Maternal Mortality Analysis

By

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MATERNAL MORTALITY

Introduction

In the 2008 Sudan 5th Population Census two questions were used to derive estimates of maternal deaths based on a 10 per cent sample of all enumerated households in the Short Questionnaire. The second question was not attempted in previous censuses although it was introduced for the first time in the Sudan Household Health Survey 2006, (SHHS, 2006). The question was a direct question addressed to the household head asking for married females in reproductive ages that died during pregnancy or delivery or after six weeks of delivery during the last twelve months preceding the census reference period (22 April 2008). The Maternal Mortality Ratios (MMR) as were drawn from the SHHS results were extremely high exceeding 1000 deaths per 100000 live birth for the country as a whole with large differentials between North and South Sudan as well as between states compared with the latest estimate through the sisterhood method in the Safe Motherhood Survey 1999 (SMS, 1999) which was 509 deaths per 100000 live births.

Although the expected results of the direct question were not sufficiently scrutinized or adequately evaluated, in the census 2008 the direct question was preferred than the indirect sisterhood type of questions for very good reasons:

1- The sisterhood data are indirect and provides a retrospective estimate rather than a current estimate.

2- The interpretation of the estimate is complicated in populations with extensive displacement as is the case for Sudan.

For these two important reasons beside other reasons the 2008 census included the direct question to estimate maternal mortality for the year 2007. The results reflected the same biases shown in the SHHS, 2006 with high MMRs for the country as a whole and for administrative and geographical divisions. The original data are shown in Annex I as an excel sheet No.1 it is quite clear that these data need to be adjusted statistically as attempts to revisit the raw data were not successful because of the difficulty of recognizing the RDS shaded images.

Adjustment Procedures

In any attempt to adjust demographic data using statistical methods, four important principles must considered before the adjustment:

First the principle of serendipity means that any data collected from the field is useful whatever errors and biases it contains and for this reason effort should be made to retain the general pattern of the original data and get the best out of it.

Second the principle of rehabilitation. The word rehabilitation is used here in the medical sense that in treating a patient do not overdose him i.e. try to use what is termed "Rational Therapy". This applies exactly to statistical adjustment of demographic data when one should not overcorrect or use sophisticated statistical models when simple models are adequate.

Third the principle of consistency, this is, in fact, the most important principle in adjusting demographic data because any demographic regime is consistent by nature. For this reason any estimate one makes through statistical adjustment should be compatible with other demographic dynamics and their components. For instance, one may not find infant mortality rate of 200 per 1000 in a country and in the same time find life expectancy at birth of 70 years or Total Fertility Rate around 2 and mean age at marriage around 30 years or the population under age 15 around 45 per cent and the crude birth rate is less than 20 per 1000. All these are consistency checks that safeguard the statistical adjustment from losing tract.

Creating a Standard for Correction

Sudan is an African country still in the incipient stage of demographic transition with falling death rate and a very slowly declining birth rate with expectation of life less than 60 years. Such a demographic regime is found in 11 African countries including Sudan, see table (5.1). From this table the average number of women who are currently married by 5 years age groups is calculated together with the average age specific birth rate for the ten countries. Multiplying the two averages for age groups gives the number of deliveries by age of mother. Then using Graham[1] per unit risk of maternal death, the number of women dying during pregnancy, delivery or after six weeks of delivery is estimated and from it standard Maternal Mortality Ratios (MMR)are calculated. These calculations are shown in table (5.2).

Table (5.1)
Countries in the Incipient Stage of Demographic Transition

Ser.	Country	Year	TFR	CMR	e0
1	Cameron	2005	5.6	151	58
2	Democratic Rep. of Congo	2009	5.7	110	58.2
3	Ghana	2006	5.4	134	58.3
4	Kenya	2008	5.9	156	58
5	Nigeria	2005	5.5	143	57.7
6	Malawi	2005	5.8	120	58.1
7	Senegal	2006	5.9	139	58.2
8	Tanzania	2007	5.6	146	57.9
9	Togo	2008	5.4	146	58
10	Zimbabwe	2007	5.1	145	57.8

Source: Nation Master.com, Maternal Mortality in the World (most recent).

Table (5.2)
Calculation of Standard MMR from Data for African Countries in the Incipient Stage of Demographic Transition.

Age	Females	ASFR	L. Birth	M death	MMR	Graham per Unit Risk
15 to 19	85715	0.12	10286	46	447.218	0.0045
20 to 24	83877	0.18	15098	31	205.327	0.00206
25 to 29	82011	0.25	20503	70	341.418	0.00343
30 to 34	80052	0.19	15210	46	302.435	0.00305
35 to 39	77902	0.19	14801	68	459.417	0.00466
40 to 44	75355	0.11	8289.1	40	482.564	0.00494
45 to 49	72281	0.062	*4481*.4	24	535.544	0.00543
50 to 54	68176	0.01	681.76	4	586.717	

Source: Own calculation based on Table(1).

Fitting the Observed to the Standard Using Brass Logit System

The brass Logit system is given by:

$$\text{Logit}(p) = \text{Log}_e\left(\frac{1-p}{p}\right) \quad \text{----------} \quad (1)$$

The logit transformation, which is of interest here, is slightly more complicated than other transformation methods. It is also different in that it can be used only for transforming proportions. Hence the use of *p* rather than x in the equation.

The transformation has some interesting properties:

When $p = 0$ then logit $(p) = 0.5\ \text{Log}_e(1/0) = +\text{infinity}$.

When $p=1$ then logit $(p) = 0.5\ \text{Log}_e(0/1) = -\text{infinity}$.

When $p=0.5$ then logit $(p) = 0.5\ \text{Log}_e(0.5/0.5) = -0.0$.

To return to model standard, a set of MMR values are just proportions if a radix is created by dividing over the total of proportion series for example, MRR (15-19) is just the proportion of maternal death at age 15-19. Thus it is possible to take logits of *MMRs*. This is very useful because it has been found by Brass (1971) that if one takes two series of MMRs, and takes logits of their proportions then the relationship between the two sets of logits the relationship is remarkably linear, that is drawing a graph against the other , as in Figure (5.1) produces a straight line.

Fig (5.1)
Logits of the Standard and Observed

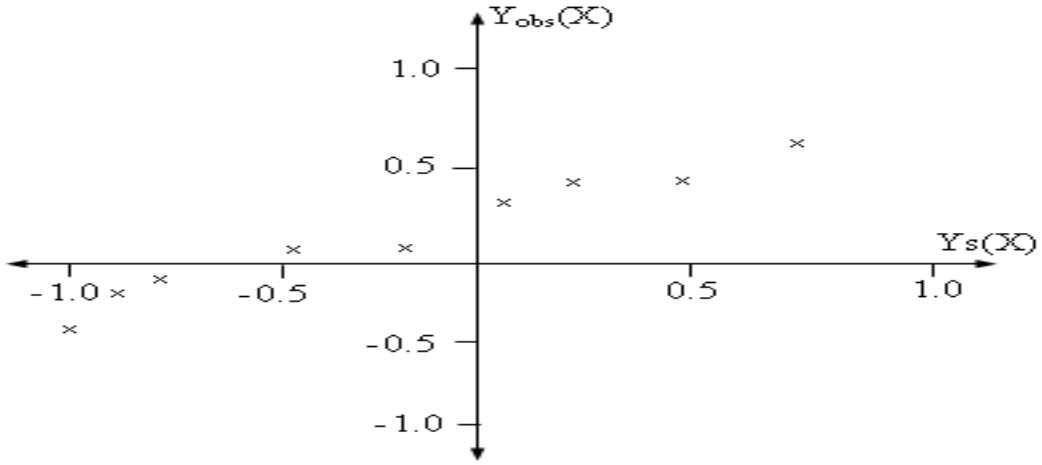

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Figure 5. 1 Fitting Brass model, Sudan Total with African Standard

This important discovery is essentially an empirical rather than a theoretical finding though Brass (1975: 91-6)[2] give some justification. Sometimes it does not give exactly a straight line, especially at the extremes of the age range.

The equation of a straight line can be written as:

$$y = a + bx$$

So it is possible to describe one set of logit MMRs by using another set of logits MMRS and calculate the appropriate values of a and b. Thus with one set of MMRs and a and b it is possible to produce another set of MMRs. Alternatively, from any one 'standard' set of MMRs it is possible to generate another set of MMRs just by varying a and b. It is this aspect of the models that makes the system 'relational'. The two parameters 'a and b' are in fact known by the Greek letters α (alpha) and β (beta). If logit MMR (observed) is denoted by Y(x) and the logits of the standard as Y_S (x), as has become conventional in the literature**,** then the equation of the straight line can be rewritten as:

$$Y(x) = \alpha + \beta\ Y_s(x) \quad \text{----------} \quad (2)$$

Now, consider α and β . Recall that in the simple equation of a straight line a is the intercept-the point at which the line crosses the y axis, and b is the slope or gradient of the line. Varying a will raise or lower the line, as in Figure 2, while varying b makes the line more or less steep.

Thus in equation (2) altering α will affect the level of maternal mortality, while altering β will affect the relationship between mortality of the primagrvidas plus young mothers and mothers of higher parities. As for the values α and β can take, clearly, if α=0.0 and β =1.0 then Y(x) will equal Ys(x)**.**

Fitting a Logit Model MMR

Very briefly, the logits of the observed MMRs are first plotted on a graph against the logits of the standard MMRs. Then a straight line is fitted to the points in some way, and α and β , the intercept and slope of the line, are calculated. The fitted logits are then computed by putting α and β, and the standard logits into the straight-line equation. Lastly, anti-logits are taken to produce a set of fitted

MMRs. This procedure has been experimented using data for Sudan totals and then generalized to all regions and states. The original data for Sudan total are shown in Table (5.3) below.

Table (5.3)
Observed Maternal Mortality Ratio for Sudan
Census 2008

Age Group	Female	Live Birth	Female Death due to Maternal Causes	Maternal Mortality Ratio
Total	11178524	1121471	17205	1534
12:14	1342956	2944	1171	39762
15:19	2000145	93841	3026	3225
20:24	1782424	252825	4758	1882
25:29	1637288	315137	1957	621
30:34	1277637	216547	2411	1113
35:39	1168920	155303	1057	680
40:44	854846	54270	878	1619
45:49	607175	19826	424	2136
50:54	507133	10779	1524	14139

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The observed MMRs are fitted to the Standard shown in table (5.2), Page 5 using ordinary least square. The fit is shown in Fig (5.1), page 4.

Form the plot α and β are estimated using OLS equation. The OLS parameters are shown below.

Coefficients (a)						
Model		**Not standardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
			Std. Error	Beta		
1	(Constant)	0	0.255			0
	Logit of the satandard	1	1.08	0.38	0.93	0.4
a	Dependent Variable: Logit of the Observed					

The straight line equation is

$$\mathbf{Y_{ob(x)} = \alpha + \beta Y_{s(x}}$$

$$\mathbf{Y_{ob(x)} = 0.255 + 1.08\ Y_{s(x)}}$$

The result of the fit to Sudan total MMRs are shown in table (4). The fitting procedure is then repeated for regions and states and the results are shown in the Annex. Summary of all states MMRs are shown in Map (1).

Table (5.4)
Fitted Maternal Deaths, Sudan

Age	Logt Sx	Fitx	Anti logit	Ob_x	es.nu. death
15 to 19	-0.237	0.91	0.1394	1449	434
20 to 24	-0.226	0.914	0.1384	1486	1129
25 to 29	-0.232	0.912	0.139	492	1247
30 to 34	-0.23	0.913	0.1388	973	967
35 to 39	-0.237	0.91	0.1395	365	717
40 to 44	-0.239	0.909	0.1396	1511	289
45 to 49	-0.241	0.908	0.1398	2894	101

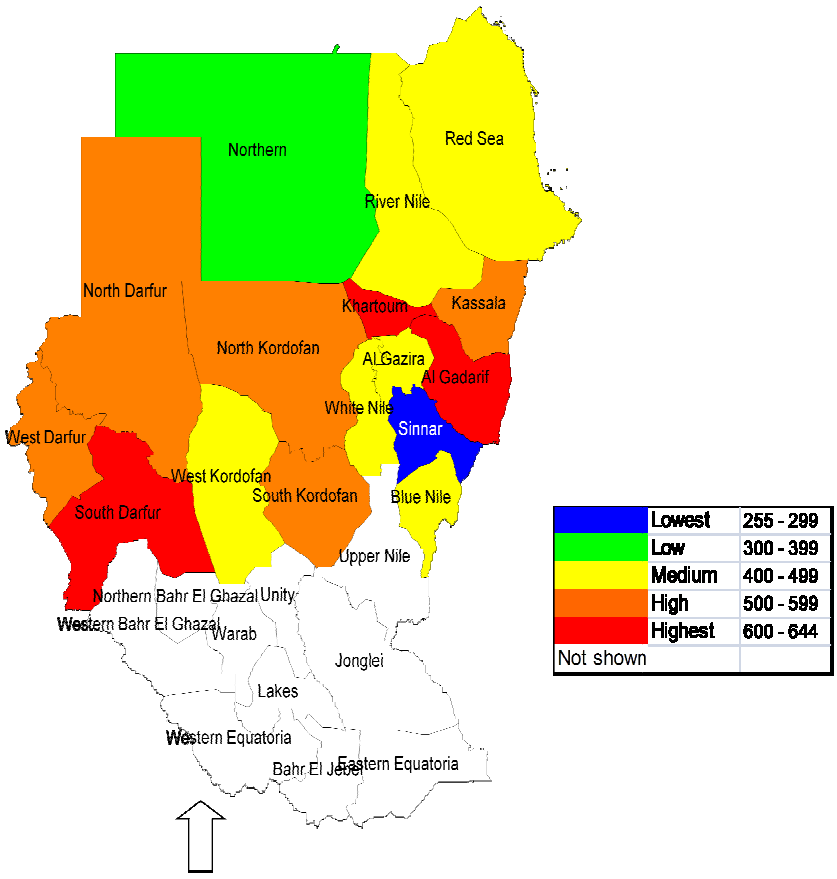
The last column represents the estimated number of death due to maternal mortality which replaces the reported maternal death in table D3 of 2008 census. The example of Sudan total is shown below together with MMRs per 100000 live births.

Table (5.5)
Adjusted Maternal Mortality Ratio for Sudan

Age Group	Female	Live Birth	Female Death due to Maternal Causes	Maternal Mortality Ratio
Total	**11178524**	**1121471**	**4884**	**435**
15:19	2000145	93841	434	462
20:24	1782424	252825	1129	413
25:29	1637288	315137	1247	396
30:34	1277637	216547	967	447
35:39	1168920	155303	717	462
40:44	854846	54270	289	533
45:49	607175	19826	101	509

Sudan Map of Maternal Mortality

Deaths per 100,000 Live Births, 2008



Source: CBS, - *2008*

N. Sudan	Northern	R. Nile	Red Sea	Kassala	Algadarif	Khartoum	Gezira
417	437	443	556	466	564	389	422
W. Nile	Sinnar	B Nile	N. Kordofan	S. Kordofan	N. Darfur	W. Darfur	S. Darfur
503	509	578	532	591	618	615	581

Checking the Validity of the Estimated MMRs

To test the validity of the logit estimates of maternal deaths, we resort to 2008 census data on orphanhood. The census provides data on the survival of parents. Here we shall use data related to the survival of the mother. Mothers who died in the last twelve months preceding the census date include those who died from maternal causes. In order to estimate this proportion of mothers we have first to obtain survival probabilities by age of mother using Brass technique**.**

The data collected from Sudan 2008 Census will be used to combine the orphanhood probability of surviving from age $\overline{M}$ to age $(x+\overline{M})$, and the Maternal Mortality Ratio among women aged 15- 49, in a combined model to estimate currant MMRatio (Waddad A.Y. 2009).

The Orphanhood probability of surviving from age $\overline{M}$, to age $(x+\overline{M})$, is:

$$\left[p_x = \frac{l_{x+\overline{M}}}{l_{\overline{M}}} \right].$$

The mathematical expression of the relationship used to infer the mortality of females from information on the survival of mothers is:

$$p_x = \frac{\int_{\alpha}^{\beta} b(y) \frac{l_{x+y}}{l_y} dy}{\int_{\alpha}^{\beta} b(y) dy} \quad \text{.....(1)}$$

This model will again be applied for the Sudan total using the information on the status of survival of mother collected from the 2008 Sudan census data, through the relationship:

$$\frac{l_{25+N}}{l_{25}} = w_N . {}_5P_{N-5} + (1 - w_N) . {}_5P_N \quad \text{.....(2)}$$

Where N is the central age of two adjacent age groups; ${}_5p_N$ is the proportion of mothers surviving among respondents aged N to $N+5$ years; and ${}_5p_{N-5}$ is the same proportion among respondents aged $N-5$ to N years.

The first step in carrying out these calculations is to obtain the W_N factors for $\overline{M}$ =29 (The mean age of women in reproductive age found to be 29, according to 2008 census data).

- Next, $\frac{l_{25+j}}{l_{25}}$ are calculated according to the formula given above in equation (2).

- Illustration of the method for Sudan total is presented blew**.**

The required data for constructing these values in both techniques around the reproductive 5 years age groups were collected from two main census sources:

a. The 2008 census data for calculating orphan hood probability of surviving P_x, gathered from information on the status of survival of mother.
b. the 2008 census data for calculating Maternal Mortality Ratio gathered from information on maternal deaths among women aged 15-49.

Logit Transformation to Maternal Mortality Ratios and Orphan hood Probability of Dying

It has been found by Brass (1971) that the relationship between logits of two sets of life tables is linear**,** in view of this, Logit transformation is applied to MM Ratio, and probability of dying (1-l_{25+j}/l_{25}) using the formula:

Logit (*P*) = (0.5*Log ((1-P)/P))

Logits obtained are presented in table (6).

Fitting a Logit Model Life Table

That important discovery found by Brass (1971) mentioned above is essentially an empirical rather than a theoretical finding, but sometimes it does not give a straight line, especially at the extremes of the age range.

Logits of Maternal Mortality Ratio (MM Ratio) and Probability of Dying values presented in table (6) are plotted as shown in figure (2) taking the MM Ratio as a dependant variable. Logits of MM Ratio

are first plotted on a graph against the logits of probability of dying. Then a straight line is fitted to the points.

The intercept and the slope of the line, □and □ are calculated using the group average method, the seven age groups 15-49, are divided in to two sets, 15-34 first four younger age groups were regarded as y_a for the dependant MMRatio, and x_a for the probability of dying, while the older three 35-49 age groups will be regarded as y_b for the dependant MMRatio, and x_b for the probability of dying. The younger point (x_a, y_a), is calculated as:

$y_a = (1.178 + 1.131 + 1.165 + 1.132)/4 = 1.152$

$x_a = (0.508+ 0.452+ 0.384 + 0.302)/4 = 0.412$

That is the younger point **$(x_a, y_a) =$** (0.411**,** 1.152)

Similarly, for the older three age groups the average point in:

$x_b = (0.230+ 0.111+ 0.013)/3 = 0.118$

$y_b = (1.136 + 1.127 + 1.08)/3 = 1.114$

That is the older point **$(x_b,y_b) =$** (0.118**,** 1.114)

Having fitted the line, the values of □ and □ are calculated. For □using the group average points such as:

$$\beta = \frac{y_a - y_b}{x_a - x_b} = \frac{1.152 - 1.114}{0.411 - 0.118} = 0.127$$

□ = 0.127

For □using the relation:

□ = y_b - □x_b = 1.114 – (0.127) (0.118) = 1.099

Testing the Power of the Relationship

The above calculated □and□are the coefficients of MM Ratio on the probability of dying; now□ the relationship of the probability of dying on the MM Ratio will be calculated and used to obtain R^2 through the equation:

R^2 =□[□(x/y) × □(y/x)] ……(3)

The Linear Regression Model

In the simple equation of a straight line is the intercept – the point at which the line crosses the y-axis, and is the slope or gradient of the line:

$$\log it\ MMratio = \alpha + \beta\ (\log it\ [1 - P_x])$$

Altering will affect the level of mortality, while altering will affect the relationship between MM Ratio and (1- P_x) **logits**.

A combined Estimation From Community Records

Here we can readjust the average by using community risk exposure to be calculated from MM Ratio of maternal mortality from (2008 census) data, MM Ratio for Sudan was estimated at 435 deaths per 100,000 live births. If we could adjust the MM Ratio estimate by taking into account community level of risk exposure, by applying our linear regression model, we can predict the new MM Ratio Logit values, given the corresponding logits of orphanhood probability of dying, in the seven reproductive age groups, then by taking the anti - logits, we can obtain the MM Ratio values, as shown in Table (7) . the life table was calculated in full format up to its last column, the expected life at birth (e_x), this was done to each of the age groups mentioned above, the e_x column, for example, tells us that women in age group 15-19, are expected to live 31.5 years at birth.

Logit Transformation to Maternal Mortality Ratios Orphan hood Probability of Dying

Logits of maternal mortality and probability of dying presented in table (5.5) were related in a regression model taking MM Ratio as a dependent variable, and , were used to construct a life table for females in the age groups 15-49.

Table (5.6)

Allocation of Each Age group Orphan hood Probability of Dying and Maternal Mortality Ratios.

Age group	Maternal Mortality Ratios*	Probability of Dying $1-l_{25+i}/l_{25}$
15-19	0.004	0.088
20-24	0.005	0.111
25-29	0.005	0.146
30-34	0.005	0.199
35-39	0.005	0.258
40-44	0.006	0.375
45-49	0.007	0.485

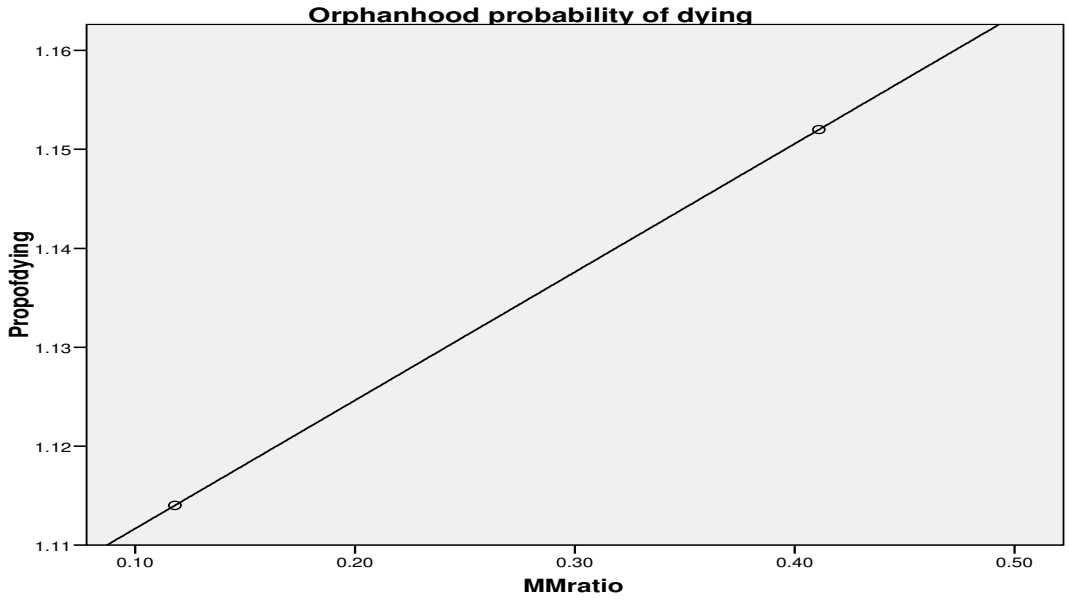
- *calculated by (CBS), Sudan 2008 census data*

Table (5.7)
Allocation of Each Age Group Logits of Orphan hood Probability of Dying and Maternal Mortality Ratios

Age Group	Logits of MMR(live births)	Logits of Probability of Dying
15:19	1.178	0.508
20:24	1.131	0.452
25:29	1.165	0.384
30:34	1.132	0.302
35:39	1.136	0.230
40:44	1.127	0.111
45:49	1.080	0.013

Fitting A Logit Model Life Table

Figure (5.2)
Data Presented in Table (5.5)



$$Logit\ \text{MMratio} = 1.099 + 0.127\ \ Logit\ (P_x)$$

A combined Estimation From Community Records

Using the combined method (Waddad A.Y. 2009) on Sudan census 2008 data, maternal mortality ratio found to be 445 per 100,000 live births

Table (5.7)

The Estimated MM Ratio

Age Group	Logits of $(1-P_x)$	Estimated logits of MM Ratio*	Estimated MM Ratio**
15-19	0.508	1.163	0.104
20-24	0.452	1.156	0.105
25-29	0.384	1.148	0.105
30-34	0.302	1.137	0.106
35-39	0.230	1.128	0.107
40-44	0.111	1.113	0.108
45-49	0.013	1.101	0.110

* $\text{Logit}\ (\text{MMrate}) = 1.099 + 0.127\ \text{Logit}\ (1 - P_x)$

** Anti Logits of the estimated MM Ratio Logits

4.6 The Adjusted Maternal Mortality Ratio Using the Combined Method

$$\text{MMRatio} = \left[\sqrt[7]{(0.104)(0.105)(0.105)(0.106)(0.107)(0.108)(0.110)}\right] \times 435$$
$$= 445\ \text{Per}\ 100000\ \text{livebirths.}$$

Thus the adjusted MM Ratio point estimation is 445 Per 100,000 live births.

The Estimated Life Table

Table (5.8)

Life Table Calculations for Sudan Women in the Reproductive Age Groups

Age group	Logit MMRatio	Logit 1-P_x	Ys(x)	$Y_{fit(x)}$	fitted l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
15-19	1.166	0.508	0.579	1.025	0.117	0.001	0.580	3.671	31.483
20-24	1.174	0.452	0.485	1.037	0.115	0.001	0.575	3.091	26.782
25-29	1.200	0.384	0.425	1.045	0.115	0.002	0.570	2.516	21.940
30-34	1.174	0.302	0.300	1.061	0.113	0.001	0.564	1.946	17.201
35-39	1.167	0.230	0.243	1.068	0.112	0.002	0.558	1.382	12.289
40-44	1.136	0.111	0.096	1.087	0.111	0.001	0.551	0.824	7.441
45-49	1.145	0.013	-0.018	1.101	0.109	0.109	0.274	0.274	2.500

Having now calculated, □ and □, it is possible to calculate the logits of the fitted model through the equation:

$$Y_{fit}(x) = \alpha + \beta . Y_s(x)$$

Then the fitted $l_x s$ are computed by taking the anti-logits of using the $Y_{fit}(x)$ equation

$$Fitted\, l_x = \frac{1}{1 + e^{2Y_{fit}(x)}}$$

The fitted $l_x s$ for the seven age groups are presented below in table (4.3), the life table was calculated in full format up to its last column, the expected life at birth (e_x), this was done to each of the age groups mentioned above, the e_x column, for example, tells us that women in age group 15-19, are expected to live 31.5 years at birth.

1-The Original census raw data

Annex (5.1)

Number of Ever Married Female Deaths During Pregnancy, Delivery or within the First two Months after Delivery in the Age-Group 12-54 During 12 Months Preceding the Census

Region	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Sudan	Total	11178524	1121471	17205	1534
	Urban	3460112	300294	3368	1121
	Rural	6999473	757604	11794	1557
	Nomads	718939	63573	2044	3215
Northern	Total	8959925	903800	12771	1413
	Urban	3069598	258620	3001	1160
	Rural	5171388	581607	7727	1329
	Nomads	718939	63573	2044	3215
Southern	Total	2218599	217672	4434	2037
	Urban	390514	41675	367	880
	Rural	1828085	175997	4067	2311

Fallow Annex (5.1)

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Northern	Total	212597	16247	87	537
	Urban	34313	2742	0	0
	Rural	174298	13290	85	641
	Nomads	3986	215	2	953
Nahr El Nil	Total	335705	34343	109	316
	Urban	100814	8844	52	586
	Rural	227390	24498	53	215
	Nomads	7500	1001	4	407

Fallow Annex (5.1)

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Red Sea	Urban	387556	24238	79	325
	Rural	164333	13620	21	152
	Nomads	157523	7941	47	591
	Total	65700	2677	11	413
Kassala	Urban	490949	38588	993	2574
	Rural	143956	10831	241	2224
	Nomads	298744	26165	689	2633
	Total	48249	1592	63	3986
Al Gedarif	Urban	382343	46109	327	709
	Rural	113804	10311	113	1095
	Nomads	263978	35222	213	604
	Total	4562	576	1	177

Fallow Annex (5.1)

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Khartoum	Total	1576861	126236	1140	903
	Urban	1284442	96237	859	893
	Rural	292419	30000	281	936
Al Gezira	Total	1126137	109575	422	385
	Urban	215241	16382	62	380
	Rural	909805	93034	355	381
	Nomads	1091	159	5	3026
White Nile	Total	521389	53086	953	1795
	Urban	176776	14560	243	1668
	Rural	333937	37239	703	1888
	Nomads	10677	1288	7	552
Sinnar	Total	388058	40662	206	506
	Urban	87210	7486	22	297
	Rural	293432	32272	170	528
	Nomads	7416	904	13	1452
Blue Nile	Total	224991	32714	517	1581
	Urban	56551	6341	101	1593
	Rural	160232	25096	408	1626
	Nomads	8208	1276	8	629

Fallow Annex (5.1)

Region	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
North Kordofan	Total	850286	107890	1046	969
	Urban	173902	18978	373	1966
	Rural	578549	79654	521	654
	Nomads	97835	9258	152	1645
South Kordofan	Total	386812	52951	561	1060
	Urban	94965	10744	129	1204
	Rural	248593	36104	340	942
	Nomads	43254	6103	92	1505
North Darfur	Total	594600	66957	1202	1795
	Urban	107549	9575	303	3166
	Rural	382065	45343	494	1090
	Nomads	104986	12038	404	3358
West Darfur	Total	374521	46979	2254	4799
	Urban	64373	7785	59	763
	Rural	241547	31139	1919	6163
	Nomads	68600	8055	276	3426
South Darfur	Total	1107119	107227	2876	2682
	Urban	251370	24183	422	1745
	Rural	608876	64611	1450	2244
	Nomads	246873	18432	1005	5450

Fallow Annex (5.1)

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
	Total	248842	22478	248	1105
Upper Nile	Urban	88639	9981	30	300
	Rural	160203	12497	218	1748
Jonglei	Total	361154	26245	519	1979
	Urban	59758	4399	31	695
	Rural	301397	21846	489	2238
Unity	Total	142707	18346	1448	7893
	Urban	29912	6588	49	741
	Rural	112796	11758	1399	11900
Warrap	Total	278210	29738	499	1677
	Urban	22157	2892	14	478
	Rural	256053	26846	485	1806
Northern Bahr El Ghazal	Total	193876	20429	432	2114
	Urban	11786	1083	0	0
	Rural	182090	19345	432	2232
Western Bahr El Ghazal	Total	82625	8747	73	836
	Urban	33606	3286	37	1112
	Rural	49019	5461	37	669
Lakes	Total	168263	20430	269	1319
	Urban	5396	677	0	0
	Rural	162867	19753	269	1364

Fallow Annex (5.1)

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Western Equatoria	Total	182284	13744	550	4001
	Urban	25768	1833	128	7010
	Rural	156515	11911	421	3538
Central Equatoria	Total	301268	30248	126	415
	Urban	93470	8932	79	879
	Rural	207798	21316	47	221
Eastern Equatoria	Total	259370	27267	270	989
	Urban	20023	2004	0	0
	Rural	239346	25262	270	1067

2- The graduated and adjusted census data

Annex (5.2)

Number of Ever Married Female Deaths During Pregnancy, Delivery or within the First two Months after Delivery, in the Age-Group 12-54 During 12 Months Preceding the Census

Region	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Sudan	Total	11178524	1121471	4884	**435**
	Urban	3460112	300294	1126	**375**
	Rural	6999473	757604	3438	**454**
	Nomads	718939	63573	320	**503**
Northern Sudan	Total	8959925	903800	3765	**417**
	Urban	3069598	258620	897	**347**
	Rural	5171388	581607	2541	**437**
	Nomads	718939	63573	327	**515**
Southern Sudan	Total	2218599	217672	1286	**591**
	Urban	390514	41675	222	**533**
	Rural	1828085	175997	1064	**605**

Fallow Annex (5.2)

Number of Ever Married Female Deaths During Pregnancy, Delivery or within the First two Months after Delivery in the Age Group 12-54 During 12 Months Preceding the Census

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Northern	Total	212597	16247	71	**437**
	Urban	34313	2742	10	**365**
	Rural	174298	13290	61	**459**
	Nomads	3986	215	0	0
Nahr El Nil	Total	335705	34343	152	**443**
	Urban	100814	8844	36	**407**
	Rural	227390	24498	111	**453**
	Nomads	7500	1001	5	**499**

Fallow Annex (5.2)
Number of Ever Married Female Deaths During Pregnancy, Delivery or within the First two Months after Delivery in the Age-Group 12-54 During 12 Months Preceding the Census

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Red Sea	Total	387556	24238	137	**565**
	Urban	164333	13620	71	**521**
	Rural	157523	7941	48	**604**
	Nomads	65700	2677	18	**672**
Kassala	Total	490949	38588	180	**466**
	Urban	143956	10831	48	**443**
	Rural	298744	26165	123	**470**
	Nomads	48249	1592	9	**565**
Al Gedarif	Total	382343	46109	260	**564**
	Urban	113804	10311	47	**456**
	Rural	263978	35222	209	**593**
	Nomads	4562	576	4	**694**

Fallow Annex (5.2)
Number of Ever Married Female Deaths During Pregnancy, Delivery or within the First two Months after Delivery in the Age-Group 12-54 During 12 Months Preceding the Census

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
Khartoum	Total	1576861	126236	491	**389**
	Urban	1284442	96237	372	**387**
	Rural	292419	30000	119	**397**
Al Gezira	Total	1126137	109575	462	**422**
	Urban	215241	16382	62	**378**
	Rural	909805	93034	400	**430**
	Nomads	1091	159	0	0
White Nile	Total	521389	53086	267	**503**
	Urban	176776	14560	64	**440**
	Rural	333937	37239	195	**524**
	Nomads	10677	1288	8	**621**
Sinnar	Total	388058	40662	207	**509**
	Urban	87210	7486	32	**427**
	Rural	293432	32272	170	**527**
	Nomads	7416	904	5	**553**
Blue Nile	Total	224991	32714	189	**578**
	Urban	56551	6341	33	**520**
	Rural	160232	25096	148	**590**
	Nomads	8208	1276	8	**627**

Fallow Annex (5.2)

Number of Ever Married Female Deaths During Pregnancy, Delivery or within the First two Months after Delivery in the Age-Group 12-54 During 12 Months Preceding the Census

State	Mode of Living	Female	Live Births	Female Death due to Maternal Causes	Maternal Mortality Ratio
North Kordofan	Total	850286	107890	574	**532**
	Urban	173902	18978	94	**495**
	Rural	578549	79654	423	**531**
	Nomads	97835	9258	60	**648**
South Kordofan	Total	386812	52951	313	**591**
	Urban	94965	10744	59	**549**
	Rural	248593	36104	215	**596**
	Nomads	43254	6103	39	**639**
North Darfur	Total	594600	66957	414	**618**
	Urban	107549	9575	52	**543**
	Rural	382065	45343	284	**626**
	Nomads	104986	12038	78	**648**
West Darfur	Total	374521	46979	289	**615**
	Urban	64373	7785	42	**540**
	Rural	241547	31139	186	**597**
	Nomads	68600	8055	51	**633**
South Darfur	Total	1107119	107227	623	**581**
	Urban	251370	24183	121	**500**
	Rural	608876	64611	367	**568**
	Nomads	246873	18432	134	**727**

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