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Carla Abouzahr, Tiziana Leone, Vincent Fauveau

Maternal mortality in South Africa: An update from the 2007 Community Survey

Michel Garenne (1)
Robert McCaa (2)
Kourtoum Nacro (3)

(1) French Institute for Research and Development (IRD), and Institut Pasteur, Unité d'Epidémiologie des Maladies Emergentes, Paris, France
(2) Minnesota Population Center, University of Minnesota, USA, and Coordinator of the IPUMS-International project
(3) United Fund for Population Activities (UNFPA), New York, USA

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Email addresses:
MG: mgarenne@pasteur.fr
RM: rmccaa@umn.edu
KN: nacro@unfpa.org

Abstract

The 2007 Community Survey conducted in South-Africa included questions on maternal deaths in the previous 12 months. The MMR was estimated at 700 per 100,000 live births, some 30% more than at the 2001 census. This high level occurred despite a low proportion of maternal deaths (4.3%) among deaths of women aged 15-49 years, even lower than the time spent in the maternal period. The high level of MMR was due to the astonishingly high level of adult mortality, which increased by 46% since 2001. The main reasons for these excessive levels were HIV/AIDS and external causes of death. Differentials in MMR were very marked, and similar to those found in 2001 with respect to urban residence, race, province, education, income, and wealth. Provincial levels of MMR correlated primarily with HIV/AIDS prevalence. Maternal mortality defined as pregnancy related death was not a proper indicator of safe motherhood in this situation.

Key Words: Maternal mortality; Case definition; Attributable risk; Risk factor; Socio-economic correlate; HIV/AIDS, External causes; South Africa

Introduction

About a year ago we published an analysis of maternal mortality in South Africa using the 2001 census data [Garenne et al., 2008]. The paper discussed the relevance of using the demographic definition of maternal mortality (pregnancy related deaths) in the context of a severe HIV/AIDS epidemic. The main findings were that the level of maternal mortality was much higher than previously estimated in South Africa, and that its relationship with obstetric care became very weak. Indeed, maternal mortality counted as any death during the maternal period (pregnancy, delivery, six weeks post-partum) included many deaths which were most likely due to chronic infectious diseases (HIV/AIDS and PTB) or to external causes (accident and violence), and had little to do with obstetric causes of death (medical definition of maternal mortality). The study also revealed very marked gradients of maternal mortality by area of residence, province, population group (race), education, income and wealth. At provincial level, maternal mortality was primarily correlated with the prevalence of HIV/AIDS and with the proportion of external causes, and less with development indicators (income, wealth, urbanization). Surprisingly, the correlation with the proportion of home deliveries was negative. In this context, the "pregnancy related death" case definition appeared misleading, and lacked specificity.

We repeated the analysis using the 2007 Community Survey, which also included similar questions on maternal deaths and on external deaths in the past 12 months. This paper presents the new findings, and compares them with the findings from the 2001 census. Here, we do not focus as much on case definitions and on the reliability of the estimates, but rather on the similarities with- and changes since- the 2001 census. Note that our estimates are not official estimates, and readers should refer to Statistics-South Africa (Stat SA) and to estimates made at CARE (University of Cape Town) for final values of mortality indicators.

Data and Methods

The 2007 Community Survey was a large scale demographic survey conducted in South Africa, from February 7 to March 7, 2007, by Statistics South Africa. It used a questionnaire similar to a census questionnaire, and was designed to replace the census that could not be conducted five years after the 2001 census. It sample size was very large, and

corresponded to a 1 per 43 sample of a full census. Its methodology is described in details in other documents [Stats SA, 2007]. In brief, a large nationally representative sample of households was drawn in two stages: enumeration areas (stratified by type of municipality) updated from the 2001 census, and dwelling units, also drawn from updated lists. Some 21.5% of enumeration areas and some 10.9% of dwellings were selected, each dwelling having equal chances of being selected. Almost all enumeration areas were visited, and non-response rate among selected households was small (6.1%).

The questionnaire used for the 2007 Community Survey was very similar to that of the 2001 Census. In addition to classic census questions on individuals and housing, it included questions on past fertility and mortality. The fertility module focused on women age 12-50, and included cohort fertility (children living in the household, children living elsewhere, and children who died, by sex), and questions on the last birth (date of last birth, sex of last birth, survival of the last birth). The fertility module started with a question on whether the woman ever had a live birth, to avoid problems in coding infertile women which existed in the 2001 census. The mortality module included questions on survival of mother and father, and a question on deaths in past 12 months in the household, with date of death (month and year), sex and age at death, and whether the death was due to external causes (non natural), and for women aged 12-50 at time of death whether it occurred during the maternal period. The precise question was: "Was the deceased person pregnant at time of death, or died within six weeks after delivery?", which is basically the same question as that asked at the 2001 census. This question defines maternal mortality as "pregnancy related death", and includes direct causes (obstetric conditions), indirect causes (infectious and non-communicable diseases) and fortuitous causes.

The 2007 Community Survey data were analyzed with straightforward demographic methods, as done with the 2001 Census data. Fertility rates were calculated from births last year (February 2006 to January 2007), and corrected for twins with a coefficient= 1.014 since the data provided only the proportion of women who delivered last year. Mortality rates were calculated from deaths last year (since February 1, 2006): all deaths in the file were included, and a correction factor of 0.948 was applied to account for the inclusion of deaths during the month of the survey (February 2007). Person-years lived in the past 12 months were calculated from the population by single year of age at time of survey, and including the person-years lived by those who died, assumed to have lived only half of the year. Life tables were constructed, by 1 year age groups and 5 year age groups, and compared with UN model life tables for developing countries, General model [United Nations, 1982]. Maternal

mortality was calculated as the ratio of pregnancy related deaths in past 12 months to the number of births in past 12 months, expressed per 100,000 births. Multivariate analysis was conducted the same way as for the 2001 census, using a linear logistic model. Independent variables were the same: level of education (measured as the number of years schooling), urban residence, population group (race) and province of residence. The limits of some provinces changed somewhat between 2001 and 2007, but changes were minor and we used the 2001 definition for analyzing the 2007 Community Survey. An absolute wealth index was computed the same way as in 2001, from housing characteristics and goods and amenities owned. [for more details see also Garenne and Hohmann, 2003; and Garenne and Hohmann 2009, prepared for this conference].

Results

Sample size

The 2007 Community Survey included a fairly large sample of 354,170 households, of which 246,618 were private households eligible for final analysis, after discounting for institutions, recreational areas and other special cases. This represents about a fourth of the 10% sample of the 2001 Census: some 949,105 persons, and 265,945 women age 15-49 [Table 1]. The crude birth rate calculated from births last year was 24.0 per 1000; the general fertility rate was slightly higher than that measured in 2001 by about 5%, indicating a modest increase in fertility. The crude death rate calculated from deaths last year was 15.3 per 1000, a 64% increase from the 2001 estimate. Maternal mortality was based on 168 maternal deaths, a sample large enough for a number of detailed investigations, although smaller than that of the 2001 census 10% sample.

Imputations

There were a number of issues with imputations in the 2001 sample, well detailed in our first paper. This does not seem to be the case in the 2007 Community Survey: only two maternal deaths (1.2%) were imputed by Hot-Deck procedures, a percentage even lower than for non-maternal deaths of women age 15-49 (2.6%). Only a few deaths had a date imputed (1.8%) or an age imputed (0.8%), which indicates that the reliability of 2007 data was high.

Mortality level and pattern

The main feature of the 2007 sample was the major rise in mortality within the five years separating the two surveys [Table 2]. From life table estimates, the death rate for children under age 15, ($_{15}q_0$) increased by 26% in five years, and was 1.8 times higher that model life table values with the same life expectancy at age 60 (United Nations General Pattern for developing countries). The death rate for young adults from age 15 to 59 ($_{45}q_{15}$) increased by 46% for both sexes, and more so for women (+57%) than for men (+38%). In 2006, the death rate of young women was 4.5 times higher than that of model life tables, and that of men was 3.2 times higher. In contrast, mortality above age 60 hardly changed, with a life expectancy around 21 years for women and around 17 years for men, which correspond roughly to 73 and 67 years of life expectancy in model life tables. This outstanding pattern of adult mortality is primarily due to HIV/AIDS and PTB, two raging epidemics in South Africa, and to the very high mortality from external causes.

Level of maternal mortality

The extremely high value of young adult mortality explains the very high values of maternal mortality, as already noted in the first paper, but with even higher values due to the rise in mortality. The raw estimate of maternal mortality was 702 per 100,000 live birth (95% CI= 603-816), a value higher than any other estimate for South Africa and than most estimates for other developing countries [Boerma, 1988; Dorrington et al., 2005; Dickson-Tetteh & Rees, 1999; Fauveau et al., 1988; Fawcus et al. 2005; Khan et al. 2001; Koenig et al. 1988; Moodley & Pattinson, 2003; Moodley 2003; NCCEMD, 1988; Van Coeverden de Groot, 1979 & 1986)]. This estimate of maternal mortality was 29% higher than the value estimated from the 2001 census data ($P<0.004$). However, from 2001 to 2007, the proportion of maternal deaths among deaths of women aged 15-49 decreased from 6.4% to 4.3%. The increase in maternal mortality ratio seems therefore primarily due to the increase in mortality from all causes combined.

Attributable risk

We computed an expected number of maternal deaths assuming that there was no risk associated with pregnancy and delivery, in order to estimate a risk attributable to the maternal period. Details of the computations are displayed in Table 3. The maternal period is fixed to 46 weeks (40 weeks of pregnancy and 6 weeks post-partum), and the expected number of deaths during the maternal period is simply the product of population times the proportion of time spent in the maternal period times the death rate. Results show that a total of 294 deaths were expected during the maternal period, as compared with 168 observed at the survey. This means that, statistically speaking, there was no excess risk associated with the maternal period: on the contrary, the maternal period appeared as protective for survival. This is obviously due to a selection bias, the women who are in stable unions and deliver are not the same as the women who contract HIV/AIDS or die of external causes. It should be noted that this situation is very new, and due to the major demographic changes induced by HIV/AIDS. It differs markedly from the situation prevailing in the pre-AIDS era. For instance, in Niakhar, Senegal, in the 1980's, maternal deaths accounted for 25% of all deaths, and the ratio of maternal deaths to that expected during the maternal period was 1.25 [Garenne and Fontaine, 1988]. In Matlab, Bangladesh, despite lower fertility, maternal deaths accounted for 26% of all deaths, and the ratio of maternal deaths to that expected during the maternal period was 1.77 [Khlat & Ronsmans, 2000]. Both values are revealing the excess risk during the maternal period, and are very different from the 0.57 ratio found in South Africa.

Socio-economic correlates

We investigated maternal mortality differentials according to a variety of socio-economic correlates, we calculated a risk ratio of a given category to the national average, and compared the risk ratio with that found in 2001 [Table 4]. Results show a high consistency in the two differential analyses: higher risks for rural areas, for selected provinces (in particular Eastern Cape and Kwazulu-Natal), lower risk for selected population groups (Indian/Asian and White/European), decreasing risk with level of education, and a complex relationship with income and wealth, as already noted in the 2001 Census data (higher risks for the very poor and for middle classes). Only few differences in relative risks were notable and statistically significant, in particular the lower risk associated with high education in 2007.

Increases in maternal mortality from 2001 to 2007 were significant only for selected categories: rural areas (+47%), the Eastern-Cape (+74%), Black/Africans (+28%), middle income (4800-28800 ZAR) (+97%). These differences are probably related to increasing HIV/AIDS in high risk areas, and possibly with better treatment of HIV/AIDS for the higher education group.

Provincial differences

Provincial differences in maternal mortality are large in South Africa. We compared the correlations of MMR with the provincial characteristics, and found correlations similar to those found at the 2001 census [Table 5]. Largest positive correlations were with the overall level of mortality (+0.754), with the death rate from external causes (+0.664), and with HIV prevalence (+0.592), and largest negative correlations were with education (-0.396), income (-0.458) and wealth (-0.638). No recent survey providing the proportion of deliveries in institutions at provincial level in 2007 was available to compare with results from the 2001 census.

Discussion

The level of maternal mortality measured by "pregnancy related deaths" is abnormally high for a country like South-Africa, and obviously due to a lack of specificity of the case definition. By including many deaths which are most likely due to HIV/AIDS, PTB, accident and violence, it gives an exaggerated measure of the risk due to obstetric conditions. However, even if a fraction of these pregnancy related deaths is due to obstetric causes, maternal mortality in South Africa is probably still much higher than in developed countries, and deserves attention from health professionals.

The fact that maternal mortality increased rapidly from 2001 to 2007 is not surprising given the major rise in mortality over this period. This is mostly due to HIV/AIDS and PTB, and to external causes, which continue to account for a large and constant proportion of all deaths (about 14%).

Emerging diseases and conditions such as HIV/AIDS and external causes are changing mortality patterns to an extent never seen before. At a given level of mortality, regional model life tables provide a range of variations which is largely exceeded by emerging patterns such

as those seen in South Africa. And this is reflected here into the abnormally high level of maternal mortality.

Furthermore, HIV/AIDS may be an underlying cause of true maternal deaths, especially in the post-partum period. Numerous accounts of unexpected deaths during the few weeks following delivery have been reported among HIV positive women in South Africa. A cohort study of HIV positive women and their children reported a very high post-partum death rates of 2265 per 100,000 in South Africa within 36 weeks of delivery [Chopra, et al. forthcoming].

HIV/AIDS is also changing the relationship of mortality differentials with socio-economic status. If the relationship with education remains as expected, the relationship with income or wealth is not monotonic: it reveals two modes, one for the very poor, and one for the middle income classes. This is probably due to the fact that the risk of sexually transmitted infections is due to a balance between sexual behavior (more partners associated with higher socio-economic status, and prevention (more care associated with higher socio-economic status). These relations deserve more investigation, and require more specific data than these provided by a census.

The lower risk associated with the maternal period is counter-intuitive, and also deserves more research. Even if the result is a balance between genuine obstetric risks and differential attitudes and behaviors associated with pregnancy, our findings suggest that the selection for pregnancy is very high in South Africa. This also deserves more research. It could be in part associated with the lower fertility of HIV infected women, but most likely primarily due to differential behavior. Women who choose to have a baby must behave very differently from others to have a lower risk of dying.

There is no doubt that the census is the best tool to measure maternal mortality in the absence of proper vital registration, at least because of the large sample size required to reach statistical significance [Graham, 2002; Hill et al., 2006; Ronsmans & Graham 2006; Stanton et al. 2001, United Nations, 2001, 2008a, 2008b]. However, in the context of HIV/AIDS and high death rates from external causes, it necessary to include causes of death in order to focus on obstetric causes. This is the only way to measure progress in safe motherhood. This can be done using verbal autopsies, whether full scale or simplified to focus on obstetric causes [Fortney et al., 1986; Fottrell et al., 2007; Garenne & Fontaine, 1988; Fauveau et al. 1988].

The increasing level of maternal mortality is a matter of serious concern, especially when compared with international public health targets such as the “millennium development goals”. [United Nations, 2000; Rosenfield et al. 2006] Even if this increase has probably little

to do with obstetric care, it deserves more research, and calls for specific actions to reduce overall mortality, with main focus on treatment of HIV/AID and PTB, and prevention of external causes.

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Table 1: Main characteristics of the two samples, South Africa

	Characteristics	Census 2001 10% sample	Community survey 2007	Ratio 2007/2001
	Mean date	2001.8	2007.1	
Population	Nb households	991 543	246 618	
	Nb persons	3 725 655	949 105	
	Mean household size	3.76	3.85	1.02
Fertility	NB women 15-49	1 048 824	265 945	
	Nb births last year	84 520	22 397	
	GFR	0.081	0.085	1.06
	Time in maternal period %	7.1%	7.6%	1.06
Mortality	Nb deaths last year	36267	15304	
	Nb female deaths 15-49	7934	3924	
	Nb maternal deaths	508	168	
	Proportion maternal (%)	6.4%	4.3%	0.67
Raw estimates	Death rate 15-49	0.0076	0.0140	1.85
	MMR (per 100,000)	542	702	1.29
	CBR (per 1000)	0.0228	0.0240	1.05
	CDR (per 1000)	0.0093	0.0153	1.64

Note: Community survey: private households only; births rates and deaths rates corrected for minor errors (see text for details).

Table 2: Changes in mortality from 2001 to 2007, South Africa

Age group	Indicator	Community Survey 2007	Census-2001	Model Life table	Mortality increase 2007/2001	Ratio CS-20007 /MLT
Both sexes						
0-14	${}_{15}q_0$	0.099	0.079	0.055	1.26	1.8
15-59	${}_{45}q_{15}$	0.553	0.380	0.151	1.46	3.7
60+	e°(60)	18.3	19.8	18.6		
Males						
0-14	${}_{15}q_0$	0.100	0.086	0.063	1.17	1.6
15-59	${}_{45}q_{15}$	0.606	0.440	0.190	1.38	3.2
60+	e°(60)	15.5	17.3	17.0		
Females						
0-14	${}_{15}q_0$	0.099	0.072	0.047	1.38	2.1
15-59	${}_{45}q_{15}$	0.501	0.320	0.112	1.57	4.5
60+	e°(60)	20.5	21.8	20.1		

Note: Model life table: General model for developing countries; life expectancy: 67 for males and 73 for females (approximately same life expectancy at age 60).

Table 3: Estimation of mortality risks attributable to the maternal period, South Africa, Community Survey 2007 (events of past 12 months)

Age group	Population (Person-years lived)	Fertility rates (ASFR)	Percent time spent in maternal period	Mortality rates (ASDR)	Percent maternal deaths	Pregnancy related deaths	
						Expected	Observed
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
12-14	31593	0.0040	0.4	0.0015	0.0	0	0
15-19	51674	0.0729	6.5	0.0032	7.3	11	12
20-24	48358	0.1329	11.8	0.0093	7.6	53	34
25-29	39333	0.1315	11.6	0.0187	5.8	86	43
30-34	35898	0.1091	9.7	0.0242	4.6	84	40
35-39	33048	0.0701	6.2	0.0209	3.6	43	25
40-44	30463	0.0292	2.6	0.0192	1.5	15	9
45-49	26163	0.0065	0.6	0.0164	1.2	2	5
Total	296529	0.0768	6.8	0.0134	4.2	294	168

Note: Expected number of deaths (7) = product of population (2) by time spent in maternal period (4) by death rate (5). Observed number of deaths (8) = product of population (2) by death rate (5) by proportion maternal (6).

Table 4: Comparison of risk factors between 2001 Census and 2007 Community Survey, South Africa.

		Community Survey 2007		Census 2001	
Variable	Category	Nb deaths	RR	Nb deaths	RR
	Total	168	1.00	508	1.00
Residence	Urban	69	0.77	249	0.92
	Rural	99	1.27	259	1.10
Province	Western Cape	4	0.25	22	0.44
	Eastern Cape	47	1.76	88	1.29
	Northern Cape	5	0.73	7	0.75
	Free State	11	1.23	34	1.19
	Kwazulu Natal	46	1.30	152	1.40
	North-West	13	0.91	57	1.36
	Gauteng	23	0.79	70	0.72
	Mpumalanga	7	0.59	37	0.94
	Limpopo	12	0.63	41	0.63
Race	Black/African	161	1.12	478	1.11
	Coloured	7	0.44	24	0.52
	Indian/Asian	0	0.00	3	0.36
	White/European	0	0.00	3	0.12
Education	0-4 years	79	1.42	52	1.63
	5-8 years	44	1.00	121	1.37
	9-11 years	31	0.85	183	1.09
	12+ years	11	0.37	152	0.69
Income	None	15	1.26	142	1.18
	< 2400 Rd	43	0.91	181	1.07
	< 4800 Rd	54	1.10	96	1.22
	< 9600 Rd	34	1.18	52	0.87
	< 28800 Rd	20	1.01	25	0.52
	> 28800 Rd	2	0.18	12	0.38
Wealth	0	5	1.88	12	1.63
	1	9	1.23	23	0.95
	2	11	0.96	37	0.97
	3	17	1.32	38	0.90
	4	14	1.22	51	1.22
	5	16	1.39	46	1.18
	6	18	1.53	49	1.36
	7	13	1.05	43	1.26
	8	18	1.39	40	1.19
	9	8	0.58	41	1.20
	10	16	1.05	29	0.87
	11	7	0.39	29	0.82

12	11	0.74	36	0.92
13	5	0.79	23	0.64
14	0	0.00	10	0.45
15	0	0.00	1	0.09

Note: Risk ratios (RR) are computed as the ratio of the maternal mortality in a category to the national average, for each survey.

Table 5: Comparison of correlation coefficients between maternal mortality level and selected indicators at provincial level, South Africa

Indicator	CS-2007	Census-2001
Crude death rate	+0.754	+0.892
Violence death rate	+0.664	+0.798
HIV seroprevalence	+0.592	+0.730
Household size	+0.308	+0.368
Birth rate	+0.240	+0.240
Urbanization	-0.254	-0.315
Education	-0.396	-0.400
Average income	-0.458	-0.495
Average wealth	-0.638	-0.490
Proportion of deliveries in institutions	NA	+0.293