# Challenge of maternal mortality estimates at regional level: Case study of Burkina Faso census 2006

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**Abstract**

Estimate of maternal mortality level is one of the important challenges surrounding the issue. This problem is a truth challenge even in countries with good registration system. In developing countries, particularly in Burkina Faso where the registration system is not working properly, census and surveys are the main providers of maternal mortality estimates. However, many authors agree that censuses provide the most reliable data about maternal mortality in developing countries. In addition, only censuses are really adequate for sub-national estimates of maternal mortality. Unfortunately, censuses data need to be redressed. In this regard, improve maternal mortality estimates from census data is an urgent need. Based on this situation, this research is undertaken to examine the method used to estimate maternal mortality in the 2006 census of Burkina Faso, highlight the weaknesses and strengths as well as make recommendations for further censuses to better capture and estimate the phenomenon.

**Objectives** this research is initiated to improve maternal mortality estimate in Burkina Faso at regional level. We examine here the method used to estimate maternal mortality level in 2006 in Burkina Faso, highlight the weaknesses and strengths as well as make recommendations for further censuses in the country to better capture and estimate the phenomenon.

**Result** The census 2006 observed data was obviously under estimating the phenomenon and were presenting some irregularities particularly at old ages and in the regional structure. Comparison with others techniques reaches the conclusion that the estimates method used during the census 2006 is a good method and just need some ameliorations.

**Conclusion** Findings show that maternal mortality estimates method during the 2006 census followed a clear and comprehensive scientific methodology. However, the method can be improved if adult female mortality ratio is used instead of adult female mortality rate during the process of adjustment coefficient calculus.

**Keywords:** maternal mortality, family planning, fertility, millennium goal, mothers and children health.

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**Introduction**

Estimate of maternal mortality level is one of the important challenges surrounding the issue. All over the world, the measurement of maternal mortality remains a great challenge even in countries with good registration system and good registration causes of death (Hill et al. [2001b]). The lack of data and the poor quality of existent information in many countries motivated United Nation agencies and many researchers to focus on estimating the level of the problem worldwide. However, the different estimates provide sometimes conflicting or incomparable results. These estimates gave the level of maternal mortality in country level but not at sub-national level where the need of maternal mortality statistics is growing in developing countries. Fighting maternal mortality at regional level with regional responses could be the answer to the problem in developing countries particularly in Burkina Faso.

In Africa and particularly in Burkina Faso where the registration system is generally not working properly or does not exist, census and surveys are the main providers of maternal mortality estimates. However, surveys face the problem of sample size to capture representative maternal mortality in country and regional level. Even the sisterhood method viewed as the solution is still providing very few number of maternal deaths specially at regional level. Therefore, data provided by surveys are still in need of serious adjustments for both the sampling errors (confidence intervals) and under declaration. In developing countries, lack of acceptable registration system, many authors agree that the census provide the most reliable data about maternal mortality (Hill et al. [2001b]). Free from sampling errors and sample size problems, censuses seems to be the adequate source of data for maternal mortality estimates at sub-national level in most developing countries (Zoungrana and Paré [2001]). Unfortunately, censuses data are also of poor quality and need to be redressed.

Improving maternal mortality estimates from census data could be an important step in knowledge about the problem. Burkina Faso took into account the question of maternal mortality during the last census 2006 and a method has been developed to adjust the observations. To better capture and estimate the phenomenon, this research is initiated to examine the method used to estimate maternal mortality level in 2006 in Burkina Faso, highlight the weaknesses and strengths as well as make recommendations for future censuses in the country. The purpose of this paper is to contribute to a decrease of maternal mortality trend in Burkina Faso by bringing necessary statistical information at regional level for a better orientation of population programs and projects.

**Methodology of the study**

Available information on maternal mortality estimates by the current administrative regions of Burkina Faso are only provided by the census 2006 and the annual statistical report of the ministry of health based on health services statistics. The analysis of the regional estimates provided by the census 2006 consisted to examine the methodology, data quality and reliability of the estimates. A comparison with others estimates of maternal mortality in the world and particularly in Africa is made. Information from Health services statistics and United Nation agencies are added in the mechanism of assessment. The coherence between the census 2006 estimates and previous or others estimates is examined. The assessment of maternal mortality in the census 2006 of Burkina Faso is made both at national and regional level.

**Maternal mortality estimates in Burkina Faso**

The issue of maternal mortality, particularly, the need of estimate the level and trends rose as an important concern with the Millennium Goal for development established in 1990. In developing countries, particularly where vital registration statistics are very weak or not available, the need of informations is highly expressed by decision makers. That is why researchers are giving more attention to maternal mortality estimates, trying to fill the gap between available data and growing demand of information. However, challenges are also very important, existent data are insufficient and poor quality.

All these challenges make difficult getting reliable estimate. However, most of the problems of maternal mortality estimates are also accounted in some other phenomenon. These challenges developed more passion for research in the domain. For many authors as Graham et al. [2008], the solution is not to wait forever the perfect data to provide maternal mortality statistics needed. We firmly believe that all available data should be used to estimate and understand the phenomenon in order to help policy makers to take actions and monitor projects and programs related to the phenomenon. Indeed, the situation of total absence of estimates base on scientific and coherent approach for decision making should be avoid on maternal mortality programs. Until now, no method can be pointed as perfect approach of maternal mortality estimates. There is still a place for research to make improvement by reducing as smaller as possible bias related to the estimates techniques and make more efficient the uses of the statistics provided.

This article is not the first trying to estimate phenomenon in Burkina Faso at national or regional level. The census 2006 and the DHS 1998 already

estimates the level of maternal mortality at national and regional level. But, what do we keep as strengths of the methods used for these estimates, what can we improve? Method of maternal mortality estimates is improving in the world. According to Graham et al. [2008], many approaches of maternal mortality have been developed since 1990. How to get profit of the scientific advance in the domain to also improve maternal mortality estimates in Burkina Faso censuses? How do we expect to come over the challenges related to maternal morality estimate in Burkina Faso? how do we expect to contribute to existent method? This study cannot find the solution to all the challenges surrounding maternal morality estimates in Burkina Faso. But, we try to reduce the problems and the bias in order to improve the estimates.

Challenges related to maternal mortality in general are situated at all phases of opportunities measurements, options measurements and analytical measurement. Graham et al. [2008] defined the empirical measurements opportunities as the the set of the routine opportunities composed by death registration, health facilities' statistics, national censuses and special opportunities which are according to the authors, the surveys and demographic surveillance. In each phase we made some suggestions for next censuses in Burkina Faso. One of the most important challenges in maternal mortality estimates is to identify maternal deaths with a questionnaire. In this specific challenges, maternal mortality is generally captured in term of pregnancy related deaths (females deaths occurring during the pregnancy, delivery or post-partum period) or verbal autopsy (health practitioners or family member are asked in depth questions about the circumstances, the symptoms and others) or health professional diagnostics (where a medical certificate of death is delivered) (Graham et al. [2008]).

Another challenge in maternal mortality estimates is to identify the indicator to use in order to summarize the magnitude of the phenomenon. Indeed, it is difficult to identify the best (unbiased) indicator of monitoring and capturing the phenomenon. Census report may specify and clearly guide users about the utilities and strengths of the indicators produced according to the objectives they stand for. To do so, the methodology used to get these indicators must be clearly defined and presented in the report at least in the appendix. It is the only way to other researchers to bring improvements and to use them in the most useful manner.

The process of the estimates of maternal mortality generally starts by identifying the needs of potential users. Indeed, estimates of maternal mortality respond generally to the desire of comparison over time, between spaces (country, regions, etc), lower cost, lower bias or quality, etc. This paper goes through the methodology used to collect the data related to maternal mortality, the questionnaire and the estimates method of Burkina Faso census 2006.

**Methodology of maternal mortality estimates in Burkina Faso census 2006**

- The Questionnaire

Maternal mortality estimates in Burkina Faso is provided from many sources but only the census 2006 provide such information at regional level (current regions of the country). Capturing maternal mortality with censuses data is quite new in Africa and mostly presented as a particularity of African 2000 censuses (Hill et al. [2001b]). Burkina Faso decided to include this issue on the census 2006. The methodology used to collect the data, clean, estimate and analysis the phenomenon is discussed in this paper.

The questionnaire of the census 2006 do not have specific arrangements or instructions to collect information related to maternal mortality. A section of the questionnaire was reserved to capture mortality in general included a component about maternal mortality. Instruction was given to census agents to end the interviews with the questions related to mortality. In this section, a list of people who died in the household during the last 12 months was made and questions were asked about each death. The sex, date of death and age at death was recorded for each death occurred in the household. When the death was a female aged between 10 and 54 years old, additional information was requested to identify the period of the death (pregnancy related period or not). The four questions used to identify maternal mortality during the census of Burkina Faso 2006 were the following:

- Did the death occur during pregnancy?

- Did the death occur during delivery?

- Did the death occur after the termination of the pregnancy or the delivery?

- If yes, mention the number of days after the termination of the pregnancy or the delivery.

Based on the above questions, we understand that during the census of Burkina Faso, option has been taken in favour of pregnancy related deaths as maternal mortality definition.

- Method of maternal mortality estimates in the census 2006

The analysis of the data quality in the Burkina Faso 2006 census report concluded to an important under-reported maternal deaths. To come-over the problem, the observe number of maternal deaths has been adjusted before publication of the official national estimate of maternal mortality level. The adjusted method used is based on the constraint that the redress number of maternal deaths should be lower than the redress number of adults females deaths. With the idea that the estimates of adult female death and maternal mortality deaths are strongly dependent, the coefficient of adjustment of maternal mortality has been computed following these steps.

- The Observed number of females alive aged 10 54 years old per age $i$ and region $j$ is noted $ObFeA_{ij}$.

- The observed number of females deaths aged 10 54 years old per age $i$ and region $j$ is $ObFeD_{ij}$.

- The observe number of females deaths from maternal causes aged 10 54 years old per age $i$ and region $j$ is $ObMaD_{ij}$.

- Multiply the life table mortality ratio ($MRatio_{ij}$) by the observe number of females alive ($ObFeA_{ij}$) to obtain the adjusted number of females deaths ($AjFeD_{ij}$).

$$AjFeD_{ij} = MRatio_{ij} \times ObFeA_{ij}$$

We must pay attention to not use the mortality Rate (generally note $_xq_n$) instead of the mortality ratio ($MRAtio_{ij}$ generally noted $_xm_n$)

- Compute the adjustment coefficients of females deaths per age and region ($CFD_{ij}$) by dividing the adjusted number of females deaths ($AjFeD_{ij}$) by the observe number of females deaths ($ObFeD_{ij}$).

$$CFD_{ij} = \frac{AjFeD_{ij}}{ObFeA_{ij}}$$

- Consider that the adjustment coefficients of females deaths per age and region ($CFD_{ij}$) is the same as the the adjustment coefficients of maternal deaths per age and region ($CMD_{ij} = CFD_{ij} = C_{ij}$).

- Compute the adjusted number of maternal mortality ($AjMaD_{ij}$) by multiplying the observe number of maternal mortality ($ObMaD_{ij}$) and adjustment coefficients of maternal deaths ($C_{ij}$).

$$AjMaD_{ij} = C_{ij} \times ObMaD_{ij}$$

- From this stage we compute the maternal mortality ratio ($MMRatio_{ij}$) by dividing the adjusted number of maternal deaths ($AjMaD_{ij}$) by the number of live births ($LB_{ij}$). We can also compute the others indicators such as the maternal mortality rate ($MMRate_{ij}$).

$$MMRatio_{ij} = 100000 \times \frac{AjMaD_{ij}}{LB_{ij}}$$

$$MMRate_{ij} = 1000 \times \frac{AjMaD_{ij}}{ObFeA_{ij}}$$

.

One of the strong hypothesis underlying this method is the assumption that the adjustment coefficient of adult females mortality is the same as the coefficient of maternal mortality. This assumption implicitly suggests that the under reported rate of adult females deaths is the same as the proportion of under reported maternal deaths by age and region. Under this hypothesis, the proportion of maternal deaths among females deaths remain identical before (observe) and after adjustments.

$$Pr(AjMaD) = \frac{AjMaD_{ij}}{AjFeD_{ij}} = \frac{ObMaD_{ij} \times C_{ij}}{ObFeD_{ij} \times C_{ij}} = \frac{ObMaD_{ij}}{ObFeD_{ij}} = Pr(ObMaD)$$

.

Where $Pr(AjMaD)$ is the proportion of adjusted maternal deaths among adjusted females deaths and $Pr(ObMaD)$, the proportion of observe maternal deaths among observe females deaths.

We believe that this is one of the limit of this method. Indeed, we firmly believe that the proportion of maternal deaths among the undeclared adult females deaths is greater than the proportion of observe maternal deaths among the observe adult females deaths.

The method used for maternal mortality estimates during the census 2006 of Burkina Faso is highly depending on the estimates of females mortality at reproductive ages. In consequence, the females life table used to adjust the observe values of females deaths require a close look in order to better understand and make relevant suggestions. Others methods of adult mortality estimates should be examined and the ministry of health data also use for comparison. This study tried to understand in details maternal mortality in the census 2006 and went through the methodology step by step, checking every single aspect. Thus, propositions are made regarding the problem of hypothesis underlying the method and one of the most important part is the data quality analysis or the treatment of missing data.

- Missing Information

Analysis of the data quality starts with the evaluation of missing information. In the census 2006 data, the missing data were very low, in general less than 3 %. In the process of maternal mortality estimates during the census 2006, the missing data have been ignored. But, regarding the character of the phenomenon (statistically rare because of small numbers of cases), we propose to treat missing information according to their nature. First type of missing data is related to the period of deaths (during pregnancy, delivery or post-partum period). The expected answers for these questions were whether yes or no but, we have some cases of "non responses". Some people (...%) did not mention if the death was pregnancy related or not. For this type of missing, we propose in further census to use some imputation techniques to input the information (Hot deck, cold deck, etc.). This technique has been used for the census 2001 of South Africa (Hill et al. [2001b]) to input missing data related to maternal deaths. In this study, we decided to not take any action about such kind of non-available data, we just ignored them. The second case of missing data is related to the age of females alive, deaths females and also maternal deaths. In this case, we proposed for further censuses to equally distribute the missing information as we did in this paper. This equal distribution were base in the following formula:

$$\mathbf{X}_{ij} = \frac{(X_{ij} \times T_j)}{(T_j - Mis_j)}$$

Where $T_j$ is the total number of observation for the region $j$, $Mis_j$ is the missing observation of the region $j$ and $X_{ij}$ the observe number of observations at age $i$ for the region $j$ and $\mathbf{X}_{ij}$ the number of observation at age $i$ for the region $j$ after distribution of missing data.

**Assessment of estimates quality**

The analysis of the quality of the estimate output is very important. The comparison of maternal mortality rate as published in the census report 2006 and the existent estimates from others sources highlight very important information. Maternal mortality estimates provided by the census is currently the lower estimates of maternal mortality and it is closer to the estimates provided by previous surveys (DHS) in the country as well as the estimate provided by Hogan, M.C. et al. (2010) (Hogan et al. [2010]). Globally, this assessment did not bring out the evidence that the census provided a wrong value of maternal mortality estimate.
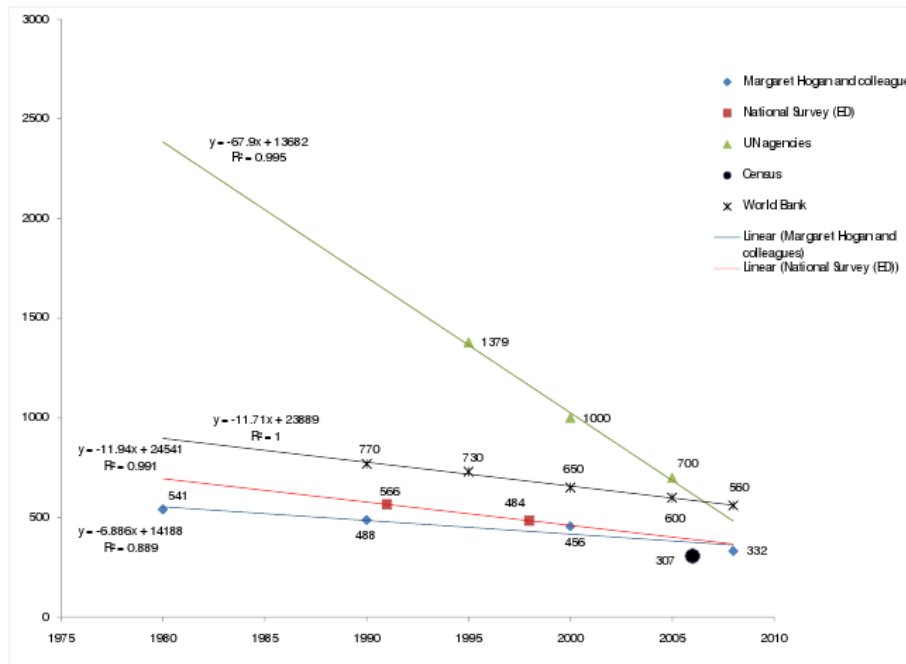
Figure 1: Comparison of maternal mortality rate provided by the census 2006 and others estimates

The internal analysis of the estimates focus on the age distribution of maternal mortality level in Burkina. The trend of maternal mortality by ages as showed in figure 2 and 3 revealed a quite acceptable distribution by ages.

According to the literature, maternal mortality ratio is highest in young and old ages. Only information at old ages, particularly the last age group 45-49 years presented a real problem because lower than MMRatio at 40-45 years old. Comparison of the shapes of maternal mortality rate and fertility rate by ages are quite similar, thus acceptable (fig.3). Generally it is forgotten to evaluate the estimates by examining what is happening at regional level. Indeed, the technique use have serious unexpected impacts on the regional structure of maternal mortality.

The above figure 5 rise a real concern about the structure of maternal mortality per region of the country. Indeed, the adjusted of maternal deaths during the census changed the structure of the observed maternal mortality level per regions (the figure 4). This is visible with the regions of "Est" and "Sud-Ouest". The crucial problem revealed by the analysis of the adjustment output is the number of maternal deaths added (after adjustment) to the collected number of maternal deaths. Indeed, the technique of estimate decreased the number of maternal deaths in the region of "Sud-Ouest" (fig-
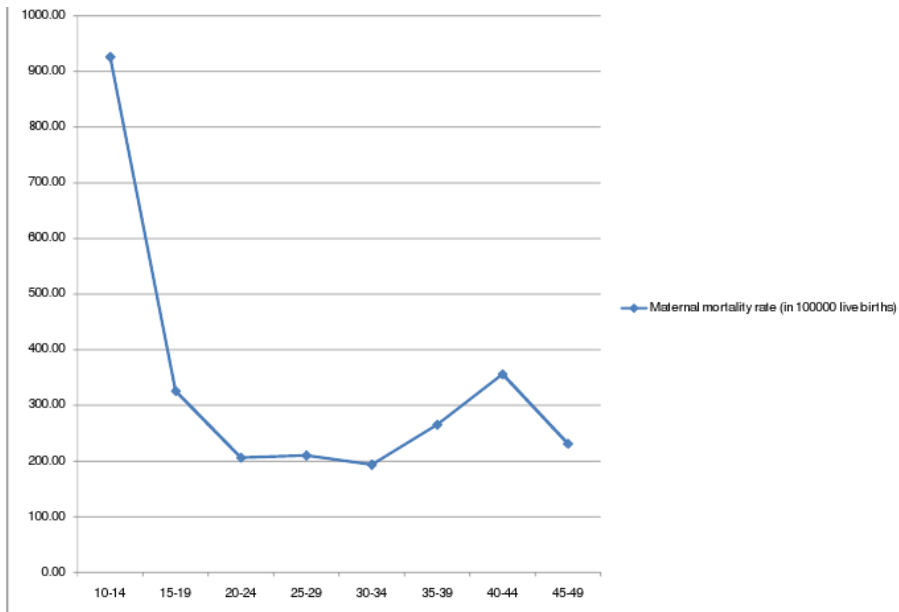
Figure 2: Age distribution of observe maternal mortality ratio provided by the census 2006
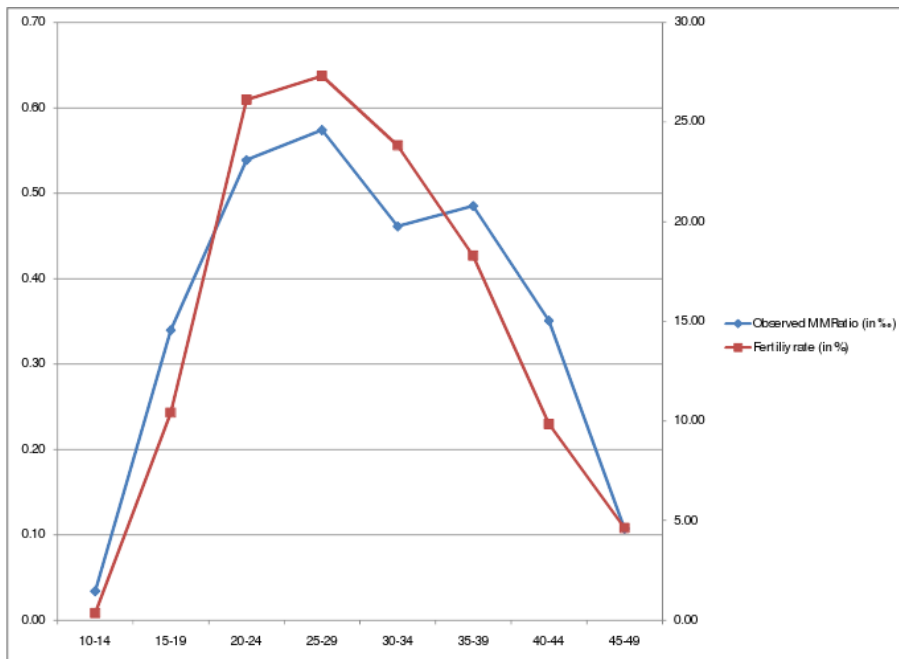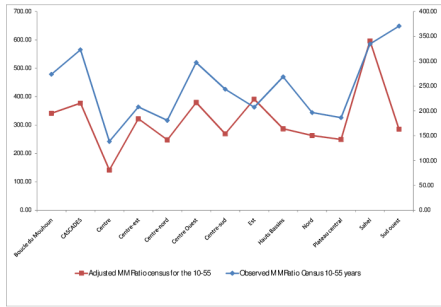


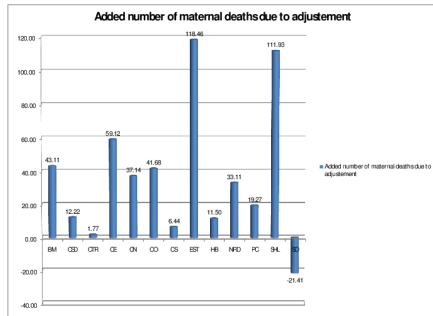Figure 3: Comparison of observe MMRatio and observe fertility rate distribution by ages groups

Figure 4: Comparison of observe and adjusted maternal mortality rate structure by region

Figure 5: Regional distribution of the added number of maternal deaths due to adjustment in the census 2006

ure 5). That means there were an over-reported cases of maternal deaths in the region, what is hardly acceptable. Such results have been frequently met during the assessment of the estimates outputs by age and region.

The figures above compare the regional distribution of maternal mortality level given by the census and the health ministry. The aim is not to compare the magnitudes but the distribution per region. After adjustment, the regional structure of maternal mortality is closer to the non adjusted maternal mortality level provided by the ministry of health. That it means that the ministry of health data could be use to assess the information provided by the census? or is this just a question of chance? or is a problem of adjustment method? These questions could get more reliable answers after the next household data collection which will provide information at regional level.

**Weakness and strengths of the method and the estimates**
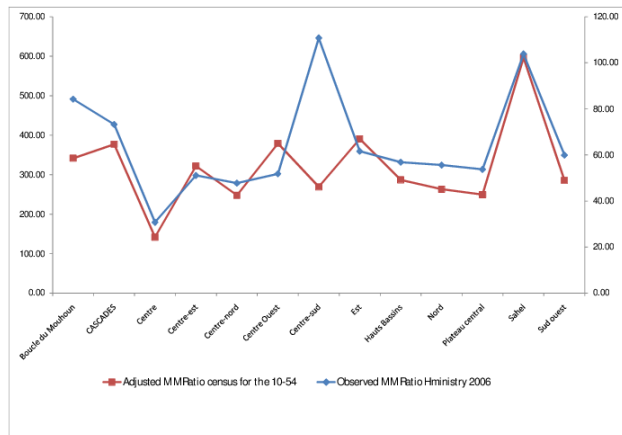
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Figure 6: Comparison of adjusted MMRatio provided by the census and observed MMRatio structure of the health ministry in 2006.
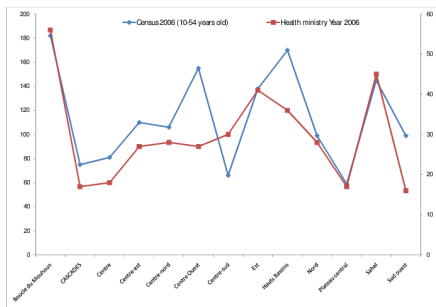
Figure 7: Comparison of the census and health ministry maternal mortality regional structures

The method used in the census 2006 is very interesting and based on a scientific method under some reasonable hypotheses. Because maternal deaths are among adult females deaths, the estimates method should consider it in the adjustment process as a control in order to avoid an adjusted maternal deaths greater than those of female deaths. However, the adjustment method showed a non representativeness of the census observe number of maternal mortality at regional level. Indeed, the adjustment changed the structure of maternal mortality by region. As example, the observe maternal mortality rates were respectively 0.501, 0.534, 0.556, 0.581 and 0.662 ma-

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ternal deaths per 1000 women in reproduction ages in the regions of "Est", "Centre-Ouest", "Boucle du Mouhoun", "Cascades" and "Sud-Ouest". But after adjustment, maternal mortality rates became respectively 0.51, 0.68, 0.68, 0.69 and 0.9 in the regions of "Sud Ouest", "Centre Ouest", "Cascades", "Boucle du Mouhoun" and Cascades. This is in contradiction with what was expected. Indeed, the census as a full picture of the country at a given time, as an exhaustive enumeration of people in the country, was supposed to give us the structure of maternal mortality by region and province for the country. Unfortunately, it is not the case, it provides an "unreliable" distribution of maternal deaths by region according to the non uniformity of the adjustment coefficient per region.

The method to redress maternal mortality is based on the adjustment coefficient of female deaths in reproductive ages could be the cause underlying the changes among regions in term of maternal mortality impacts. The assessment of the regional estimates of maternal mortality in Burkina Faso reaches to an important result: the adjusted maternal deaths present a structure close to those produce by the Ministry of Health (from health centres). If future household data confirm this trend, information from the ministry of health could be used to monitor maternal mortality. However, the adjusted measure of maternal mortality in the region of "Sud-Ouest" need a particular attention because the number of observe maternal deaths has been reduced, which seems like more maternal deaths were declared by the respondents. Such a situation in the specific case of maternal mortality estimate need in-depth investigation. Regarding the weaknesses in the current method, a methodology has been proposed in this study to reduce the shortcomings.

### Suggested method for future censuses

Many methods have been experienced in this study. All are based on the method used during the census 2006 of Burkina Faso. In all the approaches, we decided to keep using the life table to adjust the number of adult female deaths and we distributed the missing information related to ages of females alive and those dead from maternal cause or those not. A part from the distribution of the missing data, the first model (approach 1) followed all the others steps of the census 2006. The second approach (A2) differs from the first approach (Approach 1) because instead of using the coefficient of adjustment, we computed the number of adult females deaths omitted (undeclared) and we added 30% of them to the observe number of maternal deaths per ages to obtain the adjusted maternal deaths. In this approach (A2) when adjusted number of adults females deaths is lower than the observe number of adult female deaths for a given age and region, we do not adjust the observe number of maternal deaths. We also tested the first

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approach (A3) with keeping the observe number of maternal deaths in case of adjustment coefficient less than 1.

With the first approach (A1), we have found that the regions of "Sud Ouest", "Centre-Sud" and "Centre" have the adjusted number of maternal deaths less than the observe number maternal deaths. Also, a very few percentage of undeclared adult females deaths were attributed to maternal causes (between zero and 20%). Results of the second approach (A2) and the improve approach 1 called approach 3 are highlighted in the table below.

Table 1: Maternal mortality ratio (per 100 000 live births)

| Regions | Approach 1 | Approach 2 | Approach 3 |
|---|---|---|---|
| Boucle du Mouhoun | 318 | 420 | 342 |
| Cascades | 327 | 429 | 366 |
| Centre | 131 | 140 | 140 |
| Centre Est | 296 | 569 | 319 |
| Centre Nord | 229 | 403 | 240 |
| Centre Ouest | 332 | 503 | 373 |
| Centre Sud | 223 | 308 | 267 |
| Est | 360 | 509 | 379 |
| Hauts Bassins | 281 | 302 | 282 |
| Nord | 238 | 427 | 262 |
| Plateau Central | 213 | 401 | 247 |
| Sahel | 546 | 726 | 586 |
| Sud Ouest | 258 | 386 | 386 |
| Total Burkina Faso | 283 | 413 | 303 |

Finally, we decided to choose the approach 2, because the estimates provided are closer to the existent estimates of maternal mortality internationally. However, the 30% has been taken arbitrary because we believe that this is a the minimum for the country. Keeping also constant 30% at all age groups between 10-54 years old and for all regions constitute is part of the shortcomings of this method. The method proposed to estimate maternal mortality with census data at this stage of our research can be presented in following steps:

- Proportional distribution of missing values related to the ages (unknown ages) of females alive and after select just the number of females from 10 to 54 years old per age and region ($ObFeA_{ij}$).

- Proportional distribution of missing values related to the ages (unknown ages) of observe females deaths and after select just the observe number of females deaths from 10 to 54 years old per age and region ($ObFeD_{ij}$).

- Proportional distribution of missing values related to the ages (unknown ages) of maternal deaths aged 10 to 54 years old per age ($i$) and region ($ObMaD_{ij}$).

- With the life table used to adjust mortality level in the country, take in the female life table mortality ratio ($MRatio_{ij}$) per region and multiply by the observe number of females alive ($ObFeA_{ij}$) to obtain the adjusted number of females deaths ($AjFeD_{ij} = MRatio_{ij} \times ObFeA_{ij}$). We must pay attention not to use the mortality Rate (generally note $_xq_n$) instead of the mortality ratio (here note $MRAtio_{ij}$ but generally note $_xm_n$)

- We computed the number of adult females deaths omitted (undeclared) as $UndFeD_{ij} = AjFeD_{ij} - ObFeD_{ij}$

- Where ($UndFeD_{ij} > 0$), add a portion ($p_{k,j}\%$) of the undeclared adults females deaths to the observe number of maternal deaths per ages groups $k \in (10 - 24, 25 - 34, 35 - 54)$ and region $j$ to obtain the adjusted maternal deaths

$$AjMaD_{ij} = ObMaD_{ij} + p_{k,j} \times UndFeD_{ij}$$

.

- Where $UndFeD_{ij} < 0$, we keep the number the observe number of maternal deaths as the adjusted number of maternal deaths ($p_{k,j} = 0$). That's means:
$$AjMaD_{ij} = ObMaD_{ij}$$

- In this approach 2 we took as example $p_{k,j} = 30\% = 0.03$ for all region $j$ and all age group $k$.

- From this stage we compute the maternal mortality ratio ($MMRatio_{ij} = 100000 \times AjMaD_{ij} \div LB_{ij}$) by dividing the adjusted number of maternal deaths ($AjMaD_{ij}$) by the number of live births ($LB_{ij}$). We can also compute the others indicators such as the maternal mortality rate ($MMRate_{ij} = 1000 \times AjMaD_{ij} \div ObFeA_{ij}$).

**Conclusion and policy implications**

The census 2006 observed data were obviously under estimating the level of maternal mortality and were presenting some irregularities particularly at old ages and in the regional structure. Comparison with others techniques reaches the conclusion that the estimates method used during the census 2006 is very good and needs just some improvements.

Findings showed that maternal mortality estimates method during the 2006 census followed a clear and scientific methodology. However, the method can be improved if a better solution is found for cases where adjusted number of maternal deaths is lower than observe number of maternal deaths.

Finally, some recommendations are made to improve further estimates of the phenomenon using census data:

- Since maternal mortality estimate is closely related to adult females mortality (adjusted number of maternal deaths can not be greater than adjusted number of adult females deaths). Several methods exist to estimate adult female mortality, then particular importance should be given in investigating others methods and using the best in order to avoid the use of life table which is less based on the data collected.

- In the questionnaire, ask a question about an existent of a death certificate and even ask to see it and mention if a maternal cause of death is mentioned. This information will help to adjust information related to mortality by region both those of the census and those provided by the ministry of health as well.

- This study proposes to add a question about the "the relationship between the deaths and the head of the household". This information should help to understand if most of the maternal deaths appeared in the family or family in law or elsewhere and this can facilitate explanatory analysis.

- The question related the occurrence of the death during pregnancy should have the modalities "Not sure" and "don't know". We firmly believe that interviewer introduce the cases of doubting in "No (death during pregnancy)".

- The data quality related to maternal mortality should be more analysed. The problem of low maternal mortality for the age group 45-49 and 50-54 years old need further analysis. The suggestion of this study is to extrapolate the information since we know that the curve of maternal mortality rate per age must be in form of "J". We just make the hypothesis on the maintain of the trend at previous old ages.

- Use the adult females mortality ratio $(_x m_n)$ to compute the adjusted number of adult female deaths instead of the mortality rate $(_x q_n)$ because the information used are transversal.

- Regarding the importance of fertility information in maternal mortality estimates, it is very important to harmonize the questions. In other words, because maternal mortality concerned women aged 10-54 years

old, the number of live births should also concern women aged 10-54 years old. The idea of considering the huge ages interval to capture maternal morality was very interesting in order to make some comparison with ministry of health data where all maternal deaths are concerned, those less than 15 years old as well as more than 49 years old. Also because the phenomenon is very sensitive to small numbers, every case of deaths should not be missing. Therefore, increase the boundary for fertility could allow better understanding of the problem.

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