Changes in mortality among children under five years from 1996 to 2006 in Benin : The role of mother's education

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September 2013

Abstract

Even though the role of maternal education on child mortality have been studied at different points in time, the understanding about how this relationship varies according to the mothers age group remain empirically less documented. The attention related to different cohorts of mothers is likely to reflect heterogeneity in the relationship between maternal education and child survival as the dominant approaches tend to hide. Using data from two DHS, we attempt to remedy this lack of information by examining the changes in child survival in Benin between 1991-1996 and 2001-2006, and the role of mothers education by age group in these changes. Findings of two complementary statistical methods (random and fixed effects) are consistent and confirm the hypothesis that the effects of maternal education on child survival varies across mothers age group over time. In particular, reducing the child mortality risk in 2006 was most remarkable among young mothers.

Introduction

Many studies indicate poor health and higher mortality among children whose mothers are not educated (Bbaale & Buyinza, 2012; Boyle, et al., 2006; Buor, 2003; Caldwell, 1979; Fuchs, et al., 2010; Hale, et al., 2009; Hatt & Waters, 2006; Hobcraft, et al., 1984; Huq & Tasnim, 2008; Pison, 2010; Tabutin & Schoumaker, 2004). In these studies, it is generally accepted that the mother's education positively influences the health and the survival of children because the educated women are more likely to increase the economic resources of the household, to use care services for themselves and for children (prenatal care, assisted delivery, postnatal care, immunization, etc.), to provide a better supply to their offspring and be more self-reliant; they may have more knowledge about health issues, particularly on hygiene and safety practices (Cleland & van Ginneken, 1988; Grossman, 2005). Similarly, educated women are more likely to respond more quickly to new knowledge(Grossman, 2005).

The reduction of disparities and improved health and survival of children whose mothers are not educated continues to be a major challenge for governments of low-income countries and international organizations, especially by the consistent implementation of policies and programs aimed at answer these questions. The priorities of these policies and programs have been the subject of several meetings (summits Millennium) and should be regularly updated.

However, despite the strong association observed between maternal education and health or child survival, many empirical studies remain still quite nuanced in their results, indicating a weak or sometimes lack of relationship. According to some authors (Aslam & Kingdon, 2012; Desai & Alva, 1998; Hobcraft, 1993), the reasons (especially

methodological and conceptual) of this handing-over in question rest in part on problems of measurement and data that can be observed at different levels (micro and macro).

But this is not the only measurement and data problem that deserves attention. Other studies put forward the assumption according to which the force of this association depend of the observation window (historical dimension) (Levine, et al., 1994), where it is supposed that the link between maternal education and child health or child mortality would have undergone significant changes because of macro-societal transformations (expansion of care services for maternal and child health, economic and social changes, as well as the modernization and urbanization of societies), and also because of the changes made by the education itself, which in turn can lead to changes in how it exerts its effect on health or mortality (Hale, et al., 2009; Peña, et al., 1999).

In this perspective, and taking account the increase in women's education in most developing countries (Gakidou, et al., 2010; Wolfgang, et al., 2007), the analyses relating to the role of maternal education on child mortality in different contexts and at various points in time would allow to examine the importance and contribution of education in improving the child survival. Such analyzes have been conducted in recent studies (Gakidou, et al., 2010; Hale, et al., 2009) where it is shown that the mother's education plays an important role in reducing child mortality, especially in recent times.
However, few studies have tried to understand how this relationship varies according to the mothers age group. The attention related to different cohorts of mothers is likely to reflect heterogeneity in the relationship between maternal education and child survival as the dominant approaches tend to hide. Taking into account the temporal changes in education, one would expect that the various possible factors (mechanisms) by which maternal education affects child survival (reproductive behavior, living conditions, etc.) are likely to change over time (Hale, et al., 2009).

Using data from two Demographic and Health Surveys, we attempt to remedy this lack of information by examining the changes in child survival in Benin between 1991-1996 and 2001-2006, and the role of mothers education by age group in these changes. The relevance of the Beninese context follows from temporal changes observed in under-five-years mortality and the level of mothers education. Indeed, during the period 1996-2006 greatly marked by many reforms in education and health of mothers and children in developing countries, Benin has committed more to promote the health of the mother and child, free schooling for girls, and primary education for all (CAPOD, 2010). According to estimates of demographic surveys and health for the period 1996-2006, under-five mortality levels have declined, from 166,5‰ in 1996 to 125‰ in 2006 (INSAE & Macro Internatioanl Inc, 2007). These rates are still largely above the level achieved at the global level and the target level referred to in the Millennium goals for development (OMS, 2012). During the same period, the proportion of uneducated population has declined, especially among women of childbearing age (70.8% in 1996 against 63.7% in 2006).

Evidence of literature and working hypothesis

The importance of maternal education on child mortality has been the subject of several empirical studies in developing countries. But always is that, in the context where most of these countries are marked by a demographic transition late, rapid and diverse, the relationship between mother's education and child mortality may not be uniform over time for all countries.

Using data from the Malaysian Family Life Survey (MFLS) to examine the factors behind the decline in infant mortality in Malaysia during the period 1946-1975, DaVanZo et al. (1986) found a very substantial improvement of maternal education. They also found that the beneficial effect of maternal education on infant mortality is relatively more important during the period 1961-1975, but no statistically significant effect during the period 1945-1960. Pena et al. (1999) used data from Nicaragua to assess trends in fertility and mortality occurred in Nicaragua between 1963 and 1993. The results of their analysis show that the decline in infant mortality mainly affected children of uneducated mothers, due to the increase in services primary health care. With data from Chile, respective work of Fernandez et al. (2007) and Frenz et Gonzalez (2010) showed that the decline in infant mortality observed during the period 1990-2005 was linked to children whose mothers are better educated.

More recently, the work of Gakidou et al. (2010) carried out on data from 175 developing countries between the period 1970-2009 showed that more than half of the reduction in under-five deaths observed in these countries is attributed to the increase in the level of education among women of reproductive age

Although differences in child survival by maternal education were studied in time, the mechanisms by which maternal education affects child survival are not well understood or empirically documented. Some work has highlighted a number of factors such as changes in reproductive behavior, better access to health care system including the increase in the proportion of educated women over time (Hale, et al., 2009). Breierova and Duflos (2004) also reported in their work that the level of education of women is significantly higher in communities where there are more schools. In addition, it is also shown that improving the level of education is likely to alter fertility behavior (reduction of offspring), marriage (late marriage) and socioeconomic status, contributing indirectly to reducing child (Hobcraft, 1993; Tulasidhar, 1993).

However, if we agree to recognize the central role of maternal education in reducing child mortality, its impact according to the mothers age group is almost not studied. Yet, it is possible that this relationship varies according to the mothers age group. The importance of this question has been highlighted in some studies examining the relationship between education and health in general, as well from the perspective of life course or repeated cross-section (Andrea E. Willson, et al., 2007; Lynch, 2003, 2006; Yang, 2007), using the cumulative advantage models or age models. The hypothesis of age effect, the one on which we focus in this article assumes that taking into account the temporal dimension, the impact

of mothers education on child survival is likely to be lower among older mothers than young mothers because these last are more likely to be better educated, to be more exposed to new technologies of information, which can promote a greater knowledge of health than in the past (Lynch, 2003). In the same logic, the cohorts of women may also have different health behaviors, because of the knowledge and life experiences that vary from one period to another period for the same level of education.

Data and methods

The data of this study are drawn from two Demographic and Health Surveys (DHS) conducted in 1996 and 2006. DHS are retrospective surveys, conducted on samples (by clusters) representative at national level, at the place of residence and at the departmental level. The information collected from household, women and community provide detailed information about the reproductive lives of women (15-49 years) required for child mortality analysis, as well as on the characteristics of children, mothers, household and community.

Table 1 provides information on the sample size of households and women respondents (15-49 years), as well as data on births and deaths of children born in the five years preceding the survey, for period 1991-1996 and 2001-2006. The sample size of 2006 was higher than in 1996 because of its coupling with the survey into the living conditions of households (EMICoV), which requires a large sample size to ensure representation at the commune level, while maintaining acceptable information for key indicators of DHS (INSAE & Macro Internatioanl Inc, 2007). Regarding mothers age group, we focused specifically on two categories (15-29 years, 30-49 years), taking into account the average age of women in our sample according to the education level. This categorization implies that exposure to education is more prevalent among women under 30 years, in the lack of information on the age at which the level of education attained (at the time of the survey) is obtained. Between the two surveys, the proportion of educated women (Primary and more) increased from 37% to 44% ($p < 0.000$) among women under 30 years, and 20% to 26.4% ($p < 0.000$) among women of 30-49 years.

[Table 1 about here]

Figure 1 shows the distribution of births by age group and education level of mothers for the two surveys. It shows the relative changes that occurred between the two surveys. Overall, the proportion of births by maternal education vary significantly from one period to another for each maternal age group (respectively $p < 0.002$ and $p < 0.000$ for age groups <30 years and 30 -49 years).

[Figure 1 about here]

Data limitations.

Because of the cross-sectional nature of the data and the objectives in the DHS, these data have a number of constraints and limitations for this study. Generally, information on reproductive lives of women are subject to problems of omissions or inaccuracies events (in particular births and deaths) and errors of age reporting and dates (Boerma & Sommerfelt, 1993; Tabutin, 2006). However, Sullivan et al. (1990) showed that these limits induce a very small margin of error in the measurements of recent events, since the analysis of the ratios of death of the early neonatal period on all deaths in the neonatal period is generally greater than the critical point of 70% which can indicate an omission of neonatal deaths. A recent study on the estimation of child mortality trends with DHS in 1996 and 2006 in Benin showed that the risk of bias related to the dating of events is negligible (Rutstein, et al., 2009).

Another constraint to data on reproductive history is the selectivity bias because these data were collected from survivors and non-migrant women at the time of the survey. This bias can be important if the child mortality whose mothers have died or migrant is different from that of other children. But, following other works (Kravdal, 2004) which showed that the exclusion of mothers who migrated after the birth of children did not affect the estimates in the study of mortality, we assumed that the risk of death of these children is not different from others.

One can also suspect that the estimation of child mortality according to the mothers education can introduce bias if the frequency of orphaned children of mother and raised by the father, or the entrusted children death is important (Brockerhoff & De Rose, 1994).

To reduce the magnitude of its potential biases that we underlined, we chose to restrict the analysis sample to live births in the five years preceding the survey, where we also assume that the mother's education changes very little of the birth of the child at the time of the survey. In addition, some variables related to the health of the child are not available beyond this period of observation.

Statistical models

Two types of analyzes are carried out whose first, essentially descriptive, uses survival analysis, in particular the life table to examine the differences in mortality among children under five years during the period 1991-1996 and 2001-2006. The values estimated from the life table are used to construct survival curves that indicate the proportion of children still alive until the date of the survey, i.e., children who did know the event (death). The results are stratified according to the age group (15-29 years 30-49 years) and the educational level of mothers (uneducated, educated)[1].

[1] We have not given the classic gradient of education (none, primary, secondary and more) because of the low numbers of women who have secondary and more level in sample of hte first DHS (1996).

For the multivariate analysis, we proceed initially to an explanation of the sources of changes in child survival between the two periods, taking into account variables that we selected (Table 2), by applying a decomposition method on nonlinear models (as suggested by Powers, Yoshioka and Yun (2011)). This decomposition method allow to distinguish (1) changes due to population structure (composition effect) and (2) changes due to health behaviors in explaining child survival differences between the period 1991-1996 and 2001-2006. However, for comparison purposes, we did not take into account variables related to the use of health services (for example delivery in a health center) because they were not collected for all children born the last five years preceding the 1996 DHS survey.

Subsequently, we model the risk of dying before five years using a multivariate piecewise exponential hazards models with random effects to estimate differences in survival of children by age group and educational level of mothers between the two periods. By definition, the piecewise exponential model is a parametric model of the family of survival analysis methods. The choice of this model for multivariate analysis is guided by its flexibility and benefits. Because the risk of death is not constant during the life of an individual , it is necessary to take into account in the analyzes. The piecewise exponential model allows to cut the risk function by specific time intervals in the regression equation, where we can observe the evolution of the risk of dying before 1 month (neonatal) , 1-11 months (post-neonatal) and 12-59 months (juvenile). However, the assumption of the independence of observations underlying piecewise exponential model is often not checked due to the structure of the sample of DHS where children are nestled in women, who also nestled in the cluster surveys. Similarly, because of unobserved factors, as we noted in the introduction, we know that the non- inclusion of these factors in the analysis is likely to bias our estimates. With the DHS, we do not have all the information needed to control all of these biases. However, as it has been shown in other works (Boco, 2011; Guo & Rodriguez, 1992; Gyimah, 2007; Lu Chen, et al., 2009), the child mortality risks from the same mother are expected be correlated due to genetic factors and environmental conditions common among siblings. With our data , mothers were on average more than one child per household (1.8 in 1996 and 1.7 in 2006). So if there is a correlation between the probability of child survival coming from the same mother, it would mean that our observations do not answer any more the assumption of independence. For that, and following the approach adopted in previous studies, we introduce frailty effects and shared to control unobserved factors specific to all children of the same family. The frailty model is a random effects model (Allison, 2009; Hossain, et al., 2007). Thereafter, we consider that the random effects follow a gamma distribution (Hougaard, 1995), i.e. they are independent and identically distributed with mean 1 and variance unknown (to be determined) .

In addition to the random effects model, we also estimate a fixed effect model at the community level (cluster), specifically the Cox model with fixed effect because of the unobserved factors at the community level that can be correlated with education maternal and child survival, and because we do not have variables related to the use of health care services (individual level) for the selected sample. Therefore, we hypothesize that the use of health care services for mothers (antenatal, delivery in a health facility, etc..) depends

essentially on the existing supply of health. The use of this additional quantitative method allows us to strengthen the validity and consistency of the results of the study.

Control variables included in the multivariate models are categorized here into three groups : child characteristics (age, sex, birth order and previous birth interval), mother (age, marital status, religion), household (household size, number of children under five years, wealth index, gender of household head, father's education, type of toilet used, nature of the drinking water and place of residence).

[Table 2 about here]

Results

Descriptive results

We estimate in this section, from the life table, the proportions of child surviving at each age (in months) by age group and educational level of the mother (Figures 2a and 2b) for the period from 1991-1996 to 2001-2006. The significance of differences between the two periods is assessed by the log-rank test.

Compared to the period 1991-1996 and 2001-2006, the curves seem to indicate, among educated and uneducated mothers, a higher proportion child surviving in 2006. The evolution of the survival curves by maternal age group showed significant differences for each level of education (none, primary and more), except in the category of mothers who are educated and old (30-49 years) ($p < 0.1386$).

From one period to another, the probability of children surviving before five years are more pronounced among educated and younger mothers (Figure 2a). We also find a coincidence in the survival curves for the children of educated mothers in the age group 30-49 in 1996 with those of uneducated mothers for the same age group in 2006, either one decade after (Figure 2b).

These differences give us a first indication of the differential effects of education by age group of mothers in the child mortality risk between the two surveys, and suggest that the chances of children surviving may be partly explained by a decrease in the proportion of uneducated mothers and an increase in the proportion of educated mothers, especially among mothers under 30 years.

[Figure 2 about here]

Results of the multivariate analyzes

Decomposition of the change in child mortality, Benin DHS 1996 and 2006

The results of the decomposition analysis are presented in Table 3. In Model A (only the mother's education is taken as an explanatory variable) as in model B (the set of selected variables), the results show that the overall decline in child mortality observed between the period 1991 -1996 and 2001-2006 is mainly due to changes in behavioral responses and / or public health conditions as evidenced by the relative proportions of the effects of performance (respectively 95.86% [either 2,973 / 3,101 * 100] and 90, 11% [either 2,794 / 3,101 * 100]). More specifically, the analysis of performance effects (not shown) suggests that the observed changes are not specific to a particular explanatory variable, but rather a group of variables by which maternal education influences (household wealth index, hygiene and sanitation condition, birth order and birth interval, residence of the household, mother's age, marital status, mother's position as head of household).

[Table 3 about here]

Differences in chid survival according to educational level and age group of the mother, Benin DHS 1996 and 2006 : Results of random-effects and fixed effects models

The results of the multivariate analysis are presented in Tables 2a and 3a, for each level of mothers education. Table 4 shows the effects of interaction to better understand the changes that have occurred between the two periods (1991-1996 and 2001-2006). The estimated coefficients from the random effects model (shared frailty) and the fixed effects model are derived from the fusion of two databases where we can examine the significance of differences by period (interaction effects) . The estimated coefficients indicate the relative risks of each category of the explanatory variable with respect to the reference category (that between parenthesis).

For each category of mothers education taken separately, the random effects model provided a good indication of the importance of unobserved factors at the family level on the risk of dying before age five. More specifically, the effect of the shared frailty (theta) is statistically significant in the category of educated mothers ($p < 0.031$) like that of uneducated mothers ($p < 0.000$) , and indicates the importance of taking into account the correlation between children (siblings) of the same mother for the precision of the estimates and statistical inferences (table 2a).

By comparing the exposure times (Table 2a), the basic risks confirm the reduction of child mortality in progressively increasing age (<1 month, 1-11 months and 12-59 months) all things considered ($p < 0.000$). This decrease is more pronounced among children of educated mothers.

According to our estimates[2] (calculated from Table 2a) , the results show an overall reduction in the risk of dying before age five during the period 1991-1996 and 2001-2006. For uneducated mothers, the risk of dying before age five is reduced by 30.6% between 1996 and DHS 2006 against 11% for educated mothers. However, there are significant differences by age group and educational level of mothers. Compared to the mothers of age group 30-49 years (reference), the child mortality risk was higher in 1996 than in 2006 in the younger mothers (<30 years). But in particular, when we multiply the coefficient of mothers age group by the interaction effect between mothers age group and the period (Table 2a), we note a significant decrease of child mortality risk (RR = 1.495 in 1996 , $p < 0.000$, RR = 1.361 in 2006, $p < 0.000$). This decrease is more perceptible in children of educated mothers (RR = 2.068 in 1996 , $p < 0.019$, RR = 1.377 in 2006 $p < 0.070$) .

The results agree with those obtained in the fixed effects model (model of comparison) when we controlled for unobserved factors in clusters level. However, we did not consider the distinction between the durations of exposure to the child mortality risk and the mothers age group to enrich our results (because of problems with statistical power), as for younger children (infant period) or older (juvenile period), the influence of maternal education on child health is not certainly the same because of a combination of biological, socio-economic and environmental conditions very variables (Ricci & Becker, 1996).

In addition, mothers heads of household introduce significant differences in child mortality. In particular, among uneducated mothers, the child mortality risk remains significantly lower when the mother is the head of household (RR = 0.536 in 1996, $p <0.050$, RR = 0.651 in 2006 $p <0.001$). However, an increase of approximately 25% of relative risk was observed in 2006. By educated women, no statistically significant difference was observed in the child mortality risk in 1996, while in 2006, we observed a very significant reduction about 56% (RR = 0.086 in 1996, $p <0.805$, RR = 0.480 in 2006, $p <0.002$). Other characteristics of child (sex, birth order), mother (marital status) and household (father's education, household size, number of children under five years, and type of hygiene and sanitation, residence) also have effects on the child mortality risk, with significance levels that vary with the level of maternal education (tables 2a and 2b).

[Table 4 about here]

Sensitivity Analysis

We performed sensitivity analyzes by repeating the same analysis on data from DHS surveys in Mali for the same observation period (1991-1996 and 2001-2006), and for which the probability of dying before five years still very high, in the range of 237,5 ‰ in

[2] To estimate the difference in the relative risk of death for children between the two surveys, we took into account the estimated coefficients for the period and any other factors which the interaction takes place with the period.

1996 and 191 ‰ in 2006 (Mali and Macro 1996, 2007), with an annual rate relatively lower than that of Benin for the period 1990-2011 (1.8 against 2.4) (UNICEF, 2012).

Compared to Benin, we found a less substantial increase in the education of women of reproductive age during the two period (respectively 22.4% and 26.6% among women in the age group 15-29 years and 15% to 15.2% among women in the age group 30-49)[3]. The results of the random effects model also show less similar to those obtained in the case of Benin results. Indeed, among uneducated women, the differences in child mortality risk experienced a slight decrease among women aged less than 30 years (RR = 1.266 p <0.001 in 1996 and 1.206 p <0.009 in 2006). On the other hand, among educated mothers, no statistically significant difference was observed in 2006 (RR = 1.402 p <0.104 in 1996 and 0.882 p <0.527 in 2006). Compared to 1996, the lack of statistically significant effect observed in educated women in 2006 implies among other things that the increase of educational level among young mothers had an effect in reducing the mortality risk of their children, given that the educational level of older mothers remained stable between the two periods of observations.

Discussion and conclusion

This study examines the effects of education by age group of mothers on child survival during the period 1991-1996 and 2001-2006 in Benin. The results clearly indicate a differentiated improved of child survival by age group and educational level of mothers. In particular, reducing the child mortality risk in 2006 was most remarkable among mothers in the age group 15–29 years.

Compared to the mothers in the age group 30-49 years, the risk of dying before five years was significantly reduced among children of mothers in the age group 15-29 years with no education as among those educated mothers. The gain in child survival among younger mothers (15-29 years) seems to be explained by the substantial progress accomplished in the field of education during the decade 1996-2006. This explanation is consistent with previous studies that have shown that over time, younger women have generally a higher level of education than older women (Gakidou, et al., 2010). It also suggests that improving the education for women of reproductive age will probably lead to a greater use of family planning services, maternal and child health services. But our results confirm the hypothesis that the effects of maternal education on child survival varies across mothers age group over time. These results are robust to the inclusion of unobserved factors in the family level as has been shown in other studies (Boco, 2011).

Among other factors associated with mortality, this study suggests that the position of the mother as head of household is associated with a reduction of child mortality risk. Consistently with earlier studies (Adhikari & Podhisita, 2010; Doctor, 2011; Wickrama & Keith, 1990), these results seem to highlight the existence of a significant correlation between the position of mother as head household and behaviors reproductive health, which have a clear link in the decline of child mortality. One possible explanation for this

[3] Our calculations

correlation, highlighted by the Adhikari & Podhisita (2010) in India is that women who are heads of household are more likely to go to a health facility for treatment or to treat his children for illness, and also have some facility to address health issues with other women. Another explanation is that of autonomy in decision- making within the family sphere (Doctor, 2011; Emina, et al., 2011; Kravdal, 2004). Indeed, in African societies where cultural beliefs mean that women have difficulty of having access to resources and decision-making along the lines of child survival (discussed in the household, family planning, child nutrition, etc.), female heads of household seem to enjoy more autonomy in family decisions. In this case, the mother's education also tends to reinforce this independence, since a high level of education facilitates access to paid employment, and increase the status of women in the household (Tabutin, 2009).

However, our results cannot be interpreted as a causal relationship given the cross-sectional nature of data.

The results of this study contribute to the literature that explores the importance of maternal education in changes in child survival, focusing on the differences in the maternal age group that may not be obvious without prior research. This distinction could bring new light on the identification of needs and specific policies for improving child survival.

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Table 1: Structure of the sample of births and women interviewed

Years	Household (n)	Women 15-49 ans (n)	births (n)	deaths (n)	Educational level of women by age group					
					15-49 years (%)		< 30 years (%)		30-49 years (%)	
					UN	E	UN	E	UN	E
1996	4 499	5 491	5 062	591	70,8	29,2	63,1	36,9	80,3	19,7
2006	17 511	17 794	15929	1 366	63,7	36,3	55,8	44,2	73,6	26,4

UN=Uneducated ; E=Educated (Primary and more)

Tableau 2: Distribution (percentage) of children (0-59 months) according to the selected variables for each level of maternal education, DHS 1996, 2006.

Explanatory variables selected	1996			2006		
	Uneducated Mother	Educated Mother	Total	Uneducated Mother	Educated Mother	Total
Age of the child						
<1 month	1,09	0,9	1,05	0,95	1,03	0,97
1-11 months	20,45	20,27	20,41	19,88	23,32	20,74
12-59 months	78,45	78,82	78,54	79,17	75,65	78,29
Child's sex						
Male	49,67	52,54	50,25	50,11	51,25	50,4
Female	50,33	47,46	49,75	49,89	48,75	49,6
Birth order and preceding birth interval						
First birth	16,88	26,64	18,86	15,89	30,54	19,56
2-3 & < 24 months	4,54	6,04	4,84	4,98	4,89	4,96
2-3 & >=24 months	23,41	34,58	25,68	28,31	35,69	30,16
4+ & < 24 months	9,72	4,41	8,65	7,60	2,96	6,44
4+ & >=24 months	45,44	28,33	41,97	43,22	25,92	38,89
Mother's age at child's birth						
< 30 years	61,35	77,16	64,56	68,76	72,14	69,61
30-49 years	38,65	22,84	35,44	31,24	27,86	30,39
Marital status						
Not maried	2,83	6,22	3,52	2,59	6,29	3,51
Maried	97,17	93,78	96,48	97,4	93,71	96,49
Religion						
Traditonal	26,96	10,78	23,68	22,72	9,49	19,41
Muslim	23,34	19,42	22,54	27,32	15,34	24,32
Christian	49,71	69,8	53,78	49,96	75,17	56,27
Fathers Education						
Uneducated	68,27	25,84	59,66	62,47	18,15	51,37
Educated	21,89	56,05	28,81	30,87	70,96	40,91
Missing	9,85	18,12	11,52	6,66	10,89	7,72
Mother head of household						
Yes	3,43	10,04	4,77	7,79	11,56	8,74
No	96,57	89,96	95,23	92,21	88,44	91,26
Household wealth index						
Poorest	28,34	7,57	24,13	27,25	7,43	22,29
Poor	24,13	11,51	21,57	24,06	9,42	20,39
Middle	22,73	13,71	20,9	22,8	14,97	20,84
Rich	17,21	26,61	19,11	18,16	26	20,13
Richest	7,59	40,61	14,28	7,72	42,17	16,35
Number of child < 5 years (Mean)	4,77	3,43	4,5	4,38	3,13	4,07

Table 2: Cont'd

Explanatory variables selected	1996			2006		
	Uneducated Mother	Educated Mother	Total	Uneducated Mother	Educated Mother	Total
Household size (Mean)	9,42	7,71	9,07	7,42	5,92	7,04
Nature of water						
Tap water	12,72	44,63	19,19	17,60	49,40	25,56
Other	22,44	7,12	19,33	15,19	5,82	12,84
Fontaine	5,89	4,81	5,67	12,29	8,43	11,33
Well/Drilling/Rain	58,95	43,44	55,81	54,92	36,35	50,27
Nature of toilet						
Toilet covered	9,23	37,07	14,88	12,52	32,37	17,49
Uncovered toilet	4,95	8,50	5,67	7,07	25,68	11,73
Nature/other	85,81	54,43	79,45	80,41	41,95	70,77
Place of residence						
Urban	25,61	57,15	32,01	25,83	59,31	34,21
Rural	74,39	42,85	67,99	74,17	40,69	65,79
Number of children (0-59 months)	4036	1026	5062	11940	3989	15929
Number of death	493	98	591	1074	292	1366

Table 3: Results of the decomposition analysis

	Model A		**Model B**	
	Difference in child survival	[95% Conf. Interval]	Difference in child survival	[95% Conf. Interval]
Difference due to compositional effects	0,128**	[0,028 - 0,229]	0,307ns	[-0,321 - 0,934]
Difference due to the behavior effects	2,973***	[1,983 - 3,962]	2,794***	[1,639 - 3,949]
Overall difference	3,101***	[2,11 2 - 4,090]	3,101***	[2,125 - 4,077]

Table 4: Change in relative risk between 1996 and 2006

Random effects model

Interaction variables	Uneducated mother			Educated mother		
	Relative risk	**standard error**	**Pvalue**	**Relative risk**	**standard error**	**Pvalue**
Mother's age at child's birth						
< 30 years (réf : 30-49 years)	1,495***	0,168	0,000	2,068**	0,641	0,019
Mother head of household (réf: no)	0,536**	0,171	0,050	1,086ns	0,364	0,805
Changes observed between the period 1991-1996 and 2001-2006						
Mother's age at child's birth						
< 30 years (réf : 30-49 years)	1,361***	0,118	0,000	1,377*	0,243	0,070
Mother head of household (réf: no)	0,651***	0,088	0,001	0,48**	0,112	0,002

Fixed effects model

Mother's age at child's birth						
< 30 years (réf : 30-49 years)	1,469***	0,167	0,001	1,689ns	0,613	0,149
Mother head of household (réf: no)	0,590*	0,192	0,106	1,008ns	0,386	0,983
Changes observed between the period 1991-1996 and 2001-2006						
Mother's age at child's birth						
< 30 years (réf : 30-49 years)	1,344***	0,116	0,001	1,465**	0,290	0,054
Mother head of household (réf: no)	0,676*	0,091	0,004	0,452**	0,117	0,002

Figure 1 : Distribution of live births by age group and educational level of mothers

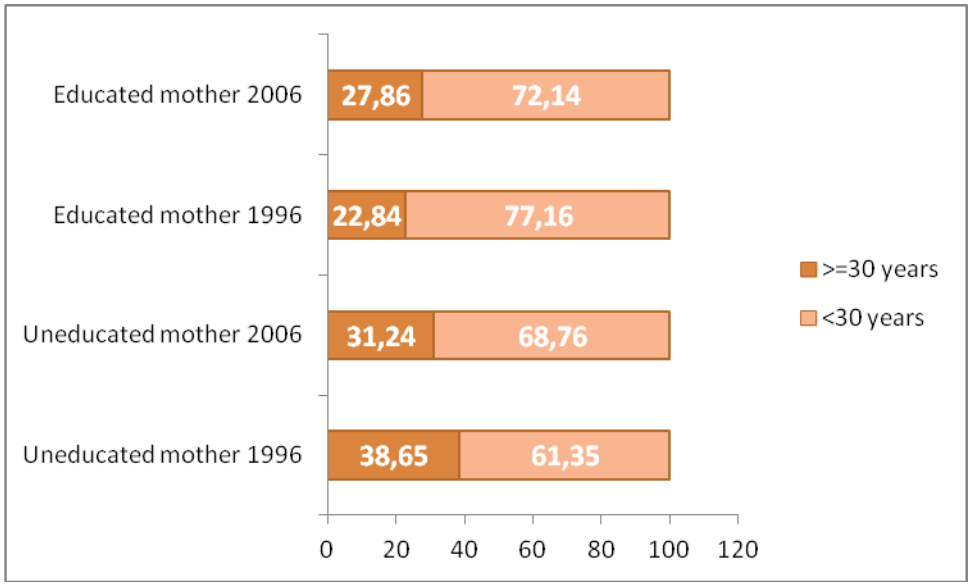
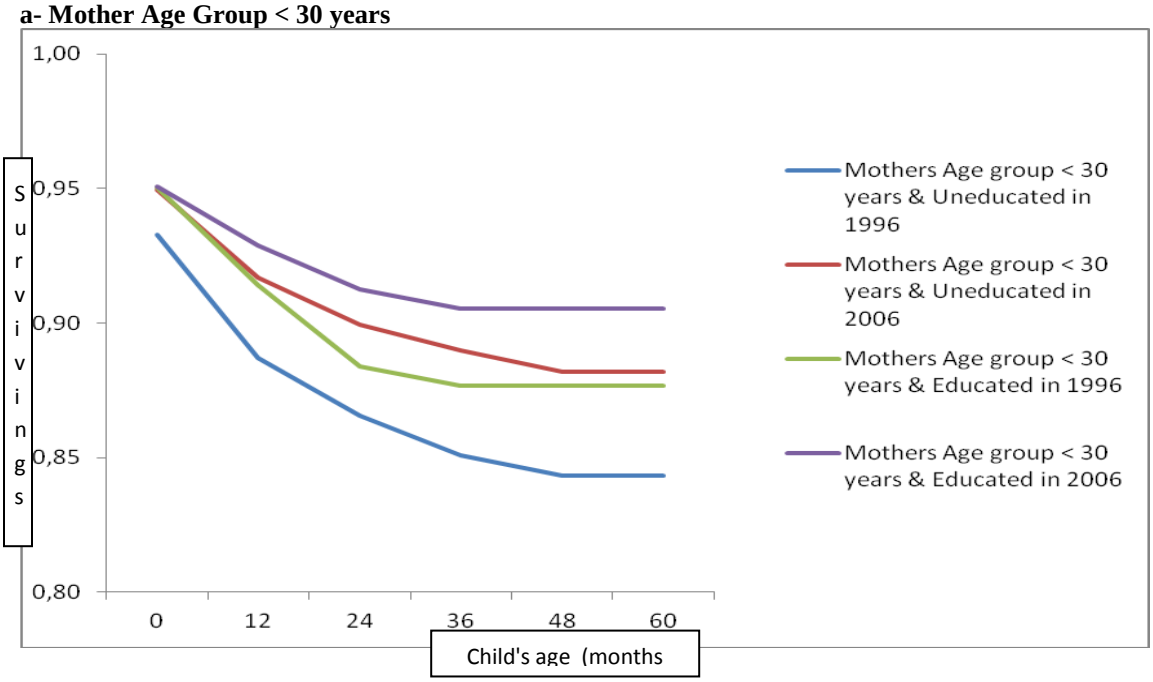


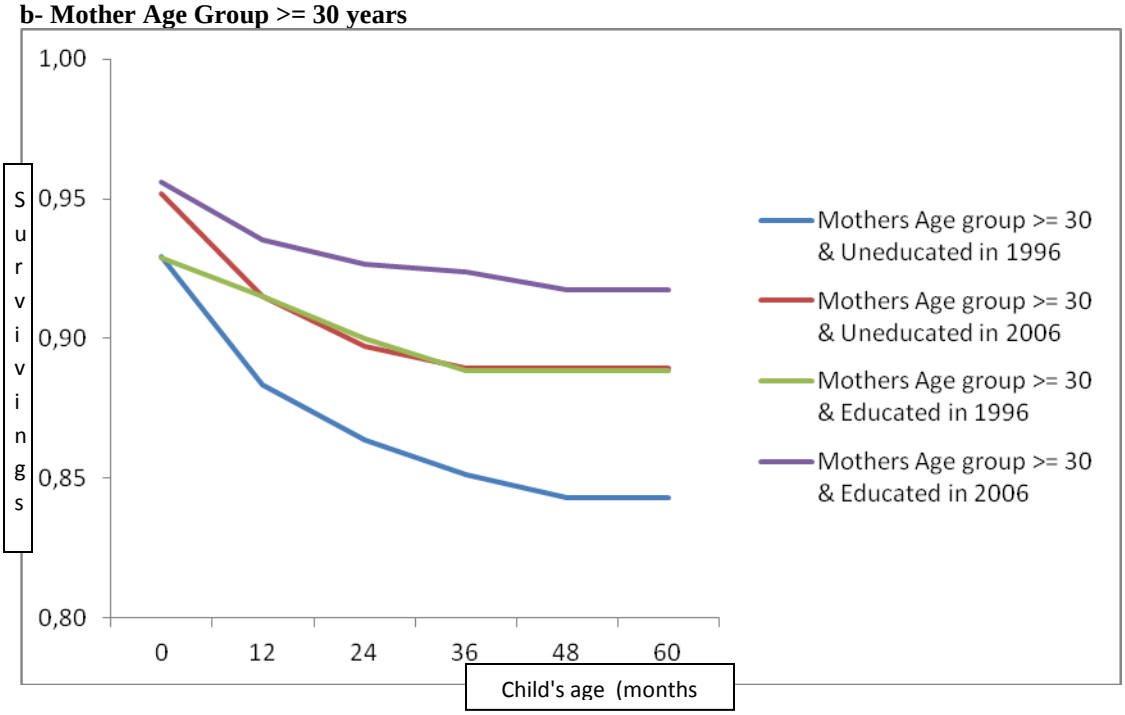
Figure 2 : Proportion of child surviving at each age by mothers for the period 1991-1996 and 2001-2006

a- Mother Age Group < 30 years



Logrank test statistics : p <0.000 & p<0.0913, respectively, for children whose mothers are uneducated or educated

b- Mother Age Group >= 30 years



Logrank test statistics : $p < 0.0001$ et $p < 0.1386$, respectively, for children whose mothers are uneducated or educated

Table 2a: Relative risk of dying before age five (Multivariate piecewise exponential hazard model with gamma-shared frailty)

Explanatory variables selected	Uneducated mother			Educated mother		
	Relative risk	**standard error**	**Pvalue**	**Relative risk**	**standard error**	**Pvalue**
Exposure time (réf : <1 month)						
1-11 months	0,130	0,008	0.000	0,083	0,010	0.000
12-59 months	0,052	0,003	0.000	0,034	0,005	0.000
Mothers characteristics						
Mother's age at child's birth (réf:30-49 years)						
< 30 years	1,495	0,168	0.000	2,068	0,641	0.019
Period (réf : 1996)						
2006	0,782	0,075	0.010	1,351	0,399	0.309
Interaction with Age group & period (réf : 30-49 years et period 1996)						
< 30 years*(2006)	0,910	0,106	0.420	0,666	0,211	0.200
Mother head of household (réf: no)	0,536	0,171	0.050	1,086	0,364	0.805
Interaction with Femme Mother head of household & Period (réf : No & 1996)						
Mother head of household *2006	1,215	0,415	0.569	0,442	0,176	0.040
Religion (réf: Traditional)						
Muslim	1,070	0,077	0.347	1,140	0,225	0.506
Christian	0,991	0,063	0.889	0,866	0,143	0.383
Marital status (réf: not maried)	0,586	0,082	0.000	0,658	0,141	0.050
Child characteristics						
Child's sex (réf: Male)	0,968	0,049	0.521	0,740	0,080	0.005
Birth order and preceding birth interval (réf: first birth)						
2-3 & < 24 months	0,898	0,104	0.352	0,598	0,152	0.043
2-3 & >=24 months	0,548	0,047	0.000	0,493	0,075	0.000
4+ & < 24 months	0,532	0,068	0.000	0,279	0,099	0.000
4+ & >=24 months	0,358	0,040	0.000	0,286	0,073	0.000
Household characteristics						
Fathers education (réf: Uneducated)						
Missing	0,835	0,094	0.108	1,112	0,208	0.568
Educated	0,991	0,064	0.884	0,721	0,101	0.020
Household wealth index (réf: Poorest)		3,000				
Poor	1,086	0,076	0.241	0,717	0,170	0.160
Middle	1,129	0,084	0.103	1,197	0,251	0.391
Rich	1,050	0,099	0.606	1,069	0,239	0.765
Richest	0,995	0,155	0.972	0,781	0,212	0.362
Numbers of children < 5 years (continues)	1,252	0,023	0.000	1,448	0,069	0.000
Household size (continues)	0,951	0,007	0.000	0,861	0,020	0.000

Table 2a: Cont'd

Explanatory variables selected	Uneducated mother			Educated mother		
	Relative risk	**standard error**	**Pvalue**	**Relative risk**	**standard error**	**Pvalue**
Nature of water (réf: Tap water)						
Other	1,122	0,118	0.276	0,993	0,239	0.977
Fontaine	1,037	0,116	0.743	0,872	0,197	0.545
Well/Drilling/Rain	0,993	0,087	0.933	0,880	0,131	0.394
Nature of toilet (réf : Toilet covered)						
Uncovered Toilet	0,938	0,140	0.667	1,188	0,195	0.295
Nature/other	1,128	0,119	0.253	1,141	0,197	0.445
Place of residence (réf: urban)	1,130	0,075	0.066	1,063	0,149	0.660
Constant	-2,664	0,016	0.000	-2,412	0,041	0.000
Theta	0,356	0,098		0,435	0,269	
Likelihood X^2 theta = 0	17,870		0.000	3,480		0.031

Tableau 2b : Risque relatif de décès des enfants avant l'âge de 5 ans (Modèle de Cox à effets fixes)

Variables explicatives sélectionnées	Mère non éduquée			Mère éduquée		
	Risque relatif	**Erreur standard**	**Pvalue**	**Risque relatif**	**Erreur standard**	**Pvalue**
Mothers characteristics						
Mother's age at child's birth (réf:30-49 years)						
< 30 years	1,469	0,167	0.001	1,689	0,613	0.149
Period (réf : 1996)						
2006	omitted			omitted		
Interaction with Age group & period (réf : 30-49 years et period 1996)						
< 30 years*(2006)	0,915	0,105	0.437	0,867	0,322	0.702
Mother head of household (réf: no)	0,590	0,192	0.106	1,008	0,386	0.983
Interaction with Femme Mother head of household & Period (réf : No & 1996)						
Mother head of household *2006	1,145	0,398	0.697	0,448	0,200	0.073
Religion (réf: Traditional)						
Muslim	1,024	0,107	0.824	0,823	0,220	0.466
Christian	0,987	0,073	0.857	0,668	0,147	0.066
Marital status (réf: not maried)	0,625	0,085	0.001	0,563	0,149	0.030
Child characteristics						
Child's sex (réf: Male)	0,959	0,047	0.391	0,765	0,085	0.016
Birth order and preceding birth interval (réf: first birth)						
2-3 & < 24 months	0,903	0,101	0.362	0,407	0,096	0.000
2-3 & >=24 months	0,549	0,045	0.000	0,446	0,074	0.000
4+ & < 24 months	0,568	0,070	0.000	0,152	0,060	0.000
4+ & >=24 months	0,373	0,040	0.000	0,196	0,059	0.000
Household characteristics						
Fathers education (réf: Uneducated)						
Missing	0,843	0,094	0.125	1,216	0,273	0.384
Educated	1,036	0,070	0.599	0,694	0,117	0.031
Household wealth index (réf: Poorest)						
Poor	1,095	0,079	0.209	0,498	0,137	0.011
Middle	1,126	0,090	0.135	0,701	0,194	0.200
Rich	1,088	0,112	0.413	0,558	0,164	0.047
Richest	0,897	0,158	0.539	0,510	0,171	0.045
Numbers of children < 5 years (continues)	1,233	0,022	0.000	1,616	0,108	0.000
Household size (continues)	0,949	0,008	0.000	0,837	0,026	0.000
Nature of water (réf: Tap water)						
Other	1,085	0,141	0.528	1,263	0,443	0.506
Fontaine	1,112	0,146	0.416	0,448	0,139	0.010
Well/Drilling/Rain	1,031	0,114	0.783	0,824	0,177	0.368
Nature of toilet (réf : Toilet covered)						
Uncovered Toilet	1,231	0,207	0.216	1,278	0,242	0.196
Nature/other	1,171	0,133	0.166	0,756	0,153	0.167