Jamaica	120	Benin	990
Iran[a]	120	Nigeria	1000
Korea, Republic of	130	Haiti	1000
Romania	130	Gambia	1100
Saudi Arabia	130	Senegal	1200
Tajikistan	130	Uganda	1200
Sri Lanka	140	Mali	1200
Ecuador	150	Niger	1200
Jordan	150	Rwanda[a]	1300
Paraguay	160	Burundi	1300
Algeria[a]	160	Yemen	1400
Viet Nam[a]	160	Eritrea[a]	1400
Nicaragua	160	Ethiopia	1400
Tunisia	170	Nepal	1500
Egypt	170	Angola[a]	1500
Turkey	180	Chad	1500
Syria	180	Mozambique[a]	1500
Oman	190	Bhutan	1600
Thailand	200	Guinea	1600
Guatemala	200	Sierra Leone[a]	1800

[a] Developing countries not included in the study due to missing data.

Table 2
Mean statistics for maternal mortality and health care providers in developing countries ($N = 100$)

MMR	404 maternal deaths per 100 000 live births
Nurses	259 per 100 000 population
Doctors	131 per 100 000 population
SKHA at birth	69% of births

variable, SKHA, did not exhibit multi-collinearity. To eliminate multi-collinearity from the model, the number of medical doctors per 100 000 population and the number of nurses per 100 000 population were combined to make a new variable: MDRN per 100 000 population. The new independent variable, MDRN, and SKHA were regressed with MMR. The results of the analyses follow.

4. Results

Descriptive statistics for the model variables are shown in Table 2. The table indicates that, on average, there are more nurses than medical doctors in developing countries, and that 69% of childbirths were attended by a SKHA. These results imply that approximately one third of births in the study were delivered by an untrained or trained traditional birth attendant, a family member, or the woman alone. One explanation for the approximately 500 000 maternal deaths that occur annually in developing countries is the lack of adequate or no medical care for women with pregnancy complications. These maternal deaths are usually the result of complications that arise during or after delivery in the absence of a medical doctor or an obstetrician. In fact, half of maternal deaths occur within 1 day of delivery and 80% within 2 weeks of delivery (Finger, 1997). Furthermore, a quarter of maternal deaths are the result of hemorrhaging (WHO/UNFPA/UNICEF, 1999). Many women die at an understaffed and/or ill-equipped medical facility or en route to such a facility (Jowett, 2000; Thaddeus & Maine, 1994).

Table 3 shows the correlation coefficients and regression statistics for the initial Medical Model. All variables are moderately to strongly correlated with one another. SKHA has the strongest negative correlation with MMR, −0.86, suggesting that any healthcare personnel with midwifery skills contributes to lowering the MMR. The bivariate and tolerance statistics show multi-collinearity between RN and MD variables. The multiple R for this model is positive 0.87 indicating the strong predictive and explanatory value of the variables, but again SKHA makes a major impact with a beta of −0.80.

Table 4 is a modification of Table 3. The new variable, MDRN, is substituted for medical doctors and nurses to eliminate multi-collinearity. The tolerance statistics is 0.60 for both MDRN and SKHA indicating that multi-collinearity is negligible. The beta coefficients show only SKHA with an

Table 3
The relationship between maternal mortality and health care providers ($N = 100$, *coefficients significant at $P < 0.05$ level)

	Maternal deaths per 10 000 live births (MMR)	Nurses per 100 000 (RN)	Doctors per 100 000 (MD)	SKHA present at birth
MMR	1.00	−0.50*	−0.64*	−0.86*
RN	−0.50*	1.00	0.86*	0.59*
MD	−0.64*	0.86*	1.00	0.68*
SKHA	−0.86*	0.59*	0.68*	1.00
Tolerance[a]		0.27	0.22	0.53
Multiple R	0.87			
Beta		0.17	−0.23*	−0.80*
R^2	0.76			
Adj R^2	0.75			

[a] Statistics close to zero indicate multi-collinearity.

impact. The MDRN effect appears to be negligible; the beta is only −0.02 whereas the SKHA beta is a strong −0.85. Tables 3 and 4 both show a strong Multiple R and R^2. The Medical Model and the revised model are both capable of explaining approximately 75% of maternal mortality. Twenty-five percent of maternal mortality cannot be explained by the models and may be related to social and economic resources available to women in the developing world. Inadequate diet, family planning services, education, and job opportunities as well as governments' reluctance to provide adequate maternal and child health services are indicative of the low status of women in these countries. Interestingly, the betas in the revised model imply that the majority of SKHAs are primary healthcare workers who are not medical doctors or nurses.

The findings in this study are consistent with other studies. Jowett (2000) found that increasing access to essential obstetric services could reduce maternal mortality by 74%; SKHAs provide this access and Shiffman (2000) found that the percentage of deliveries by SKHAs was a good indicator of national maternal mortality levels. However, no author researched the comparative impact of primary healthcare workers versus medical professionals on maternal deaths.

Table 4
The relationship between maternal mortality and health care providers (revised) (*coefficients significant at $P < 0.05$ level)

	Maternal deaths per 100 000 live births (MMR)	Doctors and nurses per 100 000 population (MDRN)	Percentage SKHA present at birth
MMR	1.00	−0.56*	−0.86*
MDRN	−0.56*	1.00	0.63*
SKHA	−0.86*	0.63*	1.00
Tolerance[a]		0.60	0.60
Multiple R	0.86		
Beta		−0.02	−0.85*
R^2	0.74		
Adj R^2	0.74		

[a] Statistics close to zero indicate multi-collinearity.

The relationship between the MMR and medical doctors is listed in Table 5. The 10 countries with the lowest number of medical doctors per 100 000 population have MMRs in excess of 500 maternal deaths per 100 000 live births. All of these countries are in Sub-Saharan Africa where the mean gross national product (GNP) per capita is only $522 (UNDP, 1999). However, no attempt is made here to explore the relationship between GNP per capita and the MMR; although Shiffman (2000) found a weak relationship between wealth indicators and maternal mortality. Table 5 also indicates that those 10 countries with the highest number of medical doctors per 100 000 population have MMRs that are less than 100 maternal deaths per 100 000 live births.

Tables 6 and 7 present similar findings for nurses and SKHAs, respectively. Those 10 countries with the lowest number of nurses per 100 000 population tend to have high MMRs. The 10 countries with the lowest percentage of SKHAs present at birth also have high MMRs. These tables also indicate the reverse to be true. More nurses and a higher percentage of SKHAs present at birth are associated with lower MMRs. However, a comparison of Table 5 (Maternal Mortality Rankings by Number of Doctors) with Table 8 (Rankings by MMR) reveals that those countries with the lowest number of medical doctors do not have the highest MMRs. Only three countries, Ethiopia, Eritrea, and Chad, have the lowest number of medical doctors and some of the highest MMRs (see Table 1 for a complete list of countries with their MMR). These countries are also some of the poorest countries in Africa; their GNP per capita is less than $240 (UNDP, 1999) in comparison to the sample as a whole, which is $2064.

Tables 5 and 8 also reveal that those countries with the highest number of medical doctors do not have the lowest MMRs; only Greece and Azerbaijan are listed as having the highest number of doctors and the lowest MMRs. Moreover, with the exception of Greece and Cuba, those countries with the highest number of medical doctors are located in Eastern Europe. Many Eastern European countries went through political and economic changes after the collapse of the

Table 5
Maternal mortality rankings by number of medical doctors

Country	Doctors per 100 000 population	Nurses per 100 000 population	SKHA present at birth	Maternal deaths per 100 000 live births (MMR)
Lowest number of doctors				
Malawi	2	6	55	560
Chad	2	6	15	1500
Gambia	2	25	44	1100
Eritrea	2	–	6	1400
Niger	3	17	16	1200
Ghana	4	–	44	740
Tanzania	4	46	53	770
Uganda	4	28	38	1200
Mali	4	9	24	1200
Ethiopia	4	8	8	1400
Highest number of doctors				
Moldova	356	1020	95	60
Kazakhstan	360	874	99	80
Belarus	379	1160	100	37
Russian Federation	380	659	95	75
Greece	387	278	99	10
Azerbaijan	390	1081	95	22
Lithuania	399	977	95	36
Ukraine	429	1211	100	50
Georgia	436	863	95	33
Cuba	518	752	99	95

Table 6
Maternal mortality rankings by number of nurses

Country	Nurses per 100 000 population	Doctors per 100 000 population	SKHA present at birth	Maternal deaths per 100 000 live births (MMR)
Lowest number of nurses				
Guinea	3	15	31	1600
Nepal	5	5	8	1500
Bangladesh	5	18	14	850
Bhutan	6	20	12	1600
Malawi	6	2	55	560
Chad	6	2	15	1500
Ethiopia	8	4	8	1400
Mali	9	4	24	1200
Paraguay	10	7	66	160
Maldives	13	19	90	–
Highest number of nurses				
Kyrgyzstan	879	310	95	110
Czech Republic	944	293	99	15
Lithuania	977	399	95	36
Moldova	1020	356	95	60
Uzbekistan	1032	335	90	55
Azerbaijan	1081	390	95	22
Belarus	1160	379	100	37
Malta	1189	250	98	–
Turkmenistan	1195	353	90	55
Ukraine	1211	429	100	50

Table 7
Maternal mortality rankings by percentage of SKHAs

Country	SKHA present at birth	Nurses per 100 000 population	Doctors per 100 000 population	Maternal deaths per 100 000 live births (MMR)
Lowest percentage of SKHAs				
Equatorial Guinea	5	34	21	–
Eritrea	6	–	2	1400
Nepal	8	5	5	1500
Ethiopia	8	8	4	1400
Bhutan	12	6	20	1600
Bangladesh	14	5	18	850
Chad	15	6	2	1500
Yemen	16	51	26	1400
Niger	16	–	3	1200
Angola	17	–	–	1500
Highest percentage of SKHAs				
Cuba	99	752	518	95
Romania	99	430	176	130
Kazakhstan	99	874	360	80
Albania	99	423	141	65
Bahamas	100	258	141	–
Slovenia	100	686	219	13
Belarus	100	1160	379	37
Fiji	100	215	38	–
Bulgaria	100	652	333	27
Ukraine	100	1211	429	50

Soviet Union. Economic changes may have affected the supply of medicine and other equipments. This may be one explanation for why some countries with a high number of doctors, do not have the lowest MMRs. In addition, Tables 6 and 7 show that those countries with the highest number of nurses and the highest percentage of SKHAs present at birth, also do not have the lowest MMRs. However, Tables 5–8 indicate that women in the Eastern

Table 8
Rankings by MMR

Country	Maternal deaths per 100 000 live birth (MMR)	Doctors per 100 000 population	Nurses per 100 000 population	SKHA present at birth
Lowest number of maternal deaths				
Greece	10	387	278	99
Slovenia	13	219	686	100
Portugal	15	291	304	98
Czech Republic	15	293	944	99
Poland	19	–	–	99
Macedonia	22	219	334	93
Azerbaijan	22	390	1081	95
United Arab Emirate	26	168	321	96
Bulgaria	27	333	652	100
Kuwait	29	178	468	99
Highest number of maternal deaths				
Yemen	1400	26	51	16
Eritrea	1400	2	–	6
Ethiopia	1400	4	8	8
Nepal	1500	5	5	8
Angola	1500	–	–	17
Chad	1500	2	6	15
Mozambique	1500	–	–	30
Bhutan	1600	20	6	12
Guinea	1600	15	3	31
Sierra Leone	1800	–	–	25

European countries have a lower risk of dying in childbirth in comparison to other countries in the developing world.

5. Discussion

The data only partially supports the hypothesis that as the level of care increases, the MMR decreases. That is, there is a stronger negative correlation between medical doctors and the MMR than between nurses and the MMR as listed in Table 3. However, SKHA has the strongest negative correlation coefficient and the strongest impact on the multiple *R*. In addition Table 4 shows that even when we combine our two variables, medical doctors and nurses, SKHA still has the strongest impact on the dependent variable, MMR. We can only speculate that this variable, SKHA, is disproportionately a representative of primary healthcare workers. Therefore, our hypothesis is only partially supported by the data. A higher level of care (as indicated by a medical doctor and/or nurse) does not appear to lower the MMR in developing countries. The second hypothesis is, however, supported by the data. That is, as the percentage of SKHA increases, the MMR decreases.

One of the limitations of this study is the missing data; another one is the 'time lag'. The MMR is for 1990 and the number of medical doctors, nurses, and SKHAs are for the years 1993 and 1997, respectively. In addition, we do not know the percentage or number of SKHAs who are medical doctors, nurses, trained midwives, primary healthcare workers, and trained traditional birth attendants. However, the time lag should not affect the validity of the study since MMRs are still high in developing countries today. If countries with higher MMRs in 1990 achieved relatively higher increases in numbers of SKHA by 1997, then the model will underestimate the effectiveness of SKHA in reducing maternal deaths. However, the converse is less likely —countries with more resources and lower MMRs in 1990 are plausibly more likely to put new efforts towards physicians and nurses rather than SKHA. In this case, the model would underestimate the effectiveness of physicians and/or nurses in reducing maternal deaths. These possibilities should be kept in mind when interpreting the results.

Other limitations of the study include not assessing the impact of economic development, daily caloric intake, contraceptive use, abortion, public health expenditure, and female status on maternal death. The relationship between these issues and health providers to the MMR are explored in a separate paper. The focus of this paper is primarily on the types of health providers who assist women in the developing world with childbirth.

The upgrading of healthcare providers may not be associated with better care. During the early part of the 20th century, the percentage of American midwives who attended births dropped from 50 to 12.5% (Devitt, 1979), but the change from midwife to physician did not decrease maternal deaths. In fact, Newark, New Jersey, and New York City reported higher maternal deaths for physicians attending births than for midwives (Devitt, 1979). Causes of maternal deaths for American midwives were attributed to unsanitary conditions and lack of training. Causes of maternal deaths for physicians were attributed to excessive surgical deliveries (Loudon, 1992). Upgrading of care in the United States did not reduce maternal mortality until the 1933 White House Conference on Child Health Protection linked maternal deaths to aseptic practices and excessive surgeries (CDC, 1999b).

In developing countries access to essential obstetric care is a problem. Pregnant women and their families delay emergency or proper obstetric care due to lack of knowledge, money, transportation, and/or confidence in modern medicine (Barnes-Josiah et al., 1998). Even when they agree to services they may be denied due to lack of money; e.g. a Somali woman was denied medical care because she could not afford the $300 for the cesarean section (Prendiville, 1998). A spokesperson for a private clinic in Addis Ababa, Ethiopia in 1994 said that a normal birth cost 397 Birr (about $50) and a cesarean section 798 Birr (a little over $100 US dollars). In a country where the per capita income is less than $110, this is more than the average woman can afford. In addition to the cost of health care, medical facilities are understaffed; even if a woman can afford to pay the fee, medical care may not be available. Trained and untrained traditional birth attendants provide maternal care services to community women at a reasonable fee. Edwards, Birkett, and Sengeh (1989) found in Sierra Leone that trained traditional birth attendants were paid about $3 for a delivery and untrained traditional birth attendants about $2; a South African study found traditional birth attendants received no money but gifts for their services, some valued at $4 (Selepe & Thomas, 2000). Most women are thus more likely to be able to afford a trained or untrained traditional birth attendant.

Although the data only partially support the hypothesis that higher-level provider care produces lower MMRs, the data do support the hypothesis that as the percentage of SKHA increases, the MMR decreases. A SKHA present at childbirth, whether it be a medical doctor, nurse, trained midwife, or primary healthcare worker (and possibly a trained traditional birth attendant) can lower the MMR or reduce maternal deaths by providing essential obstetric services or referring pregnant women to a medical professional. However, more reductions would presumably occur if medical doctors were available at all births and if pregnant women did not delay seeking care from competent medical professionals before, during, and after childbirth.

6. Lessons learned

The original purpose of this study was to find statistical support for the training of traditional birth attendants to

assist in the reduction of maternal mortality in developing countries. However, data were not available on the number of trained traditional birth attendants practicing in developing countries, and trained traditional birth attendants are usually excluded from the category of SKHA. In addition, many international organizations are not consistent with the terminology that is used to describe or define health providers. In this study, the data for SKHA was taken from the 'Maternal Health Around the World' website. The website defined 'a skilled person' as a doctor, midwife, or nurse. However, it did not define midwife. Therefore, the reader is left wondering if the midwife is a trained or untrained traditional birth attendant or some other midlevel or ancillary health professional. The World Health Organization and World Bank are the sources for the Maternal Health Around the World data. The World Health Organization (WHO/UNFPA/UNICEF) in a 1999 publication refers to skilled personnel as being a doctor or midwife; later in the same publication, it adds nurse. It states that other healthcare providers, such as auxiliary nurse/midwife, community midwife, village midwife, and health visitor may have acquired the skills necessary for a SKHA. However, it does not indicate whether the village or community midwife was a traditional birth attendant or a traditional healer who was provided midwifery training by a government or non-governmental organization. In a footnote we are informed that traditional birth attendants have also received training in childbirth but that may be insufficient. The publication states that 'their practices are conditioned by strong cultural and traditional norms, which may also impede the effectiveness of their training' (WHO/UNFPA/UNICEF, 1999, p. 31). In other words, even with adequate training traditional birth attendants may not be considered SKHAs because of their cultural background. Yet, we do not know if governments are including them in their surveys of SKHAs, skilled personnel, or skilled health staff (all terms used to describe personnel who are recognized by governments and non-governmental organizations to assist in childbirth).

The World Bank's 2001 World Development Indicators defined births attended by 'a skilled health staff' as 'personnel trained to give necessary supervision, care, and advice to women during pregnancy, labor, and the postpartum period, to conduct deliveries on their own, and to care for newborns' (p. 109). It did not specify which health care personnel are included in this definition. Similarly, the Human Development Report 1999 (UNDP, 1999) list the number of nurses per 100 000 population for each country, but did not indicate whether this category included registered nurse, licensed practical nurse, nurse/midwife and/or community or village midwife.

The World Bank in its African Development Indicators, 2001 elaborates on the problem of collecting data from developing countries. The Bank states that many times surveys are limited to urban areas or capital cities; yet the data are reported as national statistics. Health indicators such as the percentage of births attended by SKHAs, maternal death rates, and infant mortality rates may be based on a survey of hospitals in urban areas only. In addition, the number of medical doctors in a country may include midlevel professionals, or persons who perform some of the same functions as medical doctors but are not qualified physicians.

7. Conclusion

The lack of consistency in health care terminology by international data collection organizations make it difficult to determine the impact of primary health care workers and trained traditional birth attendants on maternal mortality. This study found that SKHAs had a greater impact on maternal mortality than medical doctors and/or nurses. However, because of the inconsistency in terminology it is difficult to identify the health care personnel (e.g. primary health care worker or trained traditional birth attendant) responsible for this 'success'.

Cross national studies are needed to evaluate the effectiveness of maternal and child health care services and personnel, but they will be of limited value until the inconsistency in data collection and terminology defining health care personnel are resolved.

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