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Determinants of Regional Disparities in Under Age five Mortality in Cote d'Ivoire

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Determinants of Regional Disparities in Under Age Mortality in Cote d'Ivoire

By

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Mortality in Cote d'Ivoire

By

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ABSTRACT

Background: The launch of the Millennium Development Goal4, in 2000 and the national and international mobilization it spurs results to a decline of child under age five mortality rate from 90 per 1000 living birth in 1990 to 40 per thousands in 2012. That decline however is not evenly distributed across the globe and the majority of countries in the Sub-Saharan African region continue to experience a higher rate of under age five mortality than expected in 2013. Within country disparities in child mortality and it determinants was suggested to account for the lagging of those countries to reduce their under age five mortality rate. **Objective:** the study examined the variation in child mortality across statistical regions in Cote d'Ivoire and the community level factors that can explain those variations after controlling child, the mothers and the household characteristics. **Method:** The study used data obtained from the 2011-2012 Cote d'Ivoire' Demography Health Survey. The study population consisted of 7511 children born within the 5 years preceding the survey. Frequency tables were created to show the distribution of the selected child mortality determinants across regions in Cote d'ivoire and three Logistic models were run to measure the association between the under age five mortality and the selected determinants. **Results**: The proportion of under age five mortality in the study population was 8.52%. There was a statistically significant variation in child mortality across regions. At the community level, the proportion of mothers with a least a secondary education was associated with under-age five mortality risk (OR=0.99, CI=0.98-0.99). There was no significant association between child mortality and the other selected community factors included in the study. **Conclusion:** This study reveals a significant variation of under age five mortality rate across region in Cote d'Ivoire, even after controlling or child, mother and household level factors. The findings of this study suggest a need for further exploration of the factors that can explain those differences.

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Chapter I

INTRODUCTION

Infant and child mortality reduction have been the subject of a sustained effort of the international community and national communities alike over the last three decades. Those efforts are crystalized in the Millennium Development Goal 4 (MDG4) which in 2000 called for a two-thirds reduction in under-age-five (under-five) mortality rate by 2015 relative to the 1990 rate. Since the launch of the MDG initiative, the under-five mortality rate felt substantially. The under-five mortality rate in 2012 was estimated at 48 deaths per 10,000 live births as compared to 90 deaths per 10,000 live births in 1990 worldwide (You, Bastian, Wu, et. al. 2013). This decline in child mortality, however, is unevenly distributed across the globe with countries in Sub-Saharan Africa, and Oceania experiencing less than 50% of a decline in their child mortality rate as compared to other regions of the globe (You, & al 2013). The study of the reasons why those countries lag behind in terms of reduction in their under-five mortality rate suggests an unequal distribution of health intervention and mortality across various socio-economic groups as one of the major reasons (Amouzou, Kozuki, & Gwatkin 2014; Bryce et al. 2003). The studies of those inequalities for the most part however concerned inequalities determined by Socio-economics standing of the child parents and rarely inequalities relate to place and geography. However as Houweling & Kunst (2009) suggest in their framework for the study of child mortality, unequal exposure of children to the mortality risk factors or protective factors across places and geography could also be a determining factors in the disparities in child mortality across countries and within countries. Therefore the approaches to reduce the disparities in child mortality within countries should concern themselves with isolating the factors that determine those geographic inequalities in child mortality in order to develop

strategies to reduce them in addition to the measures to reduce inequalities linked to socio economics status. Moreover, we contend that from a policy perspective, the most efficient way to reduce the socio-economic related inequities in child mortality in those countries will be to use a geographical approach to targeting those disadvantages, since people of lowest socio-economic status generally live together in the same place. It is in this regard that we undertake this study of the regional inequality in child mortality in Cote d'Ivoire. This study to our knowledge will be one of the first to assess the within-country regional differences in child mortality in Cote d'Ivoire, using multivariate statistical analysis.

According to the 2011-2012 health and demography survey in Cote d'Ivoire, the national under -five mortality rate covering the ten year period before the survey was 124 per 1000 live births (Institut National de la Statistique & ICF International, 2012, Pp 125). That rate however masks considerable differences in child mortality among the statistical regions. The region with the highest estimated rate (209 per 1000 live births) has almost three times the mortality rate of the region with the lowest rate (which is 74 per 1000 births)(Institut National de la Statistique & ICF International, 2012, Pp 129). Reducing the child mortality rate in this country therefore requires understanding of the factors that can explain that differential across regions, so that interventions tailored to the need of each region can be designed and implemented. The objective of this study is therefore to (1) test for the significance of the difference of child mortality across statistical region of Cote d'Ivoire and (2) to determine the factors that contribute to that geographic inequality with a special emphasis on community level factors.

Research Hypothesis:

Hypothesis1: There are significant variations in child mortality across regions in Cote d'Ivoire.

Hypothesis2: The variation in child mortality is explained in part by community level factors.

Chapter II

LITERATURE REVIEW

Houweling and Kunst (2009), in their framework for the study of inequalities in child mortality in the developing world, posited that those inequalities are the product of an unequal distribution of proximate determinants of child mortality across groups of people. The unequal distribution of proximate determinants in turn is the consequence of social and geographic stratification of the population and the children exposed to the risk of death.

Following the seminal article by Mosley and Chen (1984), the determinants of child mortality are regularly conceptualized as belonging to two broad categories. The first category is the proximate determinants of health, comprised of "maternal factors, environmental contamination, nutrient deficiency, injury and personal illness control" page 141. The second category includes the socio economics determinants of child mortality. Those socio-economics factors according to the model are of three types; individual factors such as parents' education, productivity; household level factors such as household income and/or wealth, and community level such access to healthcare in the community and it ecological setting. According to that model the effect of the social determinants on child mortality are necessary mediated by the proximate determinants to impact the child's likelihood of survival.

This model offers a good starting point to identify the determinants of child mortality that may explain variation in the child mortality risk across regions, and indeed will serve as basis for our conceptual model. In our model, we reorganize the classification of the determinants into three broad categories, which are: individual-level variables (which include mother and child level variables), household level variables (which include the same household variables

identified by other authors) and other community-level variables. We decided to frame the determinants this way because the proximate and socioeconomics determinants according to that model are linked to the same conceptual unit of analysis. For example the mother age and mother education are two attributed of the same unit which is mother, or community characteristics such air or water quality of the environment in which the child live are attribute of the community in the same sense availability of healthcare services or basic sanitation infrastructure are. Also we estimate that conceptualizing the determinants of child mortality as individual, household level and community factors allow for a better identification of locus of intervention to reduce the exposure of child to mortality risk factors.

II.1. Individual level factors

This category includes all the risk factors of child mortality in developing countries that are related to characteristics at the child and mother levels. With respect to the child characteristics, the sex of the child, his or her birth order, and the preceding birth interval are known correlates of the child risk of death. Regarding the child's sex, Sawyer (2012) found in a trend analysis that male children were more likely to experience death as compared to female children. This finding is prevalent across studies from the developing world, except in China and India where it is found that female children are more likely to die than male children. This pattern of survival by child sex is supported by another study by Kazembe, Clarke, & Kandala (2014), who also contend that the direction of the association between child mortality and sex is heterogonous across countries in Africa. Based on the findings of these two studies we hypothesize that in Cote d'Ivoire male children will experience a higher risk of death as compared to females.

As regards the child birth order and the preceding birth interval, first born children and children occupying the fifth and above rank have been found to be more at risk of death as compared to children between the second and fourth ranks (Antai, 2011). As regards the preceding birth interval, the literature suggests that children born within less than 24 months of the birth of another child were more likely to experienced death, as compared to those born with a preceding birth interval greater than 24 months (Andoh, Umezaki, Nakaruma, Kizuki & Takano 2007; Houle, Stein, Kahn et al., 2013). Regarding the effect of the birth interval on the likelihood of child death, however, the causal direction is still an object of debate. Some authors such us Kuate-Defo (2002) argue that the observed association may be due to what they call the "replacement effect", or the inclination of women whose children died earlier in their life to get pregnant as soon as possible in order to replace the dead child, resulting in a vicious cycle in which the women give birth at shorter birth intervals, leading to the increased likelihood of death of the child, and so forth.

Apart from these three factors, other factors correlated with greater likelihood of child death are: being a twin or a multiple birth (Uthman, Uthman & Yahaya, 2008), or being born premature, or with a small gestational age (Katz, Lee, Kozuki, Lawn, Cousens, Blencowe & al, 2013; Gladstone, White, Kafulafula, Neilson, & van den Broek, 2011).

As regards the mother's characteristics that increase risk of child mortality in the developing world, the literature suggests that mother's age at first birth, mother's age, mother's marital status, and mother's education are correlated with child mortality. Regarding the relationship between mother's age at first birth and child mortality, the evidence stems from two different but complementary streams. The first stream of evidence is from the direct study of the child mortality risk and mother's age at first birth. Such studies are scare, however, and the

available evidence shows that children born of mothers between 27-29 years of age were more likely to survive as compared to those born of mothers of other age groups (less than 18 years, or 33 years old and above) (Finneley, Zlatin & Canning, 2011). The second stream of evidence examines the relationship between mother's age at first marriage and child mortality risk. This evidence also shows that as the mother's age at first birth decreases, the risk of child death increases (Kayode, Victor, & Uthman, 2012; Follasade, 2000). Finneley (2011) point to biological processes such as the immaturity of the mothers when they give birth at younger ages, lack of experience in childcare of young mothers, and extreme age as plausible mechanisms through which mother's age at first birth impact the child likelihood of death.

As regards mother's age at birth and child likelihood of survival, the evidence is mixed. Some authors found that as the mother's age increased, child likelihood of death decreased (Folassade, 2004; Balk, Pullun, Storeygard, Greenwell & Neuman, 2004). By contrast, some researchers found no statistically significant association between child risk of death and mother's age (Kembo and Guinneken, 2009). The heterogeneity in the nature of the association between child mortality and women's age is highlighted by the work of Malderen, Oyen, Speybroeck (2013) who found in multi-country analysis of determinants of child mortality in Africa that, for the most part there is no association between these two factors. Despite the lack of any clear hypothesized relationship between these two variables, we decided to include mother's age in our analysis. We know of one study by Balk et.al. (2004) which found a relationship between mother's age and child mortality in the West African region where Cote d'Ivoire is located. Another variable that has been found to be associated with child mortality in various studies that we do not include in our analysis is mother's parity, where an increased risk of child death has been found as mother's parity increased (Kayode et al., 2012; Girma and Berhane, 2011).

In addition to these bio-demographic characteristics of the mothers, two others factors related to the social position of the mother seem to correlate with child likelihood of death. Those are the woman's marital status and her educational achievement. Regarding the mother's marital status, Clark & Hamplová (2013) study data from eleven countries in the Sub-Saharan Africa region and argue that, as compared to child born of women continuously married, children born of mothers of other marital status were more likely to die. The effect was most significant when the comparison was made against children born of women who never married or who divorced. This finding however is opposite to that of Antai (2011) who found no statistical association between mother's marital status and child likelihood of death in a study in Nigeria.

Another mother-level variable that is consistently found to be associated with child mortality in the developing countries is the mother's education level (Cassez. Sanchez and Coldman, 1997; Cadewell & Cadwell, 1988, Balk et al., 2004,). However, the strength of this association was found to be inconsistent across geographic areas, with a relatively weak or no correlation at all between mother's education and child mortality in sub-Saharan African countries, as compared to countries in other region (Desai & Alva, 1998). The inconsistency in the association between child mortality and mother's education across those regions was hypothesized to be due to household characteristics and environmental factors (such us access to healthcare and water) which tend to attenuate the magnitude of the association between child mortality and education (Desai & Alva, 1998). Based on the work of Balk et al (2004) in the West African region, we expect children born of mothers with complete primary or secondary education to have a better likelihood of survival, as compared to children born of mothers with no education.

II.2. Household level variable

The household level variables in our model include household composition and the household socio-economic standing (SES). Regarding household composition, Andoh et al. (2006) contend that the demographic composition of the household affects the survival of the children. They argue that the proportion of children under five in the household, as well as the ratio of under - age five year olds to those five years old and above were correlated with the death of children. As an explanation for this possible correlation they advanced the argument that a high number of under-five children in a household may lead to competition between the children to get the care needed to thrive from their parent and care givers. Their finding is supported by another study by Houle et al. (2013) who found that the risk of death in children steadily increases as the number of children under five years old in the household increases, up to the 6^{th} children or more, at which point the effect appears to decrease. Their findings are not statistically significant except for the number of children in the household between ages 4 and 6.

The household SES has been the object of extensive research, and most findings suggest that the wealth-related inequities in the developing world, especially in the African region, are heterogeneously distributed (Malderen, Oyen & Speybroeck, 2013) with a strong relationship between those two factors in some countries and no relationship at all in others countries. Within countries where wealth was found to be associated with inequities in child mortality, the pattern of inequities appears to fall under the category, labeled by Speybroeck, Konings, Lunch and al, 2010, as 'queuing', meaning that the children born of household in the middle and highest quintiles experiences a better survival outcome as compare to those in the lowest quintiles. The evidence of a strong association between child mortality and household SES is also found in the review by Houweling and Kunst (2009), who showed a consistence association between under

age five mortality and the parent socio economics status , even though the pattern of the association varies across regions of the globe. Beside those household related factors, others factors such the household infrastructures, the type of fuel used in the household and , household sanitation and water sources were suggested as possible factors that determined the child survival(Mesike & Mojeku, 2012; Folasade, 2000).

II.3.Community level factors

In our conceptual model for this study, we group under 'community factors' both environmental factors (from the Mosley and Chen framework) and other variables that they called community factors. Traditionally the unit of analysis for the study of community factors has been the place of residence, characterized along the urban/rural divide. The direction of the association between rural location and child survival has been inconsistent across studies. Some authors found that children living in urban areas have a better chance of survival as compared to those in rural areas (Kayode, Adekanbi, Uthman, 2012; Kazembe, Clarke and Kandal, 2012). Other authors such as Andoh et. al. (2007) found no association between the child's urbanity of residence and their likelihood of survival. As a possible explanation for the contradictory findings regarding the association between child mortality and rural or urban residence, Bocquier, Madise & Zulu (2012) argued that the observed disadvantages of rural children are possibility due their lack of access to sanitation and their lack of economic opportunity. Moreover the work of some authors suggest that the correlation between child mortality and the urbanity of the place they live in varies along a urban-rural continuum depending upon the density of the population and the distance of the place from a major urban city (Balk Pullum, storeygard, Greenweel and Newman, 2004). This suggestion is in total agreement with that of Root (1997) who also alluded to

variation in density in region across Zimbabwe as a possible explanation for the variation in child mortality.

Besides this rural-urban factor, some authors have used constructs such as neighborhood, region of residence and even country as the geographic unit for studing the effect of community contextual and compositional factors on child mortality risk (Kravda, 2004, Adedini,Odimegwu, Imasiki, Ononkpono &Ibisomi,2014, Cheng, Schuster-Wallace, Watt, Newbold, & Mente, 2012). The evidence for the most part comes from the studies that compare across countries, but more recently variation in the community and regional context within countries has gained traction, in developing countries and especially in Africa. Measures of access to health care on child mortality are often studied within countries, at more local scales. The evidence linking this variable to child mortality is mixed with some authors arguing that access to healthcare measured as distance to the nearest health center play a major role in child mortality in Africa (Schoeps, Gabrysch, Niamba, Sie´, & Heiko Becher, 2010) while other authors failed to find such an association (Moïsi, Gatakaa, Noor, Williams, Bauni, Tsofa, et al 201). Another community level factor analyzed in the literature with regard to child mortality in the developing world is the utilization of child and maternal health services, measured as the proportion or average of the women in the community who used those services. Here again the evidence is mixed with Antai (2011) finding an association between the proportion of women in a community who used prenatal services and the odds of child death, but found no association with the proportion of women who used hospital delivery. On the contrary Adedini et al. (2014) found an association between the community proportion of women using hospital delivery and child mortality but no effect of community proportion of women using prenatal care services when controlling for individual-level and other community and place of residence factors.

Another variable, the community rate of educational attainment by mothers has also been the object of much attention in recent years as possible predictors of child mortality. This variable is hypothesized to influence the level of child mortality in a community through an increase using of healthcare services especially of preventive services by the women in the community (Kravda, 2004). The evidence here again is mixed, with some authors finding a negative correlation between that variable and child mortality. Kravda (2004) for example found in India that as the average years of education of women in the community increased, the risk of child death decreased. Other studies failed to find a statistically significant association between community levels of educational achievement and child mortality risk (Antai, 2011; Adenindi, 2014). The variability in the relationship between child mortality and proportion of women in the community who have at least a secondary level education is confirmed by the work of Boco (2010), which shows that this relationship varies across countries in Sub-Saharan Africa.

Population access and utilization of economics and social health-related infrastructures such us electricity, water and sanitation have been the object of debate in the literature regarding their effects on child mortality. Regarding the effect of electricity, Wang (2003) found in a multi-country study across several countries that access to electricity explained the differential in child mortality, especially in urban communities in developing countries. His finding is supported by Kravda (2004) who also found that in India, the proportion of households with access to electricity in a community is negatively associated with child mortality. Contrary to those studies, Adenindi et al (2014) found no association between access to electricity in the community and child mortality. Hypothesizing the possible causal pathways from access to electricity, Wang (2003) suggests that access to electricity, especially in urban areas, may contribute to a reduction in child respiratory diseases and diarrheal disease, two of the most

prevalent child killers in developing countries. Other studies have examined the relationship between community-level access to water and sanitation and child mortality. The bulk of the evidence comes from multi-country studies For instance Cheng, Schuster-Wallace, Watt, Newbold, & Mente (2012) demonstrated in a study using data from 193 countries that better access to water and improved sanitation were associated with a decrease in child mortality. This finding accords with various other studies that also found an association between access to water and child mortality (Balk, Pullum, Storeygard, Greenwell & Neuman, 2004).

Other community-level contextual factors which have been studied in relationship to child mortality are: community level wealth, which shows an inconsistent association with child mortality (Adenini, 2011); and ethnic homogeneity, whereby more ethnically homogenous communities experience lower mortality rates as compared to more heterogeneous ones (Boco, 2010).

Chapter III

METHODS AND PROCEDURES

III.1.Data sources and study sample size

III.1.1 Data Source

The data used for this research are from the 2011-2012 Cote d'Ivoire Demography and Health Survey (DHS). The DHS is survey program aim at collecting data on population and health trends in developing countries. To this date the DHS program covers almost 90 countries and conducted more than 200 surveys. The DHS Cote d'Ivoire is as survey with two stratification level and two stages cluster sampling. The first strata consisted of region, and within region the populations are stratified in rural and urban population. At the first stage, primary sampling unit are randomly selected within each geographic area with a sampling probability proportional to their size. And at the second stage within the primary sampling unit, household to be surveyed were sampled using a systematic sampling procedure with equal probability of sampling.

III.1.2. Study sample

The original sample size consisted of 7776 births that took place within the five years preceding the survey. We chose that timeframe in order to minimize any bias in the mother's recollection of their birth events. Of those cases we excluded 174 cases for which the region in which the mothers were surveyed was not a de jure place of residence. In addition we excluded from the analysis a total of 91 cases there were missing information on the place of delivery, accessibility to water and sanitation. The final sample on which the analysis was conducted consisted of 7511 cases of children born within the five years preceding the survey.

III.2. Definition of the variables in the study

3.2.1. Outcome variables

Under age five mortality rates: defined as the proportion of child who died before attaining their fifth birthday divided by the total number of child born within 5 years preceding the survey.

3.2.2. Predictors

Child level variables

- The sex of the child
- Preceding birth interval: we categorized this variable into less than 24 months, 24 months, and above to reflect intervals between successive live births. This categorization was necessary since we imputed to all the first birth a preceding birth order superior to 24 months. If we were to treat that variable as continuous then it would not have been possible to include the first birth order since there was no way to determine their exact preceding birth order. The exclusion of first birth order in this case would have led to a loss of power due to the exclusion of almost 1,602 cases.
- Birth order: we categorized this variable into three categories: First birth, second to fifth birth, and sixth birth and above.

Mother level variables

- The age of the mother: we categorized mother's age into four group: less than or equal to 18 years, 19 to 23 years ., .24 to 28 years ., 29 to 33 years ., and 34 years old and above
- Mother's age at first birth: we categorized mother's age at first birth into three levels: less than or equal to 18 years, 19 to 23 years, and 24 years old and above.

- Educational Achievement: this variable had three levels defined as no education, primary education only, and secondary education or above.
- Mother's Marital status, we collapsed the various categories in three groups defined as never married, married and/or in a union, and divorced/widowed/no longer living together or separated.

Household level variables

- Wealth index: we used the index provided in the dataset. This index was calculated using a principal components analysis to generate weights reflecting the assets included in the computation of the index. This index served to group households in five categories: poorest, poorer, middle, richer, and richest.
- Proportion of children under age five in the household: this variable is defined as the proportion of children with age less than five years in the household at the time of the survey to the total inhabitants of the household. The proportion was then categorized as low if the proportion was less than or equal to 25, medium if the proportion was between 25 and 50%, and high if the proportion was 50% and above.

Community level variables

Five community level variables were included in the analysis. Those variables were computed at the primary sampling unit. The primary sampling unit consisted of an aggregate of a minimum of 10 households and a maximum of 50 households clustered together (Institut National de la Statistique & ICF International, 2012). Those variables are:

- Proportion of households with access to improved water sources in the community. The improved water source was defined based on the WHO classification of water sources (WHO/UNICEF Joint Monitoring program, n.d).
- Proportion of households in the community with access to improved sanitation facility. Improved sanitation facility was defined according to the WHO criterion for improved sanitation (WHO/UNICEF Joint Monitoring program, n.d).
- Proportion of households in the community with access to electricity.
- Proportion of births delivered in a health center: we defined births as delivered in a health center if the delivery took place in any health facility whether it is public or private, excluding any delivery that took place in a government health post.
- Proportion of households in the community with secondary and higher education: this proportion was dichotomized into low if that proportion was less than or equal to 44% and high if it was strictly superior to 44%

III.3. Analysis

Descriptive analysis

The descriptive analysis consisted of the computation of the sample proportions for the dependent variables and all the predictors by region.

Multivariate analysis

We used a logistic model to run the multivariate analysis. The choice of that model was guided by the binary nature of the outcome variable. Four successively complex models were estimated:

- Model 1: In the first model we regressed the likelihood of child mortality as function of the child region of residence
- Model 2: In the second model we added to the variables in the model 1 the child, mother, and household level factors.
- Model 3: In the third model we added to the variables in the second model the community level variables.

Because of the possibility of correlation in the error term due to clustering by region we used a robust estimation method with region designated as the cluster unit to compute the standard errors in the models.

Chapter IV

Results

IV.1. Descriptive analysis

IV.1.1. Distribution of child mortality by region

Table1: Frequency of child mortality by region.

Region	Number of Births	Number of Deaths	Proportion (%)
National	7511	640	8.52
Centre	623	56	8.99
Centre -Est	590	53	8.98
Centre-Nord	741	37	4.99
Centre-Ouest	699	33	4.72
Nord	743	99	**13.32**
Nord-Est	613	55	8.97
Nord-Ouest	1065	143	**13.43**
Ouest	700	56	8.00
Sud sans Abidjan	501	29	5.79
Sud Ouest	620	33	5.32
Abidjan	616	46	7.47

According to the table above, the proportion of children who died in our sample before reaching their fifth year was 8.52% nationally. That proportion however varies across regions with the Nord-Ouest and Nord showing the highest proportion of child deaths (13.43 and 13.32

respectively). The lowest were observed respectively in the Centre-Ouest and Centre-Nord regions.

IV.1.2. Distribution of child characteristics by region

Table 2: summary of the distribution of male children by region

Region	Total	Mean	Standard deviation
National	7511	0.50	0.50
Center	623	0.50	0.50
Center East	590	0.50	0.50
Centre Nord	741	0.51	0.50
Centre Ouest	699	0.49	0.50
Nord	743	0.50	0 .50
Nord-Est	613	0.51	0.50
Nord-Ouest	1,065	0.47	0.50
Ouest	700	0.49	0.50
Sud sans Abidjan	501	0.50	0.50
Sud-Ouest	620	0.53	0.50
Ville d'Abidjan	616	0.49	0.50
National	7511	0.50	0.50

Table 3: Birth Order

Region	First Birth N(%)	2-5 births order N(%)	Sixth birth order and above N(%)
National	1,625 (21.63)	4,416 (58.79)	1,470 (19.57)
Center	141 (22.63)	321 (51.52)	161(25.84)
Center East	156 (26.42)	345 (58.47)	89 (15.08)
Centre Nord	148 (19.97)	463 (62.48)	130 (17.54)
Centre Ouest	155 (22.17)	408 (58.37)	136 (19.46)
Nord	125 (16.82)	438 (58.95)	180 (24.23)
Nord-Est	114 (18.60)	376 (61.34)	123 (20.07)
Nord-Ouest	183 (17.18)	587 (55.12)	295 (27.70)
Ouest	144 (20.57)	407 (58.14)	149 (21.29)
Sud sans Abidjan	125 (24.95)	284 (56.64)	92 (18.36)
Sud Ouest	159 (25.65)	392 (63.23)	69 (11.13)
Ville d'Abidjan	175 (28.41)	395 (64.12)	46 (7.47)

The analysis of the distribution of children by birth order and preceding birth interval shows that there is heterogeneity among the regions in the distribution of births by birth order.

Table 4: Preceding Birth interval

Region	Less than 24 months N (%)	Equal or greater than 24 months N (%)
National	874(11.64)	6,637(88.36)
Center	59(9.47)	564(90.53)
Center East	47(7.97)	543(92.03)
Centre Nord	83(11.20)	658(88.80)
Centre Ouest	71(10.16)	628(89.84)
Nord	105(14.13)	638(85.87)
Nord-Est	55(8.97)	558(91.03)
Nord-Ouest	183(17.18)	882(82.82)
Ouest	92(13.14)	608(86.86)
Sud sans Abidjan	44(8.78)	457(91.22)
Sud Ouest	75(12.10)	545(87.90)
Ville d'Abidjan	60(9.74)	556(90.26)

IV.1.3. Distribution of characteristics of mothers by region

Tableau5: Mother's age at First birth by region

Region	18 years and less N (%)	19-23 years N (%)	24 years and above N (%)
National	4,023 (53.56)	2,825 (37.61)	663 (8.83)
Center	358 (57.46)	226 (36.28)	39 (6.26)
Center East	306 (51.86)	236 (40.00)	48 (8.14)
Centre Nord	399 (53.85)	254 (34.28)	88 (11.88)
Centre Ouest	384 (54.94)	266 (38.05)	49 (7.01)
Nord	411 (55.32)	287 (38.63)	45 (6.06)
Nord-Est	318 (51.88)	243 (39.64)	52 (8.48)
Nord-Ouest	594 (55.77)	383 (35.96)	88 (8.26)
Ouest	436 (62.29)	227 (32.43)	37 (5.29)
Sud sans Abidjan	249 (49.70)	195 (38.92)	57 (11.38)
Sud Ouest	331 (53.39)	220 (35.48)	69 (11.13)
Ville d'Abidjan	237 (38.47)	288 (46.75)	91 (14.77)

Tableau 6: Distribution of mother's age by region

Region	<=18 year N (%)	19-23 years N (%)	24-28 years N (%)	29-33 years N (%)	34 years and above N (%)
National	305 (4.06)	1568(20.88)	2159(28.74)	1608(21.41)	1871(24.91)
Center	39(6.26)	113 (18.14)	172 (27.61)	127 (2.39)	172 (27.61)
Center East	22(3.73)	147 (24.92)	175(29.66)	121 (20.51)	125 (21.19)
Centre Nord	33(4.45)	130 (17.54)	213(28.74)	174 (23.48)	191 (25.78)
Centre Ouest	44(6.29)	163 (23.32)	187 (26.75)	140 (20.03)	165 (23.61)
Nord	15(2.02)	149(20.05)	207(27.86)	190(25.57)	182 (24.50)
Nord-Est	15(2.45)	152(24.80)	144(23.49)	129(21.04)	173 (28.22)
Nord-Ouest	30(2.82)	194(18.22)	306(28.73)	211(19.81)	324(30.42)
Ouest	32 (4.57)	158(22.57)	215(30.71)	129(18.43)	166 (23.71)
Sud sans Abidjan	23 (5.49)	103(50.56)	145(28.94)	114(22.75)	116 (23.15)
Sud Ouest	30 (4.84)	149(24.03)	197(31.77)	119(19.19)	125 (20.16)
Ville d'Abidjan	22 (3.57)	110(17.86)	198(32.14)	154(25.00)	132 (21.43)

The distribution of mothers' age showed that the majority of women at the national level are 24 years old or above. The distribution by region shows that the Center Ouest has the highest proportion of mother 18 years and below (6.29%) followed by the Center region. The Northern regions exhibit the highest proportions in the oldest age group.

Tableau 7: Distribution of Mother's Educational achievement by region.

Region	No education N (%)	Primary education N (%)	Secondary Education and above N (%)
National	5,100 (67.90)	1719 (22.89)	692 (9.21)
Center	418 (67.09)	142 (22.79)	63 (10.11)
Center East	374 (63.39)	140 (23.73)	76 (12.88)
Centre Nord	519 (70.04)	146 (19.70)	76 (10.26)
Centre-Ouest	440 (62.95)	203 (29.04)	56 (8.01)
Nord	608 (81.83)	86 (11.57)	49 (6.59)
Nord-Est	428 (69.82)	141 (23.00)	44 (7.18)
Nord-Ouest	925 (86.85)	106 (9.95)	34 (3.19)
Ouest	394 (56.29)	252 (36.00)	54 (7.71)
Sud sans Abidjan	280 (55.89)	164 (32.73)	57 (11.38)
Sud Ouest	432 (69.68)	150 (24.19)	38 (6.13)
Ville d'Abidjan	282 (45.28)	189 (30.68)	145 (23.54)

Tableau 8: Distribution of Mother's marital status by region

Region	Never Married N(%)	Married/in union N(%)	Divorced/separated/widowed N(%)
National	786 (10.46)	6,429 (85.59)	296 (3.94)
Center	130 (20.87)	459 (73.68)	34 (5.46)
Center East	81 (13.73)	481 (81.53)	28 (4.75)
Centre Nord	116 (15.65)	604 (81.51)	21 (2.83)
Centre Ouest	53 (7.58)	619 (88.56)	27 (3.86)
Nord	31 (4.17)	693 (93.27)	19 (2.56)
Nord-Est	84 (13.70)	506 (82.54)	23 (3.75)
Nord-Ouest	38 (3.57)	1,007 (94.55)	20 (1.88)
Ouest	57 (8.14)	592 (84.57)	51 (7.29)
Sud sans Abidjan	76 15.17)	404 (80.39)	21 (4.19)
Sud Ouest	59 (9.52)	548 (88.39)	13 (2.10)
Ville d'Abidjan	61 (9.90)	516 (83.77)	39 (6.33)

IV.1.4: Distribution of Household level determinants.

Tableau 9: wealth index distribution by region

Region	Poorest N (%)	Poorer N (%)	Middle N (%)	Richer N (%)	Richest N (%)
National	1,750 (23.30)	1,639 (21.82)	1,788 (23.81)	1,308 (17.41)	1026 13.66)
Center	205 (32.91)	176 (28.25)	112 (17.98)	80 (12.84)	50 (8.03)
Center East	98 (16.61)	164 (27.80)	151 (25.59)	105(17.80)	72 (12.20)
Centre Nord	107 (14.44)	148 (19.97)	218 (29.42)	115 (15.52)	153 (20.65)
Centre Ouest	194 (27.75)	182 (26.04)	133 (19.03)	108 (15.45)	82 (11.73)
Nord	96 (12.52)	109 (14.67)	285 (38.36)	143 (19.25)	110 (14.80)
Nord-Est	208 (33.53)	171 (27.90)	114 (18.60)	68 (11.09)	52 (8.48)
Nord-Ouest	234 (21.97)	193 (18.12)	380 (35.68)	180 (16.90)	78 (7.32)
Ouest	307 (43.86)	155 (22.14)	100 (14.29)	83 (11.86)	55 (7.86)
Sud sans Abidjan	98 (19.56)	166 (33.13)	109 (21.76)	73 (14.57)	55 (10.98)
Sud Ouest	203 (32.70)	175 (28.23)	123 (18.84)	96 (15.48)	23 (3.71)
Ville d'Abidjan	00 (0.00)	00 (0.00)	63 (10.23)	257 (41.72)	296 (48.05)

Tableau 10: Proportion of children less than 5 years old in the household

Region	Less than or equal 25 N (%)	Strictly greater than 25 and less than equal 50 N (%)	Strictly greater than 50 n (%)
National	3,248 (43.24)	4,056 (54.00)	207(2.76).
Center	285 (45.75)	330 (52.97)	8 (1.28)
Center East	265 (44.92)	300 (50.85)	25 (4.24)
Centre Nord	355 (47.91)	365 (49.26)	21 (2.83)
Centre-Ouest	272 (38.91)	412 (58.94)	15 (2.15)
Nord	299 (40.24)	420 (56.53)	24(3.23)
Nord-Est	253 (41.27)	332 (54.16)	28(4.57)
Nord-Ouest	461 (43.39)	590 (55.40)	14(1.31)
Ouest	286 (40.86)	399 (57.00)	15(2.14)
Sud sans Abidjan	242 (48.30)	239 (47.70)	20(3.99)
Sud Ouest	222 (35.81)	380 (61.29)	18(2.90)
Ville d'Abidjan	308 (50)	289 (46.92)	19(3.08)

IV.1.4: Distribution of Community level determinants of child mortality

IV.1.4.1: Distribution of the children by place of residence and by region

Table 11: Distribution of children by place of resident and by region

Region	Rural N (%)	Urban N (%)
National	5,026 (66.95)	2,485 (33.08)
Center	464 (74.48)	159 (25.52)
Center East	394 (66.78)	196 (33.22)
Centre Nord	341 (46.02)	400 (53.98)
Centre-Ouest	507 (72.53)	192 (27.47)
Nord	542 (72.95)	201 (27.05)
Nord-Est	490 (79.93)	123 (20.07)
Nord-Ouest	889 (83.47)	176 (16.53)
Ouest	534 (76.29)	166 (23.71)
Sud sans Abidjan	343 (68.46)	158 (31.54)
Sud Ouest	522 (84.19)	98 (15.81)
Ville d'Abidjan	0.00	616 (100)

Tableau 12: Distribution of the proportion of women with a least a high school education in the community

Region	Count	Mean proportion of women with high school education and above in the primary sampling unit(SD)	Mean proportion of women who delivered in a health center (SD)
National	7511	9.17 (12.81)	51.84 (31.05)
Center	**623**	10.02 (12.60)	42.86 (30.20)
Center East	590	12.80 (15.20)	69.15 (25.28)
Centre Nord	741	10.25 (13.34)	53.85 (35.57)
Centre Ouest	**699**	8.16 (11.58)	44.78 (22.99)
Nord	743	6.40 (9.19)	51.00 (30.27)
Nord-Est	613	7.11 (9.63)	59.05 (29.68)
Nord-Ouest	1065	3.15 (6.50)	25.35 (23.24)
Ouest	700	7.68 (7.92)	48.71 (20.54)
Sud sans Abidjan	501	11.31 (15.58)	62.87 (27.45)
Sud Ouest	620	5.99 (10.29)	44.51 (24.50)
Ville d'Abidjan	616	23.69 (17.12)	91.56 (7.64)

Table13: Distribution of the proportion of households in the community with access to improved water source

Region	count	Mean proportion of Household with access to improve water source in the primary sampling unit (SD)	Mean proportion of household with access to improve toilet in the primary sampling unit (SD)
National	7511	76.31 (28.425)	39.97 (34.934)
Center	**623**	83.62 (30.756)	28.41 (34.853)
Center East	590	76.27 (28.040)	52.03 (31.571)
Centre Nord	741	85.70 (20.633)	48.18 (38.454)
Centre Ouest	**699**	71.96 (28.036)	23.32 (26.763)
Nord	743	84.25 (22.352)	37.28 (34.725)
Nord-Est	613	76.02 (26.865)	23.98 (31.594)
Nord-Ouest	1065	78.23 (21.885)	39.62 (30.495)
Ouest	700	65.29 (27.607)	33.14 (28.004)
Sud sans Abidjan	501	70.86 (29.718)	50.30 (29.744)
Sud Ouest	620	44.03 (31.508)	21.29 (23.448)
Ville d'Abidjan	616	99.51 (1.645)	87.01 (16.364)

Table 14: Distribution of the proportion of households in the community with access to electricity

Region	count	Mean proportion of Household with electricity in the primary sampling unit(SD)
National	7511	46.64 (42.84)
Center	**623**	41.53 (38.06)
Center East	590	55.46 (43.50)
Centre Nord	741	52.50 (43.39)
Centre Ouest	**699**	43.98 (38.20)
Nord	743	25.75 (39.57)
Nord-Est	613	38.30 (40.43)
Nord-Ouest	1065	35.81 (41.53)
Ouest	700	47.35 (40.04)
Sud sans Abidjan	501	55.03 (41.05)
Sud Ouest	620	33.74 (40.04)
Ville d'Abidjan	616	96.92 (14.12)

IV.2 Multivariate Analysis

The following shows the estimation results for the three successively more complex models, beginning with the simplest model.

IV.2 .1: Analysis of the relationship between Region and child mortality

IV.2.1: Relationship between Region and child mortality unadjusted: **Model 1**

Table15: Association between Region and under five mortality risk

Region	Odds Ratio	Confidence interval	P value
Abidjan	1 (reference)		
Center	1.22	.81-1.84	0.331
Center East	1.22	0.81-1.85	0.338
Centre Nord	.65	.41-1.02	0.06
Centre Ouest	.61	0.39-0.97	0.038***
Nord	1.90	1.32-2.75	0.001***
Nord-Est	1.22	0.81-1.84	0.337
Nord-Ouest	1.92	0.72-1.62	0.000***
Ouest	1.08	.47-1.23	0.719
Sud sans Abidjan	.76	0.44-1.11	0.266
Sud Ouest	.70	0.44-1.11	0.125

The estimation results for Model 1 show that the risk of death differs across the region, when no other statistical covariates besides region are included in the model. Children born in the Centre-Ouest region are significantly less likely to die as compared to those in the capital, while those born in the Nord region and Nord Oust region are (respectively) 1.90 and 1.92 times and statistically significantly more likely to die as compared to children born in Abidjan. There is no

statistically significant difference between the risk of death for children born in Abidjan and the children born in other regions apart of the three mentioned above.

Table16: Association between Region and child mortality after adjusting for individual level and household variable**: Model 2**

Variables	Odds ratio	Confidence interval	Pvalue
Region			
Abidjan (Reference)			
Centre	1.01	0.89-1.16	0.83
Centre Est	1.12	0.99-1.27	0.072
Centre Nord	**0.59**	**0.5-0.66**	**0.000*** **
Centre Ouest	**0.53**	**0.48-0.59**	**0.000*** **
Nord	**1.72**	**1.53-1.92**	**0.000*** **
Nord Est	1.08	0.94-1.22	0.264
Nord Ouest	**1.50**	**1.31-1.73**	**0.000*** **
Ouest	**0.83**	**0.74-0.92**	**0.000*** **
Sud	**0.64**	**0.56-0.73**	**0.000*** **
Sud Ouest	**0.62**	**0.53-0.72**	**0.000*** **
Child sex			
Male (Reference)			
Female	**0.62**	**0.54-0.71**	**0.000*** **
Birth order			
First (reference)			
2-5	**0.72**	**0.52-0.99**	**0.04*** **
6+	0.79	0.51-1.23	0.23

Table 16 (cont'd)

Variables	Odds ratio	Confidence interval	Pvalue
Preceding birth interval			
<24 months (reference)			
>=24 months	**0.40**	**0.32-0.49**	**0.000*** **
Mother age			
Less than 18 years(reference)			
19-23	1.28	0.77-2.12	0.98
24-28	1.51	0.88-2.60	0.13
29-33	1.34	0.75-2.39	0.32
34 and above	1.56	0.80-3.05	0.19
Mother age at first Birth			
Less than 18 (reference)			
19-23	1.25	0.98-1.61	0.07
24 and above	0.89	0.49-1.63	0.71
Marital status			
Not married (reference)			
Married	**1.42**	**1.02-1.97**	**0.038*** **
Divorced	**2.02**	**1.43-2.85**	**0.000*** **
Education			
No education			
Primary	0.98	0.83 -1.15	0.79
Secondary	0.81	0.61 1.07	0.13

Table 16 (Cont'd)

Variables	Odds ratio	Confidence interval	Pvalue
Proportion of children under five years old in the household Less than 25% (reference)			
25-50	**.40**	**0.32 -0.51**	**0.00*** **
75 and above	**.10**	**0.040 0.28**	**0.00*** **
Wealth index			
Poorest (reference)			
Poorer	0.81	.60- 1.10	0.18
Middle	**0.68**	**0.59- 0.79**	**0.00*** **
Richer	**0.69**	**0.54-0.87**	**0.002*** **
richest	**0.57**	**0.42- 0.77**	**0.000*** **

*** Statistically significant at the 5% level.

After controlling for child, mother, and household-level determinants of child mortality, we find that a larger number of regions have significantly different rates of child mortality than the Capital. In some of the regions the likelihood of child death is significantly lower than in the capital (Sud, Sud-Ouest) while in others, the likelihood is significantly higher as compared to the capital(Nord, Nord Oust and Ouest). This change in the coefficients' magnitudes show that part of the correlation between child mortality and region found in the model1 is explained by factors related to the child, the mother and the household

Table 17: Association between Child mortality and region after controlling for individual, household and community level factors: **Model 3**

Variables	Odds ratio	Confidence interval	Pvalue
Region			
Abidjan Reference			
Centre	0.97	0.79-1.19	0.79
Centre Est	1.1	0.95-1.30	0.19
Centre Nord	**0.55**	**0.45-0.66**	**0.000*** **
Centre Ouest	**0.49**	**0.40-0.58**	**0.000*** **
Nord	**1.61**	**1.30-1.99**	**0.000**** **
Nord Est	1	0.84-1.19	0.98
Nord Ouest	**1.43**	**1.10-1.84**	**0.006*** **
ouest	**0.78**	**0.66-0.91**	**0.002**** **
Sud	**0.62**	**0.53-0.74**	**0.000*** **
Sud Ouest	**0.55**	**0.43-0.70**	**0.000*** **
Community			
Proportion health center delivery	1.00	0.99-1.00	0.840
Proportion household improved water source	1	0.99-1	0.400
Proportion households with improved toilet	1	0.99-1.00	0.290
Proportion women with high and above education	**0.99**	**0.98-0.999**	**0.040** **
Urban Rural			
Rural (reference)	1		
Urban	0.81	0.61-1.08	0.15

Tableau 17(cont'd)

Variables	Odd ratio	Confidence interval	Pvalue
Child sex			
Male Reference	1		
Female	**0.32**	**0.54-0.71**	**0.000*** **
Birth order			
First	1		
2-5	**0.71**	**0.52-0.98**	**0.04*** **
6+	0.77	0.51-1.20	0.25
Preceding birth interval			
<24 months reference	1		
>=24 months	**0.40**	**0.32-0.50**	**0.000*** **
Mother age			
Less than 18 years	1		
19-23	1.29	0.78-2.14	0.32
24-28	1.53	0.88-1.65	0.13
29-33	1.37	0.77-2.44	0.29
34 and above	1.60	0.82-3.13	0.17
Mother age at first Birth			
Less than 18 reference	1		
19-23	1.26	0.99-1.61	0.066
24 and above	0.90	0.50-1.64	0.733
Marital status			
Not married reference	1		
Married	1.40	0.98-1.97	0.062
Divorced	**2.04**	**1.43-2.90**	**0.000** **
Education			
No education reference	1	0.86-1.18	0.942
Primary	1.00	0.69-1.18	0.450
Secondary			

Table 17 (cont'd)

Variables	Odds ratio	Confidence interval	Pvalue
Proportion of children under five years old in the household			
Less than 25% (reference)	1		
25-50	**0.40**	**0.32-0.5**	**0.000*** **
75 and above	**0.10**	**0.04-0.28**	**0.000*** **
Wealth index			
Poorest (reference)	1		
Poorer	0.86	0.62-1.19	0.36
Middle	**0.70**	**0.58-0.84**	**0.000** **
Richer	0.72	0.53-1	0.47
richest	**0.63**	**0.41-0.97**	**0.035*** **

*** Statistically significant at the 5% level

Of the community level factors included in the study, only the proportion of women in the community with a secondary and above education level show an association with child mortality(OR=0.99, p=0.040). In addition the coefficient for the region changed again with a reduction of the strength of coefficient for the region for which the region is a risk factor and an increase of the magnitude in the region for which region shows a protective effect. This result shows that community level factors play a role in explaining the differences in child mortality across region in Cote d'Ivoire.

Table 18: summary of the Region coefficients

	Coefficients and Confidence intervals		
Region	Model1	Model2	Model3
Abidjan	1 (reference)		
Center	1.22 (0.81-1.84)	1.01(0.89-1.16)	0.97(0.79-1.19)
Center East	1.22 (0.81-1.85)	1.12(0.99-1.27)	1.1(0.95-1.30)
Centre Nord	.65 (0.41-1.02)	0.59(0.5-0.66)***	0.55(0.45-0.66)***
Centre Ouest	.61 (0.39-0.97)***	0.53(0.48-0.59)	0.49(0.40-0.58)***
Nord	1.90 (1.32-2.75)***	1.72(1.53-1.92)***	1.61(1.30-1.99)
Nord-Est	1.22 (0.81-1.84)	1.08(0.94-1.22)	1(0.84-1.19)
Nord-Ouest	1.92 (1.36-2.72)***	1.50(1.31-1.73)***	1.43(1.10-1.84)***
Ouest	1.08 (0.72-1.62)	0.83(0.74-0.92)***	0.78(0.66-0.91)***
Sud sans Abidjan	.76 (0.47-1.23)	0.64(0.56-0.73)***	0.62(0.53-0.74)***
Sud Ouest	0.70 (0.44-1.11)	0.62(0.53-0.72)***	0.55(0.43-0.70)***

Chapter V.

DISCUSSION AND CONCLUSION

V.1. Discussion

The present study aims was to explore the geographic differential in child mortality in Cote d'Ivoire and the possible factors that could explaine that differential if any exist. The main findings of that study are as follows.

Descriptive analysis

The descriptive analysis assessed the distribution of the determinants of child mortality to be included in the model, by region. That descriptive study showed that, as far as determinants of the child mortality related to the child are concerned the male and female are equally distributed in the country with a mean of (0.5), except for the Nord-Ouest region were males dominate and the Sud-Ouest region where females dominate. That difference however was small. As for the Birth order of the children included in this study only 19.57% were of the sixth and above order and 21.63% were of the first order. Here again the difference across region was small. . The Nord-Ouest (27.70%), the Center (25.84%) and the Nord (24.23%) had the higher proportion of children of the sixth and above order among the children while the City of Abidjan (28.41%), the Center-Est region (26.42%) and the Sud Ouest region (25.65%) had the highest proportion of children of first birth order. Lastly as regards the preceding birth interval, nationally the proportion of children born within less than 24 following the birth of another child was 11.64. The Nord-Ouest region (17.18%), the Nord region (14.13%) and the Ouest region (13.14%) exhibited the highest proportion of children born with a preceding birth order less than 24 months. In general the Nord Ouest region and Nord region had a higher proportion of children

with determinants associated with child mortality. There was considerable heterogeneity among the regions as regards these predictors of child mortality.

Regarding the characteristics of child mortality associated with the mothers, they were more homogeneously distributed across the country. The proportion of women who gave birth to their first child at age 18 and below was (53.56%) nationally with the Ouest region and Center showing a small departure from that proportion in the in the upper direction with respective proportion of 62.26% and 57.47%. The Centre-Ouest and the Centre had the highest proportion of children born of mothers' age 18 and less at the time of the survey, while the Nord-Ouest and the Nord-Est had the highest proportion of mothers aged 34 years and above. Regarding the mother's education only 9.21% of the women in our sample had high school or higher levels of educational attainment. This number is slightly lower than the proportion of women with high school or higher levels of educational attainment in Cote d'Ivoire, as found by Andoh & al (2007) (11.04% as hand calculated by us). The Nord-Ouest region had the lowest proportion, with 3.19% of the women in that region having a high school or higher levels of educational attainment. Lastly as regards marital status, 10.46% of the women were never married and 3.94 were divorced, separated or widowed. The Center (20.87%) and the Center Nord regions had the highest proportion of never-married women, while Abidjan and the Ouest region had the highest proportion of divorced, separated or widowed women.

Turning to the distribution of household level factors, we find that 45.12% of the women were living in a household categorized as poor or poorer, which is 3.98 below the national poverty proportion of 48.9% in 2008 estimated by the ADBG (African Development Bank Group, 2011, page 4). The Ouest region (66%), the Nord-Est (61.43%) and the Centre (61.16%) had the highest proportions of poor households. As for the proportion of children under five

years old in the household, the majority of the households had between 25% and 50% of children less than five years old.

Finally, as far as the community level factors are concerned, 66% of our sample was from a rural area, in contrast to the UN data that showed an urban population percentage of 52% versus 48% in rural areas (UNdata, Cote d'Ivoire, social indicators, online resource). The mean proportion of women with secondary education and above within the primary sampling unit was lowest in the Nord Ouest and the Ouest regions (6.5% and 7.92%, respectively) compared to a national level mean of 12.81%. The mean proportion of women who delivered in a health center was 31.05% in our sample. This proportion is below the reported proportion of 57% reported by the WHO based on the demography and health survey 2011-2012 of cote d'Ivoire (WHO, 2013), The discrepancy may be due to the fact that we exclude from our definition of health center, the government health post (those are small health center manage by individual who are not Doctor, nor nurses or midwives) as well as the difference in the period covered by the WHO report.

The proportion of households with access to improved water sources was 76.31% nationally in par with the 80% of population with access to improved water sources reported in 2011 in the country (UNICEF & WHO, 2013). This proportion however showed some regional differences with the Sud-Ouest region showing a rate of 44.03%. The mean proportion of household in the community with access to an improved sanitation facility was 39.97%. This proportion was higher than the 24% reported in 2011 for the country (UNICEF and WHO, 2013). The regions of Sud-Ouest (21.29%) and Center Ouest (23.32%) and Nord Est (23.98%) however had lower proportions. These proportions were almost equal to the 24% reported by UNICEF and WHO. Lastly, the national proportion of households with access to electricity was

46.64% nationally. This number is below the proportion of 58.9% reported by the World Bank in 2010 (World Bank, World Bank data online resource).

Multivariate analysis

Three different models were constructed to examine whether there were significant differences in child mortality across regions in the country, and whether child, maternal, household and community level factors explained those differences. We estimated successively more inclusive models to examine how regional differences exhibited in the simplest model could perhaps be partially explained by community and person-level factor differences across the regions. The first model (Model 1, Table 15) includes only the region indicator variables. The second model (Model 2, Table 16) includes in addition the child, mother, and household level variables. The third model (Model 3, Table 17) includes in addition the community level variables.

Model 1 showed that child mortality did vary by region, with several regions exhibiting statistically significant differences from Abidjan. Children born the Nord and the Nord Ouest exhibited 1.90 and 1.92 times higher odds of dying as compared to those born in the Capital. On the contrary, a child born of the mother residing in the Centre-Ouest had 0.39 times (lower) odds of dying than children born in the Capital. These findings are consistent with another study by Antai (2011), who found in Nigeria a statistically significant difference in child mortality risk across region. Likewise Macassa (2012) found differences in child mortality risk across region in Mozambique were statistically significant.

The Aim of models 2 and 3 was to determine whether accounting for characteristics of the study population (compositional factors) and characteristics of the local socio-economic

environments (contextual factors) can explain enough of the variation across regions that the differences across regions become statistically insignificant, in the fully-adjusted models.

The inclusion of the child, mother, and household level factors reduced the odds ratio for the Nord from 1.90 to 1.72 and that of Nord Ouest from 1.92 to 1.50, but they remained significantly higher than the odds of death in the Capital region. In addition Ouest, Sud, Sud-Ouest and the Centre regions emerged as being significantly different from the capital once these person-level factors were added to the model. Thus we can conclude that the unadjusted differences across regions in Model 1 were confounded by the omitted differences among individuals across the regions. For example, after adding the personal covariates in Model 2 to the regions in Model 1, a child born in the Ouest had now 0.83 odds of death as compared to the child born in Abidjan, in addition a child born in the Sud, Sud Ouest and Centre Nord had respectively lower odds of death than in the unadjusted model. These numbers demonstrate that part of the Regional variation in child mortality in Cote d'Ivoire is determined by individual and household level variables. Model 2 suggests that the child level factors and household level variables were significantly associated with child mortality in general in the country, as discussed further below. By contrast, maternal level factors (except for marital status) did not show significant associations with child mortality, as discussed further below

Regarding the child level factors, being female, being of birth order 2-5 and having a birth interval greater than or equal to 24 were correlated with a reduced risk of death. These findings are in general agreement with the literature, which shows that these factors reduced the risk of death in children (Antai, 2011; Houle & al, 2013, Kazembe & al, 2012).

As regards the household level factors, the results suggest that a child who lives in a household with a higher proportion of children under five years old was more likely to survive,

as compared to those who lived in a household with less than 25% of children aged less than 5 years old. Our finding contradicts the study by Andoh et al (2007) who found that children living in households with a higher proportion (categorized as between 39-100%) of children under five years old were almost two times more likely to die, as compared to those who lived in a household where the proportion of children under five years old was less than 20%. The difference in results might be due to the difference in the way we categorize the data. We were constrained to no more than 3 categories in order to keep a sufficient number of child deaths in each category, while Andoh et al defined five different categories.

The wealth index also demonstrated a strong association with child mortality, with children born of rich, richer and middle wealth categories less likely to experience death as compared to those in the poorest categories. There was not a statistically significant difference in risk between the 'poorer' and the 'poorest' categories. The association between child mortality and the wealth index in Cote d'Ivoire is also consistent with findings in the literature that child mortality is unequally distributed across socio-economic classes (Houweling and Kunst, 20011, Kazembe and al, 2013).

Finally, as regards the mother level factors, the increased risk of death for children born of married as compared to the never married is opposite to the finding of Clark & Hamplová, (2013) which show that children born of never married women and divorced women were more likely to die as compared to those born of married women. This difference may be due to the fact that, in our data, the region with the highest proportion of child mortality also had the highest proportion of married women (the Nord and the Nord-Ouest). It is possible that women in those regions married earlier and therefore were more likely to give birth at an earlier age which is assumed to contribute to negative risk factors. However, our data do not support that hypothesis

since the Nord and the Nord-Ouest region had proportions of children born of mothers aged 18 years and less that were not strikingly different to that of the other region.

In Model 3, we include the additional adjustment for the community level variables. Including these variables further reduced the estimated odds of death for children born in the Nord and Nord- Ouest regions. Being born of a mother residing in the Ouest region changed the odds of more than onto less than 1, while other regions with odds of death less 1than saw enhanced protective effects from the more complex modeling. These changes in odds of death across regions with the addition of the community-level factors suggest that these factors account for some of the observed differences in death rates in the unadjusted data (Model 1). .

The proportion of women with a high school education and above in the community demonstrated protective effects with child survival status. The child's odds of death decreased by 0.99 point for each additional percent point of women with secondary education achievement within the community. Our finding is opposite to Antai (2011) who reached the conclusion in his study that the proportion of women in a community with higher education had no statistically significant association with child survival but is in accordance with the finding of Kravda in India (2004).

In our study, children living in a rural community did not have a significantly higher risk of death than children in urban areas. This finding is in agreement of that of Andoh (2007) who also studied predictors of child mortality in Cote d'Ivoire. Andoh (2007) found that after controlling for other factors, there was no association between child mortality and place of residence even though in unadjusted comparisons an association was found.

Regarding the remaining community factors, access to electricity was found to be a significant predictor of child mortality in a cross country analysis by Wang (2003) especially in urban areas. However, we found no statistically significant association. Likewise the use of a healthcare center for delivery, or the proportion of households with access to improved sources of water and sanitation did not show significant association with child mortality in our model. Regarding the effect of water and sanitation, our finding contradict that of Cheng et al (2012), who found that an increase in the proportions of individual who had access to improved water sources and improved sanitation was associated the child in under age five child likelihood of death. Our result however is supported in part by the work of Fink, Gunther and Hill (2011) who found no relationship between increased access to improved water sources and child mortality.

The failure to show an association between electricity, sanitation, and access to improved water source with child mortality in our study may be due to relatively little variation in those community resources across regions in Cote d'Ivoire (table13).

The goal of this study was to assess whether there were significant differences in child mortality risk across regions within Cote d'Ivoire and to determine whether specific factors can account for these differences. The three models we estimated show that despite controlling for community level factors, household level variables, and maternal and child characteristics, there remains a substantial difference in risk of under age five mortality across regions. This residual difference in child mortality across regions could be accounted for by other factors not included in the model. One set of factors not included are characteristics of the supply of healthcare services, and access to care factors. Unfortunately, detailed information regarding the location of supply factors is not easily accessible and could not be included in this study. Other omitted factors may also be responsible for the unexplained variation. Drawing from the Mosley and

Chen framework for the study of child mortality (Mosley and Chen, 1984), and the findings in other settings and across countries, we surmise that important omitted variables might include behavioral risk factors, factors related to the population density and ecologic setting of the region, as well as factors regarding supply of healthcare services and access to other basic information infrastructures (e.g. cell service and internet) that may influence child mortality.

V.2. Limitations of the study.

The findings in this study should be interpreted in consideration of the following caveats regarding the data and the modeling used. First, as explained in the methods section we excluded from our study 265 or 3.41% cases from our study. If those cases were systematically different from the remaining, then we might have a selection bias in our findings. However, given the limited number of cases excluded, and given that the majority of cases were those which were not *de jure* residents in those regions, any remaining bias should not change the overall conclusions of the study.

A second limitation is related to recall bias from self-report in survey Recall bias stems from the fact that the survey used to generate the data rely on the woman's recall of her birth event to construct the birth history. It is possible that the women may have forgotten some events or had imperfect recall of the details. However we hope that restricting the data to those events that occurred no more than five years before the survey could help minimize those biases.

The third limitation has to do with the non-inclusion in our model of factors recognized in the literature as influencing child survival prospects. Those factors however were unavailable in the dataset we used. We have provided a thorough assessment of many demand-side factors, which have explained away a considerable portion of the variation among regions in child

mortality. We surmise that with complete data on all aspects of the socio-ecological system, we could explain away some additional all of the differences in under five mortality across regions. This however is beyond the scope of this study, but would be useful in future research.

V.3.Recommendation

The study demonstrates a significant association between child mortality and *de jure* region of residence of the parents, especially the mothers. It also provides an overview of some of the factors that might explain those geographic differences. In light of the findings and the limitations in our modeling, it appears that there is a need to further explore this issue of disparities in child mortality across regions in the country. Future studies should attempt to include in models factors related to healthcare supply, as well additional behavioral known factors related to child health and child mortality. Doing so will help to disaggregate the important determinants of child mortality by region and better customize information that could be used to develop public health interventions in those regions. Finally, with regard to the heterogeneity in the nature of the association between social determinants and child mortality encounter in the literature, it might be important for the research community to standardize the definition and the measurement of variables so as to improve comparison across studies.

Conclusion

Despite some improvement since 1990 in child mortality in the sub-Saharan Africa region and in Cote d'Ivoire in particular, the mortality rate of children age less than five years old remains high. a There is evidence that the country will not meet its goal of bringing the underage five mortality rate from 166 per thousand live birth to 51 per thousand live birth (WHO, 2013). In this regard, this study of the predictors of differential child mortality across regions and in the

country is significant. The study shows that there are differences in child mortality across regions in the country and that part of those differences can be attributed to factors related to the household and the child. The study however failed to find a statistically significant association between child mortality rate and most of the community level factors included in this study. These findings support the importance of developing interventions necessity to develop policy and interventions that are focused on the factors that affect the child not only at the national level, but also at the household and regional levels. It also points to the need for further research in the factors that might explain more of the regional differences, such behavioral factors and factors describing possible difference in the supply of health services across those regions.

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