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ABSTRACT

The intent of this study is to elucidate the image of under-five mortality and to sort out which strong causes are linked to this phenomenon in Rwanda. The idea of conducting this analysis was linked to the will I was feeling to contribute, on the basis of a quantitative analysis outcome, to a good policy making oriented to the enhancement of the welfare of children and mothers in Rwanda.

The main tools I used are mainly Mosley and Chen's model on determinants of child mortality as a theoretical background and the Rwanda Demographic and Health Survey compiled file (year 2000) from which I selected the needed variables of my analysis. Information on child survival and selected plausible causes related variables was depicted from mothers' responses. Thus, individual file (mother's file) was used along this analysis.

Women aged 15-45 and men aged between 15 and 59 years responded to the DHS questionnaire along the year 2000.

Following the objectives assigned to this study, the following main methods were used:

- Survival analysis was used to highlight the image of under-five mortality in Rwanda and this was done on the total sample (N=7922).
- Univariate and multivariate logistic regression methods were used to identify factors associated with the outcome variable (under-five mortality) and to identify a combined effect through examination of interactions existing between different factors.

The hypothesis of the study was that the high under-five mortality rate in Rwanda would be caused by direct factors (maternal related factors, environmental, nutrients, personal illness control factors) and indirect factors (Individual socioeconomic factors, Household and community socioeconomic factors).

Results from the survival analysis confirmed the high rate of under-five mortality in infancy with more registered deaths for infant boys compared to infant girls. Among direct factors, five factors predicted significantly (with $p<0.05$) under-five mortality in Rwanda. These factors are the interval in months between births, the floor material of the house where the child is born or lives in and the number of persons living in the house of the child who have died or survived along the observational period (1995-2000), the size of the child at birth for very large children and for children born with average size and the educational level of the mother.

Among indirect factors, mother's level of education and mother's place of residence showed a statistical relationship with under-five mortality in Rwanda and thus were selected to be significantly predicting under-five mortality based on their significance level.

Further research on the causes of Infant mortality in Rwanda were recommended and critical areas of intervention related to the above six influential six factors were mentioned at the end of this study.

CHAPTER I. INTRODUCTION

I.1. Problem Statement

In year 2000, the United Nations Millennium development policy targeted child mortality as one of its main goal to be achieved in 2015. The reduction of child mortality ratio up to two third by 2015 was its fourth goal. Although steady progress has been made in Central and Eastern Europe, South Asia, East Asia and the Pacific since the early 1990s, it has been at an average annual reduction rate that will fall short of ensuring that the fourth Millennium Development Goal is met. UNICEF estimates that, at present rates, under-five mortality will be reduced by approximately 23% globally over the 1990-2015 periods -- well below the goal of a two-thirds reduction (UNICEF, 2004).

On the other side, mortality rates among children under the age of five remain strikingly high throughout the majority of sub-Saharan Africa. According to the 1995 United Nations report, 18 of the 20 countries across the world with the highest childhood mortality rates were in sub-Saharan Africa. In1998, under-five mortality in this region was averaged to 173 per 1000 live born compared to the minimum goal of 70/1000 internationally adopted in the 1990 World Summit for Children.

The 2005 World Bank press release on the analysis of infant and child mortality and progress of Millennium Development Goals in the world ascertained that Sub-Saharan African countries failed to reduce under-five mortality. This press release report shows that despite interventions oriented to this issue, under-five children mortality in this region declined with a very low magnitude ranging from 187 per 1000 live births in 1990 to 171 per 1000 live births in 2003 (World Bank, 2005).

Rwanda, among other countries of this region still has a high under-five mortality rate going up to 198/1000 deaths according to the recent UNICEF report (UNICEF, 2005). There has not been any significant improvement in under-five mortality since 1950 as this can be seen on the figure in the appendix on under-five mortality trends in Rwanda up to year 2000. The decrease in under-five mortality is only observable between 1985 and 1991 before it increases to a top level around 1994 because of genocide. After 1994, the government efforts to reduce this rate didn't go above the 1970 level due to many factors such as abject poverty among the population, a big number of social infrastructures such as health care and nutrition centers destroyed by the war, a big number of female population which is illiterate, more than 800 000 orphan children looking after their younger others, HIV AIDS and many other constraints. According to MDG statement, there should be a reduction of 4.4% of annual reduction. According to the Estimates of the Millennium Development Goals in 2004, only 1.1% and 1.3% of annual deaths was registered respectively for infant and under-five children in Rwanda, between 1990 and 2002.(Source: MINECOFIN 2004).

The 2000 National Demographic and Health Survey (DHS 2000) also estimates the infant mortality rate to be 107 per 1000 live births and the under-five mortality rate to 196 per 1000 births (ORC Macro, 2001). This rate has increased compared to the one presented in the 1992 DHS estimated to 158/1000 under-five mortality due to war and genocide of 1994.

In Rwanda, malaria is the major cause of morbidity and mortality in children followed by acute respiratory infections, diarrhea diseases and injuries. Peri-natal conditions also account for a large number of infant deaths in Rwanda mostly related to the health status of the mother and environmental conditions. The WHO, UNICEF and UNFPA estimated respectively a maternal mortality ratio of 1300/100000 births in 1990, 2400/100000 births for the year 1994 and 1400 for the year 2000. At the same time, the RDHS 1992 and 2000 registered respectively only 22% and 28% of births attended by skilled health personnel, meaning that the rest 78% and 72% births took place at home. Malnutrition and micro-nutrient deficiencies are serious problems in Rwanda and significant causes of child mortality. A long way is still to go through to meet the fourth Millennium Development goal in Rwanda. (Source: UNDP-RWANDA, MDG progress report, 2003).

The above mentioned facts on infant and under-five mortality explains the relevance of this study. It will help in the identification of influential factors associated to the high under-five mortality rate in Rwanda and thus, will contribute to the government's strategic plan in reducing the level of infant and child mortality, this leading to the achievement of the millennium development goal of reducing under-five mortality by two-third in 2015.

I.2. Relevance of the Study

The relevance of this research is to trace a demarcation between the high under-five mortality rate and its direct and indirect determinants in Rwanda, given that no research of this kind was conducted before in Rwanda. Once this linkage observed, this study will provide explanations on the main causes of the high under-five mortality in Rwanda and hence, identify critical areas of intervention for policy makers and all stakeholders intervening for the child welfare improvement in Rwanda.

I.3. Research Objectives

A. General objective

To find out existing linkages between the high under-five mortality phenomenon and its direct and indirect determinants in Rwanda.

B. Specific Objectives

- To highlight a picture of the survival pattern over time of under-five children in Rwanda on the basis of the year 2000 Rwanda Demographic and Health survey data.
- To trace a demarcation between high under-five mortality and its direct and indirect determinants in Rwanda.
- To provide recommendations on critical areas of intervention in favor of under-five children survival in Rwanda.

I.4. Research Questions

This study-research is based on the following research questions:

- What is the survival pattern over time of under-five children in Rwanda, and what is the effect of a child's sex on this status?
- What could be the causal relationship between direct and indirect factors and under-five mortality in Rwanda?
- Which are critical areas of intervention to improve under-five children welfare in Rwanda?

I.5. Structure of the Study

This thesis is structured into six chapters. The first chapter, which is the introduction of the study, presents a general context of the study through the statement of the problem, the relevance of the study, the research objectives and questions and finally this structure of the thesis. The second chapter presents the theoretical and conceptual framework of the study where key concepts related to the study are defined, a summary of literatures related to this study is presented, the fundamental theory related to this research and most specifically Mosley and Chen's model on determinants of under-five mortality upon which the conceptualization of the study was constructed, key variables included in the conceptual model are defined and finally the research hypothesis is presented.

The third chapter presents the kind of data used in this study and different methods used along the analysis process. The fourth presents results of the study and the fifth chapter entails the general conclusion and policy recommendations.

CHAPTER II. THEORETICAL AND CONCEPTUAL FRAMEWORK

II.1. Basic Concepts definition

Preston H. Samuel et al (2001:35-70) and ORC MACRO report (2001) classify concepts related to under-five mortality into 5 categories. They define:

a. Peri-natal mortality as the probability of dying for a fetus between 28 weeks of pregnancy and one week after its birth.

b. Neonatal mortality as the probability of dying within the 1st month of life

c. Infant mortality as the probability of dying before the 1st birthday (1q0)

d. Post-neonatal mortality as the difference between infant and neonatal mortality

e. Child mortality as the probability of dying between the 1st and 5th birthdays (4q1)

f. Under-five mortality as the probability of dying before the fifth birthday (5q0)

This study focuses mainly on the mortality status of children born in Rwanda between 1995 and 2000 thus, who are aged under-five. It will take into account different factors influencing this phenomenon as enlighted by Mosley and Chen's model on determinants of child and infant mortality.

II.2. Literature Review

In this section, we present an array of researchers who conducted scientific studies on child mortality worldwide. In this regard for example, Bourne and Walker (1991) assessed mortality risks of under-five children on the basis of sex differential. The result of his research showed a positive effect of mother's education on child survival with an increasing effect on female children as age at death was increasing.

Buiya and Streatfield (1991) also made a follow up of 7,913 live births in Matlab villages in Bangladesh from 1982 to 1984 and studied a probability of death for survivors at the beginning of age interval for children aged from 1 to 35 completed months. He also noticed a positive association between mother's education and children survival with more importance for boys.

Trussels and Hammerslough (1983), using a hazard model function, they explained a significant association between under-five mortality and place of residence(rural and urban), sex of child, birth order, age of the mother at birth and toilet facility in SRILANKA.

Victora et al. (1992) made a follow up by home visit in 1984, a number of 6,011 births born in three maternity hospitals of Pelotas, Brazil in 1982. For his study, maternal education is strongly associated with children's health outcomes. On the other hand, Sastry (1997), on the basis of the Brazil's DHS data, assessed mortality risks for infants and children aged from 0 to 59 completed months. He concluded that the risk of death is negatively associated with the mother's education even after controlling for family level and community level clustering effects. Several other researchers went further to understand child mortality determinants by analyzing many other possible determinants apart from education.

Martine et al (1983) demonstrated that in Indonesia, Philippines and Pakistan, the age of the mother has a significant impact on child mortality. They clearly demarcated high under-five mortality among women aged less than 20 years compared to their counterparts aged above 20 to 34 years old.

Eliwo Akoto and Basile O.T. (2000), analyzed socioeconomic inequalities in infant and child mortality among urban and rural areas in Sub-Saharan Africa using multivariate logistics regression. He found out that the place of residence, the age of the mother and medical coverage for pregnancy and delivery as key determinants of infant and child mortality.

Clive J. Mutunga (2004) assessed environmental determinants of child mortality in urban Kenya. Using the Kenyan Demographic and Health Survey (2000), he constructed a duration model framework to capture socio-economic and environmental characteristics impacting infant and child mortality in urban areas of Kenya. His results demonstrated that socioeconomic and environmental characteristics had significantly different impacts on mortality rates at different ages.

Many researchers such as Caldwell, McDonald, Mosley, Chen and several others deepened the research on factors influencing child mortality. Indirect factors, environmental and biomedical factors were pointed to be the main leading factors of this phenomenon. A link between mother's education, nutritional status, environment, accessibility and quality of health care services, mother's age and parity, length of child spacing interval, HIV/AIDS, religious and cultural beliefs and infant and under-five mortality rate was established by the above researchers.

Chen (1980, 1985a, 1985b) came up with a more comprehensive conceptual framework with a concept of synergism. According to him, there is not only one variable leading to under-five mortality but a combination of many factors contributing to the outcome of under-five mortality event.

The social synergy is based on the observation that the same factor (e.g: education, poverty) can influence more other direct determinants to create the risk of under-five mortality. According to him, a mother's education can affect the child survival through differential pre-natal care, safe delivery and her own nutritional status. Her level of education extends her skills and choices in practicing health care, nutrition, hygiene, preventive care and disease treatment.

II.3. Theoretical Framework

This research is based on Mosley and Chen (1984) theoretical framework to reach its objectives and thus to answer to its research questions. Though this model was conceived to point out determinants of under-five mortality, it has been a standard instrument in analyzing and understanding under-five mortality as this was documented by many researchers such as Boerma (1996).

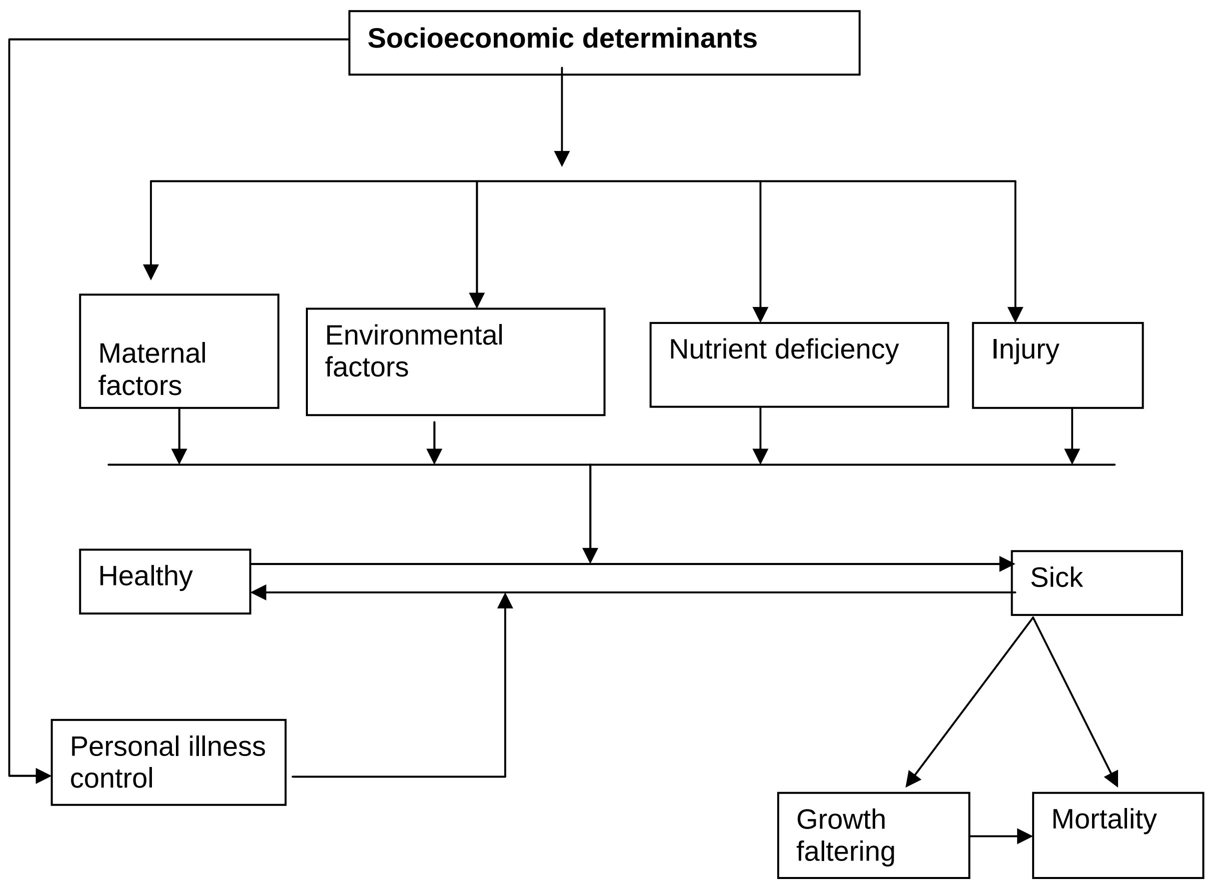
Mosley and Chen's model consolidates both socioeconomic and proximate factors as main determinants of under-five children's mortality. Biological factors are considered as direct factors whereas socioeconomic factors are considered as indirect factors in their conceptual framework. They enlarged Chen's framework by grouping determinants of under-five mortality into 5 categories relating to (1) environmental contamination, (2) maternal factors (3) nutrient availability, (4) injuries and (5) disease control. They grouped these factors into direct and indirect risk factors.

The direct factors comprise a) maternal factors (age at birth, parity, and birth intervals), b) nutrient deficiency factors (nutrient availability to the infant and to the mother during pregnancy and lactation), c) injuries (recent injuries or injury-related disabilities), d) environmental contamination factors (intensity of household crowding, water and food contamination, housing conditions, energy availability…), e) personal illness control (use of preventive services as immunizations, malaria prophylactics or antenatal care, and use of curative measures for specific conditions).

The indirect factors are made of a) Individual level factors (skills, health and time, usually measured by mother's educational level, tradition/norms/attitudes, beliefs about disease causation…), b) Household level factors (food availability, clothing, transportation, daily hygienic and preventive care, access to information…), c) Community level factors (climate, temperature, altitude, season, rainfall, health system variables…).

In this perspective, Mosley and Chen's following conceptual model enlightened my path to the formulation of my hypothesis and problem statement:

Figure 1: Mosley and Chen's model of under-five mortality determinants



Source: Mosley and Chen, 1984

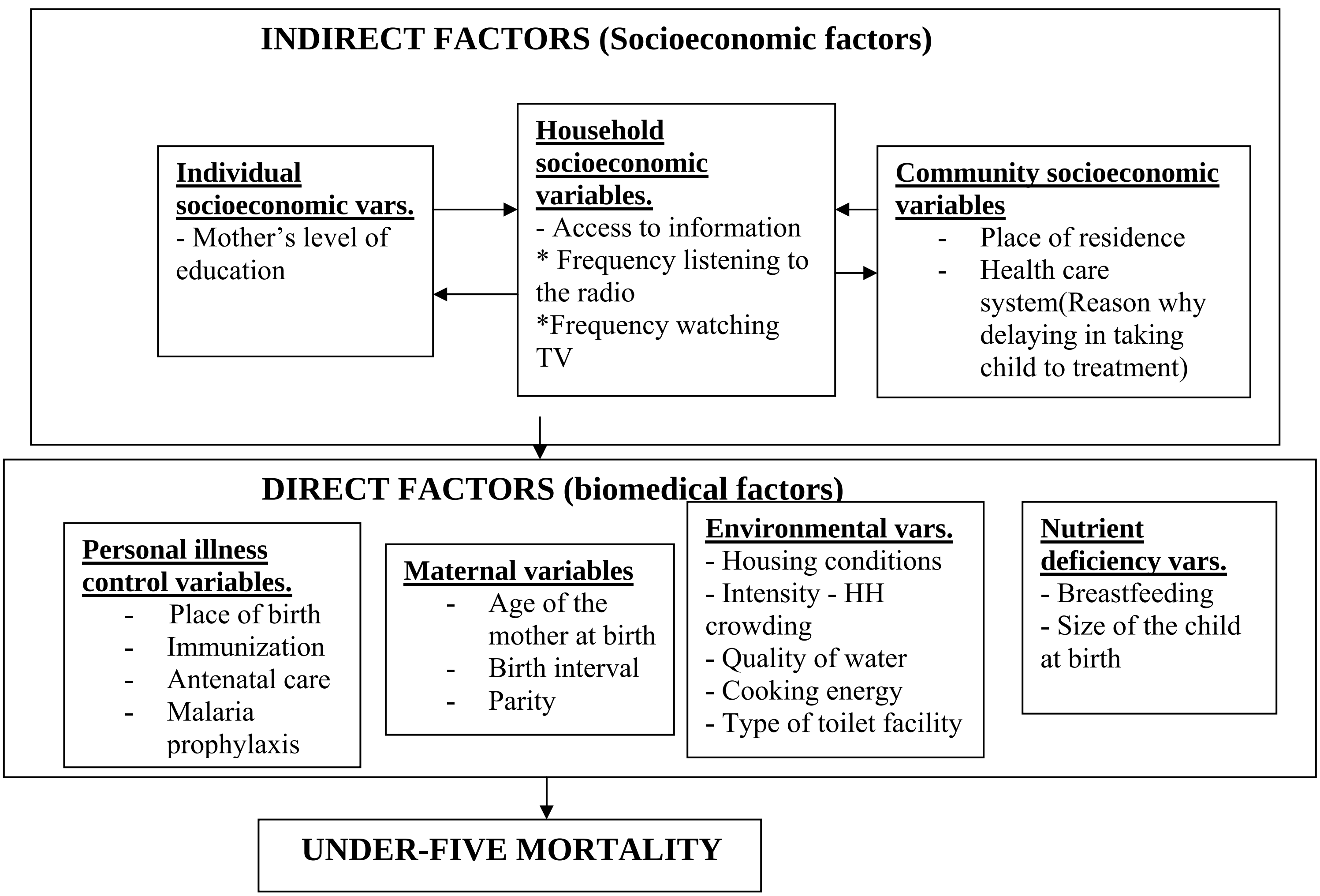
Mosley and Chen here above show us how under-five mortality phenomenon is caused by an aggregate of risk factors. Proximate and socioeconomic determinants interact and lead to under-five mortality. Environmental, nutrient deficiency factors associated with maternal, personal illness control and injury related factors affect positively or negatively a child by giving him a healthy and sickness status. The sickness status could be a cause of a child's growth faltering or death. Direct determinants are directly linked to child survival whereas socioeconomic or indirect factors influence under-five mortality when they are combined with the first one.

II.4. Conceptualization of the Study

II.4.1. Conceptual Model of the Study

The conceptual model of this study is mainly based on Mosley and Chen's model, though some variables were not analyzed due to the lack of information in our basic data file (RDHS 2000). It (the model) explains that direct factors have a leading effect of the under-five mortality phenomenon in Rwanda, but these ones are also to a certain extent influenced by indirect factors and a general effect of all of them will determine which ones have a strong relationship with under-five mortality.

Figure 2: Conceptual model of the study



Source: Adapted from Mosley and Chen's theory (1984)

Relationship between variables

The conceptual model shows the interaction between factors that would affect or favor the health status of children or lead to under-five mortality. For a better analysis, I have divided these risk factors into direct and indirect factors. The direct factors are related to the biomedical and environmental variables that could affect the child from the mother or from the unsafe care of the child through medication and prevention. These factors regroup maternal variables, environmental and personal illness control variables.

The indirect factors or socioeconomic factors regroup variables, which do not affect directly the health of the child, but amplify the effect of the direct factors on under-five mortality. They mainly regroup variables relating to environment situation, household related variables, beliefs, attitudes and economic status of the parents (mother), place of residence and the health system existing in the area of residence of the parents. These factors affect the health of the child mainly from outside the body of the child and his (her) mother. They have also a big impact on the health of the child and thus, none of the two (direct and indirect factors) is to be neglected. Considering the biomedical factors as well as the indirect factors in policy making or intervention strategy will increase the chances of the child survival and the contrary for under-five mortality.

This model differs a little bit with Mosley and Chen's conceptual model. I tried to adapt it to their model as an inspiring model, but the fact being that my analysis will be based on the Rwanda Demographic and Health Survey data base; I was obliged not to consider some factors like injury for which the survey doesn't provide any information. On the other hand, I couldn't find any quantitative nor qualitative information about the child being healthy or sick, and thus, I didn't consider these factors in my model.

II.4.2 Variable Definition

The main concepts in this model are subdivided into direct and indirect factors.

Direct factors (biomedical factors)

- *Nutrient deficiency variables*: Anthropometrical measures are not explicitly provided by provided by DHS 2000 data. Thus, on this component, breastfeeding factor will allow to assess the nutritional status of the child.
- *Environmental variables*: This research will assess the housing conditions that could affect the child namely the construction material, the overcrowding of the house depending on the number of people living in the house and the size

of the house, the type of toilet facility used by the household members, the source of water supply and the energy used for food preparation

- *Maternal variables:* this will help us to assess whether under-five mortality is caused by the age of the mother giving birth, the number of children this woman has given birth, the birth interval between births that could affect a child if the interval is short when this child does not get enough time to breastfeed.
- *Personal illness control variables:* these variables relate to the place where the child was born, implying whether the mother was assisted by professional medical attendants when born at a health care facility or by trained or not trained midwives or by a friend when the child was born at home, to whether the child was immunized or not, if the child received vaccination or vitamin A supplement or if he was protected against malaria by prophylaxis.

Indirect factors (socioeconomic factors): According to Mosley and Chen (1984), these factors are operating through the direct factors as effect modifiers.

- *Community level variables*: these include the place of residence and the health system existing in the community, its accessibility and cost.
- *Household level variables:* relate mainly to the household access to information, the proof for this will be the frequency of listening to a radio or watching television.
- *Individual level variables:* these variables will help us to evaluate to which extent mother's level of education, her religion belongingness and her preference in terms of child's sex could have an effect on under-five mortality.

II.4.3. Research Hypothesis

UNICEF report (2005) and the Rwanda Demographic and Health survey report (2000) respectively confirm the existence of a high under-five mortality rate in Rwanda.

On the basis of Mosley and Chen's theory on under-five child survival and mortality, we assume that the high under-five mortality in Rwanda is influenced by direct and indirect risk factors and that any positive change in these factors can reduce this rate.

a) **Dependent variable:** The high under-five mortality in Rwanda is a dependent variable.

b) **Independent variables:** Direct factors (maternal related factors, environmental, nutrients, personal illness control factors) and indirect factors (Individual socioeconomic factors, Household and community socioeconomic factors) are the main causes of the under-five mortality in Rwanda.

CHAPTER III. DATA AND METHODS

III.1. Selection of the Data

The analyzed secondary data was available from the Rwanda Demographic and Health Survey (2000) data.

According to ORC Macro (2001), the objective of the DHS is "*to provide current and reliable data on fertility and family planning behavior, child mortality, child nutritional status, household wealth… and on HIV/AIDS. It provides information on regional and national estimates on population and health* (ORC Macro 2001: 181)"

Through this survey, a total number of 10421 females aged between 15 and 49 years and 2717 males of 15 to 59 years age responded to the DHS questionnaire. A total number of 9696 households were questioned countrywide within January 6th to January 8th 2000 at National level.

The results of this survey used DHS4 Model "B-core version 7.8+AIDS and involves children aged between 0 and 59 months, women aged between 15-49 years as its main sample. The calendar time of observation was set between January 1995 and November 1999. The recoding structure for this DHS used Measure DHS+ (DHS4, B-core, version 1.2.7).

The DHS 2000 gathered information about demographic and health status of families including mothers, fathers and children in questioned households. It provides information about the identification of the mothers and fathers, their level of education, area of residence and several other issues nationwide. Among other issues, the birth history and the survival pattern over time of children born from a woman were also addressed. As stated above, different files covered all the needed information for this survey (Rwcouple's file, RwHousehold's file, RwChildren's file and RwIndividual's file).

The couple's file gives general information on each of partners, on the matrimonial status of the couples and on their reproductive health. The Household file provides information on all household members including the father, the mother and children. The sex (where necessary), the age, the level of education, the wealth possessed by the household members such as items available in their house, the type of cooking material etc., the relationship structure is provided.

The children's file contains responses to questions related to the identification of the mother for every child, the antenatal care, the environmental and socioeconomic factors of his/her welfare (the roof, floor material of the house, the children and mothers' antenatal or postnatal care, age of the parents and children and the survival pattern over time of the children in last five years) among other issues. This file is created from the women's file based on their birth history. The Individual (Women's) file consists of the background of the mother, the reproduction status, contraceptive use, pregnancy and postnatal care, the child immunization and health, the child and mother's nutrition, the marriage and sexual activity, the fertility preference, the husband's background and woman's work, HIV/AIDS and other STDs, other Health and Welfare issues. Questions related to registered births in the last five years, in the last year and in the month of interview or related to the current pregnancy were asked to women.

As far as this retrospective study is concerned, only the Children's file and the Individual's (Women) file provide all the necessary information about every individual mother and child of the sample. The merging of these two files can also allow selecting all explanatory variables for the under-five mortality in Rwanda since they combine both mothers' characteristics as well as their children born between the year 1995 and 1999.

But since the child mortality and survival estimation is done indirectly (arithmetic average of children who, either died or survived to whom women in the sample have given birth calculated on the basis of the birth history of mothers), the individual file (women's) is sufficient for this matter. It contains all needed variables from the individual and children's files and thus is sufficient to explain the survival or failure of every child born between 1995 and 2000. It regroups all information on the family wealth, the mother and father's characteristics and on every sampled child. It is a much moderate file which was reorganized by the DHS and comprises relevant variables for the understanding of the causes of under-five mortality in Rwanda for our case. This file will be our reference file and only explanatory variables for our analysis will be considered.

III.2. Research Process Operationalization

BABBIE defines operationalization as the development of specific research procedures (operations) that will result in empirical observations representing those concepts in the real world (Babbie 2001, p.132).

For this research, operationalization has been done through the summary of the whole research process and the measurement and recoding of independent variables used in the analysis.

Table 1: Research process operationalization

Research question	Determinants	Indicators	Dependent variable	Independent variable (got or built from the DHS model)	Analysis tool
1. What is the survival pattern over time of under-five children in Rwanda and what is the effect of a child's sex on this status?	Children's survival or failure status, children's sex belongingness	Survival or failure ratios for children of both sexes between August 1995 and November 2000.	Binary Child alive or dead	- Child is alive or dead - Sex of the child	-KAPLAN MEIER -LIFE TABLE
2. What could be the causal relationship between direct and indirect factors and under-five mortality in Rwanda?	-Nutrition deficiency var. -Environmental variables Age of the mother -Personal illness control variables	-Breastfeeding - Birth interval - Parity - Housing, - Intensity in the HH - Quality of water, - -Cooking energy - Delivery, - Immunization -Antenatal care, -Malaria prophylaxis	Binary Child alive or dead	- Age of the mother at birth - duration breastfeeding - Preceding birth interval - Birth interval - Total children ever born - Size of child at birth -Type of housing floor material - Source of drinking water - Type of cooking energy - Type of toilet facility - Number of HH members -Tetanus injection before birth -Antenatal visits for pregnancy -Place of delivery -Duration breastfeeding - Child sleep under mosquito net	Univariate and multivariate logistics regression
	-Individual socioeconomic variables. Household socioeconomic variables Community socioeconomic level variables	- Mother's education - Health - Information - Residence	Binary Child alive or dead	- Mother's level of education - Health care system * Possession health card * Ever had vaccination before birth * Tetanus injection before birth - Access to information * frequency listening to radio * frequency watching TV - Place of residence (urban-rural)	Univariate and multivariate logistics regression

The table above presents research procedures (operations) that will result in empirical observations representing those concepts in the real world going from the research questions to key indicators of what we want to know about the outcome variables, the dependent and independent variables as well as the tool to be used in the analysis. Thus, along the next analysis steps, Kaplan Meier and Life table will be used to check the association between the survival pattern of under-five children in Rwanda on the basis of sex belongingness and this will provide a response to the first question of this research. Univariate and Multivariate analysis will be used to build an association between under-five mortality and each of the independent variable for the univariate analysis and finally check this association between all variables with significant effect on under-five mortality for the multivariate analysis.

This last part of the analysis will provide information on a combined effect of all significant variables from the univariate analysis, to be taken into consideration as the most effective variables in predicting the outcome variable (under-five mortality). The purpose for this multivariate analysis will be to assess whether the observed effect in the univariate analysis remains the same for each variable when controlling for other variables in the multivariate analysis in order to make final conclusions and recommendations.

Table 2: Measurement and recoding of independent variables to be used in the analysis

Group and name of variables	***Specification on value recoding***

DIRECT FACTORS	
A. Personal illness control variables	
- Place of delivery (m15)	20 through 36=1(Hospital, clinics), 10 through 12= 2 (home and other places)
- Ever had vaccination (h10)	0=0(no), 1=1(yes)
- Tetanus injection before birth(m1)	0=0(no), 1 through 6 = 1(yes)
- Has health card(h1)	0 through 2=1(yes),3=2(no),
- Under-five children slept under mosquito net(V460)	0=0(no), 1 through 2= 1(yes)
B. Maternal variables	
- Mother's age in years at birth of child (computed)	Lowest through 18= 1, 18 through 34= 2, 35 and highest=3
- Preceding birth interval (b11) measured in months	Lowest through 23=1, 24 through 36= 2, 36 through highest=3
- Total children ever born (V201) recoded into Parity	1 through 5= 1, 6 through 10= 2, 11 through 15= 3
C. Environmental variables	
- Type of floor material (127) recoded into House floor material	30 through 34=1(improved material=cement, ceramic tiles..), 0thers= 2(Rudimentary, earth..)
- Number of household members (V136) reflecting intensity-HH crowding	2 through 5= 1, 6 through 10 = 2, 11 through 18= 3
- Source of drinking water (V113) recoded into Sowater	10 through 13= 1(piped water), Others=2(open well water)
- Type of cooking energy (V161) recoded into cooking energy	1 through 5= 1(modern), 6 through 7= 2(traditional), Others=3
- Type of toilet facility (V116)	10 through 11=1(flush toilet), 20 through 22= 2(pit and traditional toilet), 30= 3(no toilet facility),
D. Nutrient deficiency variables	
- Breastfeeding(m4)	95 through 96= 1(breastfed), 94= 2(never breastfed)
- Size of the child at birth	1 through 2=1(very large size), 3= 2(average), 4= 3 (very small size)
INDIRECT FACTORS	
A. Individual level variables	
- Mother's level of Education (V106) recoded into edlevel	0=0 (no education), 1=1 (primary), 2 through 3=2 (secondary and higher)
B. Household level variables	
- Frequency listening to Radio (V158) recoded into Lisradio	3=1 (most often), 0 through 2= 2 (not listening)
- Frequency watching Television (V159) recoded into waTV	3=1(most often), 0 through 2= 2(not watching)
C. Community level variables	
-Type of place of residence(V102), not recoded nor computed, taken directly from RDHS 2000	1= urban, 2= Rural
*Health care system	
- Reason why delaying to take child to treatment(s463ga)	2 through 4= 1 (no money for treatment or transport), 1=2 (illness not serious), others=3

The above table presents the measurement and the recoding of independent variables to be included in the analysis. The recoding system intends to make variables operational along the analysis, the fact being that most of them are classified in more than 3 values. It presents variables that were judged to be relevant for the analysis, these variables being classified in indirect and direct factors.

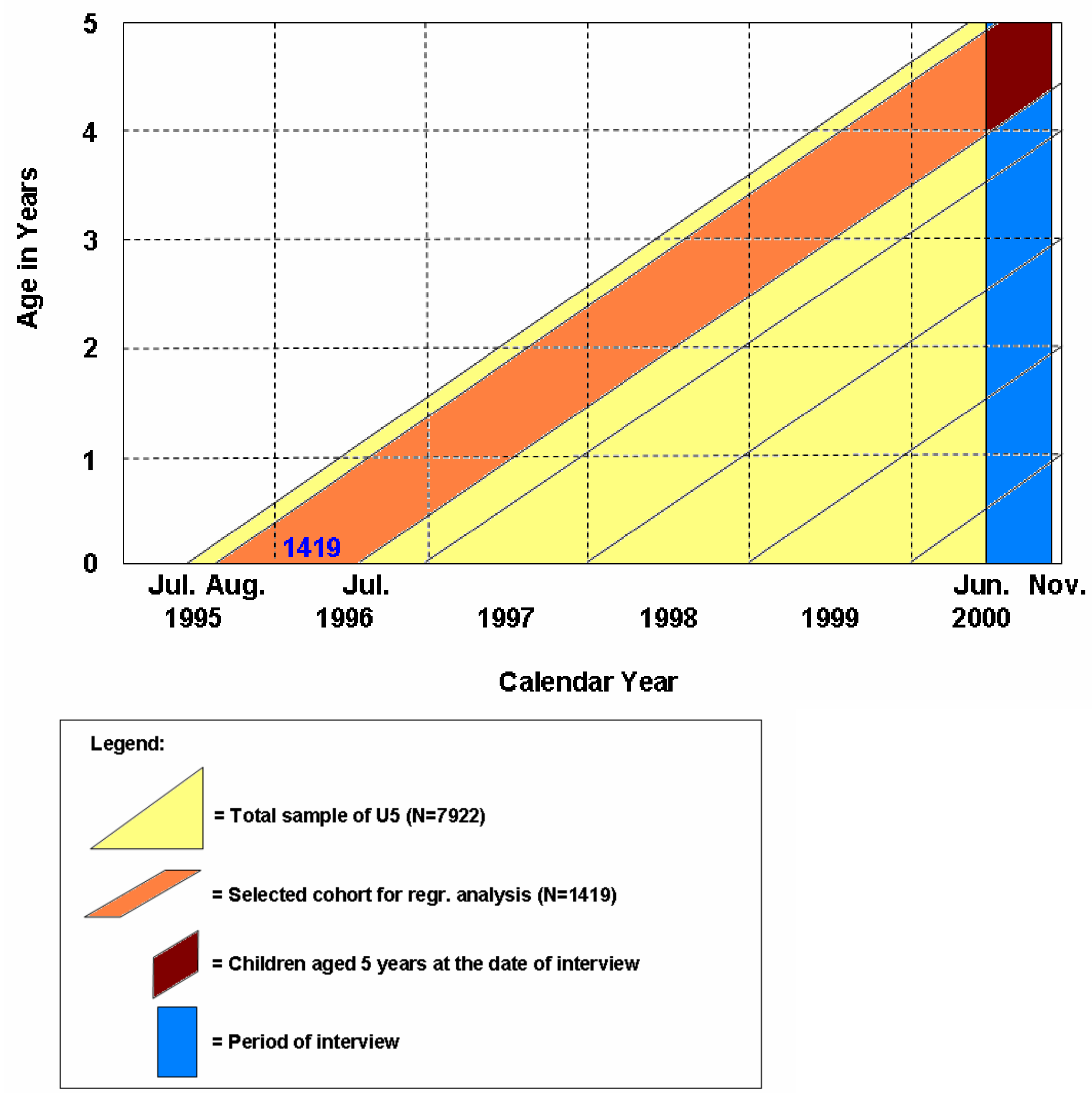
The direct factors involve the place of delivery of the mother, child ever having vaccination, the mother having had tetanus injection before birth, the possession of a health card by the mother, the child sleeping under mosquito net, mother's age in years at the time of the child's birth, the preceding birth interval, parity (total number of children ever born), the type of floor material, household members, source of drinking water, type of cooking energy, type of toilet facility and breastfeeding.

The indirect factors include mother's level of education as individual's socioeconomic variable, the frequency of listening to radio and the frequency of watching television as household socioeconomic variables and the place of residence as community socioeconomic variable.

III.3. Selection of the Sample

Six birth Cohorts (1995, 1996, 1997, 1998, 1999 and 2000) were registered between the year 1995 and 2000. The birth and survival histories of these cohorts being different, a combined analysis of all these cohorts would lead to a biased result. This would be caused by the fact that for instance the survival pattern over time of the 1995 wouldn't be the same as the 1998 or 1999 cohorts which are exposed to the risk of dying only one year or two before the time of observation (t2). The 1995 and 1996 cohorts are much more exposed to the risk of dying for a long period of time before the later cohorts were born. Added to this, the cause of death for infant (aged from 0 to 1 year who is more vulnerable) is not the same as children who are aged 2 and more years. Thus, this study will consider two types of sample for better results. First, the survival analysis will take into account all births (7922 children) along all calendar years. Second, further analysis (univariate and multivariate analysis of independent variables) will only take into account children who would be exactly 5 years at the time of interview. The observation of their survival pattern over time along this period will provide a reliable outcome and hence allow us to formulate useful recommendations. The following lexis diagram shows different cohorts, including the 1995 (August) and 1996 (July) which is the sample cohort for the next part of this study.

Figure 3: Lexis Diagram



This is a lexis diagram. It presents the birth history and the survival pattern over time of children who were born between July 1995 and November 2000. The blue column at the end of the diagram shows the period through which interview took place, this being between June and November 2000. The yellow parallelogram represents the cohort of interest for univariate and multivariate analysis and, for sake of analytical precision; it was set in the interval between August 1995 (where a significant number of registered births can be observed) and July 1996. This is a one year period of observation and will be extended to the rest of the years of interest of our analysis. At the time of interview (the red part of the parallelogram at the end of the parallelogram), as stated before, children surviving from this cohort will be more or less aged 5 years. On the basis of life tables and Kaplan Meier survival curves, a demonstration of the survival differences between the two different kinds of cohort-children will be made in the further part of this study. Children who are still alive after

November 2000 (the last month of interview) will be right censored and could be followed by another kind of specific study after the interview.

III.4. Methods of Analysis

III.4.1. Introduction

The first objective of this study is mainly to provide explanations on the survival pattern over time of under-five children in Rwanda. The second objective is to build a relationship between direct factors and the outcome measure (under-five mortality), these factors being, on the other hand modified to a certain extent by the indirect factors. The unit of my analysis includes all children born between 1995 and 2000 calendar years for the survival analysis and from August 1995 to July 2000 for the logistic regression.

The Life table and Kaplan Meier microanalysis will be used to estimate the survival or failure status of all children in my sample since January 1995 up to January 1999. This will allow to evaluate the probability of dying/surviving status of under five children in Rwanda and thus, to build a survival function.

After the lifeline will be built, the multiple logistics regression analysis will be used to understand the causes of each child's survival pattern over time and to sort out which of the independent factors influence the most, on the under-five mortality phenomenon in Rwanda. This analysis will help in building a relationship between the outcome variable (under-five mortality) and the measuring variables (direct and indirect explanatory variables) and thus, to answer to the following question: ***"What could be the causal relationship between direct and indirect factors and under-five mortality in Rwanda"?***

III.4.2. Analysis with Life Table and Kaplan Meier

The Life table and Kaplan Meier techniques will be used to estimate the survival and the failure probabilities of under-five children born between 1995 and 2000 calendar years. The life table will allow to depict survival ratios and Kaplan Meier method will be used to estimate the probability of dying (the hazard probability), the probability of surviving with median survival time. As mentioned earlier, these techniques will allow this research to provide a sex based survival pattern over time probability of dying or surviving in Rwanda for children born between August 1995 and July 1996 who are observed for a period of five years. At the end of this analysis, we will be able to make comments on the average survival or failure for either male or female children and thus, explain a difference in probabilities of surviving for both sexes. The intention here is mainly to build a lifeline for each child. This method lead to the answer of the following research question**: *"What is the survival pattern over time of under-five children in Rwanda and what is the effect of a child's sex on this status*"?**

The life table tool will allow making a survival analysis of under-five cohort of children with a fixed length of intervals of time (3 months in our case). The SPSS table results will help in clarifying the hazard rate (the probability of dying) for both male and female children.

According to D. Collett (1999) in her book entitled Modeling Survival Data in Medical Research, the KAPLAN MEIER estimate of survivor is given by the following formulas:

A. The Survival Probability along a Specified Observational Time

$$\hat{S}(t_g) = \prod_{i=1}^{g} \left(\frac{n_i - d_i}{n_i} \right)$$

$\hat{S}(t_g)$ being the survival function on the basis of the observation time (t) which is equal to 5 years for our case and to (g) which expresses the failure times amongst all the cohort of children born in 1995, g being inferior or equal to n $(g \leq n)$.

n_i Is the total number of children alive at the start of the observational interval (392 in our case, children from the sample who were born in 1995).

d_i is the number of children who died during the time interval.

B. The Hazard Function

$$\hat{H}_t = \frac{d_i}{\{n_i(t_{i+1} - t_i)\}}$$

$\hat{H}_t$ is the probability that an individual dies at or just after time t, if and only if he or she has survived to that time. It represents the instantaneous death rate for an individual surviving to time t. It shows the overall survival pattern, the hazard pattern and differences between observed groups (male and female children in our case) before further model fitting.

III.4.3. Analysis with Univariate and Multivariate Logistics Regressions

The univariate analysis allowed us to explain the effect of each independent variable on the outcome variable (under-five mortality in our case). This relationship will allow a sound selection of variables having a significant effect on under-five mortality in Rwanda. The multiple logistics regressions helped to identify useful variables in making the prediction of the hypothesis. This means that, on the basis of a set of independent variables (e.g. the level of education of the mother, the place of delivery…) helped to know the effect of each independent variable when controlling for other variables in predicting a binary dependent variable (child surviving or dying in our case) for a specific time period (5 years for this analysis).

Marija Norusis (1990) explains that multiple regression analysis and discriminant analysis are two techniques that can help in explaining a binary dependent variable from a set of independent variables. However, she shows that these two techniques pose difficulties when the dependent variable have only two values(binary-an event occurring or not occurring), which would lead the analyst to interpret predicted values as probabilities when on the other hand for the multivariate logistic regression analysis, these values are not constrained to fall in the interval between 0 and 1.

As a solution to this problem, the use of the logit function helps in refining the relationship between the binary dependent variable and a set of more than one independent variable. For the context of this study, the logit and the estimates of its probability are presented below:

$\text{Logit}(y) = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \ldots\ldots\ \beta zXz$

P(y=1-the probability of dying for a child) =
$EXP\{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \ldots \beta zXz\}/1+EXP\{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta zXz\}$. Y is a binary dependent variable and is defined through 2 dichotomies as follow: Y= 1 if child is died and y= 0 if child survived.

X represents values of independent variables (direct and indirect factors to under-five mortality) whereas βi expresses coefficients of the independent variables and measures the effect of Xi on the odds (the chance-the probability) that a child dies (y= 1). The basic formula for the analysis with logistic is (P/1-P= ExpBo*ExpB1X). P/1-P expresses the probability of success of an event (the probability of child to die) divided by the probability of no event happening-not dying in our case. ExpB (Exponential B) values represent the odds ratio and measures the degree of change in odds for every one unit increase in the independent variables.

The odds ratio (ExpB) is useful in this analysis for comparing the effect of two or more independent variables (here under-five mortality risk factors) on the dependent variable (here child dead or alive).

- If ExpB value (or OR) is less than 1, it means that the probability of a child to die decreases when associated to the concerned independent variable
- If Exp (B) is more than 1 the odds (the likelihood) of children dying is greater for one unit of increase in the corresponding independent variable
- If Exp (B) is equal to 1, the probability of dying is not influenced either negatively or positively by the referred variable.

CHAPTER IV. RESULTS OF THE ANALYSIS

IV.1. Introduction

This section presents details on the outcome of the analysis. The life table, Kaplan Meier and survival curves will give the survival pattern over time in Rwanda. Descriptive statistics (frequencies and cross-tabulations) will allow us to test the relationship between variables and the dependent variable (under-five mortality).

The Life table, the Kaplan Meier and survival curves analysis will take into account all children born between July 1995 and November 2000, which means 7922 children. With the intention of maximizing accuracy of my results, 1419 children born between August 1995 and July 1996 will be considered in the logistic regression and the log-linear regression analysis. Only children born within this period had reached the highest age at the date of interview and thus, the length of exposure to risk of dying is long compared to other children.

IV.2. Survival Pattern Over Time of Under-five Children in Rwanda

The life table and Kaplan Meier plot (survival curve) were used to provide an explanation to the first question of this research:

"***What is the survival pattern over time of under-five children in Rwanda, and what is the effect of a child's sex on this status"?***

The Life Table for the Whole Country Sample (n=7922)

Table 3: Life table for male children

```
This subfile contains:    7922 observations
```

Life Table
Survival Variable DURATI_B Duration
for B4 Sex of chil = 1 Male

Intrvl Start Time	Number Entrng this Intrvl	Number Wdrawn During Intrvl	Number Exposd to Risk	Number of Termnl Events	Propn Termi-nating	Propn Sur-viving	Cumul Propn Surv at End	Proba-bility Densty	Hazard Rate
,0	4006,0	186,0	3913,0	239,0	,0611	,9389	,9389	,0204	,0210
3,0	3581,0	213,0	3474,5	63,0	,0181	,9819	,9219	,0057	,0061
6,0	3305,0	243,0	3183,5	64,0	,0201	,9799	,9034	,0062	,0068
9,0	2998,0	226,0	2885,0	41,0	,0142	,9858	,8905	,0043	,0048
12,0	2731,0	196,0	2633,0	51,0	,0194	,9806	,8733	,0057	,0065
15,0	2484,0	208,0	2380,0	24,0	,0101	,9899	,8645	,0029	,0034
18,0	2252,0	160,0	2172,0	27,0	,0124	,9876	,8537	,0036	,0042
21,0	2065,0	114,0	2008,0	1,0	,0005	,9995	,8533	,0001	,0002
24,0	1950,0	144,0	1878,0	34,0	,0181	,9819	,8379	,0051	,0061
27,0	1772,0	146,0	1699,0	4,0	,0024	,9976	,8359	,0007	,0008
30,0	1622,0	139,0	1552,5	3,0	,0019	,9981	,8343	,0005	,0006
33,0	1480,0	141,0	1409,5	,0	,0000	1,0000	,8343	,0000	,0000
36,0	1339,0	150,0	1264,0	18,0	,0142	,9858	,8224	,0040	,0048
39,0	1171,0	185,0	1078,5	,0	,0000	1,0000	,8224	,0000	,0000
42,0	986,0	175,0	898,5	,0	,0000	1,0000	,8224	,0000	,0000
45,0	811,0	132,0	745,0	,0	,0000	1,0000	,8224	,0000	,0000
48,0	679,0	203,0	577,5	3,0	,0052	,9948	,8181	,0014	,0017
51,0	473,0	186,0	380,0	,0	,0000	1,0000	,8181	,0000	,0000
54,0	287,0	145,0	214,5	,0	,0000	1,0000	,8181	,0000	,0000
57,0	142,0	142,0	71,0	,0	,0000	1,0000	,8181	,0000	,0000

The median survival time for these data is 57,00+

Table 4: Life table for female children

Life Table
Survival Variable DURATI_B Duration
for B4 Sex of child = 2 Female
Number Number Number Number Cumul

Intrvl Start Time	Entrng this Intrvl	Wdrawn During Intrvl	Exposd to Risk	of Termnl Events	Propn Termi-nating	Propn Sur-viving	Propn Surv at End	Proba-bility Densty	Hazard Rate
,0	3916,0	164,0	3834,0	188,0	,0490	,9510	,9510	,0163	,0168
3,0	3564,0	207,0	3460,5	62,0	,0179	,9821	,9339	,0057	,0060
6,0	3295,0	213,0	3188,5	61,0	,0191	,9809	,9161	,0060	,0064
9,0	3021,0	222,0	2910,0	43,0	,0148	,9852	,9025	,0045	,0050
12,0	2756,0	191,0	2660,5	43,0	,0162	,9838	,8879	,0049	,0054
15,0	2522,0	208,0	2418,0	23,0	,0095	,9905	,8795	,0028	,0032
18,0	2291,0	135,0	2223,5	21,0	,0094	,9906	,8712	,0028	,0032
21,0	2135,0	98,0	2086,0	2,0	,0010	,9990	,8703	,0003	,0003
24,0	2035,0	148,0	1961,0	28,0	,0143	,9857	,8579	,0041	,0048
27,0	1859,0	172,0	1773,0	3,0	,0017	,9983	,8565	,0005	,0006
30,0	1684,0	152,0	1608,0	1,0	,0006	,9994	,8559	,0002	,0002
33,0	1531,0	160,0	1451,0	2,0	,0014	,9986	,8548	,0004	,0005
36,0	1369,0	163,0	1287,5	13,0	,0101	,9899	,8461	,0029	,0034
39,0	1193,0	165,0	1110,5	,0	,0000	1,0000	,8461	,0000	,0000
42,0	1028,0	165,0	945,5	,0	,0000	1,0000	,8461	,0000	,0000
45,0	863,0	138,0	794,0	,0	,0000	1,0000	,8461	,0000	,0000
48,0	725,0	167,0	641,5	2,0	,0031	,9969	,8435	,0009	,0010
51,0	556,0	178,0	467,0	,0	,0000	1,0000	,8435	,0000	,0000
54,0	378,0	207,0	274,5	1,0	,0036	,9964	,8404	,0010	,0012
57,0	170,0	170,0	85,0	,0	,0000	1,0000	,8404	,0000	,0000

The median survival time for these data is 57,00+

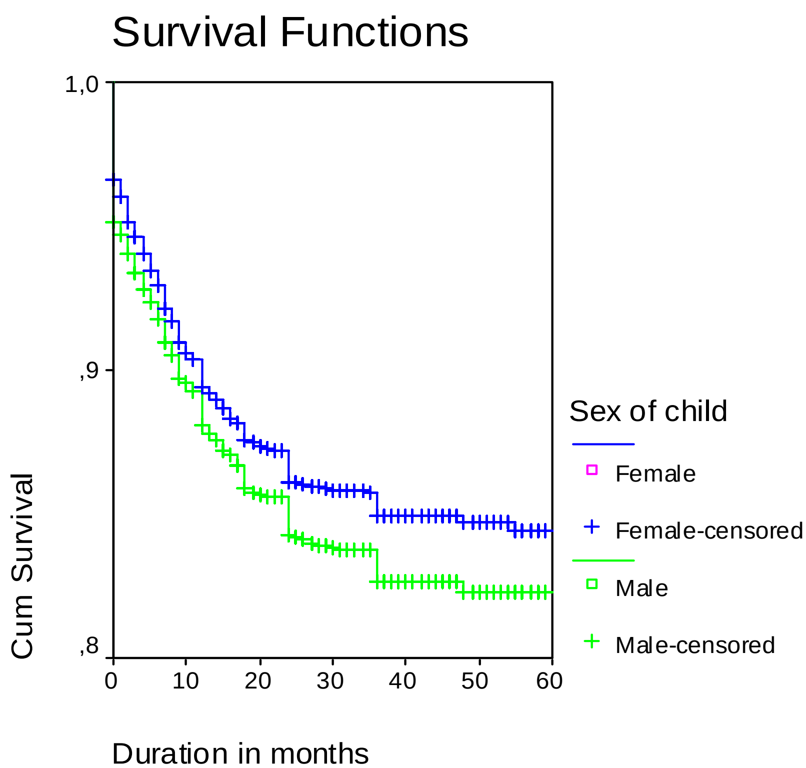
The tables above show hazard rates of dying for under-five children at the beginning of the interval and goes on decreasing with the time. This means that there are many children who die in early childhood and the chance of surviving at this age is thus very low though it increases with the time. This is observed for both male and female children but with a mere less probability for female children. This is explained by hazard rates for the two sexes whereby the hazard rate of dying for male children is 0.0210 and the hazard rate of dying for female children is 0.0168.

The probability of dying in infancy which could be extrapolated for the rest of the months since it goes decreasing down from 0.0210 and 0.0168 for male and female children respectively. This outcome of the life table doesn't differ very far from the results of the frequencies on the computed event (child dead or not). This event shows that at the end of the observation, 13.4% out of 7922 children died along the observational time (5 years).

The male-female differential can also be interpreted from the following survival curve, which reflects the sex difference based survival probability of under-five children in Rwanda.

A. Kaplan Meier Survival Functions for the Whole Sample

Figure 4: Survival curve for the whole sample (N=7922)



The regression lines in this table explain the cumulative survival pattern over time of under-five children in Rwanda for the whole sample of our analysis (7922 children). The two regressive curves represent male (green curve) and female (blue curve). The sharp regression line at the beginning means that there was a high death rate of male children along the first month of birth compared to female children. Though there are children surviving at the end of the of the 60th month, this curve shows that the mortality rate for male children is high compared to female even if mortality rates for the two were almost parallel along the first 10 months. This could be explained by the above mentioned difference in terms of hazard rates.

IV.3. Survival status for Selected Sample (N=1419)

Table 4: Selected sample of children for logistic regression

Child is alive

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	240	16.9	16.9	16.9
	Yes	1179	83.1	83.1	100.0
	Total	1419	100.0	100.0	

The rate of mortality for the selected sample doesn't differ much with 13.4% of the total sample (7922 children). The difference of 3.5% (16.9% for the selected sample minus 13.4% for the total sample) could be explained by the fact that among the total sample, many children were born one year or some months before the interview and were not exposed to all calamities and risks that the children under analysis underwent for about 5 years. It is obvious that many of them died along this time period and thus lead to an increment of the mortality rate for this specific group of children.

This is the image (picture of survival pattern over time) of under-five children in Rwanda for cohorts of children born between 1995 and 2000.

From the above results, the high mortality rates for under-five children in Rwanda as demonstrated by parameters of the Rwanda Demographic and Health Survey is generally high mortality in infancy with high rates of dying registered in infant boys compared to infant girls.

The second part of this study intends to provide an answer to the following question:

What could be the contribution of the direct and indirect under-five mortality determinants in explaining this high rate of under-five mortality in Rwanda?

The Cross-tabulation results and Descriptive statistics, the univariate and multivariate analysis will allow finding an answer to the above question.

IV.4. Cross-tabulation Results

A. Sample Selection by Sex

With the intention of maximizing accuracy for this research, a cohort of 1419 births registered between August 1995 and July 1996 were selected among others and this study analyzed their survival status at the day of interview (between June and November 2000), almost 5 years of time starting from their birthdates. These children were divided into male and female as following:

Table 5: Sample selection by sex

Sex of child

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	684	48.2	48.2	48.2
	Female	735	51.8	51.8	100.0
	Total	1419	100.0	100.0	

Among the 1419 selected children, 51.8% were female whereas 48.2% are male. Recall that these are only children who were born between August 1995 and July 1996 and who will be a target of this study. Both univariate and multivariate analysis will focus on the above sample.

IV.5. Descriptive results

Table 6: Frequency distribution of all Variables in the Analysis and their Relationship with child survival (Binary child alive or dead)

		Binary Child alive	
	Frequency	NO (%)	Yes (%)
I. DIRECT FACTORS			
i. Illness Control Variables			
Place of delivery			
* Hospital, Clinics	482	68 (**14.1**)	414 (**85.9**)
* Home &other places	916	166 (**18.1)**	750 **(81.9)**
* Missing	21		
Mother received Tetanus injection before birth			
* Yes	283	28 **(9.9)**	255 **(90.1)**
* No	107	12 **(11.2)**	95 **(88.8)**
* Missing	1029		
Children U5 slept under mosquito net			
* Yes	120	13**(10.8)**	107 **(89.2**)
* No	24	1**(4.2)**	23 **(95.8)**
* Missing	1275		
ii. Maternal Variables			
Mother's age in years			
* Lowest through 18	79	17**(21.5)**	62**(78.5)**
* 19 through 34	1042	181**(17.4)**	861**(82.6)**
* 35 through Highest	298	42**(14.1)**	256**(85.9)**
Preceding Birth interval in months			
* Lowest through 23	306	87**(28.4)**	219**(71.6)**
* 24 through 36	394	59**(15)**	335**(85)**
* 36 through highest	363	40**(11)**	323**(89)**
* Missing	356		
Parity			
* 1 through 5(1)	941	153**(16.3)**	788**(83.7)**
* 6 through 10 (2)	451	82**(18.2)**	369**(81.8)**
* 11 through 13(3)	27	5**(18.5)**	22 **(81.5)**
iii. Environmental variables			
House floor material			
* Improved (Cement…)	247	28**(11.3)**	219**(88.7)**
* Others (rudimentary…)	1172	212**(18.1)**	960**(81.9)**
Household members			
* 2 through 5	688	163**(23.7)**	525**(76.3)**
* 6 through 10	689	74**(10.7)**	615**(89.3)**
* 11 through 18	41	3**(7.3)**	38**(92.7)**
* Missing	1		

		Binary Child alive	
Source of drinking Water			
* Piped water	537	91**(16.9)**	446**(83.1)**
* Open well water, river, lake…	882	149**(16.9)**	733**(83.1)**
Type of cooking energy			
* Modern	7	0	7 **(100)**
* Traditional	1392	238**(17.1)**	1154 **(82.9)**
* Others	20	2(10)	18 **(90)**
Toilet facility in the household			
* Flush toilet	19	2**(10.5)**	17**(89.5)**
* Pit or traditional toilet	1339	229**(17.1)**	1110**(82.9)**
* Missing	616		
iv. Nutrient deficiency variables			
Breastfeeding			
* Breastfed(95-96)	71	0**(0)**	71**(100)**
* Never breastfed(94)	41	31**(75.6)**	10**(24.4)**
* Missing	1307		
Size of the child at birth			
Very large (1 through 2)(1)	459	73**(15.9)**	386 **(84.1)**
Average(3)(2)	800	128 **(16)**	672 **(84)**
Very small (4 through 5) (3)	160	39**(24.4)**	121 **(75.6)**
II. INDIRECT FACTORS			
i. Individual level variables			
Mother's level of education			
* Primary or no education	1238	221**(17.9)**	1017 **(82.1)**
* Secondary and higher	181	19**(10.5)**	162 **(89.7)**
ii. Household level variables			
Frequency listening Radio			
* Not often(3)	390	61**(15.6)**	329 **(84.4)**
* Regularly(0-2)	1029	179**(17.4)**	850 **(82.6)**
Frequency watching TV			
* Not often (3)	48	5**(10.4)**	43**(89.6)**
* Regularly(0-2)	1364	234**(17.2)**	1130**(82.8)**
* Missing	7		
iii. Community level variables			
Type of place of residence			
* Urban (1)	306	39**(12.7)**	267**(87.3)**
* Rural (2)	1113	201**(18.1)**	912**(81.9)**
Reason/delay taking child to hospital			
* Illness not serious	97	14**(14.4)**	83**(85.6)**
* others(no money for transport treatment)	1322	226**(17.1)**	1096**(82.9)**

The outcome of descriptive statistics and frequencies here above demonstrates the plausibility of Mosley and Chen's hypothesis. Tested variables in the prediction of under-five mortality show differences based on Mosley and Chen's theory on determinants of under-five mortality.

Frequency under-five mortality distribution for direct factors

Frequency percentages for illness control variables

As far as the place of delivery is considered, 18.1% out of 14.1% born in hospitals or clinics of children who were born at home had already died at the day of the interview. From this fact, it is presumable that a pregnant woman being followed and assisted by health professionals when delivering would have saved 4% of children from death in Rwanda.

The mother receiving Tetanus injection vaccination has 1.3% difference in the number of under-five children who died between the total numbers of children who died from mothers who didn't receive this injection subtracted to the total number of children died from mothers who received this injection. The outcome of the frequencies on the binary child being alive or dead when Tetanus injection before is considered as under-five mortality predicting variable shows that 11.2% of children whose mothers didn't go for tetanus injection died when only 9.9% of those whose mothers benefited from this injection died.

As mentioned before and as demonstrated by many researchers, malaria is the leading cause of child mortality in general and in Rwanda particularly. A child sleeping under a well impregnated mosquito net is saved from this risk. But this is not obvious in the case of Rwanda, at least when answers from the Rwanda Demographic and Health Survey are considered. According to the above frequency table, there is a 6.6% difference of under-five mortality when sleeping and not sleeping under mosquito net is taken into account. About 10.8% of children whose mother certified that they slept under mosquito net died out of only 4.2% of children whose mothers mentioned that their children died. Of course, this would be caused by a big gap between the numbers of women who responded for children sleeping under mosquito net or not and also by a big number of missing cases (1275 out of 1419 respondents) on this variable. We will see whether it will possible to make a final observation on this variable in further analysis (univariate analysis and multivariate).

Frequency percentages for maternal variables

The age of the mother is another leading factor in child survival. Researchers have ascertained and demonstrated several cases of child mortality for women giving birth at high risky age (below 18 years and after 35 years). In our case, the outcome percentages of children dying are 21.5%, 17.4%, and 14.1 for mothers aged below 18 years, aged between 19 and 34 years and aged between 35 and higher respectively. Though age 35 and higher is also considered as a risky age, aged mothers are more experienced in taking care of children and this increases the chances for their children to survive compared to young mothers aged below eighteen.

Scientists demonstrated that the length of preceding intervals between births has an effect on the welfare and survival of infant and children. The World Health Organization report (1997) recommended a 24 months succeeding birth interval to insure a healthy status to both the succeeded and preceded child. Frequencies presented in the above table on this variable adopt this point of view. Differences in under-five mortality decrease as the duration of the birth interval increases. Twenty eight per cent (28%) of children born before 2 years had died at the date of interview, fifteen (15%) of children succeeded between 2 years and 3 years succumbed and only eleven per cent(11%) of those whose succeeding birth occurred over three years had died before they had their fifth birthday.

From the whole selected sample of children (1419), 16.3% of children who were born between the first and the fifth parity died when on the other side, 18.2% of those who were born between the sixth parity and over died.

Frequency percentages for environmental variables

As far as environmental related variables are concerned, only house floor material variable, the type of cooking energy (commented on at the beginning) and toilet facility available in the household show significant percentages. For example, children born in houses with improved house floor material like cement and other improved material have a lower percentage (11.3%) compared to the percentage of children born in houses with rudimentary floor material like sandy floor going up to a high rate of 18.1%. When the type of toilet facility existing in the household is considered, 17.1% of children born in households where pit or traditional toilets had died at the day of interview compared to 10.5% of children born in households where flush toilets are used who had died at the day of interview.

The size of household members percentages go the other way around and households with fewer members registered more under-five percentages of deaths, and these decreased as the number of household members increased. May be this is caused by the fact that houses declaring to have less members have lost many children before the interview or the opposite for those declaring a big size of household members. Real analysis still has what to tell us on insatisfaction in the explanations on percentages we got from the frequency table, given that these are only numbers presented in percentages to provide an insight the relevance of selected variables in explaining under-five mortality and not the analysis itself.

The mortality percentages for children whose mothers declared to get drinking water either from the piped water or open well water doesn't give any difference. It is the same everywhere with 16.9% of children dying.

Frequency percentages for nutrient deficiency variables

There is also a possibility that the size of the child at birth factor (one of the nutrient deficiency variables including breastfeeding) show itself (in further analysis) to be a predictor to under-five mortality in Rwanda. The frequency table shows that children who were born with a very large size and average size respectively show 15.9% and 16% of children who had died at the day of interview when on the other hand, 24.4% of children who were born with a very small size had died at the day of interview. The welfare of the child before birth depends more on the health of his/her mother and the health of the mother depends on her socioeconomic status and on her level of education. Getting nutrient food and drinks depend on the capacity of the mother or of her partner to provide with it. This variable was selected as a proxy determinant for the body mass index for the child. Further explanation on this factor will be provided in following stages of the analysis.

Frequency under-five mortality distribution for indirect factors

Frequency percentages for individual level variables (mother's educational level)

Indirect factors also provide a certain insight on the number of children who died at the age of under-five in Rwanda.

Mothers with primary or no education level registered a high percentage (17.9%) of children under-five dying in Rwanda compared to percentages presented by women with secondary or higher (10.5%). This explains Mosley and Chen's theory explaining that the higher education level of the mother, the lower the probability of under-five mortality because an educated mother knows well where services related to child survival are and knows also how to use them.

Frequency percentages for household level variables (frequency listening to Radio, frequency watching TV)

Women who listened regularly the radio or watched regularly TV registered a high rate of under-five mortality compared to those who did not do this often.

Frequency percentages for community level variables (Place of residence)

According to the table still, children whose parents live in rural areas registered a high percentage of under-five mortality (18.1%) compared to those whose parents live in urban areas with low rate (12.7%) of under-five children who died before the interview.

Some children died because parents delayed to take them to treatment or because ignorance of the seriousness of the disease. Mothers who registered 17.1% of children who died declared that this was because they didn't have money for transport or for treatment. The rest of women judged the disease which killed the child was not serious.

The type of cooking energy used in the house where the child were born and the breastfeeding status of the child show particularly high rates of under-five child survival and failure.

All children (7) born in houses where modern cooking energy is used survived. Seventy one children who were breastfed more than 6 months survived all at the date of interview whereas 75.6% of those who were never breastfed succumbed.

These two variables thus show a strong effect on the survival status of children in Rwanda. Differences in the rest of variables are not that too high but of course they give an insight on the phenomenon.

IV.6. Results of the Univariate Logistic Regression Analysis

IV.6.1. Introduction

The first question of this research having been answered in the first part of this analysis, the rest of the study (univariate analysis, multivariate analysis and combined effect analysis) will allow us to explain the relationship existing between each independent variable and the outcome variable. This relationship will allow a sound selection of variables having a significant effect on under-five mortality in Rwanda. Both direct and indirect factors will be analyzed and hence, at the end of the analysis the following research question will be answered: ***"What could be the causal relationship between direct and indirect factors and under-five mortality in Rwanda"?***

IV.6.2. Influence of Direct Factors (Illness control variables, maternal variables, environmental variables and nutrient deficiency variables) on Under-five Mortality in Rwanda

A. Effect of the Control Illness Variables

Table 7: Place of delivery of the child's mother and under-five mortality

Variable	Exp(B)-Odds ratio	Significance level
Place of delivery (ref-cat)--home	4.518	0.000
Place of delivery (1)—hospital and clinics	1.348	0.057

The above table gives information on existing effect between place of delivery and under-five mortality in Rwanda. Given that the criterion used to judge the significance level of variables is 0.05, the place of delivery is not significant at all given that it is

>0.05. In overall, this variable influences significantly under-five mortality with a high significance level of 0.000 and a very high odds ratio of 4.518.

As this analysis dealt mainly with backward selection procedure in factor selection along the analysis, the last category for each term was considered as a reference category of the analysis. The place of delivery having 2 categories (the first one referring to children born in hospitals or clinics and the second referring to children born at home), the second (children born at home) was considered to be a reference category and leads significantly to under-five mortality. Recall that for the frequencies percentages this variable registered a slightly high percentage of children dying when born at home (18.1%) compared to children who were born in hospitals or clinics with a death percentage of 14.1%.

As far as category 1 is concerned (children born in hospitals or clinics), this category misses a small chance of being significant if compared to the overall significance level with a p=0.057 with an odds ratios of 35% higher compared to the baseline category. So, this leads us to state that the first category (if it was significant) would lead to 35% higher chances of causing under-five mortality in Rwanda if compared to the reference category.

Table 8: Tetanus toxoid immunization of the mother before the birth of the child

Variable	Exp(B)-Odds ratio	Significance level
Mother received tetanus toxoid injection before birth (ref-cat)--no	9.107	0.000
Mother received tetanus toxoid injection before birth (1)-- yes	0.869	0.701

The tetanus injection of the mother before birth is a categorical variable with yes or no categories. The first category was a "yes" whereas the second category was a "no". Hence the second category was considered by the SPSS as a baseline category given that it is the last category. As other reference categories, it is highly significant. The first category (mother of the child receiving tetanus injection before birth) would have 15% less likely to cause under-five mortality in Rwanda given that its odds ratio is 15%(1-0.869) compared to the reference category which is considered to predict with 100% the whole model. The log odds of a child dying regressed against the tetanus toxoid immunization of the mother before the child was born show a non-significant value(sig. = 0.7) which is superior to p value (given that p=0.05). Since it is not significant, there is no need to delay on it.

Table 9: Under-five children slept under mosquito net

Variable	Exp(B)-Odds ratio	Significance level
Child slept under mosquito net (ref-cat)--no	22.911	0.002
Child slept under mosquito net (1)--yes	0.359	0.335

According to the UNDP-RWANDA, Millennium Development Goals progress report (2003), malaria is the leading cause of under-five mortality in Rwanda. Sleeping under mosquito net is a prior alternative in protecting children and their mothers against the risk of being affected by malaria. The table above is an outcome of SPSS univariate analysis of the variable "children under-five slept under mosquito net" and has yes or no categories and hence considered as a categorical variable. Applying backward selection, SPSS considered the second category (with a no answer) as a reference category and allocated to it maximum odds ratios of causing under-five mortality in Rwanda. This same category was thus considered as an overall category and is highly significant. The first category related to a child sleeping under mosquito net(yes) is not significant with a significance level of 0.335 which is far superior to the significance level of the model(p=0.05). This same category showing Exp(B) values of 0.359 would be said to be 64% less likely to cause under-five mortality in Rwanda if compared to odds ratios of the reference category (Exp(B)=22.911)) if it was significant. The nonsignificance of categories of this variable leads to its rejection in further analysis.

B. Effect of Maternal Variables

Table 10: Mother's age in years

Variable	Exp(B)-Odds ratio	Significance level
35 through 45(ref-cat)	6.092	0.000
Lowest through 18	0.599	0.109
19 through 34	0.781	0.182

Mother's age at birth was referred to in 3 categories. Mother's aged below up to 18 years old (14-18 years old), those aged between 19 years up to 34 years and those age between 35 to 45 years old. With a backward SPSS selection process, the third category was considered as a reference category and is highly significant due to the fact that it represents the overall significance level of the whole term. But, the rest of the categories are not here significant with respective significance level values of 0.109 and 0.182. For mothers age between 14 and 18 years old, the odds ratio of causing under-five mortality in Rwanda is 40% lesser compared to the baseline category (women aged between 35 and 45 years old). For mothers aged between age 19 and 34 years old, the odds ratio of influencing under-five mortality is estimated to

22% lesser compared to the baseline influence (100%). But the influence of these categories is not significant and hence allows us to conclude that this factor doesn't influence significantly under-five mortality in Rwanda.

Note that the cross tabulation results presented cascading scores as the age of the mother increased, meaning that the more the age of the mother, the less the rate of under-five mortality. One would say that the results of the odds ratio matches with the outcome of descriptive frequencies in that the lower the age of the mother implies a high percentage of under-five deaths. Also, considering that 21.5% of under-five children who died were born from mothers who were lower or equal to 18 years of age, and 17.4% of children who died from mothers who were aged between 19 and 34 years whereas only 14.1% of under-five deaths occurred to children whose mothers were 35 years of aged or over.

Table 11: Mother's preceding birth interval

Variable	Exp(B)-Odds ratio	Significance level
Birth interval(ref cat)—between 36 months and higher	8.075	0.000
Birth interval (1)—lower than 23 months	0.312	0.000
Birth interval (2)—between 24 and 36 months	0.703	0.108

Apart from birth interval lower than 23 months and between 24 and 36 months, the interval included between 36 months and higher was considered as a reference category and is highly significant(sig.= 0.000) with predicted odds ratios of 8.075. The outcome of the univariate analysis on the other hand shows that the first category (birth interval lower to 23 months) is also significant (sig. =0.000) and has an odds ratio which is 69% lesser compared to the overall category. This meaning that it is 69% less likely to cause under-five mortality in Rwanda. The second category (birth interval included between 24 and 36 months) is not significant with a significance value of 0.108 and Exp (B) value of 0.703. The above information on odds ratios and significance level explains that on the basis of the reference category, only the birth interval lower than 23 months explains significantly under-five mortality. This means that one additional birth below 23 months lessens the survival probability of 69% for this extra child. Note that this category has demarcated itself with a high percentage of under-five children dying in the descriptive analysis.

The descriptive frequency analysis results demonstrated that different birth intervals between births, presented respectively 28.4%, 15%, 11% of under-five deaths for children with less than 23 months of interval, for children with 24 and 36 months, and more than 36 months of birth interval. This predictor variable is totally significant because the significance level (sig. =0.000) is less than the p value of the study (p=0.05) at least for the birth interval below or equal to 23 months, the second birth interval (24-35 months) being not significant.

Table 12: Parity (Number of children per mothers)

Variable	Exp(B)-Odds ratio	Significance level
Parity (ref cat)—eleven to eighteen children	4.400	0.003
Parity (1)—one to five children	1.170	0.755
Parity (2)—six to ten children	1.023	0.965

Parity refers, in terms of this study to the total number of children ever born from a mother up to the date of interview. The number of children ever born were classified into three categories (1 to 5 being the first category, 6 to 10 being the second category and 11 to 18 being a third category). The rule of the game for SPSS in this study is to consider the third class as a reference category because of the backward elimination process.

This predictor as the previous one shows itself to be not significant as well if we consider the significance level (p=0.05) and the actual significance values which are 0.755, 0.965 and 0.654. The descriptive frequencies on the other part show that the increase in the birth interval between births would lead to a less number of children who die if we compare mortality rates of 16.3.4%, 18.2%, 18.5% of deaths for children with less than 23 months of interval, for children with 24 and 36 months, and more than 36 months of birth interval respectively.

As far as Exp. (B) values are concerned, parity (1) shows 1.170 log odds; this meaning that it has 17% higher probability of causing under-five mortality if it is compared to the overall category. Parity (2) shows 1.023 log odds of dying when aged under-five and this means that this parity has a contribution of only 2% of causing under-five mortality if compared to the baseline category. All these categories are not significant and don’t predict this model in fact.

C. Effect of Environmental Variables

Table 13: Mother's house floor material

Variable	Exp(B)-Odds ratio	Significance level
House floor material(ref-cat)	4.528	0.000
House floor material (1)	1.727	0.011

The house floor material as a predictor to under-five mortality was classified among environmental variables. The type of floor material of the house a child is born or lives in can increase her/his chances of dying or surviving due to the fact that a house's wall, floor and roof materials can allow or prevent a safe breathing. For a new born child who is more vulnerable, this environment leads to her/his suffocation (lack of air to breath) that could cause death. It was subdivided into two main categories. The first category refers to improved house floor category (cement…) and the second relates to the rudimentary house floor material (sand…).

As SPSS did for other factors, the last category (here the second-rudimentary house floor material) was considered as a reference category. Category 1 output presents an Exp. (B) value which is more than 1 (Exp.(B)=1.727)). The odds ratio of 1.727 explains that a child being born or sleeping in a house with modern (improved) house floor material increases his chances of surviving of 73 % compared to the overall contribution of the reference category. The cross-tabulation outcome shows almost similar results where 18.1% of children born in houses with rudimentary house floor material out of 11.3% of children born in improved floor material died. This variable is significant with a p value of 0.011 less than the value of significance for the whole model (p=0.05).

Table 14: Household members of the house in which the child was born and lives

Variable	Exp(B)-Odds ratio	Significance level
Household members(ref-cat)—Eleven and more members	12.665	0.000
Household members(1)--one to five members	0.254	0.024
Household members(2)--five to ten members	0.656	0.491

The household members refer to the number of individuals living in the household in which a child was born and live. It was subdivided into three main categories.

Category one relates to the range going from 1 to 5 individuals, category two refers to the range going from 6 to 10 individuals and category three regroups members included in the range between eleven members to eighteen members. As ordinary, the third category was considered as a reference category.

The confusion we had in the results of descriptive statistics where we actually saw a big number of children dying with the range of one to five household members compared to other range and the outcome variable (under-five mortality) is here liaised. In our case, only the overall category (the third category) and the first category predict significantly under-five mortality in Rwanda. The second category is not significant and thus will not be considered in further analysis. The baseline category has registered a significance level of 0.000 whereas the first category has registered a significance level of 0.024 (for household members going between 2 and 5). Household members numbering between 11 and 18 members present a non significant value of 0.491. The odds ratio(Exp(B)) value of the first category explains that the addition of one extra member in a household decreases the chances of under-five children to survive of 75% (Exp(B)= 0.254)).Though category 2 has an Exp(B) value of 0.656 its level of significance rejects this category among those that would determine under-five mortality in Rwanda.

Table 15: Source of drinking water in the household where the child was born and live

Variable	Exp(B)-Odds ratio	Significance level
Source of drinking water (ref-cat)—river, lake, rain…	4.919	0.000
Source of drinking water (1)—piped water source	0.996	0.980

The source of drinking water includes patterns of water used in the household where a child was born and lived along the period of retrospection departing from the date of interview (from July 1995 to November 2000 to more precise). These patterns were categorized into different sources. These sources include piped water source as the first category and open water source (river, lake, rain…) as the second category. SPSS considered the second water source as the reference category and is highly significant (sig. = 0.000) as other reference categories and has an odds ratio of 4.919 (100% of chances for causing under-five mortality).

The odds ratio (Exp (B)) of the source of drinking water variable is equal to 0.996 for the first source of drinking water (piped water), which is only 0.004% lower compared to the baseline category. Nevertheless, this variable is not significant once it has a significance value of 0.980 which is more than 0.05. It doesn't influence significantly under-five mortality in Rwanda.

Table 16: Type of cooking energy in mother's residence house

Variable	Exp(B)-Odds ratio	Significance level
Type of Cooking energy in the household(ref-cat)-other types of energy used in the household	9.000	0.003
Type of cooking energy in the household (1)-modern energy	54.733	0.635
Type of cooking energy in the household (2)-traditional energy	0.539	0.409

The cooking energy is one of environmental factors that play a role in child survival. Along this research, it was categorized into three main groups. Group 1 refers to modern cooking energy. Group 2 refers to traditional cooking energy like woods, charcoal and the third refers to others cooking energy used in the household where the child born or lived between 1995 and 2000. On the basis of univariate logistics regression outcome which is summarized in the table above, the overall significance level is estimated to 0.003. Recall that this is a significance level for the reference category which is the last category of other types of cooking energy used in the household. The remaining categories 1 and 2 are all no significant with a significance level of 0.635 for category 1 and 0.409 for category 2.

The odds ratio of the type of cooking energy predicting variable for the modern cooking energy is 54.733. This means that cooking with modern cooking energy would decrease the probability of under-five mortality to more than fifty five times higher compared to cooking with other types of cooking energy. But on the other hand, this is not a significant predictor since the significance value is 0.635, 0. 409 and 0.611 more than the significance value of the model (p=0.05). Thus, it will not be considered along further analysis stages.

Table 17: Size of the mother's child at birth

Variable	Exp(B)-Odds ratio	Significance level
Size of the child at birth(ref-cat)-very small size	3.103	0.000
Size of the child at birth (1)-very large size	1.704	0.017
Size of the child at birth (2)-average size	1.692	0.011

The size of the mother's child at birth relates most of the time to the welfare of the child, which depends on the other hand on the welfare of her/his mother. For this analysis, the size of the child was divided into 3 categories. Category 1 refers to children who were born with a very large size. Category 2 refers to children who were born with an average size and category 3 refers to children who were born with a very small size. As in earlier stages of this analysis, the third category was considered as a baseline category. On the basis of significance values, all categories in this variables estimate significantly the outcome variable with significant values of 0.017 for the category of children who were born with a very large size, 0.011 for the category of children who were born with average size and 0.000 for the baseline category.

Odds ratios for children with very large size is here of 1.704 (Exp (B)=1.704)) and for children with average size 1.692 (Exp(B)=1.692)). If compared to the reference category, children with very large size and with average size have respectively 70% and 69% chances of surviving. This means that being born with a very large size or with an average size increases the chances of surviving of 70% and 69% respectively if the effects of these sizes are compared to the last category with a very small size which has 100% chances of dying.

Toilet facility existing in the household(sig.=0.457, Exp(B)= 0.57, df=1), Breastfeeding(sig.=0.701,Exp(B)=0.000,df=1) also enter in the same category of variables which don't significantly predict the model and thus, which are supposed to be rejected at the end of this step of the analysis.

In the further analysis (loglinear analysis) where a combined effect of all the significant variables, each of the selected variables including this one will be again tested to build a structure among them and we will see which image each distilled variable before a final statement on their influence on under-five mortality in Rwanda.

For direct factors to under-five mortality in Rwanda, only variables with a significance level of less than 0.05($p<0.05$) were selected. These are variables that contribute significantly to the predictive ability of the model.

In our case, we only have five significant factors (***Birth interval with p= 0.000, type of house floor material with p= 0.011, number of household members with p = 0.000, Size of the child at birth with p=0.017 and 0.011 and mother's educational level with a p= 0.015)*** influencing under-five mortality. These factors are the interval in months between births, the floor material of the house where the child is born or lives in and the number of persons living in the house of the child who have died or survived along the observational period (1995-2000), the size of the child at birth for very large children and for children born with average size and the educational level of the mother.

IV.6.3. Influence of Indirect Factors (Individual socio-economic variables, Household and Community socio-economic variables) on Under-five Mortality in Rwanda

A. Effect of Individual Socio-economic Factors

Table 18: Mother's level of education

Variable	Exp(B)-Odds ratio	Significance level
Mother's level of education (ref-cat)-Secondary or higher education	8.526	0.000
Mother's level of education (1)-Primary or no education	0.540	0.015

The level of Education of the mother of the child was classified by Mosley and Chen's model in the indirect (socioeconomic) factors. According to Mosley and Chen (1984), this factor has an influence on under-five mortality since an educated mother not only increases her socioeconomic status but also knows where medical services are and how use them efficiently if compared to a mother with a lower level education. Along this study, this variable was classified into two categories. Category 1 referred to mothers with primary or no education whereas category 2 referred to mothers with secondary and higher education. This last category was considered as reference and has come up with a high significance level (sig. =0.000) and an odds ratio value of 8.526.

The first category (mothers with primary or no education) has showed a valid significant level of 0.015. With an odds ratio of 0.540, this category has 46% less likely to influence under-five survival chances if compared to the overall reference category.

This level of education of the mother decreases the probability of surviving for her child of 46% (1-0.54)). In simple terms, a child born from a mother who have only primary or no education has a decreased probability of surviving of 46% if compared to a child born from a mother with secondary or higher education(reference category) who, in this case has 100% chances of surviving. This variable is also significant with a significance level of 0.015, which less than the p value (p= 0.05) and will be part of the selected variable.

B. Effect of Household Socio-economic Factors

The frequency of listening to the radio(sig.=0.432, Exp(B)=0.881, df=1), the frequency of watching television by the mother (sig.=0.230, Exp(B)=0.564, df=1) also enter in the same category of variables which don't significantly predict the model and thus, which are supposed to be rejected at the end of this step of the analysis.

C. Effect of Community Socio-economic Factors

Table 19: Place of residence of children's mothers

Variable	Exp(B)-Odds ratio	Significance level
Place of residence (ref)-Urban	10.330	0.000
Place of residence (1)-Rural	0.663	0.029

The variable type of place of residence has 2 categories. Category one refers to mothers residing in the urban area and the second category refers to mothers residing in rural area. The type of place of residence was taken into consideration first Mosley and Chen (1984) and by this study due to the fact that the urban area provides with several opportunities in terms of availability of health care facility, information, employment (…). The availability of these opportunities increases or decreases the survival probability of a child depending on the extent to which his mother has access to them. The second category (women living in rural area) was considered as a reference category and was estimated by SPSS to significantly cause under-five mortality to the extent of 100%.

Given a significance level of 0.029 for the second category(women living in urban area), and the odds ratio of 0.663 being less than 1 implies that children born from mothers living in urban area are 33% less likely to die at this age in Rwanda if compared to the overall baseline.

Table 20: Reason why mothers delay in taking the child to treatment

Variable	Exp(B)-Odds ratio	Significance level
Reason not taking child to treatment(ref)-Mother's financial incapacity	4.849	0.000
Reason not taking child to treatment (1)-Illness not serious	1.222	0.501

Reason for not taking child to treatment was considered as one of the community level variables due to the fact that the way a community is organized relates to the way all community services are organized and distributed. This study is much more interested in the capacity of the community in its organization to provide to the mother of the child some basic needs including health care services for herself and for the child.

The reason for delaying to take the child to treatment was thus categorized into two main categories. The first category relates to child illness being not serious as a cause for this child's mother not taking him/her to treatment, the second relates to the child's mother financial incapacity to pay costs related to the transportation of the child to hospital or to the cost of the treatment itself.

SPSS made the second category a reference category for this factor. This reference category stands for 100% cause for not taking the child to treatment and for his/her death an odds ratio of 4.849. The first category consisting of child's illness not serious as a reason for not have taken him to treatment is not significant with a significance level of 0.501 and an odds ratio value of 1.222. No further interpretation is needed on this factor since it doesn't influence significantly the model under study and is rejected for the following stages of this study.

Apart from the four significant variables selected in the direct factors, two variables (***mother's level of education with p= 0.015***, ***place of residence with p=0.029)*** in the indirect factors were selected to be significantly predicting under-five mortality in Rwanda based on their significance level and will be part of the combined effect analysis (log linear analysis) here below and a structure will be built at the end.

IV.7. Testing Interaction between Significant Variables

IV.7.1. Introduction

At the end of the univariate analysis, variables with a significance level higher than 0.05 were rejected and only variables predicting significantly (for which $p<=0.05$) the model were retained for further steps of this analysis. The next step of this study was then to ask SPSS to structure or to put into order of strength all the selected variables. To do this, the log linear model selection analysis was used.

IV.7.2. Log Linear-model Selection Analysis

According to L. Van Wissen (2006), the loglinear is used in sake of the following information:

- It gives a test of association among a set of categorical variables
- It provides parameter estimates of the strength of the associations
- It detects the structure in your data and
- It handles interactions between 2, 3 and more variables

Thus, Log linear analysis (model selection) was used to build a structure among selected variables from direct and indirect factors and to identify the final terms correctly predicting the model. The main model we chose for interaction analysis is the saturated model (this model containing all factor main effects and all factor-by factor interactions and identify which terms are needed in the model). With this saturated models, the iterative proportional fit algorithm converged at iteration 1 and gave a maximum difference between observed and fitted marginal of 0.000 (between expected and observed counts) with a convergence criterion of 0.250.

The generating class for all variables included in the loglinear analysis takes the following form:

B5*BIRTHINT*FLOORMAT*HHMBERS*CHSIZEB*EDUC*V025

These selected factors (variables) included in the loglinear analysis were classified by SPSS according to the coding value level and each factor's label. SPSS gave the following output of the selected factors:

```
Factor Information

   Factor  Level  Label
   B5          2  Child is alive
   BIRTHINT    3  Birth interval
   FLOORMAT    2  House Floor material
   HHMBERS     3  Household members
   CHSIZEB     3  Size of the child at birth
   EDUC        2  Educational level
   V025        2  Type of place of residence
```

The above output factors would give in total 2*3*2*3*3*2*2 which equals to 432 cells. By trying to run loglinear analysis, it was found not possible to interpret interactions among all these variables, given that the analysis itself doesn't reach the stage where the chi square and the likelihood test are tested.

The plausible reasons for this problem are the limitation of the loglinear analysis in building associations and interactions between more than 2 variables. This finds again explanation from Van Wissen (2006) who mentions in the Demographic Survey Analysis slides that the Loglinear analysis has the following limitations:

- It becomes complicated when more than 2 variables are computed
- It is only a test and not a model with parameters that indicate the size of the association between variables

Another explanation for this weakness is that the data under analysis has 357 missing values out of 1062. Trying to build a cross-tabulation of the 705(1062-357) cases would give less than 2 cases (705/443=1.6) per cell in my cross-tabulation table. With such a small number of cases, it wouldn't be possible to build any meaningful statistical analysis with high significance and precision of estimates.

The above considerations explain that the data under this analysis does not support loglinear statistical analysis. To be able to test the significance of all selected significant variables, multivariate logistic regression was used.

IV.8. Multivariate Logistic Regression (Final Model)

IV.8.1. Introduction

A previous univariate analysis was done to test the effect of each independent variable on the dependent, which helped us to select among the whole array of independent variables which one have a significant effect on the dependent variable.

This step on analysis will mainly use multivariate logistic regression tool to test the overall effect of the selected six independent variables on the dependent. No interactions are included since the data for this analysis didn't allow loglinear analysis.

IV.8.2. Multivariate Logistic Regression Results (Final Model)

Table 21: Final Model (multivariate logistics regression model)

Indication	Variables/Constant	Exp(B) values	Sig.(0.05)
Intercept	Constant	22.106	0.000
BIRTHINT (1)	Birth interval<23 months	0.496	0.000
BIRTHINT (2)	Birth interval btn 24&36 months	0.871	0.141
FLOORMAT (1)	Floor material (modern)	1.261	0.133
HHMBERS (1)	Household members btn 1 and 5	0.390	0.003
HHMBERS (2)	Household members btn 6&10	0.769	0.413
CHSIZEB (1)	Size of the child at birth(very large size)	1.399	0.007
CHSIZEB (2)	Size of the child at birth(average size)	1.389	0.004
EDUC (1)	Mother's educational level(primary or no education)	0.490	0.000
PLACERES-v025(1)	Mother's place of residence-rural	0.490	0.000

The above table presents outputs of logistic multivariate analysis for all independent variables that proved themselves to be significant with the dependent variable in the univariate analysis. As we saw in the descriptive frequencies percentages, children with a birth interval below the age of 23 months (below 2 years) presented high percentages of children dying. The final model also confirms this through the significance level of this variable (p=0.000) and the log odds attributed to this variable (Exp. (B) =0.496)). This means that this specific birth interval leads to almost 50% less of log odds of surviving if compared to the base category.

The second birth interval between 24 and 36 months, the type of floor material and household members (second category going from 6 to 10 members) variables were rejected by the combined effect model with respectively non significant values of 0.141, 0.133, and 0.414. This means that compared to other values, these individual factors have registered a lower strength of influence. The first category of Household members presents a significance level of 0.003 (for household members going between 2 and 5). The odds ratio (Exp. (B)) value of this category explains that the addition of one extra member in a household decreases the chances of under-five children to survive of 61 % (1-0.390). The odds ratios for the final model is quite different from the odds ratio registered by this variable in the univariate analysis 75% (Exp. (B) = 0.254)) because of the combined effect of all variables.

As in the univariate analysis, the size of the child at birth variable is significant for all categories (1&2). Odds ratios for this variable explain that being born with a big or an average size increase the survival likelihood of 40% and 39% respectively if compared to overall effect of all tested variables. The effect of this variable on the outcome variable has decreased, given the respective odds ratios of 70% and 69% respectively for the first and the second category, due to the contribution of all other variables tested in this model. This model shows also that the level of education of the Mother would decrease the probability of dying for her child significantly. With a significance level of 0.000, the odds ratios for this variable are of 0.490. This means that one unit increase in the level of education of the Mother decreases her child's likelihood of dying of 51%.

As far as the place of residence is concerned, the final model presents the same odds ratios at same significance level as the level of education of the Mother. This also means that a mother living in urban area decreases the likelihood of her child dying of 51% compared to a mother living in rural area in Rwanda.

The general observation on the output of the multivariate analysis is that under-five mortality in Rwanda is much more influenced by a short birth interval between births, by the size of the child at birth, by the level of education of the mother and by the type of place of residence the mother.

CHAPTER V. CONCLUSION AND POLICY RECOMMENDATIONS

V. 1. Summary of the results

The overall aim of this study was to draw a picture of under-five mortality in Rwanda and to sort out main determinants related to this phenomenon. On the basis of outputs, 13.4% of the total country sample (7922) observed from July 1995 to November 2000 died and 16.9% of the selected sample(N= 1419) of children who would be exactly aged 5 years at the time of the interview(those born between august 1995 and July 1996) died. The life table and the survival curves showed a high hazard rate for male children in early age compared to female children in the country sample(the hazard rate of dying for male children is 0.0210 and the hazard rate of dying for female children is 0.0168). Hazard rates for the selected sample doesn't show a high differences for male and female and the curves look closely paralleled (The hazard rate for male children being 0.0165 whereas for female children it is 0.0163).

The above output of life tables and survival curves for the country sample and the selected sample shape a picture of under-five mortality in Rwanda.

The univariate and multivariate (final model) analysis further traces a demarcation between the observed under five mortality picture and its main determinants. The univariate depicted four independent direct determinant variables (Birth interval, House floor material, Household members, size of the child at birth) and two indirect variables (Mother's level of education, type of place of residence of the mother) that influence significantly the overall picture of under five mortality in Rwanda.

The multivariate attempting to check the overall effect of each significant selected variable when controlling for other variables in the final model found out that under five mortality is mainly determined by the short birth interval (below 23 months-2 years), by the number of household members, by the size of the child at birth, by the level of education of the mother and her place of residence.

V.2. Discussion of the Results

Rwanda as many other under developed countries (especially sub-Saharan Africa) has a high rate of under-five mortality. The main linked causes outlined by the univariate and multivariate are direct (short birth interval, house floor material, household members, the size of the child at birth) and indirect (the level of education of the mother and her place of residence). These six causes interlinkedly have an effect on each other to reach the high rate of under-five mortality. One can observe that short birth interval, the house floor material and the size of the child at birth could be associated with the level of education and the mother's place of residence. This goes in line with what Mosley and Chen called "Social synergy" through their following statement: "*In fact, so many proximate determinants may be directly influenced by a mother's education to radically alter chances for under-five child* *survival* (Mosley and Chen, 1984, pp.34-35). Apparently, the shortage of birth interval would have roots in ignorance, lack of information on contraceptive use, on reproductive health (…). The house floor material, the household members living in the house where the child was born, the size of the child at birth are linked to employment status and poverty and obviously education play a role in this if we consider that education increases chances of employment. In this matter for instance, the summary report of the Rwanda Demographic and Health Survey (2002) shows that families where the level of education for the head of the household is low (without or with primary level) 74% in rural against 70% in urban area live below average welfare standard whereas for families where the head of the household has completed secondary or higher education go between 51% of average welfare level to 36% high welfare level. And as far as education is concerned, the same RDHS (2002) shows that 26.1% of all the population reached secondary level in Kigali city (capital) when in other provinces, almost 9/10 attended primary level education.

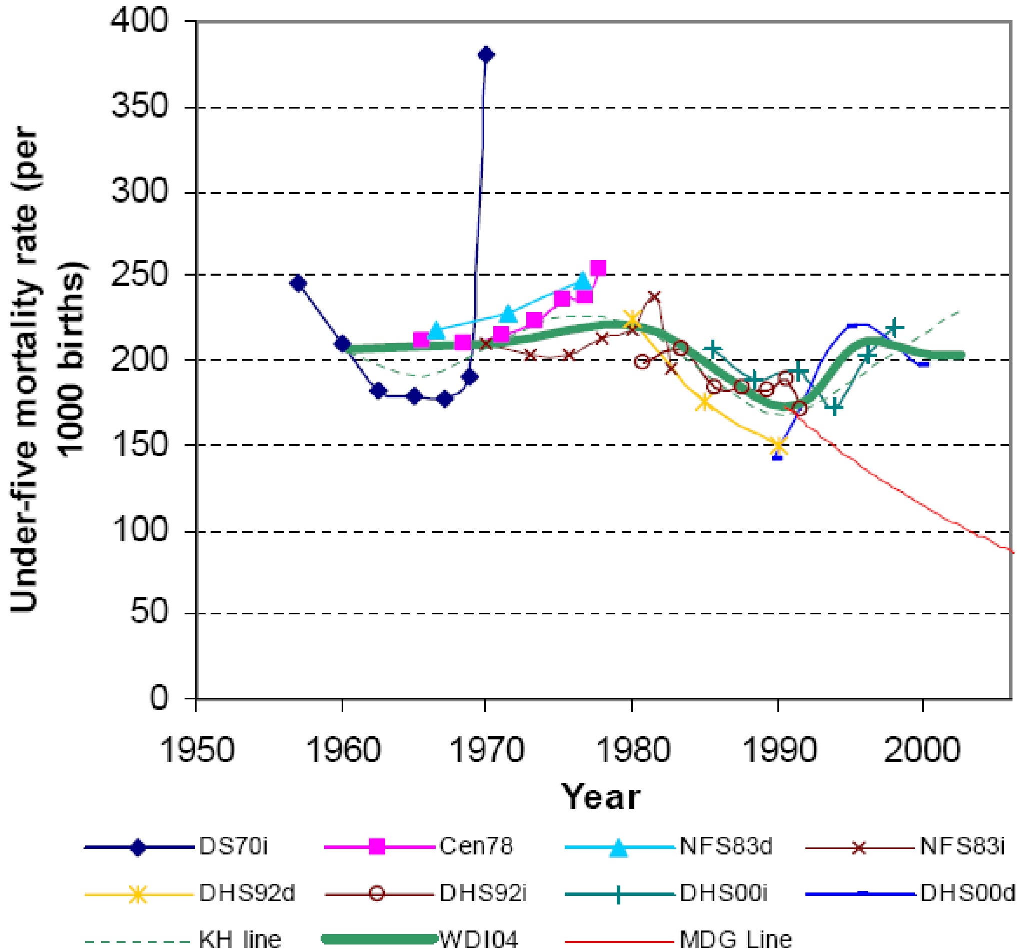
An educated women living either in urban or in rural areas knows better how to take care of her child compared to women with low or without education level. John C. Caldwell (1979, pp.408-410) referring to Nigeria argues that maternal education must be examined as an important force in its own right. According to him, education serves two important roles: it increases the ability to deal with new ideas and provides a vehicle for the import of a new culture by becoming less fatalistic about illness and also it increases her skills in health care practices related to contraceptive use, nutrition, hygiene, preventive care and disease treatment. So, education curbs all the above factors in that it is a cause to poverty, to ignorance of all kinds in child care (…). An educated woman living either in urban or rural area has almost same potentialities and knowledge related to the protection of the child and to his care of all kinds. The Rwanda Demographic and Health Survey (2000) report shows that 33.8% of women have no education, 53.4% attended primary education, 12.3% attended secondary and only 0.4% attended higher education. There could be a plausible relationship between this level of education for Rwandan mothers and the whole vicious circle of factors leading to under-five mortality.

V.3. Research and Policy recommendations

Following the outcome of this study, there is an interaction of different factors leading to high under-five mortality in Rwanda. The Kaplan Meier regression line shows particularly very high under-five mortality in infancy. Therefore, a research that would tackle the determinants of Infant Mortality Rate in Rwanda would clarify why such a big number of infant deaths and thus be a big contribution to the solution on under-five mortality. As the final model of this study has shown that under-five mortality in Rwanda is influenced by short birth interval, the house floor material of the house in which the child was born or was living in, by the household members, the size of the child at birth, mother's level of education and her place of residence, an inclusive policy formulation and implementation involving a multisectoral strategy is needed.

- Increasing the level of education and information of mothers on contraceptive use awareness, reproductive health, hygiene, preventive care and disease treatment (…) would increase the length of interval between births and the size of the child at birth.
- Reducing poverty would build the capacity of mothers and their partners to have access to food, to basic amenities, to health services and improve the quality of living conditions (house material, place of residence).
- A multisectoral strategy oriented to sex equality would also build the capacity of women and mothers to provide for themselves and for their children basic needs for their daily life.

APPENDIX 1 : Rwanda Under-five mortality trends (1950-2000)



Data source and type	Acronym
1970 Enquête démographique (indirect)	DS70i
1978 census (indirect)	Cen78
1983 Enquête nationale sur la fécondité (direct)	NFS83d
1983 Enquête nationale sur la fécondité (indirect)	NFS83i
1992 Demographic and Health Survey (direct)	DHS92d
1992 Demographic and Health Survey (indirect)	DHS92i
2000 Demographic and Health Survey (direct)	DHS00d
2000 Demographic and Health Survey (indirect)	DHS00i

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