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Inequalities in child survival in a rural area of Senegal where malaria incidence has declined

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Declaration of own work

I, Elhadji Konko Cire Ba, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in this thesis.

Elhadji Konko Cire Ba   **September 2019**

Abstract

Background: A sharp decline in under-5 mortality rates has been observed in Senegal, as in some other parts of Africa, over the last 15 years, associated most obviously with a reduction in malaria transmission that occurred in the same time period. The aim of this study was to analyze variations in under-5 mortality in order to better understand the reasons for the recent decline and the factors associated, and the extent of inequalities.

Methods: Demographic surveillance was established in four health districts in central Senegal (Mbour, Bambey, Niakhar and Fatick) in 2008. A population of about 600,000 people in 725 villages served by 54 health posts was monitored until 2010. Data for 128788 children under 5 years of age have been included in the analyses. Random effects Poisson regression was used to assess risk factors for child mortality.

Results: The leading causes of death were diarrhoea (26.6%), pneumonia (22.2%), and malaria (10.8%). Children living in more than 5km from a health facility had a 2.2-fold (95%CI 1.9, 2.6) higher risk of mortality than children living nearer to health facilities. Mortality rates were associated with the level of malaria transmission, an increase in the malaria incidence rate in children of 1 per 1,000 per year was associated with a mortality rate ratio of 1.04 (95%CI 1.02, 1.05). Children born to mothers under 16 years of age had a 1.6-fold increased risk of mortality (95%CI 1.1, 2.3) compared to children of older mothers.

Conclusions: Under 5 mortality in Senegal decreased by 57% between 1990 and 2015, but national average figures conceal substantial inequalities. Higher rates of mortality are associated with areas of persisting malaria transmission, poverty, and poorer access to health care. Strategies targeting these communities are required to improve child survival and reduce inequalities.

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Acknowledgments

Statement of author role

The idea for this thesis comes from an effectiveness study on malaria chemoprevention undertaken in 4 medical districts in Senegal with a population of about 600,000 habitants.

One component of the study was to establish a demographic surveillance system (DSS) to assess the impact of malaria chemoprevention on mortality all causes.

As an investigator in that project, I was in charge of setting up this health and demographic surveillance system from conception to completion. The idea of doing a thesis on this DSS then came to mind and I found it relevant to investigate the risk factors for mortality in children under 5 years in an area where malaria has dramatically declined.

The context of the project was very favorable for this study, especially since this subject was never investigated in this area where, until recently, malaria was by far the leading cause of death in children under five years of age.

My role was to coordinate the conduct of a census that served as a baseline for DSS rounds every 8 months.

I worked on questionnaires development, database setting up particularly on the implementation of entry time checks to minimize data entry errors. I performed quality control of paper questionnaires versus electronic database, supervised the data corrections in the field. I did the data consistency controls, generated the queries for the data base cleaning. I drafted the data analysis plan, analyzed the data and wrote all the chapters.

I did the supervision of morbidity data collection in all health posts and health huts and coordinate mortality data collection in 123 villages. I contributed to the setting up of a comprehensive pharmacovigilance system in the entire study area.

Literature search strategy

A literature search was conducted using MEDLINE, PUBMED and JSTOR to extract relevant articles published from 1990 and related to child mortality level and predictors in Senegal and/or developing countries. At first search used the following key words: "Mortality" and/or "Surv*" and/ or "Child" and/or "Senegal". A second search was done changing "Senegal" by "DHS" (Demographic Household Survey). A third search was done replacing "DHS" by "verbal autopsies". Articles related to child survival trends and predictors in developing countries were selected if data used come from census surveys or longitudinal follow up. These articles selected were checked for additional references. International agencies website working on demographic indicators (UNICEF, WHO, MEASURE, IGME, INDEPTH, WORLDBANK) was also visited to select more recent publications related to child survival trend and predictors.

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List of publications and conference presentations

1. Dieng S, **EH Ba**, Cissé B, Sallah K, Guindo A *et al.*Spatio-temporal variation of malaria hotspots in central Senegal, 2008-2012.Submitted to BMC Medicine.
2. **EH Ba** *et al.* (2018) Implementation, coverage and equity of large-scale door-to-door delivery of seasonal malaria chemoprevention to children under 10 years of age in Senegal. *Scientific Reports* **8**: 5489 (2018)
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4. Sy.O.Sy,Niang EA, Ndiaye M, Konaté L, Abdoulaye Diallo, **Ba EH**, *et al.* (2017) Entomological impact of indoor residual spraying with pirimiphos-methyl: a pilot study in an area of low malaria transmission in Senegal. . (Malaria Journal, 2017)
5. Aldiouma Diallo, Ali Sié, Sodiomon Sirima, Khadime Sylla, Mahmadou Ndiaye, Mamadou Bountogo, Espérance Ouedraogo, Roger Tine, Assane Ndiaye, Boubacar Coulibaly, Alphonse Ouedraogo, Babacar Faye**, El Hadji Ba** *et al.* (2017) An epidemiological study to assess *Plasmodium falciparum* parasite prevalence and malaria control measures in Burkina Faso and Senegal. (Malaria Journal, 2017)
6. Cissé B, **Ba EH**, *et al.* Effectiveness of Seasonal Malaria Chemoprevention in children under 10 years of age in Senegal: a stepped wedge cluster randomized trial. (Plos Medicine,2016)
7. NDiaye JL, Cissé B, **Ba EH** *et al.* Safety of seasonal IPT against malaria with sulfadoxine-pyrimethamine+amodiaquine when delivered to children by district health staff in Senegal.(Plos One,2016)
8. Lo C Aminata, Faye Babacar, **Ba El-Hadj** *et al.* Prevalence of molecular markers of drug resistance in an area of seasonal malaria chemoprevention in children in Senegal. Malaria Journal 2013
9. **Ba EH**. Establishing a surveillance system for child mortality and analysis of trends and predictors of child survival in rural area of Senegal where malaria has declined (Unpublished report, London School of Hygiene & Tropical Medicine) 2011
10. **Ba EH** Contribution à l'amélioration de la qualité des données de morbidité palustre dans trois districts sanitaires du Sénégal. (mémoire de DESS) 2011
11. preliminary report prepared for a WHO Informal meeting on IPTc,July 12th 2010

12. Sokhna C, Cisse B, **Bâ EH** *et al.* A trial of the efficacy, safety and impact on drug resistance of four drug regimens for seasonal intermittent preventive treatment in Senegalese children. PLoS ONE. 2008;3(1): e1471.
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14. Vial L, Diatta G, Tall A, **Ba EH,** *et al.* Incidence of tick-borne relapsing fever in west Africa: longitudinal study.Lancet. 2006 Jul 1;368 (9529):37-43.
15. **Ba EH**. Epidémiologie Clinique de la borréliose à tiques en zone rurale du Sénégal (Mémoire d'ingénieur), 2001

Communications

2009 Multilateral Initiative for Malaria Conference (**MIM**) Nairobi-Kenya -Oral presentation. Title: Establishing a surveillance system for measuring childhood mortality and drug-relatedserious adverse events in an area of implementation of seasonal IPT in children in Senegal.

2010: American Society of Tropical Medicine and Health (**ASTMH**): Atlanta/Georgia- Oral Presentation Title: A Surveillance system to measure childhood mortality and drug related adverse events in Three Districts in Senegal

2013: Multilateral Initiative for Malaria (**MIM**)South Africa/Durban (Oral presentation) Title: Delivery of Seasonal Malaria Chemoprevention (**SMC**) to children under 10 yrs of age in Senegal

2014: American Society of Tropical Medicine and Health (**ASTMH**): New Orleans- Oral presentation, ASTMH Travel awards winner.Title: Extending the age range for Seasonal Malaria Chemoprevention (SMC): effectiveness of SMC in children under 10 years of age delivered through the district health service in Senegal

2015: American Society of Tropical Medicine and Health (**ASTMH)**:USA/ Philadelphia- Oral presentation Title: Inequalities in child survival in a rural area of Senegal were malaria has declined

List of Abbreviations and acronyms

ACT   artemesinin-based combination therapy

AQ   amodiaquine

ASC   Agent de santé Communautaire

ANSD   Agence National de la Statistique et de Démographie

CHWs   Community Health Workers

CQ   chloroquine

CRF   Case report form

CRVS   Civil Registration and Vital Statistics

DHS   Demographic and health survey

DSDOM   Dispensateur de soins à Domicile

DSS   Demographic Surveillance System

ICCM   Integrated community case Management

ICD   International Classification of Deasease

IGCME   Interagency Group for Child Mortality Evaluation

IMCI   Integrated Management of Childhood illness

INDEPTH   International Network for the continuous Demographic Evaluation of Populations and their Health

IPT   Intermittent preventive treatment

IPTc   Intermittent preventive treatment in children

IRD   Institut de recherche pour le développement

LLINs   Impregnated Long Lasting Nets

MICS   Multiple Indicateur Cluster Survey

MSP   Ministère de la santé et de la Prévention

MDG   Millenium Development Goals

PECADOM   Prise en Charge des Cas à Domicile

PSP   Prevention saisonniere du paludisme

PNLP   Programme National de lutte contre le Paludisme

RDT   Rapid Diagnostic Test

SDSS   Simplified demographic surveillance System

SGD	Soustainable Development Goals
SOP	Standard Operating Procedures
SMC	Seasonal Malaria Chemoprevention
SP	Sulfadoxine-pyrimethamine
TEG	Technical Evaluation Group
TEN	Toxic Epidermal Necrolysis
UCAD	Universite Cheikh Anta Diop
UNICEF	United Nation International Children's Emergency Fund
WASH	Water Sanitation and Hygiene
WHO	World Health Organisation

Chapter 1: Introduction - under 5 mortality trends and the malaria decline in West Africa

1.1 Introduction

Mortality data are useful indicators of socio-economic and health progress. They are used to evaluate the success of health programs, to measure health status and compare it across populations (Hill *et al.*, 1991). The under-five mortality rate is a barometer of child health and has been chosen as the best indicator of human development by UNICEF (UNICEF, 2007). A reduction of under-five mortality by two-thirds from 1990 to 2015 was the fourth of six health-related millennium development goals (MDG) (UNITED NATIONS, 2005). MDGs were called unrealistic when elaborated in the 1990 but remarkable efforts and progress have been made, child mortality dropped by 53% from 1990 to 2015 but remain high still short compared to a target of 67% reduction, maternal deaths decreased by more than 40% in the same period. Sustainable Developments Goals (SDGs) are currently new targets and they integrate social, economic and environmental interrelated and interdependent goals, with all goals related to health. They address challenges that may affect health in the 15 coming years starting from 2016 with a big focus on equity and promotion of health and wellbeing. The worldwide mortality situation is characterized by a general decrease in the last century but trends and levels varied according to regions. Developed countries have substantially improved child health and decreased mortality, some developing countries have made progresses but sub-Saharan Africa countries are localities where the least progress has been noticed (Rajaratnam *et al.*, 2010).

However, in Senegal, progress has been better than in some neighbouring countries, under-five mortality has declined steadily from 151 per 1,000 live births in 1990 to 121 per 1,000 live births in 2005 (DHS, 1997; DHS, 2005), attributed to socio-economic development and improved health services.In 2008 data from Niakhar and Farafenni in the Gambia, showed sudden further fall in child mortality with estimated rates of 55 per 1,000 and 74 (95% CI:65-84) per 1,000 live births

respectively (Trape *et al.*, 2011; Jasseh *et al.*,2011). Understanding the reasons underlying this decline may provide insights as to what needs to be done in other countries where no such decline has been seen, if they are to achieve similar reductions.

The aim of this PhD project was to establish a surveillance system for monitoring child mortality in central Senegal, to evaluate the validity of the data, to estimate rates of mortality, and to investigate factors associated with variations in mortality rates within the study area, in order to gain a better understanding of the current levels of child mortality and the reasons behind the recent decline. In the rest of this section a) information about recent trends of child mortality in Senegal and rest of the developing world is summarized, b) the advantages and disadvantages of alternative methods for measuring mortality rates reviewed, and finally c) the specific aims of this PhD project are defined.

1.2 Recent trends in under-five mortality rates

Global estimates from the UN Inter-agency Group for Child Mortality Estimation (IGCME) show that under-five mortality rates fell in the period 1990 to 2010 from 88 to 57 deaths per 1,000 live births (UN IGCME, 2011), attributed to improvements in socioeconomic development, implementation of child survival interventions) and technological advancement (You *et al.*,2010, Black *et al.*,2010). However child mortality remains high in many sub-Sahara African countries (UN IGCME 2011; Haque *et al.*,2011).Of an estimated 7.6 million under-five deaths in 2010, 50% occurred in sub-Sahara Africa (UN IGCME, 2011). Some countries experienced a rise in the number of deaths during recent decades and disparities have increased (Accorsi *et al.*,2010; Ahmad *et al.*, 2010) (Hanque *et al.*,2011). In 2010 few sub-Saharan African countries were considered "on track" regarding the achievement of MDG4; the IGCME define "on track" under-five mortality as less than 40 deaths per 1,000 in 2010 or an average annual rate of reduction 1990-2010 of 4%. Achievement of MDG4 are remarkable as under five mortality dropped from 90 to 43% deaths per 1,000 live births between 1990 to 2015 despite a population growth in the same period. Globally the annual rate of reduction was tripled since 1990 and sub-Saharan Africa countries experienced faster reduction which was 5 times faster if we compare the period 2005-2013 with 1990-2005. Child immunization, particularly measles

vaccination contributes to prevent 15.6 million deaths from 1990 to 2013. If the same trend is kept it will take 10 more years to have a two-third reduction of under-five death with a reference period starting from 1990. Socio-economic disparities are still drivers of under-five mortality but great efforts are done in terms of equity as under five deaths decline faster in poorer households than in richer ones (Chao et al, 2018).The decline in mortality rates in developing countries has been attributed to increased urbanization, access to vaccination and adequate medical treatment (UN, 2009),(Garenne *et al.*, 2010), and nutrition (Imdad *et al.*, 2011), scaling up access to preventive public health measures, access to health care, and provision of clean water (Fink *et al.*,2011). Parental education, particularly education to the secondary level of the mother, is a key determinant of child survival (Desai *et al.*,1998), (WHO (2005) (Gadikou *et al.*,2010).Birth order, birth interval (less than two years), mother's age at birth, and breastfeeding have also been identified as associated with child survival (Gemperli *et al.*,2004; Nakamura *et al.*,2011; Ronsmans *et al.*,1996). A short birth interval could lead to early cessation of breastfeeding, exposing the child to a risk of illness from contaminated food and water. Cessation of breastfeeding could cause return to ovulation, short birth intervals and possible low birth weight, with adverse consequences for child development.

In most rural areas of West Africa, very high childhood mortality was still common in the 1960s, with about half of all children dying before the age of 5 years (Van de Walle *et al.*,1992; Garenne *et al.*,2006). Most of these deaths were attributable to infectious diseases, especially neo-natal tetanus, diarrhoea, whooping cough, malaria, measles, pneumonia or meningitis (Murray *et al.*,1997; Greenwood *et al.*,1987). Reductions in under-five mortality were observed in The Gambia and Burkina Faso in nationally representative surveys conducted from 1960 to 2004 showing that child mortality has declined and mortality patterns by age have changed over time (Ndugwa *et al.*,2008).

In Senegal, under-five mortality varies from one region to another, according to the last demographic and health survey conducted in 2014 (EDS 2014); under-five mortality rates are lower in the western and northern regions of the country than other parts. The southern part of the country has the highest under-five mortality rate (EDS 2014). Key determinants of under five mortality reported in this last survey are

the mother education, household socioeconomic status and the fact of living in a rural or urban area. Under-five mortality is strongly seasonal in Senegal, associated primarily with seasonal malaria transmission. A study in Niakhar found that season of birth is also important, children aged 9-15 months at the beginning of the rainy season experienced excess mortality compared to other age groups, mainly due to diarrheal diseases and malaria(Garenne *et al.*,1981).This is likely related to boosting of maternally-derived immunity. Much progress has been made nationally since 1960 when the probability of dying in the first five years of life was estimated to be 300/1,000 (Pison *et al.*1995). In 2001 Senegal had one of the lowest under 5 mortality rates in tropical Africa (Timaeus *et al.*, 2001). A rapid decline was observed in Niakhar where the probability of dying before age 5 passed from 485 to 213 per 1,000 between 1963 and 1999 (Delaunay *et al.*, 2001) but the decline was not a continuous process. The resistance to chloroquine emerged in the 1980s was considered responsible for a dramatic increase of malaria-specific mortality from 1990 to 1993 (Munier *et al.*, 2009). However, vaccine coverage decreasing from 1990 to 2000 (Pison *et al.*, 1995) could have played a role in the increase mortality during that period. Two diseases have been considered to play an important role in under five mortality in Senegal: measles and malaria (Delaunay *et al.*, 2001; Cantrelle *et al.*, 1986). An increase in child deaths has been noticed at a period of suboptimal vaccine coverage and the country experienced measles epidemic in 2009 (Pison *et al.*, 2013).

The Demographic and Household Survey (DHS), conducted in 2010-2011, surveyed a nationally representative sample of households, including 15688 women aged 15-49 years who were asked about birth histories, with a response rate of 93%. The survey concluded a decline in the under-five mortality rate, from 121 per 1,000 live births in the five years period preceding 2005 to 72 per 1,000 live births in the five years period preceding 2010-11. Neonatal mortality decreased slightly from 35 per 1,000 live births to 29 per 1,000 in the same period. The fertility rate also declined from 5.3 to 5.0 children per woman aged between 15 to 45 years in the five years period preceding 2005 and 2010 respectively (DHS 2010). The DHS revealed several individuals and household factors as key determinants of child mortality, including socio-economic status, maternal education, and maternal age under 20 yrs at the time of the pregnancy.

The decline in under-five mortality from 2000 to 2010 in Senegal coincided with the implementation of programs and strategies targeting child survival such as the Integrated Management of Childhood Illness (IMCI) since the 1990's (Gove *et al.*,1997), (Camara *et al.*,2008), an improved immunization program, national vitamin A and mebendazole distribution for children less than five years of age. According to the UN report on child mortality for 2015 under 5 mortality in Senegal was 140/1,000 in 1990, 47/1,000 in 2015, and the MDG4 target was 46/1,000, on this basis, Senegal was not considered to have achieved MDG4 but has done great effort as it is among countries that are tripled their annual rate of reduction. The 2010 estimate is based on data from the 2010-11 DHS survey, under 5 mortality for the 0-4 years prior to the survey (midpoint mid-2008) was 72/1,000, this is a national estimate, based on birth histories, but is higher than the estimates from Niakhar DSS for the same period (58/1,000 in 2008). Previously estimates from Niakhar have been considered to be somewhat higher than the national figures but it is possible that recent data are influenced by increased clinical input related to clinical research in Niakhar.

The main reasons behind the reduction in child mortality in Senegal are considered to be changes in the epidemiological context, development of health infrastructures and their deployment across the country and implementation of health programs such as Immunization-AIDS-Malaria-Integrated management of child Illnesses programs (Pison *et al.*,2013).

Conditions, in which people are born, grow, live and age can strongly influence their health. Quality of care can be classified into three levels: health structures, process and outcome (Mariko *et al.*, 2003). In the rural context of Senegal there are some weaknesses identified in terms of quality of care, the number of skilled health professional was approximately equal to 4.6 per 10,000 inhabitants in 2010, which is less than standards recommended by WHO 22.8 per 10,000 (GHWA and WHO 2013), infrastructures and equipment are lacking in many parts of the country comprising our study area.

Quality of healthcare is difficult to define (Basinski *et al.*,1992), despite many tentative to assess and describe (Aldana *et al.*,2001) (Choudhry *et al.*,2005) (Mosadeghrad *et al.*,2012) It depends on interactions between service process, customer and service provider (McLauglin *et al.*,2006).

Despite all these problems, Senegal is making great effort concerning health strategies. Senegal has, developed universal health coverage for under 5 years old children since 2013, free distribution of long lasting impregnated nets since 2008, free caesarian charge for complicated delivery, recruitment of more than 2,000 nurses, initiated micronutrients distribution and increased vaccine coverage . A system of promotion of health insurance has also been developed and maintained since 2014.

In the Niakhar DSS more than 45% of births occurs out of formal health structures (unpublished data) and this add more complication to the provision of adequate care needed by the newborn affecting negatively child's health during their first days of life.

1.3 Sources of Data and Methods for measuring child mortality rates in developing countries

Estimating mortality rates in developing countries requires data collection through surveys, censuses, or demographic surveillance due to the lack of reliable vital registration data (Byass *et al.*,2007, Chandramohan *et al.*,2008; Banister *et al.*,2004).

Sources of Data

Vital registration:

The gold standard in measuring mortality, when functioning well with a high coverage, is the vital registration system. The advantage is that it allows for continuous registration of events like births, deaths by age and sex (Yang *et al.*, 2005). It can be a national registration system or sample registration system (reporting of deaths in a sample of areas which can be related to a larger population). The validity of the estimated mortality rates depends on the

completeness of coverage and the accuracy with which time and place of death are recorded, and the cause of death and other factors such as the demographic and socioeconomic characteristics of the deceased may not be recorded (Stanton *et al.*,2006). In less developed countries the most serious problem with vital registration systems is the frequent failure either to cover the entire geographic area or to register all vital events. There is an interest in improving vital registration in Africa but at present it is not a reliable source of information. People that are not registered do not exist according of state for legal and economic purposes. Demand in civil registration and vital statistics (CRVS) aregrowing and theyare the foundation of modern administrative system. One of the objectives of WHO and World bank CRVS investment plan is reporting and disaggregating by age and sex of 80% of under five deaths by 2030 (World Bank & WHO, 2014). In the meantime, they want also that 80% of countries have community assessment of probable causes of deaths determined by verbal autopsies.

Health services statistics:

Health services statistics are the major source of mortality data in more developed countries and can provide information about causes of deaths. But in developing countries health facilities information is not reliable in terms of documenting deaths, deaths may be under-reported, and the data are influenced by bias caused by association of health service utilization with education and socio-economic status. Causes of death might also be inaccurate because diagnostics could not be established without proper laboratory investigation particularly in primary health care services. Health services statistics could be more reliable in cities but with the use of private clinics and lack of centralization of health data at district or region level it is difficult to get accurate information from these data.

Demographic Surveillance Systems (DSS):

A DSS is a longitudinal prospective surveillance of dynamic population cohort and consist of recording demographics and health indicators of individuals in a defined area (INDEPTH 2002). DSS is very often set up around specific intervention studies and later converted into long term surveillance systems. Households are visited in regular intervals generally between 3 to 12 months and vital events such as births, deaths, in and out migration, pregnancy outcomes are recorded.

The advantage of DSS is that it permits to measure trends and changes overtime and to work out rates based on actual data. Disadvantages are it iscostly and may not always represent populations outside the area the data are obtained from, and may become less representative over time due to the provision of improved access to health care for those identified by the surveillance as needing treatment (Hill *et al.*1991).

Village reporters:

Use of village reporters permits a kind of continuous enumeration of vital events (birth, deaths, stillbirths) and can be used to estimate child mortality particularly in remote areas. The village reporter maintains a birth and death records of his or her area (village) and records all births and deaths occurring within the village. Different sources could be used to get information: village Headman, priest, imam, midwife, head of the women's union, etc. The advantage is that the village reporter maintains contact with these individuals and promptly collects vital information. He/she also maintains and updates a list of all women of reproductive age and their pregnancy, status, which helps to ensure complete records of births. The disadvantage is that they might miss some events if they do not visit all households once a month to collect events, which may not be possible.

Methods for measuring child mortality rates in developing countries

National surveys:

The DHS estimate child mortality from birth histories through direct techniques. The woman is asked about each live birth and whether the child is still alive, and child mortality is then estimated directly from these data. MICS, and many national censuses, use an indirect method that involves asking women the number of live births they have ever had and the number of children that are still alive, then an indirect method is then used. DHS and MICS are two stage clusters design survey (UNICEF 2005; DHS 2007).The first is from a subset of geographical clusters selected proportional to population and the second is a sample of households selected from a complete household listing in the selected households. Their advantage is that they give quantitative nationally representative estimate on general

demographic levels and trends, comparable across countries; they are not costly and can procure reliable measure of child mortality levels and patterns. Disadvantages of such methods are related to the birth history methods used to collect deaths and births data with all inconvenient listed previously and related to that method. Also with the limited sample size, DHS and MICS can only detect major change in mortality, over 15% which is rare in many developing countries they also only explore factors for which known intervention are implemented and partly explain changes in the observed childhood mortality (Rustein *et al.*,2000).

Birth history methods:

The birth history method is a retrospective survey that collects complete (direct method) or summary birth histories (indirect method). Retrospective data suffer from limitations such as birth transference because of retrospective misreporting of timing of children's birth dates.Birth histories are widely used now particularly during censuses, and in DHS and Multiple Indicators Cluster Surveys (MICS). Advantages of such methods are that they can be easily incorporated into censuses and surveys and rates obtained directly from collected data.

For the direct method, women aged between 15 to 49 years are ask to report each live birth, the date of birth and if the child has died the date of death. For the indirect method number of child ever born, the number of children still alive and number of children born alive and who have died, is recorded. William Brass in 1964 (Sullivan *et al.*,1972) first developed this method; more recent works on the technique (Trussell *et al.*,1975) (United Nations 1983), were reviewed by Hill and colleagues in 1999 (Hill *et al.*,1999).. Direct estimates of child mortality using birth histories are generally consistent with indirect methods but there is a necessity to adjust for fertility change and misreporting of timing of children's birth date (Silva, 2012). Indirect method should be used only for population that experienced either smooth mortality decline or only short period of excess mortality in their recent past. Indirect method is not suitable in countries that experience excess mortality in a long period. The main problem when using indirect method is the violation of the key assumption made by Brass and related to constant fertility rate. If this assumption is not satisfied, this can lead to bias when reporting under five mortality rate (Silva, 2012). Another problem with the indirect method is the difficulty to identify and assess data errors,

for example omission of live births, when there is no gold standard to refer to. However, in a situation where birth transference is considerable and both mortality and fertility in the recent past have been approximately constant, indirect method is preferable to the direct method. The direct method is vulnerable to age displacement of children, omission and survey errors.

The birth history method has some disadvantages because it gives estimates for 0-4 years preceding the survey which is a midpoint of 2.5 years before the survey (Hill *et al.*,1991). Another problem when using birth history is selection bias because only mothers alive or present at the time of survey are interviewed. Recall bias can also occur because mothers may incorrectly recall date of birth or death as well as information bias because still birth and live birth are incorrectly recalled. This may result to an underestimation of deaths, because children whose mother died won't be surveyed and also mothers can omit to mention some child when they were born and died a long time before the survey.

1.4 The decline in malaria incidence and its association with child mortality

In the 1990s malaria was the leading cause of deaths in sub-Saharan Africa countries (Pison *et al.*,2010; Rajaratnam *et al.*,2010; Rowe *et al.*,2006) and one third of child mortality was attributable to this disease; the best example of the effect of malaria control on child survival comes from Guyana where marked improvements in child survival were associated with a dramatic reduction in malaria incidence (Meegama *et al.*,1967; Kleinschmidt *et al.*,2009).

Some studies have predicted that a reduction in malaria transmission could increase child mortality, because of an upward shift in the age distribution of clinical episodes when the risk of severe outcome is greater, and also because of an assumption about the dependence of acquired immunity on past exposure (Snow *et al.*,1997; Modiano *et al.*,1998). These concerns do not seem to have been borne out by experience because the malaria decline in some countries is listed among plausible factors that contributed to the improvement in child survival (Reyburn *et al.*,2005; Kleinchmidt *et al.*,2009) particularly in area where a large proportion of deaths were

attributed to this pandemic disease and control methods have been scaled up (Bhattarai *et al.*,2007; chizema *et al.*,2010). Several studies suggest that the improvement in child survival has been larger than would have been expected on the basis of previous estimates of malaria-specific mortality (Steketee *et al.*, 2010; Rowe *et al.*, 2007) but the reasons underlying indirect effects of malaria on mortality are not well understood. Malaria in pregnancy has been listed among indirect causes of child mortality in sub Saharan Africa countries primarily through increased risk of low birth weight (Shanks *et al.*, 2008). However, it is important to notice that the relationship between malaria control and child mortality could be confounded by factors affecting both health status and malaria transmission, and also some limitations related to quality and representativeness of data have to be taken into account. Data are often obtained from districts and health facilities not randomly selected so the findings cannot be extrapolated to all country with different malaria epidemiology (Eisele *et al.*, 2012). However, a meta-analysis of randomized trials of the use of IPTc (in children) and IPTp (in pregnancy) showed evidence of an unexpected gain in child mortality, attributed to a reduction of both direct and indirect malaria mortality (Wilson *et al.*, 2011; Greenwood *et al.*,1988).

Globally, there was a dramatic decrease in malaria cases incidence and mortality by respectively 30% and 47% between 2000 and 2013(World malaria report 2014). The drop was slow up to 2005 but accelerated after that date. In 2013 almost 128 million people were infected with malaria and was responsible to 7% of global deaths; 1/5 of deaths occurring among under-five years children in sub-Saharan Africa countries (World health organization, 2013). Many studies have shown the indirect effect of malaria on mortality all causes, the example of Sri-lanka after the Second World War is still illustrative (Brown *et al.*,1986). Malaria impairs the immune response and increases the susceptibility to non-typhoidal salmonella infections in children (Mackenzie *et al.*, 2010). Studies in Africa have shown that ITNs use can reduce deaths among under-fives by up to one third (D'Alessandro *et al.*,1995; Schellenberg *et al.*,2001; Lengler *et al.*, 2004; Lim *et al.*,2011) especially when coverage is over 80% (Roll Back Malaria 2005). Scaling up of malaria control measures contributed to malaria decline and its effect on mortality is encouraging but challenges are in the increase of accessibility, affordability, availability and sustainability of such measures. This requires good political and economic commitment as well as well

designed health policies implementation (Roll back Malaria 2010; Zhou *et al.*, 2011; Bloland *et al.*,1993).

Senegal has experienced many changes in malaria control since 2000 (Roll back malaria, 2010). After the period of resistance to chloroquine (1990's) the country adopt the use of ACTs in 2006. The introduction of Artemisinin Combination Therapy for malaria (ACTs) accompanied by new guidelines for diagnosis and treatment of malaria (Thiam *et al.*,2011), and increased coverage of insecticide-treated bed nets, have been associated with a decline in malaria incidence in parts of the country. The changes to malaria treatment guidelines involving a positive diagnostic test before antimalarial treatment has improved the treatment of non-malaria fever and have led to increased use of antibiotics. Patients presenting with febrile illness are diagnosed and treated according to a set of guidelines developed by the national malaria control program (PNLP), which specify that for cases of suspected uncomplicated malaria, antimalarial treatment is given only after a positive test result is obtained. Each month the number of positive malaria cases is reported to the PNLP, this gives a much more accurate picture of the malaria burden than was possible previously when malaria cases were not parasitologically confirmed.

Statistics from the Senegalese National Malaria Control Program (table 1.2) indicate a dramatic decrease in the number of malaria cases at the national level during recent years (PNLP Strategic Plan 2010) but that drop could be partially attributed to improved diagnosis implemented from 2008, as cases were parasitologically

confirmed from that date. Malaria-attributable mortality decreased 4 fold between 2006 and 2009, (PNLP, 2010) with no remarkable change in the way mortality data were collected. Data from DSS of Niakhar, Mlomp and Bandafassi, also indicate that dramatic decreases have occurred both in malaria incidence and all-causes child mortality since the implementation of malaria artemisinin combination therapy(Trape *et al.*,2011). LLINs are distributed to all population and free of charge since 2010 with a target of universal coverage, being poor is no longer a predictor of living in a

household without ITN. The rate of household having at least one mosquito net increased from 38% to 72% between 2005 and 2010. Three demographic surveillance sites in Senegal have reported a malaria mortality drop from 10.5 to 2% per 1,000 live births from 2000 to 2010 (Trape *et al.*,2012) with disappearance of mortality seasonality since big efforts are done on malaria control (see Figure 1.1). The explanation of this decline cannot be exclusively linked to malaria decline only because this period coincides also with increased use of antibiotics (linked to the introduction of rapid diagnostic tests for malaria) but also great effort in terms of vaccine coverage, mass campaign for oral rehydratation, Zinc and antihelminthics distribution . The analysis of health data collected by the Senegalese control program through health facilities and surveys (table 1.2) data concluded a plausible effect of effective malaria control measures on child survival gain (Twing *et al.*, 2017). That analysis concluded a 40% reduction of all causes child mortality between 2008 and 2010 with a high reduction in areas where malaria was more prevalent. In that same period data from Niakhar SDSS showed and huge reduction of the probability of dying before age 5 passing from 83.73 per 1,000 in 2008 to 42.72 per 1,000 in 2010 (table 1.3)

Table 1.1 Monthly pattern of deaths among children under 5 years of age in 1995, 2000, 2005 and 2008, 2009 and 2010 in Niakhar (note the disappearnce of the seasonal peak in 2008-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990	8	9	15	20	17	14	17	23	33	30	18	11	215
2000	14	14	9	12	10	14	15	15	37	42	31	24	237
2005	10	3	5	11	8	13	12	14	35	33	19	6	169
2006	9	8	5	4	8	5	11	8	18	43	25	14	158
2007	4	6	10	11	10	2	7	19	11	18	9	2	109
2008	8	8	4	2	10	4	11	8	9	8	6	7	85
2009	4	4	2	1	3	5	8	8	6	5	3	1	50
2010	2	5	5	6	3	3	9	11	8	8	4	0	64

Figure 1.1. Seasonal pattern of deaths among children under 5 years of age in 1995, 2000, 2005 and 2008, 2009 and 2010 (note the disappearnce of the seasonal peak in 2008-20). Source : Trape *et al.* (2012).
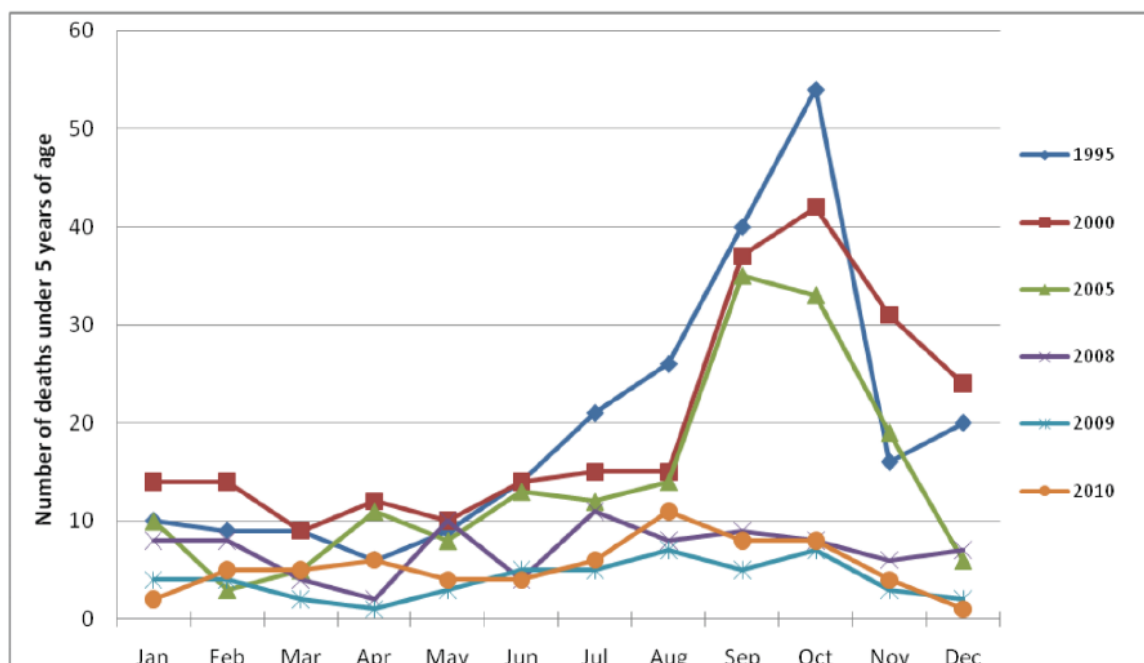
Table 1.2 Malaria proportional morbidity and mortality, and child and infant mortality, from 2005 to 2010 in Senegal.

	2005	2006	2007	2008	2009	2010	Sources
Malaria proportional morbidity		33.5%	22.5%	5.74%	3.07%	3%	Senegal National malaria control Program
Malaria proportional mortality		18.5%	18.1%	7.13%	4.4%	4%	Senegal National malaria control Program
Senegal child mortality all causes	121.5/ 1,000live births	-	-	*	-	72/1,000 live births	Demograhic and households surveys
Senegal Neonatal mortality rate	35/ 1,000 live births					29/1,000 live births	
Fertlity rate	5.3*					5.0*	

*per 1,000 women between 15 and 45 years

Table 1.3 Estimates of infant, child and under 5 mortality in Niakhar from 2004 to 2011

Age	2004-2008		2009-11	
	Probability of dying (q)	Probability of dying (q) per 1,000	Probability of dying (q)	Probability of dying (q) per 1,000
<1yr	0,03	31,55	0,02	16,94
1-4yrs	0,05	53,88	0,03	26,22
<5yrs	0,08	83,73	0,04	42,72

1.5 Inequalities in child survival

The rate of child mortality reflects a country's social and economic development. Reducing inequalities in health is a major goal in terms of public health policies and was part of MDGs. A target related to inequalities is still part of SDGs (Goal 10) with an objective to reduce inequalities within and among countries. To be able to reduce health inequalities, it is important to understand factors associated with inequality particularly those having an effect on child survival (Quentin *et al.*, 2014). Access to health care and the quality of health care are key factors that can influence child mortality (Rutherford *et al.*,2010) (Pison *et al.*,1993).In many areas in less developed countries access to health facilities is limited by place of residence (urban/rural) and the distance between place of residence and health facilities.

Access to health care defined as the presence of health services and the possibility to access to them when needed is influenced by characteristics of services provided to populations (Andersen, 1995). In Senegal child death rate decreased from 350 to 81/1,000 live births over 25 years periods in regions with implementation of health services (Pison *et al.*,1993). The association between distance and mortality is dependant onthe context and also the level of development of health structures (Cleland *et al.*, 1988).The effect of distance on child health outcomes has been investigated in many other studies and were confirmed to some (Magnani *et al.*, 1996; Armstrong *et al.*,2008;Akelle *et al.*,2008) at contrast to others (Rutherford *et al.*, 2009; Becher H *et al.*,2004).

Until a recent past the effect of distance on child mortality wasn't clearly established but a study in Burkina Faso showed that geographic accessibility of health

infrastructures is a key determinant of child survival (Schoeps *et al.*, 2010). That study was the first to take distance as a continuous variable and used continuous travel time from residence to health facilities to investigated the effect of distance on child mortality and concluded an effect on both infant and child mortality.

A pooled analysis from 29 demographic and household surveys in 21 low and middle income countries recently showed an effect of distance on child survival and delivery in health facilities (Karra *et al.*, 2017). But one big limitation of the study of effect of distance on child deaths is the fact that distance is taken as a straight line rather than an exact walking time to access to health facilities.

A systematic review of effect of distance on child mortality revealed that factors affecting access to health care are distance to health care providers and costs of obtaining health care (Rutherford *et al.*, 2010). This review found an association between distance and child mortality but did not include a meta-analysis. Indeed, a meta-analysis found a stronger effect of distance for perinatal and neonatal mortality compared to infant and child mortality (Okwaradji *et al.*,2012). In Kenya a study exploring the impact of distance on utilisation of perinatal health facilities (Feikin *et al.*, 2008) revealed that the rate of clinic visits decreases when distance increases and this after controlling factors like socio economic status, maternal education and clustering at household level. Vulnerable and needy populations often live in remote areas with difficult access to health facilities. This fact, among others, affects antenatal care-seeking and birth delivery at health facilities.

Water sanitation and hygiene (WASH) deficiencies can also have substantial consequences for mortality. WASH-associated deaths were estimated to represent 6 to 7% of mortality in less developed countries in 2008 (Jeuland *et al.*, 2013). Lack of safe water, sanitation and hygiene remain a leading cause of child deaths, according to UNICEF more than 800 children die every day from diarrhoea due to inadequate access to water or poor hygiene.

There is a high risk of death in the first days of life and despite efforts made to lower child mortality, early death (1 day) still accounts for 16% of under five deaths. The main reason is that recent efforts in terms of disease control in less developed countries have focused on problems affecting post-neonatal deaths rather than

neonatal deaths (Lawn *et al.,* 2005). Differences in mortality between areas (rural/urban) are strongly linked with differences in causes of deaths (Pison *et al.*, 2013).Mortality rates are higher in areas where diseases that have big negative impact on mortality are more prevalent. Causes of neonatal deaths needed to be better addressed in order to implement pertinent strategies that can lower neonatal deaths in SSA countries.

Household socioeconomic status and the mother's level of education remain strong determinants of inequalities in child survival, although the gap between children born to mothers with secondary or higher education and mothers without education is narrowing (Mulugeta *et al.,*2012) due by the influence of community education. The cost of health care access is a real barrier of access to health care and a study (Hill *et al.*, 2003) revealed that 36% of caregivers of ill children do not go to health facilities due to services costs. Social factors such as male control over family's financial resources and lack of health knowledge as well as lack of family support can negatively impact on health seeking behaviour (Hampshire *et al.*2002).

1.6 Justification and objectives

1.6.1 Justification

The recent dramatic improvement in child survival observed in Niakhar and Farafenni DSS, coinciding with a reduction in malaria transmission, is greater than would be expected from effective malaria control on the basis of estimates of malaria-specific mortality rates, this may reflect the indirect effects of malaria on mortality. Malaria control may therefore be a key measure for reducing child mortality. However these populations have been under demographic surveillance since the early 1960's and have high participation rates in clinical research including intervention trials of vaccines, drugs and other interventions, with associated enhanced presence of clinical staff, the improvement in child survival may therefore not be representative of the wider population.

From 2008 to 2010 a large scale study to evaluate the effectiveness of seasonal intermittent preventive treatment in children for malaria (IPTc) was undertaken in four districts in Senegal, including the DSS population of Niakhar. Demographic surveillance was set up in a population of about 600,000 people, and IPTc was

introduced in a phased manner over three years in a cluster-randomized step wedge design that left parts of the population without the intervention, as controls. This provided an opportunity to determine rates of mortality in a large population not previously under demographic surveillance, and where parasitological diagnosis of malaria is routinely performed in health facilities providing reliable information about the incidence of malaria. The aim of this PhD project was therefore to evaluate the validity of the data, to estimate rates of mortality, and to investigate factors associated with variations in mortality rates within the study area, in order to gain a better understanding of the current levels of child mortality and the reasons behind the recent decline. The use of the verbal autopsy technique for determining causes of death, in a context of very low malaria incidence, was investigated in order to understand how causes of death may have changed.

1.6.2 Specific objectives

1. To set up a DSS, assess the validity of Niakhar DSS data for the period 2008-2010 and the DSS data for the expanded area over the same period.

2. To use the DSS Data and perform drug delivery to children under 10 years of age between 2008-2010

3. To estimate under-5 mortality rates and other demographic indicators for the study areas.

4. To investigate geographic and cluster-level factors associated with child survival

5. To investigate household factors associated with child survival

6. To investigate changes in the pattern of causes of death by verbal autopsy during a period of malaria decline.

In this study we took advantage of the opportunity offered by the implementation of SMC at large scale on a population of 200,000 children under 10 years old in central Senegal to assess the risk factors of dying before age 5 between 2008 and 2010. In a context of non-completeness of the vital statistics data, we had to go through the establishment of a DSS to identify the target at the level of our area of intervention, then to use the DSS data to locate the children eligible for receiving SMC and then measure the impact of SMC on mortality from all causes. Updating DSS data every 8 months has also allowed us to properly document births and deaths and also collect

economic and geographic data that will be used in the investigation of mortality risk factors.

1.7 Conceptual Framework

Many conceptual frameworks have been used to define and investigate potential links and interrelations that can happen between factors that can influence child survival (Masuy-stroobant *et al.*,2002) (Millard *et al.*,1994; Mosley *et al.*,1984; Tabutin *et al.*,1995). The framework of the study (figure 1.2) is adapted from the Mosley and Chen framework on child survival in developing countries and based on available information in the DSS dataset. The Mosley and Chen framework is based on the premise that most social, economic, cultural and health system variables operate through a set of proximate determinant to influence child mortality. This conceptual framework, despite its pertinence has some limitations (Massa *et al.*,2011) and two of them are that omitted or not measured variables could bias statistical estimations (Hill *et al.*,2003) or intermediate variables are difficult to measure or are not systematically collected (Wander *et al.*,2009).

Individual behavior face to a health problem depends on his level of exposition but also his level of information regarding the health problem. The local context could influence health and child survival independently of individual characteristics. It has also been shown that level of development of a locality can have direct effect on population living in the locality without modifying household socio-economic characteristics (Robert *et al.*,1999).

In our work the focus will be risk factors at cluster, community, household and individual level for child mortality. Five groups of variables are identified; maternal factors; environmental contamination, nutrient deficient, injuries and personal illness control. Factors like socio-economic variable do not directly affect child mortality but affect it in association with others like maternal and demographic factors (age at child birth, birth order). Children living in rural area have greater risk of dying than children in urban area. This difference is increased by household socio characteristics. Poor performance and rarity of health structures do not allow even the wealthiest to escape the ill-effects of their environment.

1.8 Geographic factors

The fact of living in a specific environment can expose resident to a set of external factors that can influence positively or negatively their health. Place of residence (urban or rural area), physical characteristic of the environment (water quality-pollution-etc...), malaria transmission could influence the health system and the level of economic development of a locality. Access to health care is conditioned by physical, geographical and economic accessibility. Mortality differences observed between rural and urban areas could be explained by the fact that better quality of health care is more seen in urban areas than rural ones (Lalou et al, 1997; Van de Poel *et al.*, 2009). Good quality of health care can influence health seeking behavior and indirectly improve child resistance against diseases that have great impact on mortality (Moisi *et al.*,2010) (Rutherford *et al.*, 2010). We expect to have mortality difference according to existence or not of health facilities or the distance between health facilities and village of residence.

Ethnicity and religion can influence health seeking and child mortality. Communities with several ethnic groups are less homogeneous and this can negatively influence group solidarity. Societies with lack of group solidarity are more exposed to child mortality because of the difficulty of appropriation of healthy attitudes promoted to improve child health (Rutherford *et al.*, 1983). Ethnic groups that are more represented can influence others in terms of attitude or comportment regarding strategies implemented targeting child survival.

1.9 Household level factors

Socio economic characteristic of a household and parents' education have been spotted as potential risk factor of child survival. Parent's education increases the level of comprehension of diseases and eases the appropriation of attitudes and measures promoted for a better child care. When parents are highly educated access to paid job is easier and this increases the socio economic status of the household. It has been shown in the past that mother education is strongly linked to child survival (Desai *et al.*,1998) (Gakidou *et al.*, 2010). Educated mothers understand easily reasons behind family planning antenatal care seeking or child vaccination. Risk and disease exposure depends on the faculty of households to

take care of expenses related to their health and if the household size is big resources available might not be enough, families most of the time prioritize due to economic constraints of big households (Bongaarts *et al.*,2001), and children are less priority than adults. When resources are rare and limited, giving adequate care to all household members could be a problem.

1.10 Individual Level factors

These variables are strongly influenced by those identified at household level, such as socio-economic status and parent's education. Health seeking behaviour depends on availability of health care facilities and resources needed to pay for consultation or drug purchase. Economic resources depend on education and parents economic activities. Educated mothers are less likely to get married early and are more exposed to family planning because understanding better the benefit of such measure for their health and the one of their child. Bio-demographic factors such as age, sex, birth order, mother age at child birth and mother marital status have been identified in the literature as being key determinants of child survival (Brockerhoff *et al.*, 2000) (Ronsmans *et al.*,1996)

The list of explanatory variables is far to be exhaustive but these are what we can investigate based on our DSS data.

We are mindful about possibility of existence of underlying causes of deaths that could be ignored in our model but we think that this list of variables could give accurate and pertinent information that will contribute to determine risk factors of child mortality in our study area in a context where disparities between and within communities increased the recent decade (Pison *et al.*,2010) (Rajaratnam al.,2010).

Community level Factors

- Place of residence
- Health system
- Distance to health facicilty
- Ethnicity

- Phiysical caracteristics of the the Environnement

Socio economic factors

- Maternal education
- Socio economic status of the household
- Birth order
- Mother age at child birth
- Age
- Sex
- Religion
- Ethnicity

Proximate Determinants

Maternal factors

- Maternal age at child birth
- Household wealth
- Mother marital status

Health seeking behavior

- Use of health Facilities

Child Mortality

Figure 1.2 : Conceptual Framework showing inter-relation of risk factors for child mortality

Chapter 2: Description of the study site and setting up the DSS system and the malaria surveillance

2.1 Description and choice of the study site and study population

The study site is a rural/ semi-urban area of four health districts; Mbour Bambey Niakhar and Fatick, in west-central Senegal (see Figure 2.1, Figure 2.2-2.4). The climate of the area is sudano-sahelian with a single rainy season which lasts from July to the beginning of October; monthly mean temperature ranges from 24°C (December-January) to 30°C (May-June). The average annual precipitation decreased from more than 800mm before 1960 to 418mm for the period 1982-1989 and reached a peak of 846 mm in 2008. A part of the study area (Niakhar DSS) received electricity gradually starting in 2002 then 2005 and 2006, respectively for Diohine, Toucar and Ngayokheme. Public water distribution started in 1990 in the rural part of niakhar health district. The soil is ferruginous and land use has changed overtime because of intensive agricultural activities and population density increase, the natural vegetation including woody species and wooded savanna (Figure2.4) are replaced by agricultural activities (Tappan *et al.*,2004)

The choice of the study area was motivated by 3 factors: 1) It was believed that malaria mortality in the under 5 age group would be larger in areas of moderate transmission in central Senegal, as opposed to the more intense malaria transmission areas in the south of the country, or the low transmission areas in the north. 2) It was desirable to choose an area around the DSS area of Niakhar, this allowed comparison with historical data, and to validate the data from the wider area with the data from Niakhar DSS. 3) proximity to Dakar and availability of IRD facilities in Niakhar and Mbour was logistically convenient. The area can be considered to be representative of Sahelian areas with a short malaria season, where control measures have reduced malaria transmission, though not of the whole of Senegal.
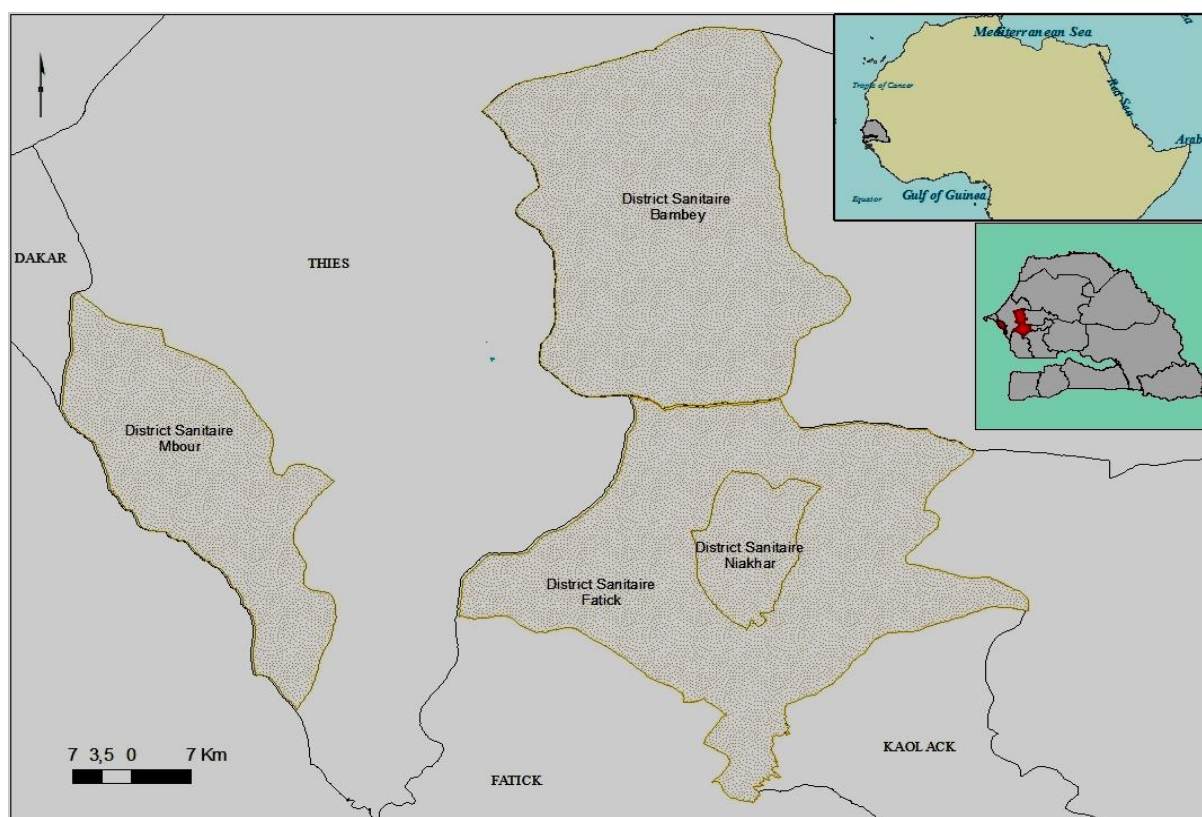
Figure 2.1: Localization of the study site in Senegal

The dominant ethnic groups are serere and ouolof and agriculture during raining season is the main source of income. The main agricultural crops are millet and groundnuts. The literacy rate among over 10 years old in rural populations in Senegal was 33.5% in 2013 (ANSD 2013). All villages are accessible all around the year with good primary and secondary roads (Figure2.2). The study area count 54 health posts divided into six zones counting 9 health posts each.

From 2008 to 2010 a large scale implementation of seasonal malaria chemoprevention (SMC) (Cisse *et al.*,2016) was gradually undertaken by the Senegalese ministry of health targeting children under 10 years old. A stepped wedge cluster randomized trial design was used allowing implementation of SMC in 9, 27 and 45 health posts respectively in 2008, 2009 and 2010. The six zones of the study area were randomized based on the following criteria: distance to the health center, population size, latitude and longitude and an indicator of the health post's performance. Health staff and community leaders agreed to randomization on the understanding that a similar number of health posts would implement SMC in each district in each year.
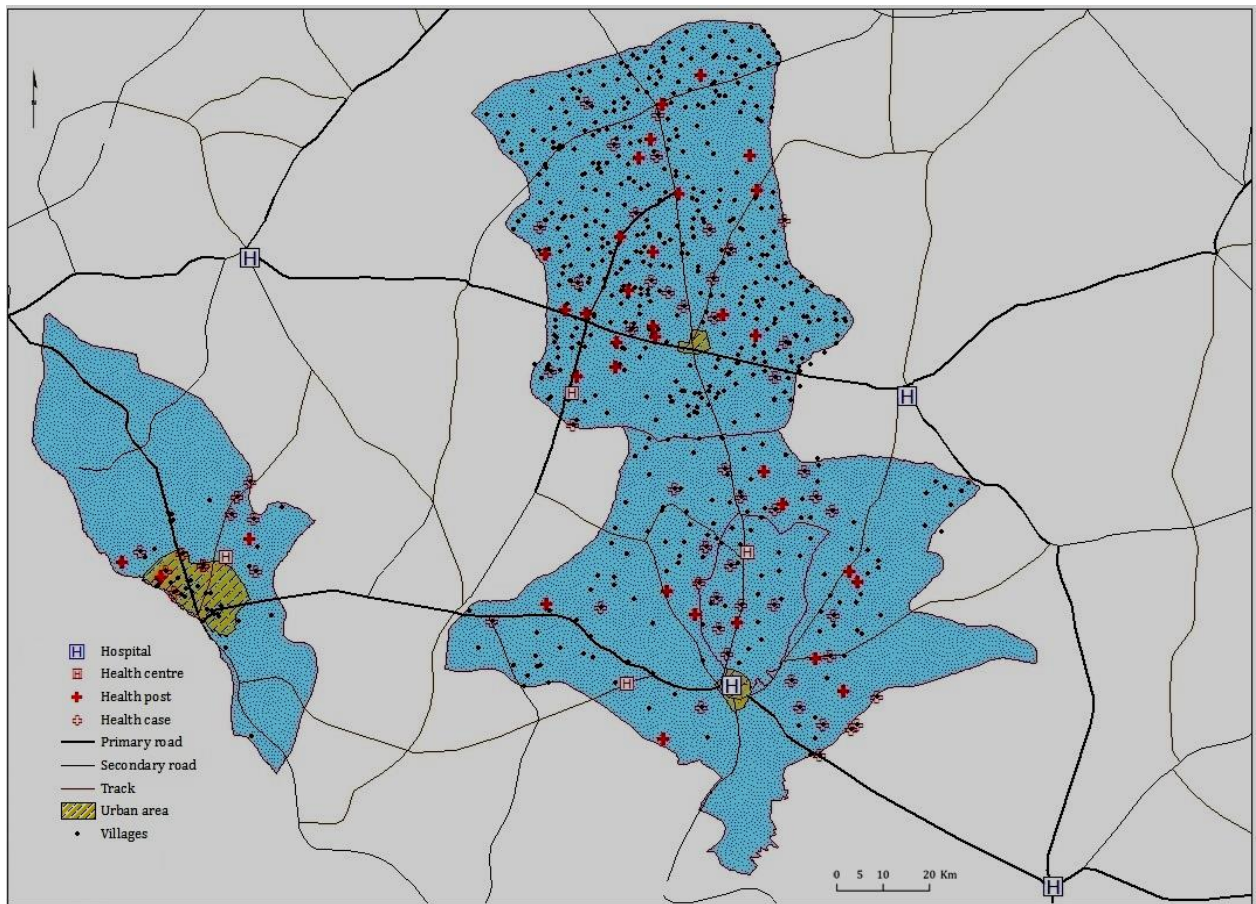
Figure 2.2:Roads healths structures in urban and rural parts of the study area
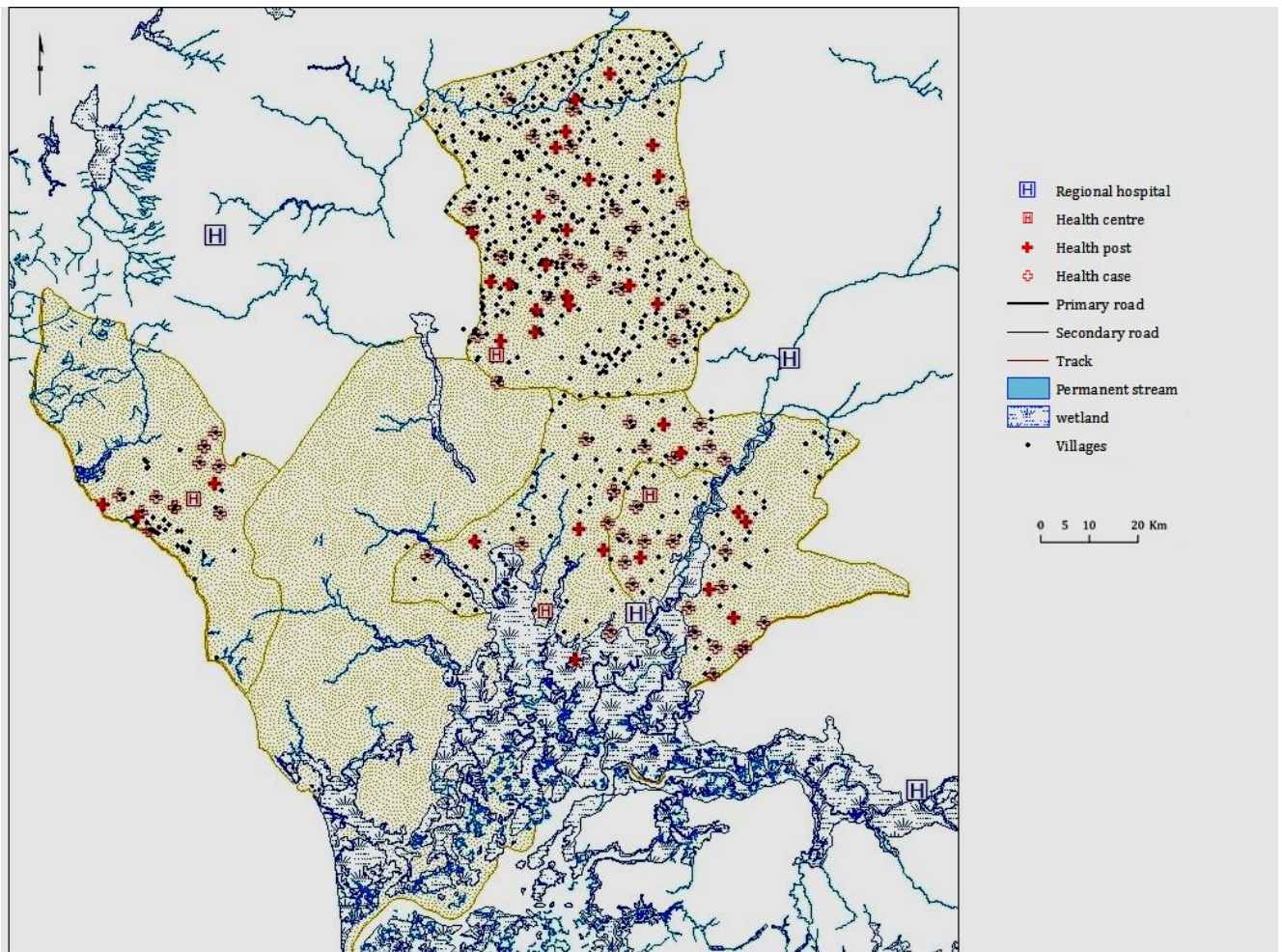
Figure 2.3: Health structures and hydrology network of the study area

The area is served by 3 referral hospitals (Kaolack, Diourbel and Thies) and four district health centers (Mbour, Fatick, Niakhar and Bambey) (see Figure 2.3). There are 15 additional health centers in districts adjacent to the study area. The closest part of the study area to the capital of Senegal is at 70 km distance. Vitamin A is delivered to children aged 6 months to 5 years twice per year (usually around June and December) by community health workers who visit each household. Children aged 1-5 years are also treated with mebendazole during these visits. In Bambey district, from 2006-2009, azithromycin treatment was delivered to all age groups above 6 months except pregnant women, once per year from November to December for treatment of trachoma. About 59% of 12-23 month old children are fully vaccinated. Uncomplicated malaria is treated with duocotexin (chloroquine was replaced by AQ+SP in 2003 and by artemisinin combination therapy, ACT, in 2006). From September 2007, a clinical algorithm was introduced to all health posts and health centers for the diagnosis and treatment of children presenting with a febrile

illness to improve the targeting of ACT treatment. This requires children to be tested with a RDT when there is a fever with no obvious cause, and prohibits treatment with an antimalarial without a positive test result. In 2007 and 2008, large scale distribution of long lasting insecticide treated bednets (LLINs) was organized. Nets were provided free for pregnant women and children under-five years of age through a voucher scheme. Intermittent Preventive Treatment with SP for pregnant women at antenatal visits was introduced in 2007. From 2009 the study area experience universal coverage of long lasting nets initiated by the national malaria control program (Thwing *et al.*, 2011) for children aged 6 to 59 months.

Since 2010 two new strategies called "PECADOM" and "Badienou Gokh" have been developed in the study area. These strategies are based on lay CHWs providing basic care such as diagnostic and treatment of malaria and referring sick people to health posts for additional checkup (PECADOM) in areas that are more than 5 km far from health posts, and promoting healthy attitude (birth spacing, vaccination, hygiene and sanitation measures….) and giving health information to women and head of household (Badienou Gokh").

2.2 The Health system in Senegal

Senegal public healthcare system is designed as a pyramid with hospitals representing the top of the pyramid followed by health centers in the middle and finally health posts and health huts at the lower level. In 2014, Senegal counted 86 hospitals, 242 health centers, 1 250 health posts and 1506 health huts (Tine *et al.*,2014). In parallel to public sector, private for profit and nonprofit entities and the army provide health care at each level of the pyramid (Tine *et al.* 2014). With a national health plan called PNDS (Ministere de la sante Sénégal, 2009), the country developed a plan for improving maternal and child health, a plan guiding the country to a higher quality of health services and development and strengthens of human resources as well as improvement of health infrastructures. This plan contributes to increase availability of health services, their expansion to remote areas as well as recruitment of health staff throughout the country. Despite development of such plan disparities in terms of quality and availability of health workforce persist in Senegal particularly between rural and urban area. Health workers are concentrated in specific urban centers such as Dakar with 0.2 physician for 1,000 population while

Fatick region has 0.04 physician per 1,000 population (WHO 2006).Place of residence still have an influence on access to health information, health seeking and quality care (Zurn *et al.*,2010).
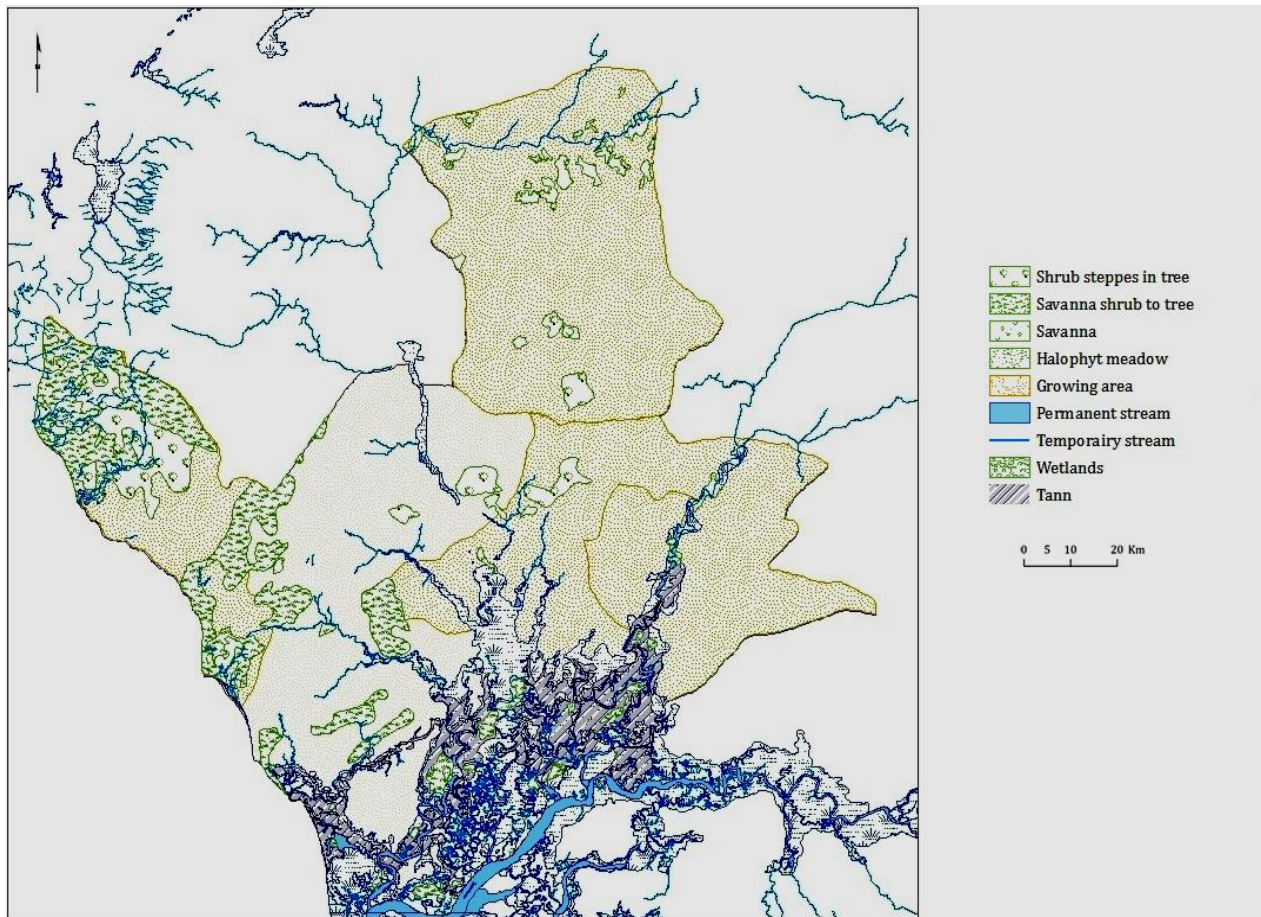
Figure2.4. Land cover of the study area

2.4 Setting up the Demographic Surveillance System

2.4.1 Background

A DSS is a longitudinal, prospective and dynamic surveillance of a population cohort in a defined geographical area and consist of recording demographic indicators (in or out migration, births, deaths, fertility etc.) socioeconomics indicators and health data for people living in that area (INDEPTH 2002). A surveillance system is usually set up for population monitoring and to collect data for planning, implementing and evaluating public health actions. In areas that lack a system for the declaration of

vital events, DSS are used to measure the magnitude and trends of risk factors associated with health events. DSSs can provide robust and reliable information on the health problems faced by the most disadvantaged communities and also allow the conduct of clinical trials with good quality demographic data contributing at the same time to the development of science in general and health in particular.

Traditional sources of health (health posts-health huts-health centers-hospitals) and demographic (vital registration registers) information have demonstrated their limits in settings like sub Saharan African countries. Despite their contribution in providing data for public health policy, data they provide do not always reflect the reality of the context they are coming from. Data from the health system represent a fragment of the reality and vital registration is not systematic.

The Demographical Surveillance System (DSS) was set up to evaluate the effectiveness of a seasonal malaria chemoprevention (SMC) study with impact on all-cause mortality as primary end point. There were several alternative methods to using a DSS for assessing the effectiveness of the study but they each had limitations in the location of interest. Vital registration data in the study area is incomplete and so it is impossible to use such methods to monitor mortality and evaluate the effectiveness of the study. The use of village reporters was also unsuitable mainly because seasonal migration in and out of the area is common and a system using deaths from village reporters might not give reliable denominators for mortality rates. Health services statistics are not reliable because access to health care services is not the same everywhere. Additionally, reporting of death tends to only include events occurring in the health facility which is likely to greatly underestimate mortality. The birth history method was thought not to be suitable because it may not provide reliable estimates for very recent time periods and can be influenced by rounding of ages of death (Hill *et al.*, 1991). For these reasons a simplified DSS system was designed and set up to measure mortality rates in the study area.

The first DSS was set up in Senegal in 1962 (Delaunay *et al.*,2013), the country has other DSS in Bandafassi (Pison *et al.*,2014) and Mlomp (Pison *et al.*,2002). The simplified DSS we set up is bigger than previous ones in the country and covered

four medical districts (Fatick, Niakhar, Mbour, and Bambey) with a population of 570,000 inhabitants.   Having established the DSS for the purposes of evaluating the impact of SMC was an opportunity to be able to monitor trends and risk factors of vital events in the study area.

2.4.2 Methods

Organization of baseline Census

To start the continuous surveillance of the area a census is carried out from March to June 2008 to have a list of all population members living in the study area. The Niakhar DSS questionnaires were used as a template and changed according to our needs in order to make census forms (Appendix 1). A pilot study of all forms was organized with community health workers prior to validation and use. We received the support from experienced demographers and database managers with more than ten years' experience in conducting demographic data collection.

Staff mobilized

Community health workers living in the study area, well accepted and proposed by the public health staff were recruited for the census. We mobilized 187 community health workers for the enumeration of approximately 600,000 habitants. Each group of 10 CHWs was supervised by 1 junior supervisor, each district coordinated by one senior supervisor and all senior supervisors were under the responsibility of field coordinator. I was in charge of the DSS management in collaboration with a data manager, demographers and statisticians. 34 data entry clerks were recruited to enter all forms in 3 months. In total 215 people were involved for the census which last 50 working days.

Mapping the area

For the region of interest we obtained maps from the national Senegalese statistical office to identify and update the number of existing households for each village of over 500 inhabitants.   For hamlets and villages with population less than 500 inhabitants, cartographers were recruited to make maps.   Teams of field workers were recruited to make lists of households with the name of each single head of household to visit during the survey. Compounds were first listed and numbered with

the head of the compounds. A circus with households to visit was made each day for enumerators and supervisors

Information communication and sensitization

Communication and sensitization were important aspects of the census process and helped to avoid misunderstandings and eventual refusals. The first step was information of medical and health authorities. Meetings were held with health authorities where the project, its design, the selection of health posts and the implications and main objectives of the DSS were explained. During these meetings it became clear that involving the administrative authorities would be necessary for any activity requiring population surveys.

After explaining to each prefecture the details of and reasons for the DSS we received a positive go ahead from the administrative authorities. We then started informing the community head of villages, president of rural communities, religious authorities and ladies unions.

A communication plan was written using alternatively proximity (household visits and flyers) and mass communication (radio programs, traditional criers) technics to be sure that the all population is aware of the survey. The project field coordinator participated in major activities and answered any question raised. We took the opportunity at these meetings to explain the reasons for the DSS and why we need accurate information from them to better address health problem identified in their community. The meetings were organized one month before the start of the census in order to keep the population informed and prepared.

SOP Writing and validation

A key step for implementing a project is Standard operating procedures (SOPs) and questionnaire writing, testing and validating. All procedures to be used during the census were written and validated by the team project management group. People in charge of major activities like enumeration, supervision, coordination and data management wrote SOPs and field worker manual in collaboration with their staff. During weekly meetings, drafts were discussed and validated. Questionnaires used in the Niakhar DSS were taken as a baseline, and modified according to the specificity of our project and research questions we wanted to address.

Community consent

Community consent was obtained during meetings organized at village level where the project activities were explained using pre-prepared information sheet for community leaders. At these meetings further meetings were planned for village's heads. The program was then publicized through public meetings, local radio, and via village criers using the appropriate local language (Wolof or Serer). Households were visited to explain the aims and activities of the census using a standard information sheet. Verbal consent of the head of the household was sought and consent or refusal was recorded by the interviewer. Each field worker had a manual explaining in detail the steps of the census (see appendix2).

Baseline census

The estimated population from the previous national census was used as baseline to estimate the target population and therefore the approximate number of community health workers to hire for the census. A list with household number and head of household name was used by field workers to identify the locations to visit each day. Compound members were grouped by households and linked to the household head by a code (see census form appendix 3).All persons found in a compound were enumerated by field workers who differentiated residents and visitors. Residents were people who normally reside in the village they were found in or non-resident who intended to stay at least 6 months. Individuals living in the same compound are grouped in household defined as "All persons living under one roof or occupying a separate housing unit and separate cooking facilities". A unique ID is assigned for each compound each household and each single individual in the study area. Age was checked carefully particularly for children under 5 years; in this case the vaccination card was used to precisely determine the child's age. If the vaccination card was missing historical calendar with important dates of events happening in the study area were listed or known date of birth of brothers, sisters or cousins living in the same compound are used to estimate the date of birth. For adults, ID cards are used and in case year of birth is the only information available we estimated date of birth by using historical calendar or 15th June plus year of birth. The head of the household is the targeted respondent in each compound in case he is absent his wife is questioned and in case they are both absent an adult responsible is used as

a respondent. Respondent name is recorded in case additional information is required and the date of visits marked on each household questionnaire.

Quality control of baseline census

The first step of quality control was focused on checking if all compounds for each village or hamlet were visited. The next step was the verification of the validity of date of birth given by respondents. In case a child is under 5 years old his vaccination card was asked or his birth cards for verification.

Quality control was performed at three different levels to guarantee validity of data. A junior supervisor had 10 community health workers under his responsibility and had to check, and correct all forms coming from his community health workers. A sample (10%) of all forms corrected by junior supervisors was cross checked by the district senior supervisor. This was done to formalize supervision, if problems were noted these were highlighted and the field staff made aware of the need to check this in all forms. All forms after being corrected and checked at district level were sent to the DSS coordinator for a second control of 1% of forms. Feed backs were made each week to assess performance and forms sent back to the field for correction.

Unscheduled (random duplicates households) visits were performed by junior and senior supervisors at village level to see how field workers were performing the work and if all guidelines written on the field worker manual were respected. This involves enumerating for a second time a set of households randomly selected by the district supervisor to check the validity and accuracy of data. In case of big discrepancies, for example forgetting more than 10% of the household members, not checking date of birth for children under five, errors in the resident status of household members , recording information outside a compound without interviewing a household member, not asking questions to the right person , the census was redone and the field worker fired. The control was performed every two weeks to allow the district supervisor to correct questionnaires and send them to the DSS coordinator.

Census Data Management

A simple questionnaire was used because knowing by experience that errors in data collection and entry increase in relation to length and complexity of questionnaires.

An access data base was built for data entry and connected to a server. Three back-ups were made to ensure security of data (2 servers and one external disc). Entry times and programmed checks were implemented to minimize data entry errors. During data entry when an error is found on a questionnaire, a "problem form" is filled and sent with the questionnaire to the field coordinator for confirmation with the fieldwork team.

Census internal data quality control

Each week a sample of entered forms (10%) is selected and checked against the original form, corrections are made if less than 10% of forms have an error. If the error rate is greater than 10% for a clerk in a week the data is re-entered for that clerk. Data entry for the census was completed within 3 months and data were compiled by health post, village and hamlets with all information to be updated during DSS rounds.

Starting simplified DSS rounds

Once a base population was established from the census continued surveillance of the population could be maintained by updating the census information with regular rounds of data collection. An average of ten months for a round was used. DSS paper forms were printed (see appendix 9) from the census database with all information about all enumerated household members during the census. Junior supervisors used during the census were employed as enumerators for the DSS. As with the census, the head of household was targeted for surveying or one of his wives in his absence and a responsible adult otherwise. Information about residency status, relationship to the head of the household, marital status, educational level, religion, and date of birth were updated or corrected for each member of the household. This made it necessary to have well trained people to update and correct census data. The same method used during the census to confirm date of birth was used and a birth or stillbirth form filled for each live birth or stillbirth. Deaths, births, in and out migrations that occurred between last census and current DSS round or between previous DSS round and current DSS round are recorded on specific forms (see appendix 7 and 8). If a DSS member moved inside the DSS area his ID was kept and linked to the new household. When someone came from outside the study area a new ID was given and linked to the household of destination. The same rules

for resident status during the census were kept. Pregnancy status since the previous visit was asked to all women age between 15 to 49 years as well as pregnancy outcome if a pregnancy had been documented during a previous round. Information about pregnancy and miscarriage between rounds are also collected. Stillbirth, early neonatal deaths and miscarriage are recorded as well as place of death and multiple births. Consistency checks were performed to be sure that all events that happened after the earliest date of census and any events that appear to have happened before the census are checked to see if the date is genuine or needs to be updated. For children under 10 years, the place where the child sleeps was inspected to determine bed net use, vaccination dates were recorded from the vaccination card, and any hospital admission was noted. Information on socioeconomic status of the household was also collected in one of the rounds. People omitted or wrongly added in the census database were either added or removed from the list of population living in the study area. The first round took place during the period September 2008 to August 2009 and we have completed 6 DSS rounds. Forms to capture deaths were update after the third round to better differentiate stillbirths and early neonatal deaths.

DSS data entry

Data entry is based on data entered during census or previous DSS rounds. The access data base is updated by a new date of visit with indicators for rounds and the information are updated based on registers filled by enumerators. After the second round we started using an SQL-server data base. During the third round we introduced the use of teleform to scan deaths, birth, in and out migration forms to avoid data entry errors and speed up significantly the data entry process.

DSS quality control

The first step was to verify that all villages, compounds and households visited during the census were also visited during DSS rounds. The second was to calculate and compare indicators such as twinning rates, mortality, stillbirth and early neonatal deaths and crude birth rate between the Niakhar DSS and the newly set up DSS. Thirty villages surrounding the Niakhar DSS and belonging to the new DSS with similar populations was selected and demographic indicators compared. It is thought

that some demographic indicators should be similar in the two areas, and the comparison can therefore be used to check the quality of data collected in the new larger DSS assuming that Niakhar DSS is our gold standard.

Data cleaning

Extraction from the main data base was done to provide a specific data base for the census and for each individual DSS round. Data cleaning was performed with simple cross tabulation using stata to verify missing events like dates (birth-deaths-departure-arrival) residential status- household numbers-ID numbers and all other variables of interest. The first step was to verify duplicates and people declaring a residential status before the census and who were not enumerated during the census (Omitted persons) or people who left the study area a long time before census. These people were either added or removed from the baseline census data base. The next step was to cross check between different dates of birth given during each round to verify consistency of date of birth. Since date of birth obtained during DSS rounds was collected by more senior enumerators (former junior supervisors during the census) we paid more credit to DSS rounds dates of births. In case of discrepancy between date of birth for census and date of birth during DSS Rounds, we choose date of birth for the DSS and asked the DSS enumerator to confirm during subsequent rounds. Data cleaning concerned also correction of missing IDs and events without forms for example an event coded as a death, birth, in or out migration without the relevant form filled was cross checked and corrected either in the field if a form has to be filled or on the DSS register if the code has to be corrected after field investigation. Other data corrected were related to missing household numbers, incorrect village code due to spelling problems, problems with multiplicity of births. The data cleaning took us more than one year to have a clean data base after several field trips for field data correction.

Causes of deaths

Verbal autopsies were used to investigate the probable cause of death. It is not feasible to do this for all deaths, so 13 health posts have been selected and verbal autopsy completed for each recorded under 10 years old death in the 123 villages in these health post areas. Interviews were completed within 4 months following the death using a standardized questionnaire derived from the one developed by

INDEPTH network (revised august 2003, see appendix 4). Six experienced interviewers from IRD Niakhar's DSS are employed to work with supervisors. Each questionnaire was reviewed independently by two clinicians who assigned the probable underlying cause of death based on their own medical appraisal. Discordant diagnoses were discussed by a panel of clinicians for a consensus. The International classification of diseases ICD 10 is used.

Malaria Surveillance

In Senegal diagnosis and anti-malarial treatment are free of charge (apart from a consultation fee of CFA200-300), for all. Malaria surveillance was done in the four districts of the study area served by 54 health posts and 72 health huts, and four district health centers. Three referral hospitals, just outside the study area (in Diourbel, Thies and Kaolack) receive patients from the study area. In health huts and health posts malaria cases are documented in registers (name, date of consultation, age, symptoms, RDT result, and treatment). Data from registers are tallied in a monthly basis and entered in a database. Data entry was performed twice, firstly recording just the date, age and RDT result of each case in the register, and then independently, the complete register was entered (including symptoms and treatment, and address or village of residence). Villages were coded, by staff familiar with the area, using a master-list of all villages and hamlets in the study area. Where local names for parts of larger villages or quarters of towns had been used, these were checked by DSS field interviews familiar with the area. The number of malaria cases was cross-checked against the monthly tallies prepared for the National Malaria Control Programme. Malaria was defined as a positive RDT, or, where RDT was not performed, a clinical diagnosis of malaria.

2.4.3 Results

Census

The census reported 1077 villages and hamlets containing 47 360 households, the average number of individuals in a household is 12 (min=1, max=306). 0.36% of households without identified head of household and 0.44% with more than 1 head of household. 572 persons were found with age missing (0.1%) and 77 persons without village of residence. The total population of the study area is 570143, of whom 107,900 were aged 0-59 months and 97,752 were aged 60-120 months at the

time of the 2008 census. The population served by each health post ranges from 1,803 to 41520 with a median of 8400. The number of children 0-59 months served by each post ranges from 313 to 8941 (median 1402), and the number aged 0-120 months ranges from 603 to 16138 (median 2654). The age distribution in the study area is given by the age pyramid below. The census was easier in rural areas than urban areas like Mbour because of changes between date of household listing and date of census. In urban areas people, meanly, those renting houses or rooms can move from one place to another in a very short period of time and this make the enumeration a bit difficult. Figure 2.5 below shows the population age pyramid with more than 50% of the population aged below 20 years old.
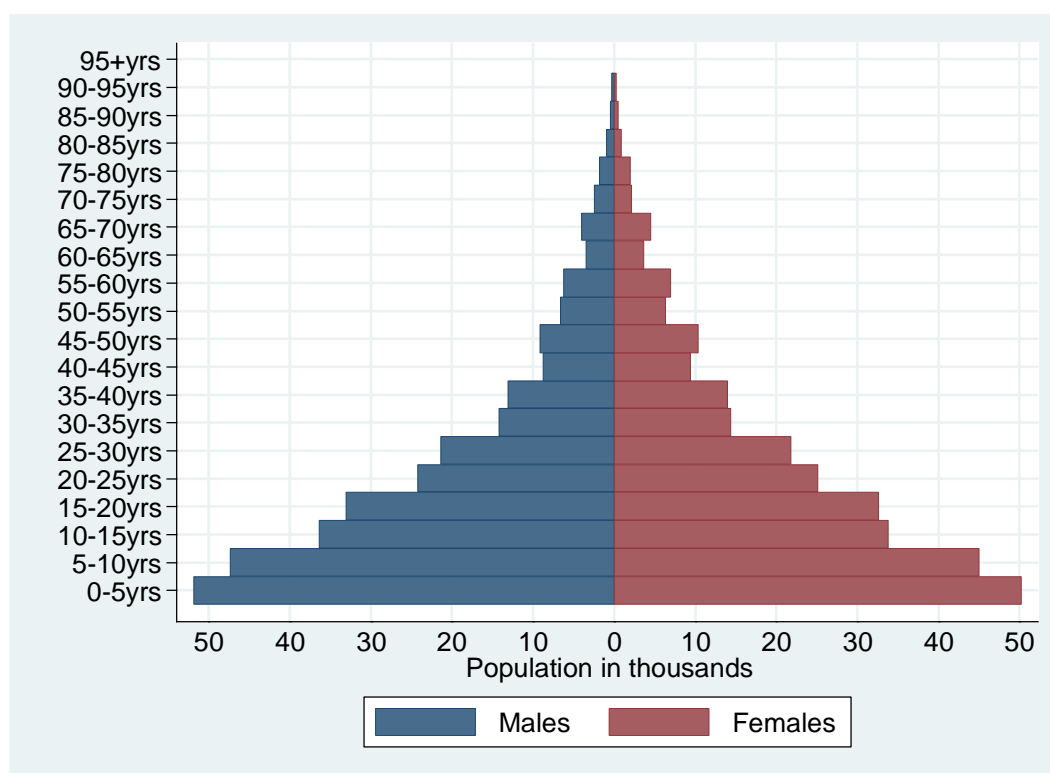
Figure 2.5: Population Structure Mbour, Fatick and Bambey,Year 2008, in the baseline census

Characteristics of the DSS population

Collecting DSS data using paper questionnaire wasn't an easy process a. In our DSS we visited approximately 48,000 households with the median household size equal to 11. Illiteracy rate was 48% and the median age was 18 years. The sex ratio was 50% and the major ethnic groups are Serere (56%) Ouolofs (33%) and Polar (7%). Bednets ownership fluctuated from 52 to 99% between 2008 and 2009

coinciding with the year of universal distribution of nets in Senegal particularly in our study area. Main problem encountered was on dates of events mainly births, deaths, in and out migration. Some duplicated information were seen but not more than 5% and this was more seen between two subsequent round and when the two respondent are different. I was not easy to run the DSS in the urban part of the study area (Mbour) where we encountered some missing household between the census and first DSS round and between rounds. Households are more stable in rural area than in urban area. This was mainly due by the fact that people in urban areas rented houses or rooms and can change houses from one round to another. During DSS rounds under estimation of early deaths or miscarriages can happen particularly when they happen right after the interviewers visit. As we did one round every 9 months unwanted events (early deaths, miscarriages or stillbirths) happening in a period of time of one month after previous DSS round might be forgotten by respondent.

Table 2.1: Characteristics of the DSS population at each survey round

Study population	Round 1	Round2	Round 3	Round 4
Number of villages visited	1125	1098	160	740
Contributing population (Resident==1 | 2)	580,729	590,775	102,801	555,245
Age structure				
Median age	17.6	18.1	18.4	17.7
Population under 5 years	87,044 (16%)	72,692 (13%)	13,869 (13%)	88,651 (16%)
Missing age information	42,777	50,638	9	4,087
Education				
Not been to school	273,335 (48%)	275,395 (47%)	40,894 (41%)	241,271 (46%)
Primary	140,839 (25%)	143,111 (25%)	28.912 (29%)	129,204 (25%)
Secondary and above	43,915 (8%)	51,941 (9%)	14,290 (13%)	54,581 (10%)
Other (Coranique/Alphabetisation)	104,227 (18%)	107,299 (18%)	16,316 (16%)	98,223 (19%)
Pre-school	3,694 (0.7%)	4,005 (0.7%)	1,017 (1%)	3,614 (0.7%)
Number missing	14,578	8,973	2,400	28,401
Gender				
Male population (%)	292,498 (50%)	294,913 (50%)	51,312 (50%)	276,779 (50%)
Number missing	117	2017	28	3013
Ethnicity				
Wolof	196,612 (34%)	198,953 (34%)	34,203 (33%)	184,212 (33%)
Serer	325,720 (56%)	331,686 (56%)	56,563 (55%)	317,489 (57%)
Pular	38,891 (7%)	39,555 (7%)	6,413 (6%)	34,960 (7%)
Mandigue	8,775 (2%)	8,590 (1%)	3,211 (3%)	7,853 (1%)
Diola	3,060 (0.5%)	3,305 (0.6%)	683 (0.7%)	2,908 (0.5%)
Soninke	2,123 (0.4%)	2,143 (0.4%)	522 (0.6%)	1,948 (0.4%)
Other	6,019 (1%)	6,303 (1%)	1,185 (1%)	5,651 (1%)
Number missing	469	284	21	390
Religion				
Muslim	550,963 (95%)	547,682 (95%)	92,192 (93%)	514,365 (95%)
Christian	28,830 (5%)	28,506 (5%)	6,469 (7%)	24,607 (5%)
Other	262 (0%)	247 (0%)	29 (0%)	363 (0%)
Number missing	674	14,384	4,111	16,081
Bed nets ownership				
Owns bed net	255,819 (52%)	366,696 (99%)	77,741 (77%)	376,139 (99%)
Owns ITN	223,040 (45%)	366,468 (93%)	67,453 (67%)	374,767 (92%)
Slept in ITN night before survey				
Number missing	89,764	223,214	2,064	176,405
Household information				
Number of Households*	47624	48,709	8,418	43,188
Households in Urban area	2,685 (6%)	3,571 (7%)	1,235 (15%)	2,651 (6%)
Median household size (IQR)	11 (7-15)	10 (7-15)	10 (7-16)	11 (8-16)

The comparison of village reporters file and DSS data base showed big discrepancies between the 2 ways of collecting early mortality data. Village reporters detected 40% more stillbirths than the DSS and particularly when an early death occurs the month following the previous round. Movement of people inside the study area was a big challenge to avoid double counting of some household members and people living their villages after being enumerated kept their ID numbers.

The number of villages visited changed considerably between round 1&2 done in 2008 and 2009 and round 3&4 done part of 2009 and 2010. The main reason is that after round 2 we decided to put together villages and hamlets liked to them instead of taking each hamlet as a separate village. In round 3 we only visited 160 villages because they were the only villages we did not visit that current year. As our work was planned to end in 2010 we decided to visit all villages in 2010 for better comparison between years.

Comparison of demographic indicators

Demographic indicators are reported for the whole DSS and within the three departments of Bambey, Fatick and Mbour. Niakhar DSS results are also provided for comparison. The indicators are calculated for 2008, 2009 and 2010 and an average across the three years is given. The crude birth rate is calculated as the number of births in the calendar year divided by the mid-year population estimate. The stillbirth and neonatal mortality rate is calculated as the number of stillbirths per year or live births who died within 28 days divided by the number of live births in the year. One and five-year mortality are calculated using the method described by Delaunay et al (2001).

	DSS					
	TOTAL	Bambey	Fatick	Mbour	DSS villages near Niakhar	Niakhar
Population (July 2009)	**592331**	**285635**	**143024**	**163672**	**33558**	**39810**
Crude birth rate/1,000/yr	32.8	30.8	37.1	25.4	34.2	42.0
Stillbirth rate	21.7	18.8	16.4	36.1	17.7	17.3
Neonatal(<28days)mortality rate per 100 births	3.6	4.2	3.3	2.6	4.5	7.0
Infant (<1yr)mortality rate per 1,000 births	9.6	11.7	8.9	6.0	9.1	18.9
Child (1-4yrs) mortality rate per 1,000 births	14.1	16.5	16.3	7.8	17.7	29.8
<5 mortality rate/1,000 births	23.6	28.1	25.1	13.7	26.7	48.1
Crude mortality rate/1,000pyr	4.2	4.4	5.2	3.1	5.1	6.5
Life expectancy at birth	70.3	70.7	66.9	72.4	67.3	65.9

Table 2.2: Health indicators by DSS area, average 2008-2010

The results indicate that the birth, still birth rates and life expectancy are roughly comparable between the new larger DSS and the long running Niakhar DSS. Crude mortality rate lay also in acceptable proportion if we compare the two areas. There appear to be fewer deaths in the DSS area compared to the Niakhar particularly child deaths. That difference could come from Mbour area (Urban area) with better socio economic status and better health facilities. The big differences in terms of under-five mortality could be partly explained by under reporting of deaths in the new DSS or misclassification of deaths due to inaccuracy of date of births in the first year of the DSS. One big challenge for the coming DSS rounds will be to see where that difference is coming from. We were expecting to have the same mortality as they are almost the same population if we compare the 30 villages in the bid DSS and the one in Niakhar DSS.

Verbal autopsies

Verbal autopsies of deaths in children under ten years were carried out in 13 health posts between March 2009 and December 2011. The median time

between death and autopsy was around 4.5 months. A total of 444 autopsies were carried out of which 413 were classified in the ICD-10 groupings. The distribution of causes of death in broad ICD groupings by age group is given in Table 3. 130 (29%) of deaths were within 28 days of birth and 247 (56%) in children under one year. In those that died within 28 days cause of death was mainly attributed to problems originating in the perinatal period (107, 85%), of these 38 (36%) were due to infections (P35-P39) and 20 (19%) due to cardiovascular and respiratory disorders (P20-P29). In those aged over 28 days at death the most common cause of death 105 (37%) was intestinal infectious diseases (A00-A09). 36 (13%) were attributed to protozoal diseases (B50-B64), 16 (6%) due to other infectious diseases (B99) and 14 (5%) due to influenza and pneumonia (J10-J18). Smaller groupings of causes take less than 5% share each. Diarrheal and perinatal infections represent respectively 26.6% and 22.2% of deaths while malaria represents 11%. (Figure 2.6)

	ICD-10	Age at death				Total
		<28 days	28-365 days	1-5 yrs	5+yrs	
I	Certain infectious and parasitic diseases	2	53	97	13	165
II	Neoplasms	1	1	0	0	2
III	Diseases of the blood and blood-forming organs	0	3	2	1	6
IV	Endocrine, nutritional and metabolic diseases	0	4	4	0	8
VI	Diseases of the nervous system	2	3	6	1	12
IX	Diseases of the circulatory system	0	0	0	1	1
X	Diseases of the respiratory system	3	11	19	0	33
XI	Diseases of the digestive system	1	1	7	1	10
XIII	Diseases of the musculoskeletal system and connective tissue	0	0	1	2	3
XIV	Diseases of the genitourinary system	0	0	2	1	3
XV	Pregnancy, childbirth and puerperium	2	0	0	0	2
XVI	Certain conditions originating in the perinatal period	107	9	0	0	116
XVII	Congenital malformation, deformations and chromosomal abnormalities	1	8	0	0	9
XVIII	Symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified	6	10	3	1	20
XIX	Injury, poisoning and certain other external causes	1	5	4	8	18
XX	External causes of morbidity and mortality	0	0	1	2	3

Table 2.3: Cause of death by age group in 13 health posts from March 2009 – December 2011using ICD10
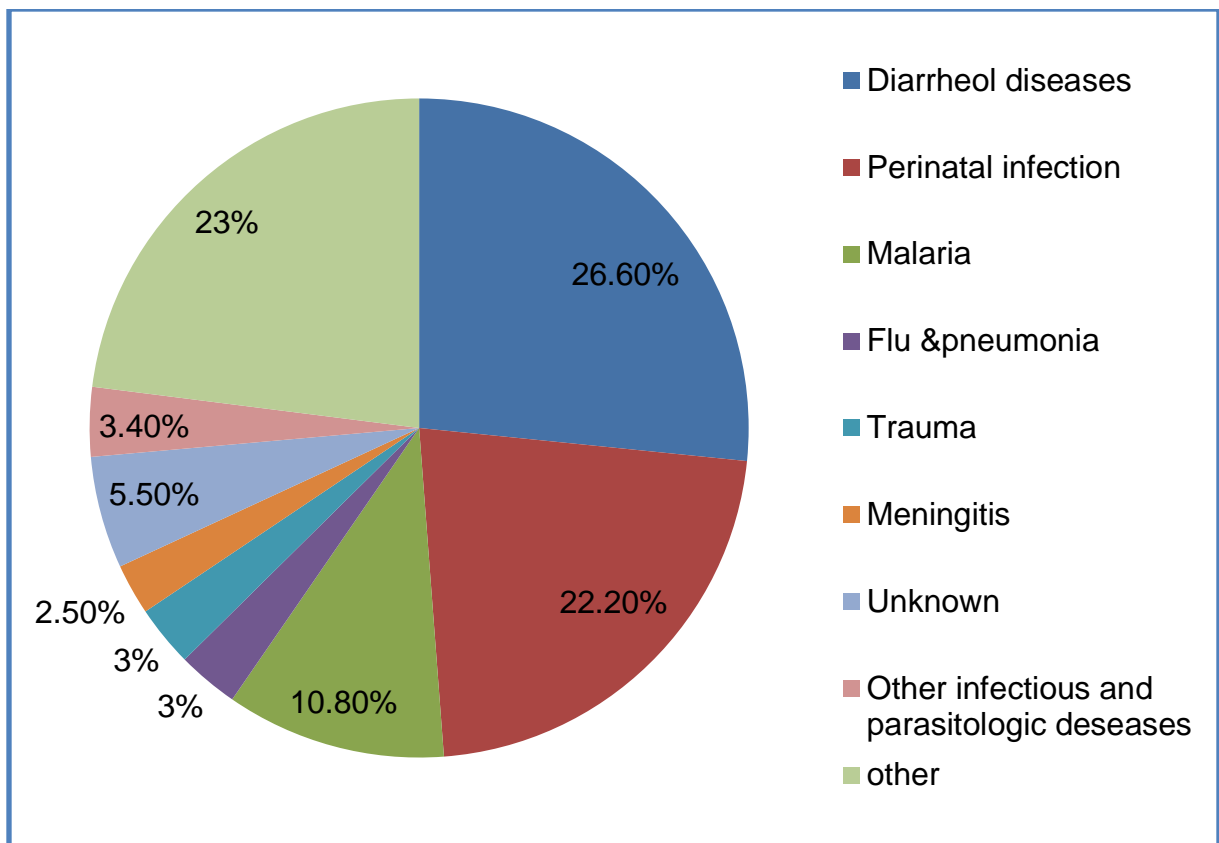
Figure 2.6 Cause of death by age group in 13 health posts from March 2009 – December 2011

Results from Malaria surveillance

Malaria incidence is instable from one year to another if we compare incidence rate obtained in 2008, 2009, and 2010 (table 2.4). No explanation is yet available for the very low incidence seen in 2009.

YEAR	All malaria cases	RDT Confirmed
2008	1	1
2009	0.38 (0.35,0.41)	0.51(0.47,0.56)
2010	1.98 (1.80,2.17)	2.51 (2.28, 2.77)

Table 2.4 Malaria Incidence rate ratio (95% CI) from 2008 to 2010

Malaria incidence is lower among age groups receiving SMC than older age groups. (Table 2.5).

	All malaria cases	RDT Confirmed
Age <5 yrs	1	1
5-9 yrs	1.58 (1.45,1.72)	2.01 (1.82,2.22)
10-19 yrs	1.68 (1.54,1.83)	2.40 (2.17, 2.65)
20-29 yrs	1.46 (1.34,1.60)	2.08 (1.87,2.31)
30-49 yrs	1.18 (1.07,1.29)	1.63 (1.46,1.81)
50 +yrs	0.73 (0.66, 0.82)	1.03 (0.90,,1.17)

Table 2.5 Malaria Incidence rate ratio per age group (95% CI) from 2008 to 2010

Random effects Poisson regression relating the number of malaria cases in each health post area to the person time at risk has shown an Indirect effect of SMC with 26% reduction in malaria treatments in older age groups probably due to children under 10 yrs receiving SMC and a direct effect with a 60% reduction in malaria treatments in children under 10 yrs old.(table 3)

Variables		All malaria cases Rate ratio (95%CI)	RDT Confirmed Rate ratio (95%CI)
Direct effect	No SMC	1	1
	SMC	0.31 (0.28,0.35)	0.40 (0.36,0.46)
Indirect effect	No SMC	1	1
	SMC	0.71 (0.65,0.79)	0.74 (0.67,0.82)

Table 2.6 Effect of SMC on Malaria

Strengths and limitations

This DSS is the largest in Senegal to date providing systematic surveillance of a wide demographic of the population in terms of living conditions and location. Covering a population in excess of 600,000 people means we are able to learn more from the characteristics of villages, households and individuals. The DSS has been set up and executed without problems with local communities, health and administrative authorities. The local communities were involved early on and so the fieldworkers and in-depth questioning was widely accepted with less than 1% refusals.

When comparing the mortality rates from the Niakhar system and the verbal autopsies from selected areas there is an indication that some early deaths may have been missed. This could in some part be due to the regularity of the survey, since the rounds are carried out every 10 months, some very early deaths may be missed as it can be an upsetting event to question about or a pregnancy may not have been reported. As the DSS continues some fine tuning of the methods can be made, for example, to ensure that any reported pregnancy at one round has a pregnancy outcome reported at the next, questionnaires can be improved and the importance of asking about pregnancy outcomes highlighted to fieldworkers.

Chapter 3: Implementation, coverage and equity of large-scale door-to-door delivery of seasonal malaria chemoprevention to children under 10 years of age in Senegal

Introduction

3.1 Background

Since 2012, countries in the Sahel have started to introduce Seasonal Malaria Chemoprevention (SMC) for children under 5 years of age. The current policy is limited to children under the age of 5 but in many parts of the Sahel there is a substantial burden of malaria in older children who could benefit from SMC. SMC involves monthly antimalarial treatment for up to four months to prevent malaria, and is recommended by the World Health Organization (WHO) for children who live in areas with intense and highly seasonal malaria transmission in the Sahel sub-region (World Health Organization, 2012). In 2017, twelve countries have SMC programmes reaching about 15million children (Burkina Faso, Cameroon, Chad, Gambia, Ghana, Guinea, Guinea Bissau, Mali, Niger, Nigeria, Senegal and Togo). In Senegal, children up to 10 years of age are included, in all other countries SMC is limited to children under 5 years of age in accordance with the current WHO recommendation.

Prior to WHO's recommendation, one of the key concerns regarding SMC was the feasibility of delivering it on a large scale through routine health services, especially given the requirement that SMC be delivered at monthly intervals during the rainy season, and the most appropriate methods for delivery. Preliminary findings from the study reported here contributed to WHO's 2012 policy recommendation. The possibility of extending the recommended age range to include children up to the age of 10 is now also under consideration. A number of possible delivery methods for SMC were being considered for children under 5. In The Gambia, a cluster-randomized trial in 12,000 children, found that village health workers achieved substantially higher coverage than delivery through mobile, nurse-led vaccination clinics, and that delivery by village health workers was both equitable and more cost-effective (Bojang *et al.*, 2011). In

Ghana, a small village-randomized trial found that community volunteers achieved slightly higher coverage than health workers in clinics and outreach clinics, although both achieved high coverage; they concluded that a combination of approaches could be necessary in some settings (Kweku *et al.*, 2009). In Mali and Burkina Faso, a qualitative study found that parents and community health workers (CHWs) involved in a clinical trial of SMC efficacy, largely favoured future SMC distribution from fixed points in villages, the method used in the trial, and were concerned about the ability of families to administer the second and third daily doses of amodiaquine (AQ) at home (Pitt *et al.*, 2012). In Senegal, a different approach was taken to SMC implementation research. Consultations were held with health staff to select the most appropriate method of delivery. This method was piloted, and subsequently evaluated on a large scale in a wider range of settings in children under 5 and then in children up to 10 years of age. The findings from these studies are described in this chapter. The studies in Ghana and The Gambia included relatively small numbers of children in a single year with substantial implementation support from researchers, while the efficacy trials in Mali and Burkina Faso employed researcher-led distribution strategies. Implementation research in an operational setting was therefore important to address questions as to whether and how routine health services could successfully deliver SMC on a large scale and achieve high and equitable coverage, and about how to reach older children.

3.2 Study overview

We report on the process of developing and adapting the methods for implementing SMC in central Senegal over a 3-year scale-up period and the levels of coverage and equity achieved. A randomized trial in Niakhar, Senegal (Cisse *et al.* 2006) had shown that monthly administration of antimalarial treatment (a one-day regimen of sulfadoxine plus one dose of artesunate) to children resulted in an unprecedented level of protection, with an efficacy of 86%. A subsequent trial (Sokhna *et al.* 2008) showed that sulfadoxine-pyrimethamine

plus amodiaquine (SP+AQ) was an even more effective regimen. Use of SP+AQ required a 3-day course of treatment each month, but had the advantage, in addition to improved efficacy, that its use for SMC would allow artemisinin combinations to be reserved for treatment of acute malaria cases, where their rapid action would be most beneficial. Implementation research to determine how SMC with SP+AQ could be delivered most effectively was then an urgent priority. Over the malaria seasons (2008-10), SMC was adapted and rolled out in a stepped wedge randomized implementation trial, reaching 9 rural and semi-urban health posts' catchment areas in 2008, 27 in 2009, and more than 150,000 children across 46 health posts in 2010 (**Table 3.1**). Of the 78 health posts in the three main implementation districts, 9 rural and semi-urban health posts were observed as controls throughout the study period and 23 urban health posts were excluded, as operational conditions and epidemiology were expected to differ substantially in urban settings. Further details of the design and randomization process are provided elsewhere (Cisse *et al.*, 2016).

For the first year of large-scale implementation, SMC was delivered to children under 5 (aged 3 to 59 months), however, in response to the changing malaria epidemiology, the target age range was expanded in 2009 and 2010 to children under 10 (aged 3 to 119 months).

In the following sections, we describe the setting and then report on the the main implementation trial, with the aim of informing ongoing implementation across the Sahel and further policy development. Impact of SMC on mortality all causes will be also investigated and presented.

Table 3.1 Implementation summary [1] Includes doses that were refused or rejected. [2] In 2010, Fatick was officially divided into two districts: Fatick and Niakhar. For comparability, they are listed together for all three years.

Year (phase)	Target age group	District	Rural or semi-urban	Health posts implementing SMC	CHWs	Children[1] per CHW (mean)	Children[1] per CHW per day (mean)
2008	**3-59 months**	Bambey District	Rural	3	50	87	29
		Fatick District	Rural	3	68	73	24
		Mbour District	Semi-urban	3	77	81	27
		Total		9	195	80	27
2009	**3-119 months**	Bambey District	Rural	9	254	155	39
		Fatick District	Rural	10	178	166	42
		Mbour District	Semi-urban	8	153	138	34
		Total		27	585	154	39
2010	**3-119 months**	Bambey District	Rural	16	380	199	51
		Fatick and Niakhar Districts[2]	Rural	16	272	181	45
		Mbour District	Semi-urban	13	238	179	37
		Total		46	890	186	44

Table 3.1 summarizes the total number of children seen per year per health district and age group. In 2008 drug delivery was done in 9 health posts for children aged between 3-59 months and in 2009 and 2010 we included those aged from 60 to 119 months. In 2009 and 2010 we moved respectively from 27 to 45 health health posts. The table shows total CHWs mobilized, the mean number of children seen per community worker, and the mean number of children per community worker and per day.

3.3 Setting

The implementation trial was conducted in the three neighbouring districts of Mbour (Thiès Region), Bambey (Diourbel Region), and Fatick (Fatick Region). In 2010, Niakhar District was created from part of Fatick District and continued to be included in the implementation area. The study population is described in the previous chapter.

In 2010, the 46 health posts delivering SMC in the main study area served a median population (all ages) of 10,236 people (range: 1,943 to 45,261) per health post. Each health post is normally staffed by a full-time head nurse and three support staff, all considered CHWs: a community health agent (*agent de sante communautaire*, ASC) acting as an assistant nurse, a CHW (*relais*) responsible for taking payments, and a birth attendant (*matrone*); in some posts, a midwife is also employed.

In Senegal, several categories of CHW are involved in primary health care programmes. Community health agents or *agents de santé communautaire* (ASC) are literate, lay health workers who have received specific training and perform auxiliary roles, including basic curative care, within the health post or health hut. By contrast, *relais* are more numerous and expected to be a key link between the health post and local communities; their qualifications vary and the head nurse calls on them to support the health post in information, education, and communication and in mass distribution campaigns, which the ASCs also support. *Relais polyvalents* mainly support the expanded programme on immunization, but also contribute to HIV/AIDS, malaria, tuberculosis, nutrition, and water and sanitation activities. Both the ASCs and *relais polyvalents* in the study area are members of associations, which perform functions similar to labour unions. Certain other *relais* work on a single programme, notably nutrition. ASC's are paid a monthly salary by the Comite de Sante, a local committee that oversees the work of the health post and decides how resources are used. *Relais* are paid on a daily basis through the district health office.

For large campaigns, including SMC, additional literate community members, such as secondary school students, may also be called on to act as *relais* on a temporary basis. Twice per year (usually June and December) CHWs deliver Vitamin A and mebendazole to children under 5 year through door-to-door visits. In Bambey district, from 2006 to 2009, CHWs also delivered azithromycin to treat trachoma to all residents aged over 6 months except pregnant women each year in November - December. We use the umbrella term "CHW" throughout the paper to refer to both the small number of ASCs, the much larger number of *relais*, and additional community members acting as temporary *relais*.

3.4 Large-scale implementation

3.4.1 Large-scale implementation methods

3.4.1.1 Large-scale delivery

Implementation methods used were built on a pilot study done in tivaoune between 2006 and 2007 (Ba et al,2018) . We adapted findings from that pilot study to changes in epidemiology, difficulties as they arose, and the challenges of gradually scaling up delivery while scaling back research team support over three years, so that in 2010, district health management teams could deliver SMC largely independently in 46 health posts. Early in 2010, members of the research team attended a meeting with the Global Malaria Programme, WHO, at which available evidence on IPTc was discussed preparatory to convening a review by the TEG on chemoprevention. A key point was the need to ensure that use of antimalarial drugs for preventive treatment did not undermine the policy that use of antimalarial drugs for case management should be based on a positive parasitological diagnosis. For this reason, in the 2010 implementation, there was added emphasis on the need to check if the child had a fever, and refer all febrile children so that they could be tested for malaria at the health facility and then treated with ACT if positive, or given SMC treatment if they were negative.

3.4.1.2 Communication

A series of meetings were held with the local government authorities and district health staff to explain the aims and activities of the project. In each of the three districts of the project area, the prefet (the senior local government administrative officer of the *departement*) convened meetings of the presidents of rural communities and sub-prefets in his or her *departement*, at which the aims and activities of the project were explained using an information sheet.

Each medical district developed its own communication plan and money was given to be used for raising community awareness about the intervention. Activities were organised before the first round in September and again before each of the subsequent courses as the importance of informing caregivers of the timing of SMC days before every round was a lesson learnt from pilot study. In Fatick, Niakhar and Mbour, information about the intervention was broadcast on local radio stations, and phone-in programs were organized in which project staff answered questions. In Bambey, griots (village criers) went to selected villages accompanied by the district public health officer. In all districts, village meetings were organized, heads of neighbouring villages were invited, and question and answer sessions were led by the district public health officer, the district medical officer or members of the research team. As in the pilot study, the importance of providing opportunities for questions to be asked was a key finding. These activities were facilitated by the Prefets and sous-Prefets and the Presidents of the Communaute Rurale who provided some of the transport and logistics for these activities. To improve awareness about the intervention and in response to qualitative findings in the pilot, CHWs were given T-shirts and caps bearing project insignia, which they wore during the SMC rounds.

3.4.1.3 Eligibility

From 2008, the lower age limit was raised from 2 months to 3 months because of the low risk of malaria in very young infants. From 2009, in response to the changing malaria epidemiology which was then apparent, the upper age limit was extended from 59 months to 119 months.

3.4.1.4 Drug dosage and formulation

With the expanded age range from 2009, a third age category was created for dosing, children aged 72 to 119 months, who should receive 1.5 tablets of AQ and SP on day 1 and 1.5 AQ tablets on days 2 and 3. Also from 2009, the composition of SP was changed from sulfalene to sulphadoxine because of a change in supplier. In October and November 2010, a different formulation of SP and AQ was used which was not only breakable, but also dispersible and sweetened, to facilitate administration. (**Table 3.2**).

Table 3.2 Changes in dosage and formulations by age over time

Community health workers (CHWs) were trained to administer a supervised dose of amodiaquine (AQ) and sulphadoxine-pyrimethamine (SP) to children and to provide their caregivers with two further doses of AQ to administer at home on the following two days. The correct dose was determined by age range and for the youngest and oldest children required splitting tablets.

| | | No. of tablets received per day (No.of days) | | | | | | Formulation | | Tablets |
| | Age Group | <24 Months | | 24 - 72 months | | 72 - 120 months | | | | |
Year	Month	SP (x1d)	AQ (x3d)	SP (x1d)	AQ (x3d)	SP (x1d)	AQ (x3d)	SP	AQ	
2008	Sept	0.5	0.5	1	1	NA	NA	500mg sulfalene /25mg pyrimethamine	200mg	Breakable, non-dispersible tablets
	Oct	0.5	0.5	1	1	NA	NA	500mg sulfalene /25mg pyrimethamine	200mg	Breakable, non-dispersible tablets
	Nov	0.5	0.5	1	1	NA	NA	500mg sulfalene /25mg pyrimethamine	200mg	Breakable, non-dispersible tablets
2009	Sept	0.5	0.5	1	1	1.5	1.5	500mg sulphadoxine/ 25mg pyrimethamine	153mg	Non-breakable, non-dispersible tablets
	Oct	0.5	0.5	1	1	1.5	1.5	500mg sulphadoxine/ 25mg pyrimethamine	153mg	Non-breakable, non-dispersible tablets
	Nov	0.5	0.5	1	1	1.5	1.5	500mg sulphadoxine/ 25mg pyrimethamine	153mg	Non-breakable, non-dispersible tablets
2010	Sept	0.5	0.5	1	1	1.5	1.5	500mg sulphadoxine/ 25mg pyrimethamine	153mg	Non-breakable, non-dispersible tablets
	Oct	0.5	0.5	1	1	1.5	1	500mg sulphadoxine/ 25mg pyrimethamine	200mg	Breakable, dispersible (AQ also sweetened)
	Nov	0.5	0.5	1	1	1.5	1	500mg sulphadoxine/ 25mg pyrimethamine	200mg	Breakable, dispersible (AQ also sweetened)

3.4.1.5 Drug administration

In 2008, the CHWs were provided with cups and spoons with which to administer the tablets as they had been in the pilot study, however, this raised concerns amongst carers about hygiene, and also seemed an unnecessary expense for the programme. From 2009, CHWs therefore used the household's own cups and spoons, and provided the tablets to older children to be swallowed whole under observation.

3.4.1.6 Training head nurses and community health workers

In 2008, all 9 head nurses whose health posts were randomized to implement SMC gathered in the IRD research center of Mbour for a 2-day training. BC and EHB led the training, while the four head nurses who implemented the pilot were also present and shared their experiences. In 2009 and 2010, head nurses who implemented SMC in 2008 trained those who were implementing SMC for the first time. In all three years, each implementing health post held a one-day training session on the day preceding the commencement of the September round of SMC delivery.

3.4.1.7 Record keeping

Registers were used to record monthly treatment, and tally sheets to record number of treatment doses. With the implementation of a demographic surveillance system (DSS, described below) from 2008, families were issued with SMC record cards, one for each caregiver, on which SMC treatments of children in their care were recorded.

3.4.1.8 Logistics

Administration was planned to begin on the same date in all health posts each month and year. The 5-day period at the middle of each month was chosen taking into account public holidays, and other health activities of district staff. Community sensitization and local mobilisation were organised by the district communication officer. In September 2010, each health post was provided with a printed register for each village in their catchment area, listing eligible children.

3.4.1.9 Drug procurement and management

In 2008, drugs for SMC (Dualkin, sulfalene-pyrimethamine and amodiaquine) were donated by Pfizer, Dakar; sulfalene is chemically very similar to sulfadoxine. Drugs were purchased in 2009 from planet Pharma, Paris representing Chongqing Qinyang Pharmaceutical Co Ltd and in 2010 from Kinapharm (AQ 153mg and SP 500mg) and National pharmacy of Senegal (SP 500mg).

A sample of SP and AQ tablets was tested in Dakar (Laboratoire des pharmacies et des medicaments) and London (London School of hygiene and tropical Medicine) and passed standard criteria for drug content, uniformity of content, dissolution and impurities.

Drugs were stored in the research facility in Mbour under supervision of the field research coordinator. The quantity of drugs needed for each district was calculated based on the population of children in each age-based dosing group plus a margin of 20%. Population estimates came from a census done in 2008 updated through demographic surveillance rounds. District staff or, in some cases, the health post nurses transported the drugs to the health posts at least 3 days before drug delivery was due to commence each month. The day before drug delivery each month, CHWs at each health post placed courses of tablets appropriate for each age group into plastic bags. Remaining drugs from each round were kept in health posts after the September and October campaigns and the additional tablets required given before the following month based on number of children seen during the previous month. At the end of the November rounds, all remaining drugs were sent back and stored in a controlled temperature room at the research health facility in Mbour.

3.4.1.10 Supervision and monitoring

At end of each day, the CHWs reported to the head nurse the number of children seen and drugs remaining, and checked the register for any children who had been missed. The nurse then tallied the total number of AQ and SP tablets administered, counted the number of tablets remaining, calculated wastage, and,

if less than the predicted number of tablets had been used, sought reasons for the discrepancy (e.g. refusals, errors in listings, migration of families). The nurse then reported this information to the district medical officer each day by mobile telephone and issued CHWs with drugs for the next day.

In 2008, the 9 implementing health posts continued to receive daily supervisory visits during the delivery days from either district or research staff. In addition, project DSS (Demographic Surveillance System) interviewers visited each nurse and each CHW team in their DSS circuit once per SMC round to check the team had forms and registers and used them correctly, had enough drugs, sugar, and other supplies, and were correctly dosing by age. In 2009 and particularly in 2010, however, as the number of health posts increased, the research team scaled back their support such that the DHMTs supervised largely unaided.

3.4.1.11 Pharmacovigilance

A series of steps were taken to strengthen the national PV system in the study districts, the methods and findings are described elsewhere (NDiaye *et al.* 2016).

3.4.1.12 Costing

A detailed costing study was undertaken in 2010, reported elsewhere (Pitt et al 2017).

3.4.1.13 Data collection

Data sources comprised a demographic surveillance system (DSS), administrative data, a series of cross-sectional household surveys, and a survey of CHWs. Data were recorded on paper forms and scanned into databases using the Teleform system.

3.4.1.14 Demographic Surveillance System

A census of the study area was carried out in March-May 2008. After data entry and cleaning, all households were revisited in August to give each mother or caregiver a card bearing an identification number for the household, for the mother/caregiver, and for each child in her care, with space to record information on the administration of SMC, Vitamin A, and mebendazole. Health facilities were

provided with blank DSS cards to issue to first-time mothers at their first contact with health staff after delivery, and annual rounds of household visits were conducted to record changes in household occupancy.

3.4.1.15 Administrative data

Tools to document the drug administration process (quantity of drug given, date and age group) were developed and given to each team of CHWs. Register were printed out from the demographic surveillance system data base with information to identify each child (mother's name, name of head of household, household number, village name and number - with columns to document presence, absence, refusal of treatment, and whether the child vomitted). The registers were printed once per year with columns on each page to collect information for each child each month. Tallies were made from registers to determine the number of refusals, and absent and sick children each round each year.

3.4.1.16 Cross-sectional household surveys

Surveys were conducted at the end of the malaria transmission season in December 2008, 2009, and 2010 to determine coverage of SMC and reasons for missed doses, adherence to daily doses in the most recent SMC treatment, to record bed net use by children after inspecting the place where the child slept, to measure the prevalence of parasitaemia and anaemia, and to ask about any adverse events related to SMC. In 2008, 5 villages in the catchment area of each of the 54 health posts implementing SMC were selected with probability proportional to size. In each selected village, households were selected by simple random sampling from the Demographic Surveillance System (DSS) database to yield at least 20 children in each village, giving a minimum sample of 100 children per health post, or 5,400 in total. In 2009, the sampling strategy was modified somewhat: households were selected in each health post's catchment area by simple random sampling from the DSS database to give a sample of at least 130 children per health post, resulting in an actual total sample size of 6,827 children. In 2010, to improve the power for analysing parasitaemia prevalence, the sampling strategy was again modified to over-sample the 9

remaining control health posts and those with higher malaria incidence by weighting each by a factor of 2 before randomly selecting 40 health posts with probability proportional to size. In each selected health post, households were selected by simple random sampling to yield about 25 children in each health post and 1,000 children in total.

The DSS database was used to determine the number of households to sample in each village or health post to generate the required sample size. A list of all eligible children in the selected households was prepared from the DSS database, but interviewers were instructed to recruit all children within the appropriate age range normally resident in the household, regardless of whether they were in the DSS listing or had received SMC. "Normally resident" was defined as children who had been resident for at least 6 months or, if resident for less than 6 months, planned to remain in the area for the next 6 months. In December 2008, all normally resident children aged (when surveyed) 6-63 months in the sampled households were included in the survey, and in December 2009 and 2010, all normally resident children aged (when surveyed) 6 to 123 months were included. While children who reached the age of 3 months after the September SMC round, but before the October or November rounds were eligible to receive SMC in the later months, they were not included in the December survey. In all surveys, the sampling fraction varied between health posts in order to yield an approximately constant number of children per health post. If the target number of children was not reached after all the selected households had been visited and call-backs completed, an additional listing of households, selected by simple random sampling from the same health post, was used. Sampling continued until the target sample size was reached.

The survey was conducted over 14 days each year. Interviewers alternated between health posts that had received SMC and those that had not to avoid systematic bias in the timing of the interviews. One call-back visit was arranged if the mother or a child was absent.

The mother (or other caregiver) of each child was asked about her demographic characteristics, education, sources of income, household and personal assets,

type of house and availability of electricity, telephone and water supply. For each child, the duration of residence in the village was recorded, and the place where the child slept the previous night was inspected to record the type and condition of the net. In areas where SMC had been delivered, the number of SMC courses received was recorded from the DSS card if available or from mother's recall. If scheduled SMC doses were not received, the mother was asked the reasons.

3.4.1.17 Community health worker survey

At the end of 2010, a survey was conducted of a sample of 47 CHWs, from all four districts, addressing their experience of SMC delivery. They were asked what questions were most commonly raised by caregivers; what they did if the child was febrile; whether they enquired, before administering SMC, if they child had had adverse reactions to SMC drugs previously or had known allergy to SMC drugs; whether cups, spoons, water and sugar were provided by the household or the health post; the steps taken to treat school-age children during term time; how they determined the child's age group for dosing (under 2yrs, 2-5yrs, 6yrs and over) when the child was not in the DSS listing; whether they had knowingly treated children older than 10 years; what happened if the mother said there was a child that should be treated but the child was not at home when the CHW came; whether they consistently checked if the child had received other medicines in the last month, specifically SP or AQ or bactrim, and whether or not they administered SMC in such cases; and if the child was currently on a course of antimalarial treatment did they administer SMC? It was explained that the aim of the survey was to determine what was done in practice and there were no right or wrong answers.

3.4.1.18 Data management and analysis

Coverage levels

Administrative data on the number of courses administered was tallied from health center registers and aggregated by district. Reports from health posts and

delivery tools developed to document day to day activity of drug delivery teams were collected and compared with registers to check for consistency.

Survey questionnaires were checked for completeness by the district supervisor before being batched and sent to Dakar for scanning using the Teleform system and export to Access databases. The proportion of eligible children receiving 0, 1, 2, and 3 courses of SMC and 95% confidence intervals were estimated from the survey data using a ratio estimator, with each observation weighted by the inverse of the sampling fraction for the health post using Stata version 11 (Statacorp, College Station, Texas). For 2009 and 2010 data, coverage levels were also estimated by age group to compare annual coverage for children aged 3 to 59 months with coverage of those aged 60 to 120 months in September of each year; p-values were calculated using the designed-based F test.

Equity

Equity of coverage was conceptualized as children having the same probability of receiving SMC regardless of their age (within the target age range), gender, the household's socio-economic status (SES), or their mother's education type or level. Analyses were based on the cross-sectional household surveys. Each child's SES quintile was assessed using principal components analysis of his or her mother's assets (ownership of cattle, sheep, goats, horses, donkeys, radio, television, video cassette recorder, watch, telephone, metal or wooden bed, bicycle, cart, motorbike, car), household construction (roof material, floor material), and household amenities (running water, electricity, fixed phone line, flush toilet, pit latrine, solar power, cooking fuel). The proportion of children who had received all three intended courses of SMC and the proportion who had slept under a bed net (a long-lasting insecticide-treated bed net (LLIN), any treated or impregnated bed net, or any net) the previous night were then disaggregated by SES quintile. Logistic regression was used to calculate the change in odds of coverage for a one quintile increase in SES. Test for trend for SES was done using logistic regression model fitting SES as a linear effect and accounting for survey design using STATA survey commands. Coverage of SMC was also compared across the level and type (none, Koranic, or French) of the mother's

education. Differences between groups were compared using design-based p-values.

3.4.1.19 Ethics

The trial protocol was approved by Senegal's Conseil National pour la Recherche en Santé and the ethics committee of the London School of Hygiene & Tropical Medicine. The trial is registered at www.clinicaltrials.gov, number NCT 00712374.

During each round of SMC, CHWs explained the aims of the project and the potential side effects of the study drugs using a standard script translated into the appropriate local language (Wolof or Serer), sought verbal consent from the mother or caregiver of each child, and recorded consent or refusal in a register.

Consent was sought separately for participation in cross sectional surveys. After publicizing the survey in the community through meetings with CHWs, the village head, and public meetings, DSS interviewers visited selected households. They explained the survey and finger prick using a standard information sheet, and sought written consent from the mother or caregiver of each eligible child.

3.4.2 Large-scale implementation results

3.4.2.1 Courses of SMC delivered

In the three years of the main implementation study, children aged 3 months to 10 years received more than 780,000 courses of SMC. (**Table 3.2**) The number of courses received reflects instances in which a CHW successfully administered or observed a child take the first day's dose of AQ and SP and provided AQ tablets for administration on the two following days. In a relatively small number of additional instances, a child was reached by a CHW, but the parents or child refused (7,660, 0.97% of contacts), the child vomited or spat out the first dose (892, 0.11%), or the child was unwell and therefore ineligible to receive SMC, in which case the child was referred to a health facility (314, 0.04%). In addition, 7% of targeted children were absent in 2008 and this rose to 13% in 2009, but then dropped to just 3% in 2010 (**Table 3.3**).

Table 3.3 Effective coverage: Receipt of SMC and reasons for not receiving

Findings are presented from administrative data.

Month	2008 (children 3-59 months, 3 health posts)				2009 (children 3-120 months, 27 health posts)				2010 (children 3-120 months, 46 health posts)				TOTAL
	Sep	Oct	Nov	Total	Sep	Oct	Nov	Total	Sep	Oct	Nov	Total	
Received SMC	16,218 (90.31%)	15,756 (91.77%)	14,764 (90.62%)	46,738 (90.89%)	86,949 (85.32%)	86,514 (84.88%)	88,553 (85.04%)	262,016 (85.08%)	154,014 (96.57%)	157,602 (96.63%)	159,667 (96.63%)	471,283 (96.61%)	780,037 (92.07%)
Absent	1,544 (8.60%)	1,114 (6.49%)	1,079 (6.62%)	3,737 (7.27%)	14,147 (13.88%)	13,956 (13.69%)	13,079 (12.56%)	41,182 (13.37%)	4,600 (2.88%)	4,411 (2.70%)	4,385 (2.65%)	13,396 (2.75%)	58,315 (6.88%)
Refused	45 (0.25%)	145 (0.84%)	292 (1.79%)	482 (0.94%)	649 (0.64%)	1,317 (1.29%)	2,429 (2.33%)	4,395 (1.43%)	655 (0.41%)	1,007 (0.62%)	1,121 (0.68%)	2,783 (0.57%)	7,660 (0.90%)
Vomited or spat out	142 (0.79%)	146 (0.85%)	145 (0.89%)	433 (0.84%)	68 (0.07%)	55 (0.05%)	35 (0.03%)	158 (0.05%)	177 (0.11%)	72 (0.04%)	52 (0.03%)	301 (0.06%)	892 (0.11%)
Unwell	10 (0.06%)	8 (0.05%)	13 (0.08%)	31 (0.06%)	94 (0.09%)	82 (0.08%)	38 (0.04%)	214 (0.07%)	41 (0.03%)	13 (0.01%)	15 (0.01%)	69 (0.01%)	314 (0.04%)
TOTAL	17,959 (100.00%)	17,169 (100.00%)	16,293 (100.00%)	51,421 (100.00%)	101,907 (100.00%)	101,924 (100.00%)	104,134 (100.00%)	307,965 (100.00%)	159,487 (100.00%)	163,105 (100.00%)	165,240 (100.00%)	487,832 (100.00%)	847,218 (100.00%)

3.4.2.2 Quality of delivery

At each health post, SMC delivery took between 2 and 6 days each month and involved between 4 and 68 CHWs. Each pair of CHWs administered SMC to approximately 54 children per day in 2008 (**Table 3.1**). As virtually doubling the age range only increased the number of households to visit by 13%, the average number of children receiving SMC from each pair of CHWs increased to 78 per day in 2009 and 88 per day in 2010.

The system of daily supervisory visits at every health post on every administration day in 2008 picked up a number of errors promptly. For example, in September 2008, an excess of SP tablets had been used in 3 health posts, and the supervisor discovered that this was because SP as well as AQ had been left with the mother for administration at home on days 2 and 3. In response, CHWs were sent back the same evening to collect the SP, all nurses were telephoned to remind them of procedures, and training in future years further emphasized the dosage, such that the problem did not recur.

Staff turnover was low both amongst head nurses and CHWs. Only 5 of 46 nurses left their health post during the three years, and three of the 5 remained in the study area.

In the resource use and activity survey conducted in 2010, nearly all CHWs declared that this was their first time (from 2008) delivering SMC. Questions most commonly asked by caregivers were about the purpose of SMC; why adults were not included; why these drugs (SP,AQ) were used; why children can become unwell after taking the drugs and questions related to side effects; and whether SMC would eliminate malaria. 37/47 (79%) of CHWs said they consistently referred febrile children to the health post and did not give SMC treatment, but 4 (9%) had treated febrile children and 7 (15%) had with-held treatment without referring. Checking for previous side effects or known allergies to SMC drugs was not routinely done. It was stated by several CHWs that this was because they felt that if there had been side effects, mothers would volunteer this information without being asked. 38 (81%) said that the sugar they

used in the previous SMC was provided by the project and 9 (19%) said they used sugar provided by the household. When asked about steps they had taken to treat school-age children, 36 (77%) said they had returned to the household in the afternoon, 4 (9%) said they had made appointments for the following day, 7 (15%) said treatments had been given at school supervised by the school director, and 4 (9%) said they had left drugs for this child with parents. For determining the dose to use, vaccination cards were checked but if these were not available, the age was estimated by comparison with other children in the compound. One CHW (2%) had treated children above 10 years of age. To treat children who were not present at the time of the visit, 27 (57%) mentioned making an appointment to return the following day, 13 (28%) mentioned leaving the treatment with the mother, and 7 (15%) mentioned going to find the child nearby. None of the CHWs surveyed said that they checked if the child had received SP, AQ or Bactrim in the previous month. Most (89%) said they would not administer SMC if the child was currently on a course of antimalarial treatment, 5 (11%) said they would.

3.4.2.3 Levels of coverage

According to administrative data and DSS population estimates, average monthly coverage increased from 76% in 2008, to 83% in 2009, and up to 87% in 2010 (**Table 3.4**). Coverage varied from a low of 65% of children in the target age range (3 to 59 months) receiving SMC in Mbour district in November 2008 to a high of 92% of children in the target age range (3 to 119 months) receiving SMC in Bambey district in November 2010.

Table 3.4 Effective coverage by district

Coverage estimates are based on administrative data and DSS population estimates.

District	Year	2008			2009			2010		
	Month	Sep	Oct	Nov	Sep	Oct	Nov	Sep	Oct	Nov
	Number of health posts implementing	9			27			46		
District	Target age range	3-59 months			3-119 months			3-119 months		
Bambey	Courses of SMC administered	4,677	4,250	4,104	38,673	38,583	41,102	74,047	76,018	77,292
	Target population	5,092	5,092	5,092	46,208	46,208	46,208	83,756	83,756	83,756
	Coverage	92%	83%	81%	84%	83%	89%	88%	91%	92%
Fatick and Niakhar	Courses of SMC administered	5,189	4,903	4,912	27,253	26,908	26,182	45,565	46,274	47,375
	Target population	6,482	6,482	6,482	32,659	32,659	32,659	53,863	53,863	53,863
	Coverage	80%	76%	76%	83%	82%	80%	85%	86%	88%
Mbour	Courses of SMC administered	6,352	6,603	5,748	21,023	21,023	21,269	34,402	35,310	35,000
	Year	2008			2009			2010		
	Month	Sep	Oct	Nov	Sep	Oct	Nov	Sep	Oct	Nov
	Target population	8,836	8,836	8,836	26,507	26,507	26,507	43,441	43,441	43,441
	Coverage	72%	75%	65%	79%	79%	80%	79%	81%	81%
Total	Courses of SMC administered	16,218	15,756	14,764	86,949	86,514	88,553	154,014	157,602	159,667
	Target population	20,410	20,410	20,410	105,374	105,374	105,374	181,060	181,060	181,060
	Coverage	79%	77%	72%	83%	82%	84%	85%	87%	88%

Cross-sectional surveys indicated that in 2008, 92% (95% Confidence Interval: 89%, 95.5%) of children in the target age range (3 to 59 months) received all three monthly courses of SMC (**Table 3.5**). In 2009, when both the target area and age range increased, estimated coverage decreased to 84% (82%, 87%) of targeted children receiving all three courses of SMC. In 2010, estimated coverage with all three monthly courses of SMC increased to 93% (91%, 96%) of children in the targeted age range and areas, the highest level achieved in any of the 5 years of the study. Fewer than 5% of children received one or two courses of SMC in any given year. The proportion of children captured in the end-of-season surveys who were reported not to have received any courses of SMC increased from 3.5% (2%, 5%) in 2008 up to 11% (9%, 13%) in 2009, and then decreased to 6% (4%, 8.5%) in 2010.

Table 3.5 Effective coverage by age group*

Age	No.of courses received	Year 2008 (N=1,019) % coverage (95%CI)	Year 2009 (N=3,397) % coverage (95%CI)	Year 2010 (N=882) % coverage (95%CI)
3-59 months	0	3.5% (1.9,5.1)	12.9% (10.4,15.5)	8.8% (4.9,12.8)
	1	0.9% (0.2,1.5)	2.2% (1.4,3.1)	0.4% (0.0,1.0)
	2	3.3% (0.8,5.8)	3.3% (2.0,4.6)	0.4% (0,0.9)
	3	92.3% (89.1,95.5)	81.6% (78.4,84.8)	90.4% (86.4,94.3)
60-119 months	0	NA	9.4% (7.3,11.4)	3.0% (1.3,4.6)
	Year	2008 (N=1,019)	2009 (N=3,397)	2010 (N=882)
	1	NA	0.9% (0.3,1.4)	0.0%
	2	NA	2.7% (1.5,4.0)	0.7% (0.0,1.6)
	3	NA	87.0% (84.5,89.6)	96.3% (94.4,98.2)
Overall	0	3.5% (1.9,5.1)	11.1% (9.2,13.0)	6.1% (3.7,8.5)
	1	0.9% (0.2,1.5)	1.5% (1.0,2.0)	0.2% (0.0,0.5)
	2	3.3% (0.8,5.8)	3.0% (1.8,4.1)	0.6% (0.1,1.0)
	3	92.3% (89.1,95.5)	84.4% (81.9,87.0)	93.1% (90.6,95.6)

*Coverage estimates are based on end-of-season cross-sectional survey data. In 2008 SMC was only given to children under 5 years. Children missing information on the number of SMC courses received are assumed to have received no courses. Number of courses received was not missing for any children in 2008 or 2010. Number of courses was missing for 5 children (0.15%) in 2009. Age was missing for two children in 2009 and one child in 2010, and so these three children are reflected in overall coverage, but not the age-specific coverage estimates. Design-based test of homogeneity of proportions by age group: 2009, p<0.001; 2010, p=0.0018.

For all three years, the cross-sectional survey data provided higher coverage estimates than the combination of our administrative data and DSS, which likely reflects differences in denominators. The DSS estimated the total population normally resident in the study area, whereas the cross-sectional surveys excluded people who were temporarily absent at the time of the surveys. The DSS estimates are therefore likely to have overestimated the target populations and underestimated coverage, because some families had temporarily migrated, and were therefore not present to receive SMC and potentially not even exposed to malaria.

The surveys also indicated a notable dip in coverage in 2009, whereas the administrative data indicated continuous increases in average yearly coverage. This discrepancy likely relates to the relatively high proportion of children who were absent during SMC delivery in 2009 (15%) as compared with 2008 (8%) or 2009 (3%) (**Table 3.4**); perhaps because of less effective communication, families may have been temporarily away from home on the delivery days in 2009, but nonetheless captured in end-of-season survey that year.

In 2009, 9.6% of caregivers reported difficulty administering the unsupervised doses, this percentage was slightly lower for children 5-9 years (7.4%) than for under-5's (12%). The most common problems (76% of those reporting difficulties) were refusal or rejection by the child. Other reasons included the caregiver being away, and the child being unwell. Only 2% said they had forgotten to give the two doses or had lost the tablets.

3.4.2.4 Equity of coverage

Coverage was somewhat higher amongst children aged 5 to 9 years (87%, 84.5% to 90%) than amongst children under 5 (82%, 78%, 85%, p<0.001) in 2009. Although coverage increased substantially in both age groups the following year, coverage remained higher in older children (p=0.002, **Table 3.6**).

Table 3.6 Equity: Coverage of SMC compared with bed nets by socio-economic status

Denominators (N) refer to SMC implementation areas. LLIN: Long-lasting insecticide-treated bed net.

		Socio-economic status (SES) quintile					Odds ratio for one level increase in SES	P-value for trend
2008		**Lower**	**Lower middle**	**Middle**	**Upper middle**	**Upper**		
	N	253	154	171	190	251		
	Received all 3 SMC courses (%)	94.5	91.2	87.6	90.1	94.9	1.04 (0.88, 1.22)	0.63
	Slept under any net last night (%)[e]	69.9	74.4	73.1	86.5	82.0	1.22 (1.04, 1.42)	0.012
	Slept under LLIN last night (%) [f]	53.3	53.9	58.3	68.1	67.9	1.19 (1.07, 1.33)	0.002
	Slept under treated or impregnated net or LLIN last night (%) [g]	64.9	68.6	69.6	76.8	70.3	1.08 (0.95, 1.21)	0.225
2009	N	689	725	631	674	678		
	Received all 3 SMC courses (%)	85.3	80.0	86.4	83.4	87.5	1.07 (0.95, 1.20)	0.36
	Slept under any net last night (%)[e]	42.9	60.9	55.6	61.5	77.2	1.34 (1.18, 1.53)	<0.001
	Slept under LLIN last night (%) [f]	39.9	57.3	53.0	56.0	74.7	1.33 (1.18, 1.50)	<0.001
	Slept under treated or impregnated net or LLIN last night (%) [g]	42.4	59.6	55.3	60.7	76.4	1.34 (1.18, 1.52)	<0.001

Figure 3.1 shows that SMC uptake was highly equitable, and more equitable than use of bednets, in 2008 and 2009. There was no evidence of a linear trend in the probability of receiving all 3 courses of SMC across SES quintiles in either 2008 (p=0.63) or in 2009 (p=0.36), the two years for which SES data was collected (**Table 3.5**). In 2008, coverage of all three intended courses of SMC in the poorest SES quintile was estimated at 94.5%, which was higher than all but the highest SES quintile, which achieved 94.9% coverage. In 2009, all coverage levels dropped across all quintiles, but the 85.3% coverage achieved in the poorest quintile was only slightly lower than the 87.5% coverage in the highest quintile.

Figure 3.1 Equitability of receipt of SMC and use of bed nets, by socio-economic status, in 2008 and 2009. In each year, the proportion of children who received 3 courses of SMC (in blue) was similar in all wealth rankings. Bednet use (the proportion who slept under a bednet, in green, or under a LLIN, in purple) was less equitable (lower in the poorest wealth ranking), (Under-5s in 2008, under-10s in 2009.LLIN: Long-lasting insecticide-treated bednet.)
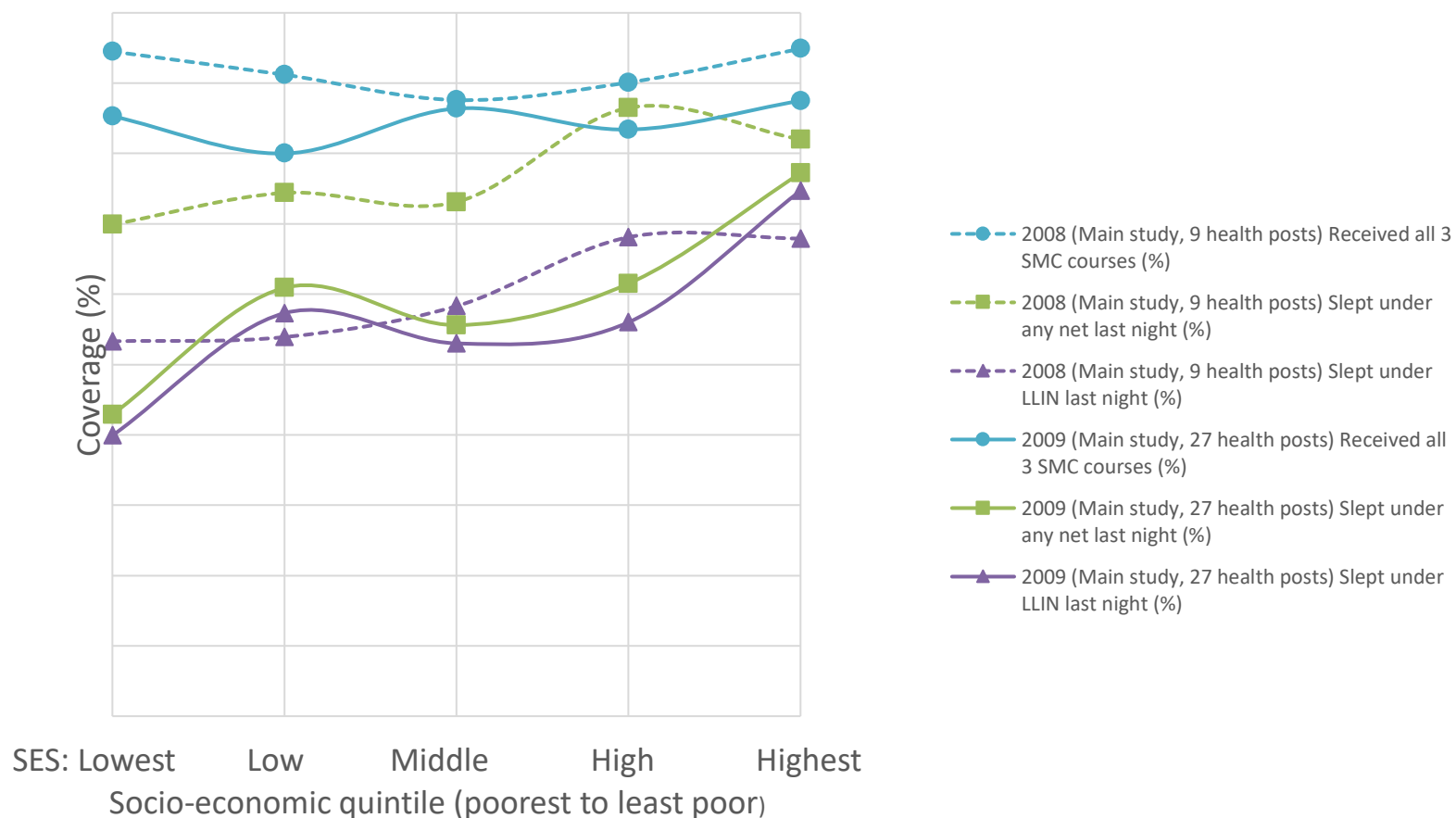
Coverage of SMC was also equitable with respect to the education of the child's mother. **Table 3.7** illustrates that there was no evidence in 2008 (p=0.55), 2009 (p=0.77), or 2010 (p=0.33) of differences in coverage according to whether the mother had no education, only a Koranic education, or any French education. In all three years, coverage levels were very similar between groups, and in both 2008 and 2010, children whose mothers had no education achieved the highest levels of SMC coverage.

This equitable and very high coverage of SMC contrasts sharply with the inequitable and lower rates of use of bed nets shown in **Figure 3.1**. In both years analysed, there was very strong evidence of a regressive trend in those children who had slept under a long-lasting insecticide-treated net (LLIN), any treated net, or any net in the night preceding the survey (**Table 3.5**). In 2008, use of an LLIN in the night preceding the survey varied from 54% in the poorest SES quintile to 69% in the highest SES quintile, reflecting an 18% (8% to 29%) increase in the odds of LLIN use for each level increase in SES quintile. In 2009, the inequity in bed net usage became even starker as only 39% of children in the poorest quintile had slept under an LLIN the preceding night compared with 75% of children in the highest SES quintile.

Table 3.7 Equity: Coverage by mother's education

French: French school and Koranic school or French school only.

	Year	2008			2009			2010		
Level/ Type of education:		None (N=586)	Koranic only (N=152)	French (N=235)	None (N= 1916)	Koranic only (N = 608)	French (N = 699)	None (N = 502)	Koranic only (N = 141)	French (N = 195)
No. of courses	0	2.9	2.5	5.2	11.1	9.3	8.6	5.6	4.5	5.5
	1	0.4	1.2	0.6	1.4	1.4	1.7	0.12	0	0.34
	2	3.3	3.9	3.0	3.0	2.2	3.5	0.24	1.65	0.34
	3	93.4	92.4	91.2	84.5	87.1	86.2	94.0	93.8	93.9
Design-based p-value for test of difference between groups										
		0.55			0.77			0.33		

3.4.2.5 Effect of SMC on mortality

Mortality was measured using demographic surveillance with households' visits every 10 months to record household occupancy and any births and deaths. During the period of the transmission season covered by SMC, the number of deaths recorded among children <3months old, 3-59 months of age, and 60-119 months of age in each zone was as shown on **Table 3.8** (SMC areas and age groups indicated by framed cells).

Table 3.8 Impact on all cause-mortality per zone per year during malaria transmission period

	Zone1			Zone2			Zone3			Zone4			Zone5			Zone6		
2008 season	D	Py100	Rate /100py	D	Py100	Rate /100py	D	Py100	Rate /100py	D	Py100	Rate /100py	D	Py100	Rate /100py	D	Py100	Rate /100py
<3mths	10	3.2598	3.07	7	2.8598	2.45	6	2.518	2.38	2	2.8266	0.71	2	2.8313	0.71	3	1.9669	153
3-59mths	23	48.4064	0.48	39	48.7984	0.80	17	40.715	0.42	26	43.8816	0.59	24	45.7245	0.52	14	29.9813	0.47
60-119mths	5	42.4782	0.12	7	41.718	0.17	4	36.5856	0.11	6	39.0046	015	0	39.3614	0.00	3	27.1212	0.11
2009 season																		
<3mths	3	3.1608	0.95	4	3.2586	1.23	6	2.8753	2.09	7	3.1364	2.23	3	2.9413	1.02	1	2.1036	0.48
3-59mths	11	48.397	0.23	27	49.3098	0.55	8	41.591	0.19	13	45.0956	0.29	7	45.9491	0.15	10	31.0961	0.32
60-119mths	6	43.9782	0.14	6	45.0201	0.13	5	38.2275	0.13	8	41.5419	0.19	4	42.0985	0.10	0	28.2911	0.00
2010season																		
<3mths	9	2.5075	3.59	9	2.5387	3.55	9	2.024	4.45	4	2.4707	1.62	4	2.3839	1.68	6	1.5038	3.99
3-59mths	28	49.147	0.57	33	49.6256	0.66	13	42.8989	0.30	20	46.7359	0.43	19	45.9586	0.41	13	31.2766	0.42
60-119mths	2	47.3042	0.04	3	47.2335	0.06	6	39.4081	0.15	7	45.3741	0.15	7	44.5021	0.16	3	29.3649	0.10

D-deaths ;PY100-personyears/100 ; rate/100py-rate per 100 person years

Poisson regression (Stata version 12 , College Station, Texas) was used, relating the number of deaths of all causes to the person time at risk during the three months of the intervention period each year, starting from the date of the first round of SMC and ending one month after the last round of SMC(15 September to 15 December), with year, age band and zone as covariates, and a gamma-distributed random effect to allow for correlation within health posts, with an indicator variable for the age group and cluster to indicate whether SMC was delivered**(Table 3.9)**. When data for the whole year were included (August to December for 2008 and January to December in 2009 and 2010), the adjusted mortality rate ratios for SMC were 0.98 (95%CI 0.82,1.2) P=0.869 in the younger age group and 0.91 (95%CI 0.69,1.2) P=0.523 in children 5-9years.

Table 3.8 Mortality rate ratios per age- group year and zone

Variable	Categories	Mortality rate ratio (95%CI)	P-value
SMC in children	No SMC	1	
3-59months	SMC	0.89 (0.65,1.20)	0.442
SMC in children	No SMC	1	
60-119months	SMC	0.97 (0.61,1.57)	0.916
Year	2008	1	
	2009	0.63 (0.49,0.81)	0.000
	2010	1.07 (0.82,1.39)	0.631
Age group	<3months	1	
	3-59months	0.25 (0.19,0.34)	0.000
	60-119months	0.066 (0.046,0.097)	0.000
Zone	1	1	
	2	1.10 (0.67,1.79)	0.708
	3	0.71 (0.43,1.18)	0.190
	4	0.92 (0.55,1.53)	0.746
	5	0.79 (0.48,1.31)	0.362
	6	0.77 (0.44,1.36)	0.373

The mortality rate ratio SMC versus control, obtained from random effects Poisson regression with a random effect for the health post, for both age groups combined, was 0.93 (95%CI 0.74,1.17).

During the transmission seasons, the mortality rate among children aged 3-59 months in the SMC area was 4,5 per 1,000 childs at risk (197 deaths) and 4.6/1,000 in control areas (159 deaths). Among children aged 5-9 years, the mortality rates were 1.30/1,000 in SMC area (45 deaths) and 1.31/1,000 in control areas (18 deaths). The mortality rate ratio SMC versus control given by a random effect model that include cluster, time and age effects, was 0.94 (0.71,1.2) for the younger age group and 1.0 (0.64,1.6) for 5-9 years old.

3.3 Discussion

This study demonstrated that SMC could be effectively delivered on a large scale through routine health services using a door-to-door approach, achieving high and equitable coverage, with good adherence to supervised and unsupervised daily treatment doses. Over 3 years, implementation was gradually scaled up from 16,000 children in 9 health posts in 2008 to more than 150,000 children in the catchment areas of 46 health posts in 2010. The coverage of SMC achieved was consistently higher than and more equitable than that of bednet use, indicating that SMC reached children who were not protected by bed nets, and the strategy successfully reached older school-age children. These findings strengthen the case for implementing SMC door-to-door, and for including older children.

Coverage was defined in terms of the number of treatments received and therefore did not capture SMC contacts where the child was referred to the clinic and did not receive SMC treatment at the clinic. An alternative definition of coverage, counting all contacts where the guidelines were followed, could also be defined. SMC record cards would need to be modified to capture such contacts.

The lower coverage in the semi-urban area of Mbour can be explained by a higher rate of refusal, and caregivers more likely to be way from home at the time of the SMC visit. Another aspect is that during rainy season some people go back to their village for agricultural activities, and returned before the survey. As the coverage is based on the population recorded between March and June (in the dry season) these absences cause a decrease in the coverage. The other aspect is that Mbour has a wealthier population than the other districts and the populations may be less likely to adhere to public health campaigns, being able to take care of the child in the event of illness they may judge it not necessary to participate in the campaigns.

Child mortality rates have recently improved associated with a dramatic reduction in the incidence of malaria (Jasseh *et al.,2011,* and Trape *et al.*,2012). Our data are consistent with this observation.

With the decline in malaria incidence in this area, transmission has become patchy. The SMC strategy may be better deployed in a targeted manner to those areas with a persisting malaria problem.

In our study 72% of malaria cases come from 27% of the population. A targeted approach can be more effective than general SMC, since it focuses its efforts on residual foci of transmission. Resources for public health are limited; public perception of the burden of malaria can change as most people with fever have negative diagnostic tests. Consequently, the expenditure allocated to preventive measures by health services and families could decrease. A targeted spatial approach is an appropriate response to this evolution of the situation. Strategies to target communities with a high incidence of malaria in order to achieve community-level disease control have been advocated (Carteret al, 2000), and have a solid basis in population theory (Nold, 1980; Hasibeder and Dye1988;. Smith et al 2007). However, to our knowledge, these strategies have not been evaluated in randomized trials. Such strategies seem increasingly relevant with the drop in the incidence of malaria and the geographic distribution becoming very uneven in the same geographic area

Findings from this study contributed to the policy recommendation for SMC (WHO 2012) and the field guide for SMC (WHO 2013). The WHO guide should be consulted for the currently recommended approach to SMC delivery. Separate tablets for infants and children are now available in blister packs, avoiding the need to break tablets, in dispersible formulations.

It had been questioned whether SMC could be delivered on a large scale in the absence of an established delivery route for reaching older children once a month. The demonstration of feasibility and acceptability on a large scale was therefore a necessary step before a policy recommendation (WHO 2012) could be made. The size of the study (which was originally motivated by power calculations to measure

the effect on mortality), permitted piloting of delivery in a wide range of settings. The study was also able to demonstrate that good compliance with monthly treatments and adherence to daily doses could be achieved through a door-to-door approach with supervision of the first dose and the remaining doses being administered by the caregiver.

Engagement between researchers and health staff at all levels during the planning phase was a key step in choosing a suitable delivery approach and in planning the evaluation. The study also benefitted from international consultations between researchers involved in SMC and policy makers, which were organised independently of this study, a meeting in Dakar in 2008 and a meeting with WHO GMP in early 2010 which led to a refinement of the delivery approach and additional data collection to allow more detailed assessment of safety and costs.

In 2011, the Technical Expert Group on Chemoprevention met to review evidence on SMC (WHO 2011). One recommendation of this group was that SMC should be prioritised in areas where the incidence of malaria was at least 0.1 per child during the main transmission period and the intervention would be highly cost effective. The study area fell outside this recommendation, but since 2013 SMC has been implemented by the National Malaria Control Programme in Senegal in the southern regions of the country where transmission is more intense. In 2017, twelve countries in the Sahel and sub-Sahel, including Senegal, have SMC programmes. In Senegal, the decision was taken to include children up to 10 years of age in the national SMC programme. Our study has shown that school-age children can be effectively reached and the time for delivery was not greatly increased by including these children.

A door-to-door approach was employed in this study. Delivery through fixed points may be suitable in some areas but this approach needs to be evaluated with respect to coverage, equitability and cost. Combining SMC with Vitamin A delivery was piloted in this study in three health posts. The complication of different dosing by age necessitated the presence of an additional person in each CHW delivery team. A larger evaluation had been planned but the supply chain and finance for Vitamin A is coordinated independently of the malaria control programme and synchronisation of SMC and Vitamin A delivery was problematic in practice. SMC can be readily combined with community case management and this has substantial advantages. SMC combined with CCM has been evaluated by NDiaye et al (2017) and Sesay *et*

al. (2011). Combining SMC with other strategies, including nutritional screening, requires further evaluation.

Our study offers a number of practical insights for implementation research. The delivery strategy continued to be adapted, with changes in all three years of the "large-scale implementation". Modifications were made to improve the programme, to respond to problems that arose, for example with suppliers, and to move towards a delivery model in which researchers played little or no role. In our study, SMC courses were recorded in a register and on the mother's card. Accurate recording of courses received is essential if impact is to be monitored, using, for example, case control studies to measure efficacy of the intervention or rebound effects, and for adverse event monitoring. Publicity campaigns and other sensitization activities played an important role in ensuring good uptake, and weaknesses in this area likely explain the dip in coverage and the high rate of absences in 2009, which was remedied in 2010.We have identified a number of practical lessons for large-scale implementation, including the importance of engagement between researchers and health staff at all levels during planning, and the value of piloting and gradual scale-up. High coverage was achieved in older, school-aged children, by informing community leaders and school teachers about dates of SMC administration, and by delivering the treatment on Friday afternoons and weekends.

3.4 Strengths and limitations

This is the first study to evaluate implementation effectiveness of SMC under operational conditions, and to assess the feasibility of reaching older children. The scale and duration of the study allowed SMC to be piloted in a wide range of settings. Robust methods were used for estimation of coverage and equity. Age-specific tablet strengths designed and packaged for SMC, that are now produced, were not available at the time the study was conducted. These new products may reduce administration errors and permit more precise dosing as they avoid the need to break tablets, and may promote adherence. However, highly effective delivery was possible with the single-strength loose tablets used in the study. Involvement of researchers may have contributed to implementation effectiveness but this involvement was limited and reduced during the project. Quantification of drug requirements benefited from the existence of the DSS system and listings of children may have helped correctly to identify eligible children and their dose.

Our study was surely underpowered to detect any effect of all-causes mortality. Despite all our cautions, the deep drop of childhood mortality rate was even higher that we could expect, thanks to the efforts of the MoH and its partners. The nation-wide measures to control the burden of the disease including treatment of only RDTs febrile cases, free ACTs, IPTp, large scale LLINs distribution etc. did play the most significant role in that reduction

Comparison with other evidence

Door-to-door approaches are also used for Polio campaigns, biannual health days for Vitamin A and deworming, and LLIN campaigns and azithromycin campaigns for trachoma, but few evaluations of the delivery approach have been published. Since the WHO policy recommendation for SMC in 2012, countries in the Sahel have introduced SMC. Experience with different modes of delivery is being gained and evaluations are being undertaken through the ACCESS-SMC project.

Transferability

Scale-up of SMC and other preventive strategies, is likely to be more effective using door to door delivery. Delivery was coordinated by district health teams and, although supported by project funds and staff, the coverage estimates in this study give an indication what might be achieved in a well-supervised national system. The use of CHWs to deliver door-to-door can reduce health inequalities but the sustainability of such approaches in mass campaign needed to be investigated as CHWs increasingly ask for payment and unless these payments are standardised more interest may be given to better paid activities.

3.5 Conclusion

Seasonal malaria chemoprevention can be delivered on a large scale through routine health services and achieve high and equitable coverage both amongst children under 5 and amongst children aged 5 to 10 years. The existence of a well-functioning CHW network and wider primary health care system, close collaboration with local health workers from the start, and gradual scale-up and adaptation of intervention methods all contributed to the success of implementation. Our experience offers a number of practical lessons both for those implementing SMC and those considering other campaigns delivered through community health workers. Delivering SMC to school-age children is feasible and the results of this study should encourage countries with SMC programmes to include older children in SMC programmes.

Chapter 4:Risk factors of under-5 mortality in rural Senegal

4.1 Introduction

A recent report from the Global Burden of Disease Study estimates that worldwide 6.3 million children under five died in 2013. This is after great advances have been made, reducing child mortality from an estimated 90 per 1,000 live births in 1990 to 46 per 1,000 live births in 2013. However, these are global statistics and although child mortality rates have been decreasing worldwide the greatest burden remains in Sub-Saharan Africa. Around half of all under five deaths in 2013 were estimated to have occurred in this region (Wang H *et al.*, 2013). The authors find that variation in under-5 mortality rates between countries was explained by the average years of education for females of childbearing age, income per person and HIV-related child death rate.

Senegal had one of the lowest under 5 mortality rates in tropical Africa in 2001(Timaeus *et al.*,2001). Under-five mortality rate has reduced by 61% in Senegal between 1990 and 2013 dropping from 141 to 55 deaths per 1,000 live births in that time. As such Senegal was ranked at number 44 globally by child mortality.

Even if we have clear reduction of under five mortality in Senegal, it is obvious that mortality decline is not the same everywhere in the country and suitable strategies are to be deployed for a better understanding of the mortality situation.

A rapid under five mortality decline was observed in Niakhar in central Senegal, where the probability of dying before age 5 passed from 485 to 213 per 1,000 between 1963 and 1999 (Delaunay. 2001). That mortality decline was not a continuous process, resistance to chloroquine emerged in the 1980s, and was considered responsible for a dramatic increase of malaria-specific mortality from 1990 to 1993 (Munier *et al.*,2009). Vaccine coverage decreasing from 1990 to 2000 (Pison G *et al.*, 2013) could also have played a role in this mortality increase during that period.

In order to get an understanding of the reasons for child mortality at a more localized level, monitoring of the population is necessary. Monitoring mortality rates in a population can also allow analysis of trends over time and the exploration of risk

factors to highlight areas of need. However, a lack of vital registration systems and poor public health infrastructure in sub-Saharan Africa makes this very difficult. To enable epidemiological studies for the monitoring of vital statistics and evaluation of health interventions Demographic Surveillance Systems (DSS) have been implemented in many areas. Some of these surveillance systems have been used to investigate risk factors associated with under five mortality.

Parental education, particularly education to secondary level of the mother, is a key determinant of child survival (Desai S *et al.*, 1998, Gaidou *et al.*,2010). Birth order, birth interval (less than two years), mother's age at birth, and breastfeeding have also been identified as associated with child survival (Girma B *et al.*,2011, Ronsmans *et al.*,1996, Gemperli *et al.*,2004, Nakamura *et al.*,2011, Cutts *et al.*,1996). A short birth interval could lead to early cessation of breastfeeding, exposing the child to a risk of illness from contaminated food and water. Cessation of breastfeeding could cause return to ovulation, short birth intervals and possible low birth weight, with adverse consequences for child development. Malaria is still, a big contributor on child mortality in sub-Sahara Africa (World malaria report, 2014). A study in rural Burkina Faso shows that death of the mother and being a twin were the strongest risk factors for child mortality as well as age of mother, birth spacing, season of birth, village, ethnic group and distance to nearest health center (Becher H *et al.*,2004, Schoeps A *et al.*,2010).

In Senegal variation between region in under-five mortality is seen according to the last demographic and health survey conducted in 2014 (DHS, 2014). Under five mortality rates are lower in the western and northern regions of the country than other parts. The southern part of the country has the highest under five mortality rate. Key determinants of under than five mortality reported in this last survey are mother education, household socioeconomic status and the fact of living in a rural or urban area.

4.2 Methods

Demographic Surveillance System
The information used in this study comes from two demographic surveillance systems (DSS). A newer DSS covers the health districts of Bambey, Mbour and Fatick and the older Niakhar DSS which is based in the Niakhar district of Fatick but is a separate survey. The newer DSS started with a baseline census of the three

districts taken in 2008 and has had 4 additional rounds of survey updates completed since then which are included in this analysis. Details of the methods and study area are reported in the descriptive paper (DSS paper). In summary approximately 654 villages are visited covering a population of over 600,000 inhabitants served by 54 health posts. At each round information is collected on births, deaths, pregnancies, and migration (in and out). At round two, additional information was collected on economic factors such as household assets, building material of dwelling, distance to potential malaria breeding sites etc. The Niakhar DSS has been running since 1962 and covers 30 villages and approximately 40,000 residents (estimate from January 2016), the same information on vital statistics is collected but no information is available on wealth of the household (Delaunay V *et al.*, 2013)

Study Population

All children aged under five years during the period 1st January 2008 and 31st December 2010, resident within the two DSS catchment areas (the new DSS area of Bambey, Mbour, Fatick, and the existing DSS in Niakhar) were included in the study.

Statistical analysis

In this study we are interested in identifying risk factors of child mortality. The variables that we consider as potential risk factors are: department, sex, ethnicity, religion, mother's marital status, mother's level of education, mother's age at birth of child, distance to the nearest health post, malaria transmission intensity (measured by the average incidence rate of outpatient cases detected at the health post (defined as positive rapid diagnostic test, RDT). Because of the interest in effects of malaria transmission on mortality, analysis was initially restricted to deaths above 3 months of age. A further analysis was then conducted, in which the malaria incidence rate was excluded a priori, as it relates to cause of death. For these analyses, all deaths under 5 years (including those under 3 months) were included. A backwards step-wise approach was used, excluding variables in turn, if they were not significantly associated with the outcome, and if excluding them did not alter coefficients for variables in the model.

The department was chosen as there are notable differences between the departments (Mbour department is richer and more urban than the two others) which may not be captured by other variables. Similarly, ethnicity and religion were included as proxies for social and behavioural differences. Maternal age was grouped, the

under-16 category was included as these mothers may be a vulnerable group (16 is the minimum legal age for marriage).

Additionally, wealth of the household is available for analysis within the new DSS but not for the Niakhar DSS. Wealth of the household is determined from the following indicators of household assets and living conditions: radios, television, telephone, car, moped, bicycle, video recorder, any livestock, any cultivated land, running water, electricity, flush toilet, pit toilet, roofing material, and wall material. These indicators are combined in a polychoric principal components analysis assuming that the first component is indicative of wealth (Rustein *et al.*, 2004). The total wealth scores were also grouped into quintiles.

In the first instance analyses are run on a complete case basis; that is, only individuals with information on all variables considered are included so as to enable comparison. Characteristics of individuals with some missing information versus those that have no missing covariate information are conducted using logistic regression. Variables that are associated with missingness will be retained in the final model. Individuals are therefore considered missing at random dependent on these covariates. Only the covariates with small amount of missing information are used in this analysis, they are: sex, ethnicity, religion, distance to nearest health post and average malaria level in the health post. As malaria data are aggregated at health post level with everyone leaving in the same health post having the same malaria variable, the use of the random effect model is more suitable. The data are then reorganized on block and xt command rather than st command was used in stata 12 for statistical analysis. The rate ratios from the random effect model represent the effects of the variable of interest, after allowing for the differences between health posts. Some health posts serve more widely scattered populations than others, this variation between health posts is captured in the random effect, so the rate ratio from the random effect model is less extreme than the crude rate ratio.

For univariate analysis, a simple poisson model of mortality accounting for time at risk was used. The unadjusted rate ratios were calculated using only individuals who had non-missing data for variables of interest. Adjustment was done for health post by including the random effect and we finally adjust for district and year except the

effect for district, which was adjusted for year only and the effect of year, which was adjusted for district only.

For the multivariate model we first include all individuals that have basic information even if don't have wealth but excluding wealth from the model, adjustment was done for all other variables. Then, the same process is used but only for individuals who have SES data. Finally adjustment was done for SES and all other variables.

The impact of distance was investigated using a multivariate model with all variables included. We compare models with and without distance to health post with no clustering at health post and no malaria variable, and then add in clustering at health post.

Results

In the initial analysis, a total of 157,276 children aged 3m – 5yrs during the study period 2008-2010 were included from the large DSS and an additional 11,820 children from the Niakhar DSS. 114,818 of these children from the large DSS and 9,357 from the Niakhar DSS have complete information on all variables excluding wealth; 77,023 from the large DSS have complete information on all variables (wealth indicators not collected in Niakhar).

There were 1,101 deaths in 3m-5yr olds during 208,420 person-years of follow-up between 2008-2010 giving an overall mortality rate of 5.28/1,000pyrs (95% CI 4.98 – 5.60).

The variables for sex, ethnicity, religion, distance to nearest health post and average malaria level in village have the lowest levels of missing data (3.5% missing information on religion and less than 1% missing information on each of the others, see Table 4.1).

Variable	Categories	Population in 2010 of 3m-5yrs (77,023)	Unadjusted				Adjusted for clustering at health post only			Adjusted for year and department and clustering at health post	
			Deaths	Person-years (1,000)	Rate (per 1,000 pyrs)	Crude rate ratio	Rate Ratio accounting for health post only 95% CI		p-value	Rate Ratio 95% CI	p-value
Department	Bambey	35,852	577	96.69	5.97						
	Fatick	24,841	389	65.95	5.90	0.98	1.03 (0.83,1.28)		0.781	1.03 (0.83,1.28)	0.808
	Mbour	16,330	135	45.78	2.95	0.49	0.58 (0.44,0.76)		0.000	0.58 (0.44,0.75)	0.000
Sex	Male	39,185	575	106.12	5.42						
	Female	37,838	526	102.30	5.14	0.95	0.94 (0.84,1.06)		0.347	0.95 (0.84,1.06)	0.349
Ethnicity	Wolof	21,773	235	59.17	3.97						
	Serere	49,155	811	132.20	6.13	1.54	1.33 (1.11,1.59)		0.002	1.37 (1.14,1.65)	0.001
	Other	6,095	55	17.05	3.23	0.81	0.92 (0.67,1.25)		0.589	1.05 (0.77,1.44)	0.757
Religion	Muslim	68,180	930	183.53	5.07						
	Other	8,843	171	24.89	6.87	1.35	1.35 (1.06,1.72)		0.016	1.29 (1.01,1.65)5	0.041
Marital status of Mother	Married	71,289	1008	192.35	5.24						
	Widowed	1,825	31	5.44	5.69	1.09	0.90 (0.62,1.32)		0.602	0.89 (0.61,1.30)	0.559
	Unmarr./divorced	3,909	62	10.62	5.84	1.11	1.23 (0.95,1.59)		0.122	1.23 (0.95,1.59)59	0.119
Mothers Education	No-schooling/ pre-school	49,837	785	136.04	5.77						
	Primary	12,792	146	34.39	4.25	0.73	0.86	0.72	1.04	0.122	0.89 (0.74,1.07)	0.216
	Secondary	2,883	27	7.03	3.84	0.67	0.82	0.56	1.21	0.319	0.86 (0.58,1.27)27	0.448
	Koranic	11,511	143	30.95	4.62	0.80	0.89	0.74	1.07	0.225	0.90 (0.75,1.08)	0.247

Table 4.1: Description and univariate associations (part 2)									
	Population	deaths	pyrs	Rate	Crude rate rate	Rate Ratio accounting for health post	p-value	Rate Ratioadjusted for year and department and	p-value

						ratio	only(95% CI)		clustering at health post(95% CI)	
Age of mother at birth of child										
	Over 16	75,811	1069	204.75	5.22					
	16 and under	1,211	32	3.66	8.73	1.68	1.66 (1.17,2.36)2.36	0.005	1.65 (1.16,2.35)5	0.005
Distance from village to health post										
	<1km	27,218	272	75.55	3.60					
	1-5km	33,489	532	90.08	5.91	1.64	1.38 (1.17,1.63)1.63	0.000	1.30 (1.10,1.53)	0.002
	>5km	16,316	297	42.78	6.94	1.94	1.48 (1.21,1.80)1.80	0.000	1.38 91.14,1.68)	0.001
Average malaria incidence rate in health post										
	per 1,000					1.022	1.026 (1.012,1.04)1	0.000	1.02 (1.00,1.03)	0.022
Wealth quintile	lowest - 1	11,228	205	29.25	7.01					
	2	11,353	174	30.35	5.73	0.82	0.85 (0.70,1.05)	0.126	0.86 (0.70,1.05)	0.138
	3	12,539	184	33.35	5.52	0.78	0.87 (0.71,1.07)	0.181	0.88 (0.72,1.09)	0.241
	4	11,818	144	31.55	4.56	0.65	0.77 (0.62,0.96)	0.022	0.80 (0.64,0.99)	0.042
	highest - 5	10,610	100	28.33	3.53	0.50	0.69 (0.53,0.90)	0.006	0.76 (0.58,0.99)	0.039
	missing	19,472	294	55.57	5.29	0.75	0.78 (0.64,0.95)	0.014	0.80 (0.66,0.97)	0.025
Year	2008		351	53.91	6.51					
	2009		356	78.26	4.55	0.74	0.74 (0.64,0.86)	0.000	0.74 (0.64,0.86)	0.000
	2010		394	76.24	5.17	0.82	0.82 (0.71,0.94)	0.005	0.82 (0.71,0.94)	0.005
Distance from village to district centre										
	<5km	13,653	127	37.57	3.38					
	5-10km	28,617	501	78.81	6.36	1.87	1.51 (1.09,2.09)	0.01	1.24 (0.92,1.68)	0.152
	10-20km	25,681	360	67.91	5.30	1.57	1.42 (1.02,1.97)	0.04	1.10 (0.80,1.51)	0.573
	30+km	9,072	113	24.13	4.68	1.39	1.28 (0..86,1.89)	0.22	0.93 (0.64,1.35)	0.703

In Table 4.1 we show the crude risk ratios for each covariate with and without a random effect for health post. The unadjusted rate ratios were calculated using only individuals who had no missing data for the variable in the table. We then do the adjustment for health post by including the random effect and finally adjust for year and district except for the effect of district, which was adjusted for year only, and the effect of year, which was adjusted for district only. In Table 4.2 we first adjust for other variables, then limit the analysis to individuals who have SES data and finally do the adjustment for SES and all other variables.

The rate ratios from the random effect model represent the effects of distance, after allowing for the differences between health posts. Some health posts serve more widely scattered populations than others, this variation between health posts is captured in the random effect, so the rate ratio for distance from the random effect model is less extreme than the crude rate ratio. Even after allowing for this variation between health posts, and other factors including socio-economic status, distance from health post remains an important risk factor (Table 4.2).

Table 4.2: Multiple regression steps

Variable	Categories	All individuals - model excluding wealth				Individuals with wealth information - model excluding wealth				Individuals with wealth information - model including wealth			
		IRR	95% CI		p-value	IRR	95% CI		p-value	IRR	95% CI		p-value
Department	Fatick vs. Bambey	0.77	0.61	0.96	0.023	0.79	0.60	1.03	0.085	0.77	0.59	1.01	0.06
	Mbour vs. Bambey	0.67	0.52	0.86	0.002	0.70	0.53	0.93	0.014	0.73	0.54	0.98	0.03
Sex	Female vs. Male	0.94	0.84	1.06	0.325	0.96	0.84	1.10	0.574	0.96	0.84	1.10	0.57
Ethnicity	Serere vs. Wolof	1.38	1.15	1.65	0.001	1.35	1.11	1.65	0.003	1.33	1.09	1.62	0.01
	Other vs. Wolof	1.06	0.77	1.45	0.738	1.15	0.80	1.63	0.454	1.13	0.79	1.61	0.51
Religion	Other vs. Muslim	1.22	0.97	1.54	0.091	1.12	0.77	1.63	0.542	1.12	0.77	1.62	0.55
Marital status of Mother	Widowed vs. Married	0.83	0.57	1.21	0.332	0.94	0.39	2.26	0.882	0.94	0.39	2.26	0.88
	Unmarried (incl divorced) vs. Married/widowed	1.20	0.92	1.57	0.168	1.37	1.04	1.82	0.026	1.37	1.04	1.81	0.03
Mothers Education	Primary vs. No school	0.91	0.76	1.10	0.341	0.85	0.68	1.06	0.145	0.86	0.69	1.08	0.19
	Secondary vs. No school	0.87	0.59	1.29	0.497	0.84	0.53	1.33	0.465	0.87	0.55	1.38	0.56
	Koranic vs. No school	0.94	0.78	1.13	0.491	0.94	0.77	1.15	0.564	0.95	0.77	1.16	0.60
Age of mother at birth of child	16 and under vs over 16	1.60	1.12	2.29	0.01	1.66	1.12	2.45	0.011	1.64	1.11	2.43	0.013
Distance from village to health post	1-5km vs <1km	1.29	1.09	1.52	0.003	1.33	1.10	1.61	0.003	1.30	1.07	1.57	0.008
	>5km vs <1km	1.39	1.14	1.70	0.001	1.39	1.11	1.76	0.005	1.35	1.07	1.71	0.011
Average malaria incidence rate in hlth post/1,000		1.02	1.00	1.03	0.026	1.00	0.98	1.03	0.645	1.00	0.98	1.03	0.685
Wealth quintile	2 vs. Lowest									0.85	0.69	1.04	0.12
	3 vs. Lowest									0.88	0.72	1.08	0.229
	4 vs. Lowest									0.82	0.65	1.03	0.084
	highest - 5 vs. Lowest									0.80	0.60	1.06	0.117
Year	2009 vs. 2008	0.78	0.67	0.92	0.002	0.85	0.71	1.01	0.068	0.84	0.71	1.01	0.065
	2010 vs. 2008	0.82	0.72	0.95	0.008	0.82	0.70	0.98	0.026	0.82	0.69	0.98	0.025

In order to adjust for wealth, which is expected to be an important risk factor for mortality but has a large amount of missing data, we must determine the impact of the adjustment and of the reduced sample. We run the multiple regression with variables, excluding wealth, in all individuals with complete information on the other covariates and then repeat these for those that also have information on wealth, finally we also adjust for wealth.

Reducing the sample from those with covariate information to those with covariate information and wealth sees some change in the effect estimates of the covariates. Department, ethnicity, age of mother, distance to health centre and year remain important risk factors in the reduced data set. Malaria incidence in the health post is no longer an important risk factor after the data set is limited to those with wealth information even before adjustment for wealth.

Mortality is higher in some health posts areas than others and Figures 4.3 and 4.4 shows that higher mortality is more noticeable in health posts that are far from health centers.

There are some differences to several of the estimates but the most noticeable is that of the effect of distance from village to health post which, though remaining significant has a smaller impact after adjusting for clustering at health post. This difference suggests that some of the effect of distance is explained by differences between health post areas, for example, if there were health posts which had many remote and few nearby villages, and all the villages had higher than average mortality due to some attribute of the health post or of the area where the health post is located, it could appear, if we don't adjust for health post, that this is a distance effect (because high mortality health post had mainly remote villages). In the unadjusted analysis Bambey and Fatick had similar mortality; after adjustment a difference was seen. Mortality seemed to steadily decrease with increasing wealth, but this effect seemed to be slightly less marked when we adjusted for health post and less marked again when we adjusted for year and district. This could be the effect district and rather year. Mbour is wealthier so this might indicate that it was an "Mbour" effect that reduced mortality in the richest rather than their wealth (Table 4.5).

When incidence is removed and no clustering at health post is accounted for the effect of distance increases to a risk ratio of 1.36 in those 1-5km away compared to <1km and a risk ratio of 1.52 in those >5km compared to <1km away, these are

estimated at 1.29 and 1.35 respectively when a random effect for health post is included.

The key trends are illustrated in Figures 4.1 to 4.3.

Figure 4.1: Association of under-5 mortality rate with socio-economic status. The red symbols show the mortality rate in each wealth ranking (against the right-hand y-axis). The blue bars show the number of children in each wealth ranking (against the left hand y-axis).
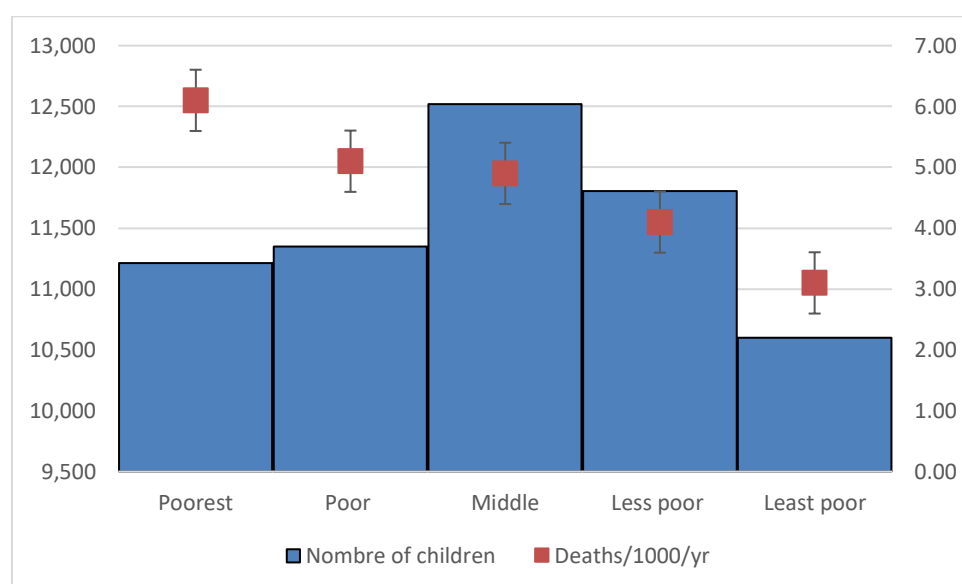
	Poorest	Poor	Middle	Less poor	Least poor
Number of children	11,212	11,347	12,519	11,806	10,599
Deaths/1,000/yr	6.10	5.10	4.90	4.10	3.10
Unadjusted rate ratio	Reference	0.81	0.78	0.65	0.50
Adjusted rate ratio*	Reference	0.85	0.88	0.79	0.75

*adjusted for year and department, and for clustering by health post

Child survival is associated with household wealth. In the poorest households, the rate of mortality in children is 2-fold higher than in the least poor households. But this association seems to be largely explained by other factors (the calendar year and the department). After adjusting for other factors, the adjusted rate ratio has decreased from 2 to 1.33, with a confidence interval that includes 1.

Figure 4.2 Child mortality rates in relation to malaria incidence number of cases per 1,000
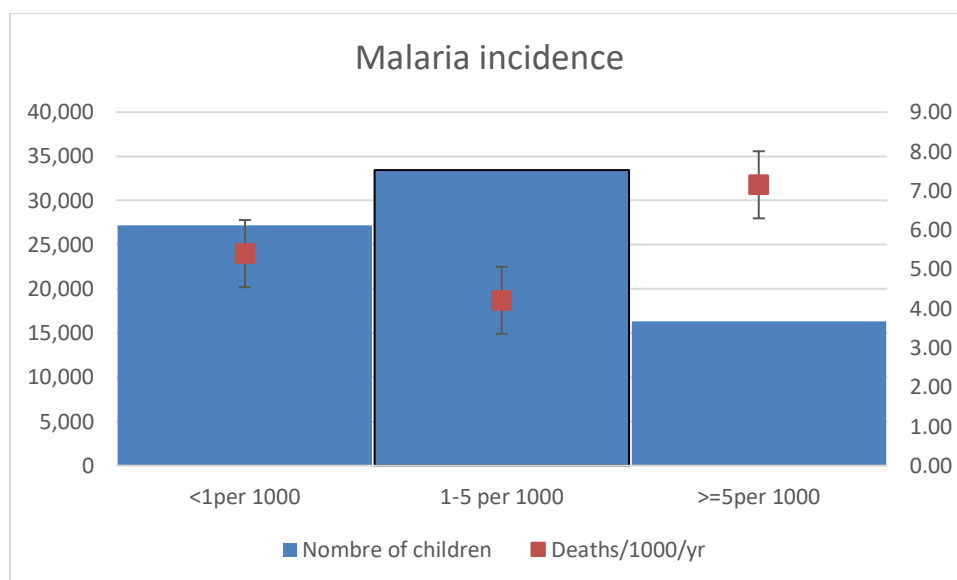
	<1 per 1,000	1-5 per 1,000	>=5per 1,000
Number of children	27,185	33,444	16,307
Deaths/1,000/yr	5.40	4.21	7.15
Unadjusted	1.00	0.80	1.45
Adjusted	1.00	0.86	1.15

Adjusted for year and department and clustering at health post using poison regression

Figure 4.3: Association of child mortality with distance to the nearest health post
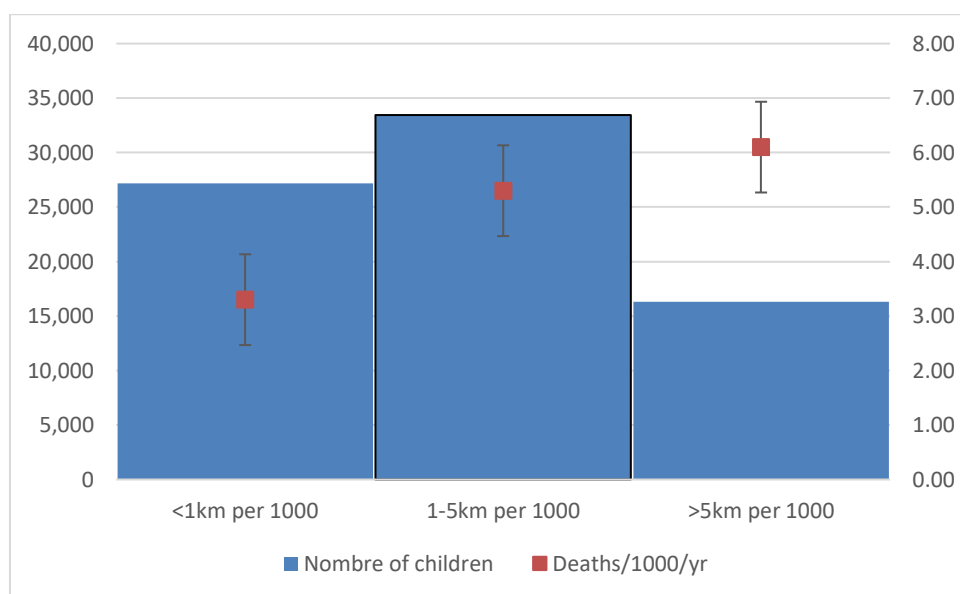
	Mortality rate ratio 95% CI		
	<1km per 1000	1-5km per 1000	>5km per 1000
Nombre of children	27 185	33 444	16 307
Deaths/1000/yr	3,30	5,30	6,10
Unadjusted rate ratio	Reference	1,64	1,93
Adjusted rate ratio#	Reference	1,30 (1.11-1.6)	1,40 (1.1-1.7)

#adjusted for year, department, and SES

The mortality rate in children increased with increasing distance of residence from the nearest health facility, with a 1.9-fold increase in mortality for children living more than 5km from a health facility compared to children living within 1km. After adjustment for year department and SES it becomes 1.40 with a confidence interval that does not include 1.

Table 4.3 Causes of death among children under 10 years of age

Group	Description	Girls <28 days	Girls 28-365 days	Girls 1-4 years	Girls 5-9 years	Boys <28 days	Boys 28-365 days	Boys 1-4 years	Boys 5-9 years
I	Certain infectious and parasitic diseases	2	29	57	6	1	28	51	8
II	Neoplasms	1	1	0	0	0	0	0	0
III	Diseases of the blood and blood-forming organs	0	0	0	0	0	3	1	1
IV	Endocrine, nutritional and metabolic diseases	0	2	2	0	0	2	5	0
VI	Diseases of the nervous system	0	0	3	1	2	3	3	0
IX	Diseases of the circulatory system	0	0	0	0	0	0	0	1
X	Diseases of the respiratory system	1	6	10	0	2	6	10	0
XI	Diseases of the digestive system	1	0	4	1	0	1	3	0
XIII	Diseases of the musculoskeletal system and connective tissue	0	0	1	1	0	0	0	1
XIV	Diseases of the genitourinary system	0	0	1	0	0	0	1	1
XV	Pregnancy, childbirth and puerperium	1	0	0	0	0	0	0	0
XVI	Certain conditions originating in the perinatal period	38	2	0	0	56	7	0	0
XVII	Congenital malformation, deformations and chromosomal abnormalities	0	1	0	0	0	8	0	0
XVIII	Symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified	3	7	3	0	1	3	0	1
XIX	Injury, poisoning and certain other external causes	0	3	3	3	1	2	2	5
XX	External causes of morbidity and mortality	0	0	0	1	0	0	1	3

Figure 4.4 Geographical variation in the child mortality rate (rate per 1000 pyrs in each health post from Table 4.4)
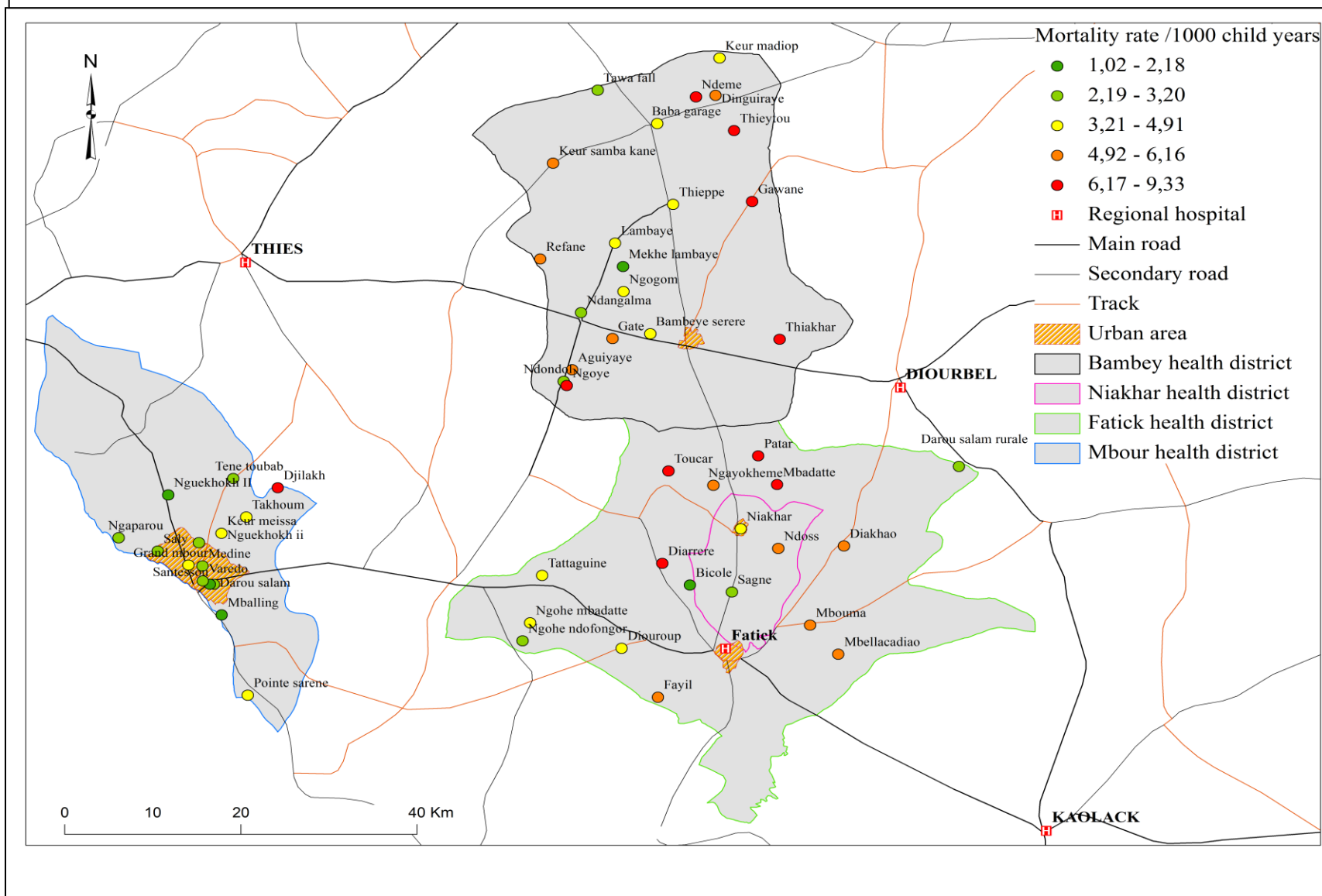
Table 4.4 Child Mortality rate per health post

District	Health Post	Deaths	Person-yrs (1,000)	Rate/1,000
BAMBEY	AGUIYAYE	25	5.41	4.62
BAMBEY	BABA GARAGE	10	3..21	3.11
BAMBEY	BAMBEYE	25	6.06	4.12
BAMBEY	DINGUIRAYE	9	1.90	4.74
BAMBEY	GATE	36	8.22	4.38
BAMBEY	GAWANE	23	3.47	6.63
BAMBEY	KEUR MADIOP	6	1.30	4.63
BAMBEY	KEUR SAMBA	34	7.59	4.48
BAMBEY	LAMBAYE	18	6.10	2.95
BAMBEY	MEKHE LAMBAYE	2	2.70	0.74
BAMBEY	NDANGALMA	15	5.82	2.58
BAMBEY	NDEME	22	4.13	5.33
BAMBEY	NDONDOL	14	6.09	2.30
BAMBEY	NGOGOM	22	6.01	3.66
BAMBEY	NGOYE	170	22.06	7.71
BAMBEY	REFANE	88	17.37	5.07
BAMBEY	TAWA FALL	4	1.54	2.60
BAMBEY	THIAKHAR	76	11.07	6.86
BAMBEY	THIEPPE	12	3.59	3.34
BAMBEY	TIEYTOU	8	1.64	4.88
FATICK	BICOLE	1	1.24	0.80
FATICK	DAROU SALAM	15	3.02	4.97
FATICK	DIAKHAO	25	5.64	4.43
FATICK	DIARRERE	67	10.91	6.14
FATICK	DIOUROUP	13	3.52	3.69
FATICK	FAYIL	11	2.42	4.55
FATICK	MBADATTE	40	5.74	6.97
FATICK	MBELLACADIAO	27	5.54	4.87
FATICK	MBOUMA	7	1.65	4.23
FATICK	NDOSS	17	3.11	5.47
FATICK	NGAYOKHEME	27	3.81	7.09
FATICK	NGOHE	3	0.80	3.77
FATICK	NGOHE	7	2.66	2.63
FATICK	NIAKHAR	21	5.46	3.85
FATICK	PATAR	46	7.29	6.31
FATICK	SAGNE	6	2.78	2.16
FATICK	TATTAGUINE	35	8.80	3.98
FATICK	TOUCAR	95	10.89	8.72
MBOUR	DAROU SALAM	27	13.13	2.06
MBOUR	DJILAKH	5	0.93	5.39
MBOUR	GRAND MBOUR	5	1.44	3.47
MBOUR	MALICOUNDA	2	1.01	1.98

MBOUR	KEUR MEISSA	12	2..98	4.03
MBOUR	MBALLING	4	1.90	2.11
MBOUR	MEDINE	14	6.24	2.24
MBOUR	NGAPAROU	9	5.29	1.70
MBOUR	NGUEKHOKH I	12	4.52	2.66
MBOUR	NGUEKHOKH II	9	5.71	1.58
MBOUR	POINTE SARENE	6	2.26	2.66
MBOUR	SALY	8	4.14	1.93
MBOUR	SANTESSOU	19	10.44	1.82
MBOUR	TAKHOUM	7	2.23	3.15
MBOUR	TEN TOUBAB	7	2.72	2.57
MBOUR	VAREDO	5	2.64	1.89

Rural health posts (Bambey and Fatick) have the highest mortality rates. Two of the 3 Niakhar DSS health posts are in the top 3.

Table 4.5 Percentage of households in each Wealth Quintile per health post

District	Health Post	Lowest	Low	Middle	High	Highest	Death Rate /1,000pyrs
Bambey	AGUIYAYE	23..11	27.81	28.20	17.28	3.61	6.16
Bambey	BABA GARAGE	9.76	24.31	26.96	22.89	16.08	4.04
Bambey	BAMBEYE SERERE	12.41	22.11	30.46	23.09	11.94	4.67
Bambey	DINGUIRAYE	22.22	37.60	21.76	10.86	7.56	5.58
Bambey	GATE	13.33	21.92	23.99	27.45	13.32	5.29
Bambey	GAWANE	26.81	34.95	18.55	11.48	8.22	8.41
Bambey	KEUR MADIOP	15.80	37.17	20.94	13.81	12.29	3.90
Bambey	KEUR SAMBA KANE	13.63	28.07	29.21	18.90	10.18	5.70
Bambey	LAMBAYE	8.91	22.89	31.41	24.69	12.10	3.60
Bambey	MEKHE LAMBAYE	3.27	17.48	25.45	30.68	23.13	1.02
Bambey	NDANGALMA	8.31	20.25	25.26	21.61	24.58	2.86
Bambey	NDEME	17.85	26.94	31.43	15.76	8.02	6.91
Bambey	NDONDOL	25.03	31.04	21.56	14.82	7.55	2.53
Bambey	NGOGOM	13.13	17.31	28.30	29.30	11.95	4.11
Bambey	NGOYE	34.67	27.40	20.56	13.47	3.90	9.33
Bambey	REFANE	9.35	20.27	30.48	26.26	13.65	6.04
Bambey	TAWA FALL	8.68	21.73	34.15	20.79	14.65	2.53
Bambey	THIAKHAR	30.08	28.61	23.22	11.73	6.36	8.01
Bambey	THIEPPE	18.94	23.99	30.79	16.61	9.67	3.86
Bambey	THIEYTOU	24.92	33.66	20.48	13.62	7.33	6.80
Fatick	BICOLE	24.52	25.49	22.07	25.15	2.77	1.11
Fatick	DAROU SALAM RURALE	34.63	19.58	15.23	19.96	10.59	3.20
Fatick	DIAKHAO	32.71	16.72	18.92	20.15	11.50	5.21

Fatick	DIARRERE	39.38	19.56	20.89	16.42	3.75	7.05
Fatick	DIOUROUP	40.14	17.97	16.17	19.56	6.18	4.80
Fatick	FAYIL	19.53	22.31	26.19	26.71	5.26	5.41
Fatick	MBADATTE	57.68	25.68	11.27	4.63	0.74	7.27
Fatick	MBELLACADIAO	38.65	16.69	22.62	18.30	3.74	5.82
Fatick	MBOUMA	33.83	19.18	17.73	28.10	1.17	5.55
Fatick	NDOSS	39.46	22.69	21.64	14.29	1.91	5.84
Fatick	NGOHE MBADATTE	55.28	19.85	13.02	10.57	1.28	4.91
Fatick	NGOHE NDOFONGOR	38.85	18.29	15.76	24.55	2.55	3.01
Fatick	NIAKHAR	27.70	17.70	15.20	23.43	15.97	4.89
Fatick	PATAR	35.75	35.70	8.92	13.92	5.71	7.54
Fatick	SAGNE	32.60	23.07	19.73	18.12	6.48	2.83
Fatick	TATTAGUINE	25.71	14.58	22.12	23.77	13.82	4.89
Mbour	DAROU SALAM	4.99	9.37	19.25	25.60	40.79	2.76
Mbour	DJILAKH	5.11	22.29	44.13	27.71	0.75	7.36
Mbour	GRAND MBOUR	0.00	0.00	0.11	8.38	91.52	4.29
Mbour	MALICOUNDA BAMBARA	0.00	0.00	7.61	16.70	75.69	2.69
Mbour	KEUR MEISSA	1.91	7.42	31.29	27.29	32.10	4.82
Mbour	MBALLING	0.31	1.42	14.17	41.18	42.92	2.01
Mbour	MEDINE	0.14	1.29	6.78	35.18	56.61	2.95
Mbour	NGAPAROU	1.11	0.61	5.46	22.36	70.46	2.50
Mbour	NGUEKHOKH I	0.72	2.12	11.00	31.88	54.28	3.80
Mbour	NGUEKHOKH II	0.83	3.35	12.84	31.01	51.96	1.91
Mbour	POINTE SARENE	3.96	9.65	16.83	34.86	34.70	4.03
Mbour	SALY	0.00	0.38	2.75	21.12	75.75	2.64
Mbour	SANTESSOU	0.71	0.34	1.17	17.75	80.02	2.18
Mbour	TAKHOUM	9.49	19.75	41.08	22.32	7.36	4.41
Mbour	TENE TOUBAB	9.81	19.71	43.74	20.51	6.23	2.94
Mbour	VAREDO	0.05	0.00	0.33	5.17	94.44	3.16

Analysis of mortality in children 0-59 months of age:

A total of 193 760 children aged 0-59 months during the study period 2008-2010 were included, of these 156,104 (142,163 from the large DSS and 13,941 from the Niakhar DSS) had complete information on all variables apart from wealth. There were 1,526 deaths under 5yr olds during 273,493 person-years of follow-up between 2008 and 2010 giving an overall mortality rate of 5.56/1,000pyrs.

Missing values: Comparing the distributions of these variables between individuals with some versus no missing data indicates that all variables are associated with missingness. Table 4.6 summarizes the distribution of missing information for each variable of interest. Aside from the variables directly related to the mother (mother's-age, marital status and education), and socioeconomic status of the household, the percentage of missing variables is 5% or less.

As for the variables related to the mother, it is rather a situation where the mother is absent from the household and the information about them is difficult to obtain. For socio-economic status, the missing values are due to the fact that the small SDSS of Niakhar did not collect socio-economic data, this explains the missing data concerning socio-economic status in the merged dataset.

The variables for sex, ethnicity, religion, distance to nearest health post and average malaria level in village have the lowest levels of missing data (5% missing information on religion and less than 1% missing information on each of the others). Comparing the distributions of these variables between those that have some versus no missing data indicates that all variables are associated with missingness. This is unsurprising since the sample numbers are so high but there are some variables that do show some clear differences. Completeness rates for variables of interest are higher in Bambey than Mbour and Fatick, and lower amongst ethic groups other thanWolof and Serere. It also indicates that the mortality rate is lower in those that have some information missing. However, this appears to be driven by those that are missing data on their mother's marital status and education, which have the greatest amount of missing information.

Variable	Missing	Total	%
Age	648	193760	0,3%
Malaria rate	0	193760	0,0%
Wealth ranking	54046	193760	27,9%
Mother's age	49172	193760	25,4%
Distance to health post	1195	193760	0,6%
Ethnic group	679	193760	0,4%
Religion	9641	193760	5,0%
Mother's education	51055	193760	26,4%
Marital status of mother	62581	193760	32,3%

Table 4.6 Distribution of missing values for variables of interest

Ethnicity, religion, and marital status, were not significantly associated with mortality after adjusting for the other factors in the model and their removal from the model did not alter the coefficients for other variables. Year, age, wealth ranking, mother's age at child death and distance to the health post, remained independently associated to child mortality (Table 4.7).

Table 4.7: Final model: factors associated with under-5 mortality

Variable	Category	Mortality rate ratio (95%CI)	P-value
Year	2008	Reference	
	2009	0.77 (0.65,0.90)	0.0033
	2010	0.89 (0.73,1.08)	
Age	<1 month	Reference	<0.0001
	1-11 months	0.15 (0.12,0.19)	
	1-4 years	0.08 (0.06,0.11)	
Wealth ranking	Lowest	Reference	0.0022
	Low	0.81 (0.69,0.96)	
	Middle	0.86 (0.68,1.09)	
	High	0.75 (0.62,0.91)	
	Highest	0.65 (0.50,0.85)	
Mother's age	<18	Reference	0.0001
	18-19	0.91 (0.68,1.21)	
	20-24	0.73 (0.55,0.96)	
	25-34	0.72 (0.60,0.85)	
	35-44	0.68 (0.51,0.91)	
	45+	0.90 (0.55,1.48)	
Distance to health post	<1km	Reference	<0.0001
	1-5km	1.43 (1.14,1.81)	
	>5km	1.56 (1.27,1.90)	

Mortality rates in poor households were 1.5 times the rates in richest households, after adjusting for other variables the model.

Difference of mortality is seen by age groups categorized as following: below 1 month, 1 to 11 months, and 1 to 4 years. Higher risk of early deaths is seen in the study area. The mortality rate is 6.6 times higher in the neonatal period compared to

post-neonatal infants (1 to 11 months of age), and 12.5 times higher than in children 1 to 4 years old. The child mortality ratee is higher when mother is below 18 than when she is above 18 (1.5 times higher compared to children born to mothers aged between 35-44years (who had the lowest rate).

Distance between household of residence and health facility is an important risk factor for child mortality in our study area. There was 43% greater mortality rate n children living 1km to 5km from a facility, compared to those living within 1km, adjusted for other variables in the model.

In further analysis, we compared mortality rates within 0.5km of a facility, with rates in children living 0.5 to 1.0km, and then at increasing distances in intervals of 1km (Figure 4.4). There was marked increase in mortality for those living 1-2km from a facility, then rising sharply for children living more than 10km for a health post .
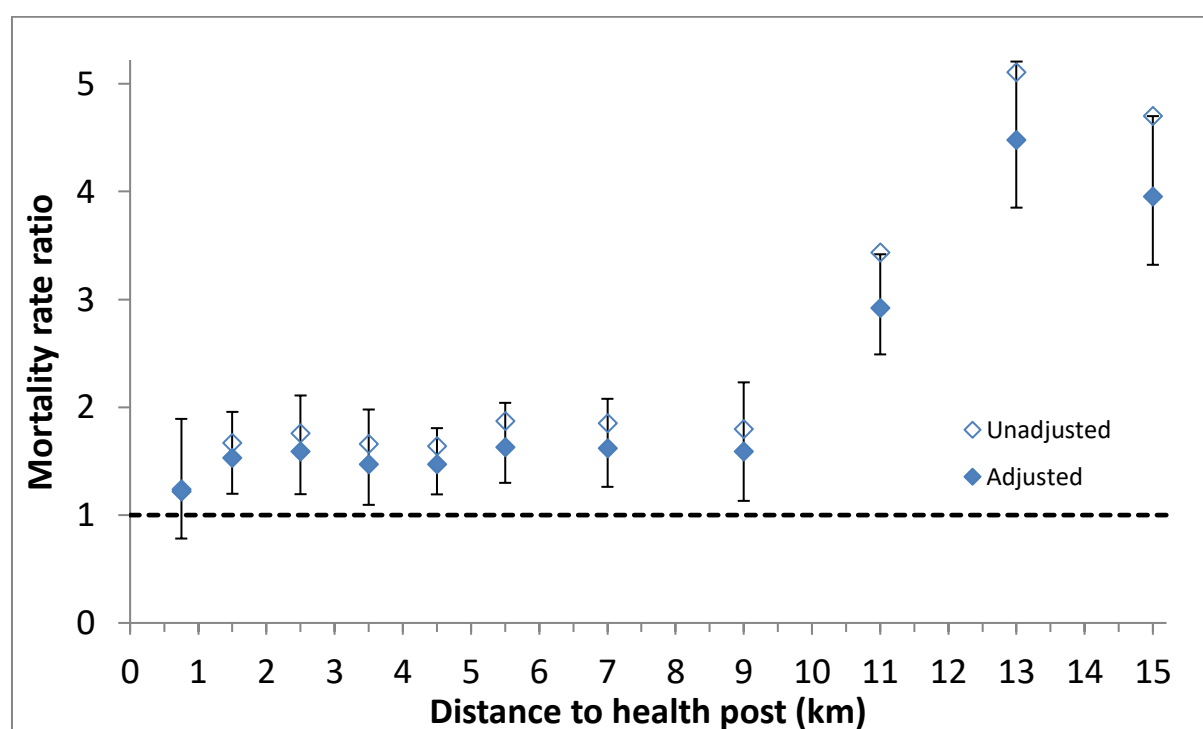

Figure 4.4 Effect of distance to health post on child mortality

Discussion

Wealth, social status, distance to health post, department, gender, ethnicity. Improving access to healthcare (more health posts) are likely to have greatest impact Our study demonstrates that distance to healthcare (more health posts) is a major risk factor for child mortality in these 4 health districts. Our findings are consistent with was has been seen elsewhere in Burkina faso and Niger (Schoeps *et al.*,2010, Becher *et al.*,2004). The effect of distance has been investigated in many studies and some of these studies found no effect of distance on child mortality (Moisi *et al.*,2010, Rutherford *et al.*,2009). For a better analysis of effect of distance on child mortality it is better to consider travel time from household to health facilities and see if it is correlated with distance knowing also that travel time can depend on means of transportation that population are using to go to health facilities. The effect of distance can be confounded by other factors such as population density, health infrastructures density education and wealth. Locality of residence (Department) is also strongly associated to child survival. Children living in more urban and wealthier localities (Mbour) experienced less mortality than others. The risk of dying is twice higher in Fatick and Bambey compared to Mbour. This confirms disparities already seen elsewhere (van de Poel *et al.*,2009, Quentin *et al.*,2014) and raises again the need to put more attention on remote districts that are most of the time under staffed with poor quality of health offers. The effect of ethnicity on child mortality was also seen previous studies (Sunday *et al.*,2015, Antai *et al.*,2011). This could be explained by the fact that ethnicity is the basis of social organization in a traditional context like in our study area and rituals and beliefs could negatively influence health seeking behavior antenatal care seeking and condition of delivery. In our study area almost 40% of women still give birth at home mainly those belonging to Sererre ethnic group.

Marital status of the mother is seen to has an effect on child mortality and this is consistent with what has been seen elsewhere (Clark *et al.*, 2013). Unmarried women can face difficulties in meeting the need for their children and are sometimes not well accepted in their society due to religious and social constraints.

Mother education is not seen to have an effect on child survival which is surprising as several previous studies described a strong association between mother education and child mortality (Fortune *et al.*, 2014, USAID DHS papers 2013). This could be done by the fact that there is little variation in mothers' education (63% have

no education and very few 5% have secondary or higher education. It may be that education is a proxy for risk factors such as wealth and access to health facilities. Mothers that have gone to school are supposed to have better socio economic status and more knowledge regarding maternal care and child nutrition. But in our area since 2008 we have an enhancement of community engagement regarding child care and the action of community health workers called "Badienou Gokh" contributes a lot to promote healthy attitude in the community meanly for women that have never been to school. Such initiative helps them understand health programs targeting children and increase their adherence to such programs. The implementation of community health initiative could have contributed to lowered or limit the effect of maternal education on child survival.

Chapter 5 Discussion and Conclusions

Although Senegal fell short of achieving MDG4, (a reduction by two-thirds, between 1990 and 2015, in the under-five mortality rate) child mortality has declined steadily, from 131.4 per 1,000 births in 1990 to 121.0 in 2005, 72 in 2010 and 49.5 in 2015, just short of the target of 44/1,000. Recent estimates in 2017 gave a mortality rate among children under 5 of 47.1 per 1,000 live births (UNICEF 2018) which is still high but constitutes an encouraging performance for Senegal compared to other west African countries. Neonatal and early neonatal deaths count for more than 30% of under 5 deaths and this needs to be addressed if the country is to maintain the downward trend. The contrast between rural and urban areas still persists and the poorest are more at risk of dying before age five.

Sources of mortality data in Senegal are mainly national census done every ten years, which do not give detailed information of individual risk factors associated with child mortality, and DHS surveys which rely on accurate recall of birth histories. We took advantage of the opportunity offered by the implementation of SMC at large scale in a population of 200,000 children under 10 years of age in central Senegal, to assess risk factors of dying before age 5 between 2008 and 2010. For this field trial, it was necessary to establish an SDSS to enumerate the target population in our area of intervention, to list the children eligible for receiving SMC for door to door delivery, and to measure the impact of SMC on mortality from all causes. The main aims of the present study were to evaluate the validity of the data from the DSS, to estimate rates of mortality, and to investigate factors associated with variations in mortality rates within the study area, in order to gain a better understanding of the current levels of child mortality and the reasons behind the recent decline.

The initial purpose of setting up the DSS was to evaluate the effectiveness of SMC in the area. Collecting DSS data using paper questionnaires is not an easy process and data cleaning involves much effort to guarantee good quality data. Quality control processes from data collection in the field to data entry and data validation need to be carefully planned and implemented. The data quality control took approximately two years to resolve all data queries, to ensure valid analysis of the data generated. During our study, 48,000 households were visited every 10 months. The average of 11 persons per household is consistent with what is generally seen in such rural area

in Senegal. The literacy rate was 48% which is similar to the national literacy rate in 2009 (49.1%). The population is young with more than 50% below 20 years old. The problem of determining accurate dates of events was challenging, requiring checking at each DSS round. This is an issue where vital registration is not systematic and dates of events not recorded in a timely manner. As we were using print-outs of the DSS database during drug delivery, this permitted additional checks allowing us to control accuracy of dates and to be sure that all eligible children were enumerated. Discrepancies in terms of eligible children omitted from the DSS were less than 1%, giving an indication of the completeness of data collected during the census and DSS rounds.

Impact of SMC: Drug delivery for SMC involved monthly visits to all households to deliver drugs to children under 10 years old. Community surveys showed that high coverage was achieved. Drug distribution was shown to be equitable, similar levels of coverage being achieved regardless of the child's age (within the target age range), gender, the household's socio-economic status (SES), or their mother's education type or level. Drug delivery was carefully planned with a system of daily supervision and achieved coverage increasing from one year to another and ranged between 76% and 87% from 2008 to 2010. The coverage was slightly higher in older children (5 to 10 years) possibly due to the ease of drug administration in this age group. Cross sectional surveys done each year of intervention gave higher estimates of coverage than obtained from tallies from drug delivery registers. This may reflect the denominator used for calculating administrative coverage, which was the total population normally resident in the study area, estimated from the DSS, whereas the cross-sectional surveys excluded people who were temporarily absent at the time of the surveys. The DSS estimates are therefore likely to have overestimated the target populations and underestimated coverage, because some families had temporarily migrated, and were therefore not present to receive SMC. The absence of evidence of a linear trend in the probability of receiving 3 courses of SMC across wealth quintiles from 2008 to 2009 is an indicator of equity of coverage when drug delivery is done using a door to door strategy.

Coverage of SMC was also equitable with respect to the education of the child's mother. There was no evidence in 2008 (p=0.55), 2009 (p=0.77), or 2010 (p=0.33) of differences in coverage according to whether the mother had no education, only a Koranic education, or any French education. In all three years, coverage levels were

very similar between groups, and in both 2008 and 2010, children whose mothers had no education had the highest levels of SMC coverage.

Our study strengthens the case for implementing SMC door-to-door, and is the first study to show the feasibility of achieving high coverage in older children. The results contributed to the policy recommendation for SMC (WHO 2012), and contributed to the use of the door to door approach in the wider scale-up of SMC in west and Central Africa.

The results contributed to the decision of the Senegalese Ministry of Health to include children up to 10 years old in the SMC programme in Senegal. The results show that school-age children can be effectively reached, and the age range for SMC can be extended from 5 to 10 years without greatly increasing the time required for delivery.

Our study offers a number of practical insights for implementation research. Accurate recording of treatment courses received is essential if impact is to be monitored, using, for example, case control studies to measure efficacy of the intervention or rebound effects, and for adverse event monitoring. Publicity campaigns and other sensitization activities have to be done and maintained and this is essential to achieve high coverage. We have identified a number of practical lessons for large-scale implementation, including the importance of engagement between researchers and health staff at all levels during planning, and the value of piloting and gradual scale-up.

Under 5 mortality rates and inequalities: Despite high levels of coverage, we were not able to demonstrate an impact of SMC on mortality. SMC reduced the incidence of malaria and severe malaria substantially but it is likely an effect on mortality was not observed because the incidence of malaria and hence the proportion of deaths caused by malaria, had decreased in the study area, so there was limited power to observe an impact on all-cause deaths. From the DSS database we obtained an overall mortality rate of 5.28/1,000pyrs (95% CI 4.98 – 5.60) in children under 5 years of age during a follow-up period between 2008 and 2010. The monitoring of mortality in children is challenging in an African rural context where the registration of vital events is weak and a large proportion of births and deaths take place at home, and where the use of the health system is variable, depending on economic and geographical factors and on the quality of service provision. Demographic surveillance systems aim to identify all the vital events that take place outside of formal health structures and whose non-recognition could lead to large biases in the

observed results. Our objective was to determine under-5 mortality rates, and to understand mortality trends observed, through the investigation of risk factors for dying before reaching the age of five years. The results showed that despite the lower level of under-5 mortality, clear inequalities persist. Living far from health facilities is an important risk factor for dying before the age of five in central Senegal. The effect of the distance between the place of residence and the health post on mortality seems to be the most important risk factor. Living further from health facilities may tend to limit contact between the population and health workers and impede access to adequate health care in a timely and suitable manner. This has been described in many other studies (Kadobera *et al.* 2012, Schoeps *et al.* 2011, Kapungwe *et al.* 2005). These studies showed that distance is strongly linked to child mortality after controlling for other household characteristics. Living near a health post can shorten the delay to receive adequate care, but may also contribute to providing to the population adequate skills and knowledge to better take care of their child's health. Those living close to a health post may be more aware of new health strategies and new campaigns run around the health posts, through community sensitization activities but also during health posts visits where health information is displayed. People living within walking distance to health facilities do not have to pay to seek care.

Strategies to reduce under-5 mortality and areas for future research: These results suggest that reduction of inequalities in terms of access to health care services, may be necessary in this region to bring down overall mortality rates. The effect of distance can also be accentuated by the geographical accessibility of health facilities. To capture these effects, the time taken or the cost involved, to go to the health facility, could be estimated, these variables might better characterize the effect of distance on access to health care. It is widely recognised that there is a need to bring health care closer to the community, for example through expansion of community case management schemes. However, barriers to health-care seeking may need innovative solutions to improve the situation.

Efforts have been made recently in Senegal, targeting children and their mother, involving free healthcare for children under 5 through universal health coverage, and improved maternal care. There have also been measures to strengthen the health system for example with the recruitment of additional medical personnel, but this objective was not fully achieved, leading to the implementation of 'contractualization'

in 2006. The beginning of the contractualization saw the recruitment of more than 1,000 health staff in 2014 (ANSD, 2017), and the creation of new health centers (as in our study area with the health center of Niakhar and hospital of Fatick). In addition, there has been wider implementation of community-based strategies such as PECADOM and DSDOM that bring malaria diagnosis and treatment to the community. This deployment of local care providers (DSDOM) trained to manage cases of malaria, diarrhea, and ARIs in the community provides preventive and promotional services related to childhood illnesses has contributed to bring care where needed and where population do not have resources to cover travel distance to seek care.

Between 2006 and 2010, the ICCM package was finalized and the program rapidly expanded. Health huts are maintained and run by volunteer CHWs and nurses, who receive structured training to enable them to detect and manage malaria, diarrhea, and pneumonia in children using rapid diagnostic tests (RDTs), ACTs, ORS, zinc, and antibiotics. This may explain why the effect of malaria is less pronounced in terms of causes of death, which now ranks as the third leading cause of death in children. Prompt diagnosis with RDT's and appropriate treatment with ACT's of malaria cases contribute also to lower the effect of malaria on mortality. These gains need to be maintained and consolidated because the level of mortality is still high in the area and additional efforts are needed in the management of respiratory and diarrheal diseases.

Living in poor households also increases the risk of dying before age 5 (Pritchard et al., 2016; You *et al.*, 2008) and our findings corroborate this. When financial resources are limited, families prioritize food over other family expenditures and this can lead to neglecting needs of young children. It may be argued that inequalities in economic power need to be tackled in order to decrease mortality. In Senegal poor populations have been targeted for financial assistance to meet basic needs and to register their child into a local health insurance system, to allow them access adequate care if needed. This strategy is called "bourses de sécurité familiale" and started in 2013. Senegal has embarked on an intense policy of universal social protection, the main measures of which are the family security grant, universal health coverage, and the improvement provision in retirement. It targets disadvantaged families and is based on criteria of income, enrollment and student attendance at school to combat social injustices. This policy has been developed through the

National Family Safety Grant Program and is strongly based on principles of redistribution of resources based on equity and social justice corresponding to useful forms of social assistance that can mitigate the effects of poverty on the most vulnerable social strata. The program started with a pilot phase in 2013 with 50,000 targeted families. Its purpose was to make available to 250,000 vulnerable families Family Security Bursaries of 100,000 FCFA / year to strengthen their livelihoods and educational and productive capacities.

This program will hopefully contribute to decrease the effect of poverty on mortality. Targeting the poorest families and guaranteeing them a fixed minimum income aims to enable them to meet certain essential household-level expenses. But an adequate evaluation of such action is needed in order to measure the real impact of its implementation and this is a topic for further research.

The development of income-generating activities for women, who are generally responsible for managing children in the event of illness, is a further strategy that has been considered. In areas of seasonal rainfall where agricultural activities are tied to the rains, farming alternatives to assure permanent availability of food products are needed. In Senegal, in 2008 a program called GOANA (Great agricultural Offensive for food and abundance) was initiated, designed to help people to grow what they eat in order to be able to cover their basic food needs. The impact of such schemes also needs to be evaluated.

Early pregnancy and early marriage are positively correlated with high infant or neonatal mortality. Early pregnancies are at increased risk for the child and mother (Guilbert *et al.*, 2013). In rural areas such as the study areas, women have less power in decision making, especially young women, and early marriage limits educational achievement which may itself be a determinant of child survival (Field *et al.*, 2007; Jennifer *et al.*, 2015). Early marriage is also linked to poverty, a further mechanism linking poverty to child mortality.

Neonatal deaths continue to account for a large part of this mortality among children under 5 years of age (30%) in our region and is therefore an important focus of efforts to reduce under-five mortality. The primary target of SDG3 is to decrease neonatal deaths to 12/1,000 live births. In our study area this could be only done through the promotion of deliveries in health facilities, as 40% of women of reproductive age give birth at home in the DSS of Niakhar. Attendance for four prenatal visits, vaccination and the promotion of deliveries assisted by qualified

personnel, needs to be strengthened and evaluated. In addition to recruitment of midwives, it is necessary to involve traditional birth attendants who assist women giving birth at home, and reinforce their training.

The local cultural realities are also to be taken into account to understand the determinants of these home deliveries and this will go through socio-anthropological studies, all this will ultimately reduce this early mortality which constitutes 30% deaths under 5 years. Another level to reduce this neonatal mortality is the strengthening of the "Badienou Gokh" initiative a strategy using neighborhood or village grandmother for the promotion of maternal, neonatal, and infant health at the individual, family, and community levels, which will strengthen advocacy for the systematic use of antenatal care and the promotion of behaviors aimed at preserving maternal health (vaccinations-deliveries at home-recovery of the technical platform etc.).

Strengths and limitations: The estimates of key demographic indicators in the expanded DSS were consistent with those found in Niakhar DSS. This suggests that our results are robust, Niakhar DSS being considered as a gold standard. The comparison of the DSS indicators of Niakhar with those of 30 villages around this DSS, shows similarities for some indicators but also discrepancies that are more pronounced for deaths of less than one year. Some deaths and births will have been missed, due to the delay between rounds of 10 months. This could be seen by comparing the results collected using village reporters and those obtained through the DSS rounds. The percentage of missed events was less than 10%, and mainly concerned early neonatal deaths, especially when they occurred soon after the DSS round. It is also possible that in the newly established DSS, the populations were not accustomed to this kind of data collection, and may have tended to be reluctant to declare unfortunate events. There may be a delay between the initiation of a DSS and the stabilization of some indicators especially when they rely on recall of individual respondents. The age of respondent is known to affect quality of answer (Nduru *et al.*2013) as well as family size. The relationship of trust between the interviewer and the respondent can influence the quality of the information collected. The circumstances of the visit can make the respondent feel more or less comfortable to answer. Shorter intervals between rounds, makes detection of pregnancies more likely, and questions can be asked at subsequent rounds about the pregnancy outcome, shorter intervals also increases the probability of detecting

deaths when caregivers have moved away after a death, and documenting the presence of temporary residents. Missed events may have led to mortality rates especially in the younger age group, being under-estimated, and may possibly introduce a bias in assessment of risk factors.

In urban Mbour, changes of address were frequent, and we were not able to accurately capture temporary movement. Collecting demographic information without interviewing every household member, may lead to bias as the respondent may not report all vital events accurately. A difficulty in estimating perinatal and neonatal deaths was the lack of precision of dates of death which could lead to misclassification of early deaths. Making the distinction between deaths of less than a week and other deaths is often difficult. The collection of deaths in real time will improve the accuracy of this indicator by tracking pregnancies through ANC and deliveries to record outcomes. Information on vaccination of all children involved in our analysis would have been desirable. Suboptimal vaccination coverage in Niakhar increased child mortality in 1997 (Pison et al, 2013). Information on factors such as breast feeding and nutritional status, which are known to be correlated with child mortality, would also have been useful.

A strength of the study is the large scale of the demographic surveillance, covering 600,000 people, which made possible the investigation of mortality risk factors over a short period of time. With a larger population, we can have more events over the time period of interest, and a wider range of situations, allowing better statistical power for assessment or risk factors than is possible in smaller DSS systems. A further strength is the population had not been under surveillance before and therefore was not influenced by regular contact with researchers. The proximity of Niakhar however provided a reference against which to assess quality of surveillance, and allowed us to use well-trained interviewers and data managers.

Further research is needed to evaluate the new strategies which may contribute to reducing under 5 mortality. In low income countries, health costs may be high in proportion to household budgets (Borghi *et al.*, 2006), and can exceed 10% of annual household income (Richard *et al.*,2009). Membership in a health mutual can improve access to care and reduce expenses, especially for curative and outpatient care (Mensah *et al.*,2010; Pammar *et al.*,2012). There is evidence that the use of health services increase when access is free (De allegri *et al.*,2010; Dzakpasu *et al.*2012; Druetz *et al.*,2015). A recent study has also shown that free delivery for pregnant

women increased by 5% the number of medically assisted deliveries and reduced by 9% the number of neonatal deaths (Mckinnon *et al.*,2014). Further research is needed to evaluate social policies and public health strategies which are being implemented in Senegal, such as "Bourse de securite Familial", universal coverage policies, and the extension of community case management, to estimate their effect and to better target strategies to reduce under 5 mortality.

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Appendix: Data collection forms and SOPs

Baseline census form

<table>
<tr><td colspan="2" align="center">**Enquête**
Questionnaire Ménage</td></tr>
<tr><td colspan="2" align="center">Identification</td></tr>
<tr>
<td>Code Enquêteur : [___][___]</td>
<td>Nom Enquêteur : ……………………………………………….</td>
</tr>
<tr>
<td>Code Région : [___]</td>
<td>Région : ……………………………………………………..</td>
</tr>
<tr>
<td>Code Département : [___]</td>
<td>Département :………………………………………….…….</td>
</tr>
<tr>
<td>Code Arrondissement : [___]</td>
<td>Arrondissement : …………………………………….…….</td>
</tr>
<tr>
<td>Code Com. rurale /Commune : [___]</td>
<td>Communauté rurale /Commune :……………………………....</td>
</tr>
<tr>
<td>Code village /Quartier : [___][___][___][___][___]</td>
<td>village /Quartier :………………………………………….</td>
</tr>
<tr>
<td>Code Hameau: [___][___]</td>
<td>Hameau :………………………………………………….. </td>
</tr>
<tr>
<td>Code concession : [___][___][___][___]</td>
<td>Nom Chef Concession :…………………………………….</td>
</tr>
<tr>
<td>Code Ménage : [___][___]</td>
<td>Nom chef Ménage :……………………………………….</td>
</tr>
</table>

Visite finale

Date : ____/____/_____ Résultat (*): [ ] [ ] Autres raisons, précisez… … … … … … …………….… ………………………………………………………. ………………………………………………………. ………………………………. Nbre total de visites : [ ]	Code Résultats * 01. Complété 02. Ménage présent, mais pas d'interlocuteur éligible disponible 03. Ménage absent 04. Reporté / questionnaire pas encore rempli 05. Refusé 06. Ménage non éligible 07. Autres raisons, précisez… … … … … … … …

Nbre total de personnes dans le ménage : [ ][ ]

Nbre total d'enfants éligibles : [ ][ ]

Nbre de ménages dans la concession : [ ]

	CONTROLEUR DE TERRAIN	OPERATEUR DE SAISIE
		[ ][ ]
NOM _____	NOM _____ [ ][ ]	NOM _____
DATE _____	DATE _____	

GRILLE MENAGE

N° Ordre.	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
	Veuillez indiquer s'il vous plaît les nom et prénom de toutes les personnes faisant partie de ce ménage, en commençant par le chef de ménage Indiquez aussi les membres du ménage actuellement absents Et les visiteurs qui ont passé la nuit dans le logement	Quels sont ses liens avec le chef de ménage (*)	Sexe 1. Homme 2. Femme	A t-il/elle passé la dernière nuit dans la concession ? 1. Oui 2. Non	Est-il/elle un membre du ménage ? 1. Membre du ménage 2. Visiteur	Date de Naissance Quelle est sa date de naissance ? DD / MM / YYYY	L'âge approximatif Dans le cas où la date de naissance n'est pas connue, demander lui d'estimer son âge.	Situation matrimoniale 1. Marié(e) Monogame 2. Marié(e) polygame 3. veuf (ve) 4. Divorcé (e) 5. Célibataire	Religion 1 Musulman 2. Chrétien 3. Autres	Ethnie (*)	Niveau instruction 1. Primaire 2. Secondaire 3. Supérieur 4. Pas été à l'école 5. Arabe ou Coran	Si Père est dans le même ménage N° ordre du Père	Si Mère est dans le même ménage N° Ordre de la Mère	Spécifier prénom(s) et Nom du Père	Spécifier prénom(s) et Nom de la Mère	Eligible (Moins de 5 ans) 1- 2-
01	……………………………	☐☐	☐	☐	☐	__/___/__	☐☐	☐	☐	☐	☐	☐☐	☐☐			
02	…………………………	☐☐	☐	☐	☐	__/___/__	☐☐	☐	☐	☐	☐	☐☐	☐☐	…………	…………	

N° Ordre.	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
	Veuillez indiquer s'ilvous plaît les nom et prénom de toutes les personnes faisant partie de ce ménage, en commençant par le chef de ménage Indiquez aussi les membres du ménage actuellement absents Et les visiteurs qui ont passé la nuit dans le logement	Quels sont ses liens avec le chef de ménage (*)	Sexe 1. Homme 2. Femme	A t-il/elle passé la dernière nuit dans la concession ? 1. Oui 2. Non	Est-il/elle un membre du ménage ? 1. Membre du ménage 2. Visiteur	DATE DE NAISSANCE Quelle est sa date de naissance ? DD / MM / YYYY	L'âge approximatif Dans le cas où la date de naissance n'est pas connue, demander lui d'estimer son âge.	SITUATION MATRIMONIALE 1. Marié(e) Monogame 2. Marié(e) polygame 3. veuf (ve) 4. Divorcé (e) 5. Célibataire	RELIGION 1. Musulman 2. Chrétien 3. Autres	ETHNIE (*)	NIVEAU INSTRUCTION 1. Primaire 2. Secondaire 3. Supérieur 4.Pas été à l'école 5.Arabe ou Coran	N° ordre du Père	N° Ordre de la Mère	Spécifier Nom du Père	Spécifier Nom de la Mère	Eligible (Moins de 5 ans) 1- Oui 2- Non

Codes pour A2 :
01. Chef de ménage (C.M.)
30. Enfant de C.M., vivant d'une mère/d'un père décédé(e) ou divorcé(e)
21. Première épouse de C.M.
31. Enfant vivant de son(sa) première épouse
22. Deuxième épouse de C.M.
32. Enfant vivant de la deuxième épouse de C.M.
23. Troisième épouse de C.M.
33. Enfant vivant de la troisième épouse de C.M.
24. Quatrième épouse de C.M.
34. Enfant vivant de quatrième épouse du C.M.
04. Père ou mère du C.M.
05. Frère ou soeur du C.M. (ayant au moins le même père ou la même mère)

Codes pour A2 (suite) :
06. Beau-père ou belle-mère du C.M.
07. Beau-frère ou belle-sœur du CM
08. Gendre ou belle-fille du C.M.et/ou de son(sa) conjointe
09. (Arrière) petit-enfant du C.M.et/ou de son(sa) conjointe
10. Autre parent du C.M. et/ou de son(sa) conjointe
11. Oncle ou tante du C.M.
12. Cousin ou cousine du C.M.
13. Neveu ou nièce du C.M.
14. Pas de liens familiaux (et pas domestique)
15. Domestique vivant dans le ménage.

Codes pour A10 :
01. wolof
02. Sérère
03. Pulaar
04. Mandingue
05. Diola
06. Soninké
07. Autres

Enquêteur assurez-vous qu'aucune personne n'a été oubliée. Récapitulez les membres du ménage avec le C.M.

Field workers Manual :MANUEL DE L'ENQUETEUR pour Census

Avant de commencer l'enquête, l'enquêteur doit se présenter, ensuite faire un résumé des objectifs du projet au chef de concession ou chef de ménage ou son interlocuteur dans la concession ou le ménage.

PAGE DE GARDE

Identification

A l'exception de la ligne Enquêteur, il ne faut remplir que la partie droite (libellé), la partie gauche (code) est réservée à la codification. Pour la ligne enquêteur, l'enquêteur écrira son numéro et son nom.

Code Enquêteur : inscrire le numéro de l'enquêteur
Enquêteur : inscrire le nom de l'enquêteur
Région : inscrire le nom de la région
Département : inscrire le nom du département
Communauté rurale/Commune : si la localité est située dans une communauté rurale, inscrire le nom de la communauté rurale, sinon inscrire le nom de la commune
Nom Chef Concession : inscrire le nom du chef de concession
Nom Chef Ménage : inscrire le nom du chef de ménage

Visite finale

 Les informations sont relatives à la date à laquelle le questionnaire est complètement terminé.

Date : il s'agit de la date de dernière visite du ménage.

Résultat : l'astérisque (*) renvoie à la codification du type de résultat. Le code est compris entre 01 et 07 selon le déroulement de la visite.

Il peut arriver que l'enquêteur soit amené à effectuer plusieurs visites dans le ménage avant de pouvoir compléter le questionnaire. Dans ce cas, la date de dernière visite et le résultat seront inscrit dans la partie blanche de cette case.

Autres raisons, précisez : si la raison n'apparaît pas dans la liste proposée, écrire en toute lettres la raison.

Nbre total de visites : inscrire le nombre de fois où l'on a visité le ménage pour compléter le questionnaire (Code Résultat = 01), ou bien avant de se rendre compte que le questionnaire ne peut être complété (Code Résultat <> 01).

Nombre total de personnes dans le ménage : renseigner après avoir compté le nombre de personnes enquêtées dans la partie Grille Ménage.

Nombre d'enfants éligibles : C'est tous les enfants de moins de 5 ans (0 à 59 mois) enregistrés dans le ménage y compris les visiteurs. Il faut faire le décompte des réponses égales à 1 dans la colonne A16 de la Grille Ménage

Nombre de ménage dans la concession : C'est le nombre de ménages répertoriés dans la concession. Ainsi, pour tous les ménages d'une même concession, ce nombre sera identique.

Les parties réservées au Superviseur, Contrôleur de terrain et Opérateur de saisie ne sont pas renseignées par l'enquêteur..

N° d'ordre : inscrire le numéro séquentiel allant de 1 au nombre total de personnes dans le ménage. Les résidents présents, absents et les visiteurs sont tous numérotés.

A1 Enumération des personnes

On inscrira toutes aussi bien toutes les personnes considérées par le répondant comme des habitants habituelles du ménage, mais aussi les personnes visiteuses.

Un chef de ménage absent depuis plus d'un an sera considéré comme émigré et ne sera pas inscrit sur la liste ; on prendra sa première épouse ou l'ainé des membres du ménage comme chef de ménage.

A2 Code lien de parenté

Toutes les personnes recensées dans le ménage sont rattachées au chef de ménage, y compris les visiteurs.

Il faut utiliser la liste de codes figurant en bas de page du questionnaire.

Les personnes dont les ascendants résident dans le ménage (père ou mère) sont identifiables à partir du n° d'ordre du parent.

A3 Sexe

Il faut indique le genre de la personne :

Homme = 1

Femme = 2

A4 A passé la dernière nuit

Si la personne a passé la nuit dernière dans la concession, inscrire 1 = Oui, sinon inscrire 2 = Non.

A5 Statut de résidence

Si la personne est un Résident habituel (Présent ou Absent), inscrire 1. Sinon, il s'agit d'un Visiteur (n'a pas l'intention de résider), alors inscrire 2.

Une personne arrivée la veille ou le jour de l'enquête avec l'intention de résider sera considérée comme résident.

A6 Date de Naissance

Il faut inscrire la date de naissance de la personne.

Si la date est connue avec précision, inscrire les jour, mois et année. Exemple : 15/12/60.

Si le jour de naissance est inconnu, et seulement les mois et année connus, inscrire le mois et l'année et mettre une croix dans la case réservée au jour. Exemple : _X_/07/40.

Si seule l'année de naissance est connue , inscrire l'année et mettre des croix dans les cases réservées au jour et mois. Exemple _X_/_X/_02

Pour bien repérer une date de naissance on peut se servir d'un calendrier événementiel relatant des événements importants ; Exemple premier semis arachide, 3éme jour de tabaski, premier lundi après korité, jour de noël etc.

Cependant il faut savoir que la date de naissance est souvent inconnue notamment en milieu rural. Or le fait d'avoir une date de naissance correcte est d'une importance capitale dans une surveillance démographique comme celle que nous voulons mener ici.

Si l'année inconnue, mettre des croix dans les cases pour indiquer que la question a bien été posée et passer a A7.

Il faut particulièrement être vigilant pour les enfants nés à partir de 2002 (Cible du PSP).

A7 Age approximatif

Si date de naissance est connue (A6 est renseigné), il ne faut rien inscrire. Sinon, procéder à l'estimation et renseigner cette case.

Un gros effort doit être fait pour avoir un âge correct notamment pour les femmes car, si vous ne faites attention, c'est là où on trouvera le plus d'incohérences.

Le plus souvent, on vous dira que je ne connais pas mon âge mais j'ai ma carte d'identité. Or, les dates mentionnées sur les cartes d'identité peuvent être erronées.

Pour cela, vous garderez en repérage la date déclarée ou mentionnée sur la carte d'identité en attendant de déterminer l'âge des enfants. L'âge de l'ainé vous guidera à apprécier l'âge de la mère ou du père vivant dans le ménage.

Pour les enfants d'une même mère, commencer par le dernier né et demander l'écart entre les deux et d'éventuels décès ou morts –nés (cf colonne A1).

Si l'âge n'est pas connu, vous demanderez le nombre d'années au premier mariage. Pour les hommes, on supposera 22 ans âge au premier plus le nombre d'année de mariage. Exemple : 22ans + 10 (nombre d'années de mariage) = 32ans.

Pour les femmes de 18 ans âge au premier mariage +10ans de mariage = 28 ans etc…

A8 Situation matrimoniale

Elle est simplifiée : le rang de mariage pour les polygames ne sera pas renseigné.

Marié(e) Monogame = 1

Marié(e) polygame   = 2

Veuf (Ve)   = 3

Divorcé(e)   = 4

Célibataire   = 5

A9 Religion Inscrire la religion

      Musulman = 1

      Chrétien = 2

      Autre = 3

A10 Ethnie

Inscrire l'ethnie selon la liste proposée en bas de pade du questionnaire

A11 Niveau d'instruction

Inscrire le niveau d'instruction

Primaire = 1

Secondaire 2

Supérieur = 3

Pas été à l'école = 4

Arabe ou coran = 5

A12 N° ordre du père

Si le père de la personne habite dans le même ménage, il faut reporter ici son numéro d'ordre.

A13 N° ordre de la mère

Si la mère de la personne habite dans le même ménage, il faut reporter ici son numéro d'ordre.

A14 Prénom et nom du père

Inscrire les prénom(s) et nom du père

A15 Prénom et nom de la mère

Inscrire les prénom(s) et nom de la mère

A16 Eligibilité.

Lorsque l'enfant a moins de 5 ans au premier mars 2008 (0 à 59 mois), il faut inscrire 1 = Eligible, sinon 2 = Non Eligible.

Avant de quitter le ménage, il faut s'assurer que toutes les colonnes sont renseignées.

Superviseurs juniors :

Avant de commencer les corrections, demander à l'enquêteur les problèmes rencontrés sur le terrain : communication, comportement des interlocuteurs, problèmes rencontrés au niveau du remplissage du questionnaire etc…

Une fois ces problèmes réglés on passe au contrôle des questionnaires en associant l'enquêteur pour voir avec lui les éventuelles erreurs et incompréhensions durant les premiers jours de recensement.

Pour le contrôle proprement parlé : Voir ligne par ligne que toutes les cases sont renseignées, repérer les inconsistance éventuelles sur les noms des parents.

Vérifier la cohérence des informations :

La partie identification. Si vous faites une erreur d'enregistrement sur le département ou l'arrondissement à la saisie, le ménage va sortir de votre zone de responsabilité etc…

Vérifier que le nombre total de personnes dans le ménage correspond au nombre total de personnes recensées à A1. Que le nombre du ménage déclaré correspond aux questionnaires ménage remplis dans la concession. Que toutes les personnes recensées sont liées au chef de ménage tout en ayant leurs ascendants à A14 et A15.

A6 et A7, un accent particulier sera mis sur les âges notamment sur les femmes en âge de procréer (l'intervalle entre l'ainé et la mère ne devrait pas être en dessous de 15 ans).

A12 à A13, vérifier que le numéro d'ordre indiqué correspond à celui enregistré à A14 ou à A15.

Chaque jour, il doit y avoir une fiche récapitulative du modèle ci-après :

Date	N° et Noms enquêteur	Nombre questionnaires complétés	Nombre questionnaires en cours	Nombre total	Observations

Ce tableau récapitulatif doit parvenir au superviseur senior du district tous les jours ouvrables avec des appréciations s'il y a lieu et tous les questionnaires ménage terminés.

MANUEL DE L'ENQUETEUR pour DSS

Avant de commencer, l'enquêteur doit se présenter, ensuite faire un résumé des objectifs du projet au chef de concession ou chef de ménage ou son interlocuteur dans la concession ou le ménage.

Le recensement effectué au mois de mars a permis de constituer la base de données initiale du système de surveillance démographique envisagée dans les 3 districts concernés. Il sera suivi de passages répétés et réguliers dans les concessions en vue de collecter dans cette première phase, les informations relatives aux grossesses, naissances ou mort-nés, décès ainsi qu'aux déplacements temporaires ou définitifs des individus rencontrés lors des visites. Ces informations collectées permettent de mettre à jour constamment la base de données et ainsi avoir une connaissance suffisamment précise de la population.

La collecte de données se fera à travers les supports qui sont présentés à la suite : le listing de surveillance démographique, la fiche de naissance/mort-né et la fiche arrivée.

LISTING DE SURVEILLANCE

Le listing de surveillance démographique est pré-imprimé pour chaque concession avec identification du chef de concession. A l'intérieur de la concession, les individus sont listés par ménage avec indentification du chef de ménage.
Les éléments d'identification de toutes les personnes vues au moment du recensement initial sont pré-imprimés à partir des informations tirées de la base de données.

Après la ligne d'identification, apparaissent les questions à poser à l'individu courant.
Pour chaque individu, les questions posées sont fonction de son profil (sexe, groupe d'âges).
Après avoir renseigné la date de visite, ces questions sont :

REPONDANT : Inscrire le numéro d'identification et le nom du répondant.

RESIDENCE : il s'agit du statut de résidence de l'individu.
Si l'individu a passé la nuit précédente dans la concession, la réponse est 1.
Si l'individu n'a pas passé la nuit précédente dans la concession, mais il habite dans la concession, il s'agit d'une absence. La réponse est 2= Absent et il faut indiquer la date de départ d'absence et le lieu de destination.
Si l'individu est décédé, la réponse est 3= Décès ; il faut indiquer la date de décès.
Si l'individu a quitté la concession pour aller habiter ailleurs, la réponse est 4=Quitter. L'individu a quitté la concession. Il faut indiquer la date de départ et aussi le lieu de destination. On a deux cas de figures : a) L'individu s'est installé dans une autre concession du district, il s'agit d'un changement d'adresse. L'individu est sorti du district, il s »agit d'une émigration. D'où l'importance de préciser le lieu de destination (impératif).

Si l'individu était absent au moment du passage précédent, sa date d'absence sera pré-imprimée sur le listing de surveillance. Alors, il faut indiquer 5=Retour et demander sa date de retour.

GROSSESSE (GROS) : Cette question n'apparait que lorsqu'il s'agit d'une femme âgée de 12 à 54 ans. Le programme d'impression qui a déterminé le profil de l'individu fera apparaître la question le cas échéant.
La réponse inscrite sera 1 si la femme est en grossesse, 2 si la femme n'est pas en grossesse, 9=Ne sait Pas.

NAISSANCE / MORT-NE (NAIS/MN) : Cette question n'apparait que lorsqu'il s'agit d'une femme âgée de 12 à 54 ans. Le programme d'impression qui a déterminé le profil de l'individu fera apparaître la question le cas échéant.
La réponse inscrite sera 1 si la femme a eu une naissance vivante, un mort-né ou bien une fausse-couche, depuis l'enquête précédente; il faudra alors **remplir** une fiche NAISSANCE OU MORT-NE ;
la réponse sera 2 si aucune naissance, ou mort-né ou fausse-couche n'a eu lieu depuis l'enquête précédente.
La réponse sera 9 si l'interlocuteur ne sait pas.

VACCINATION (VACC) : Cette question n'apparait que s'il s'agit d'un enfant de moins de 10 ans. Il faudra alors inscrire le type d'antigène : Bcg=1, Penta=2, DTCPolio= 3, Fièvre jaune=4, Rougeole=5, et autres=6, et la date. Cette information est renseignée sur la base de la carte de vaccination présentée. L'enfant peut avoir reçu plusieurs vaccinations, il faudra alors les inscrire toutes.

HOSPITALISATION (HOSP) : Cette question n'apparait que s'il s'agit d'un enfant de moins de 10 ans. Il faudra alors inscrire la date et le nom de la structure de santé où l'hospitalisation a eu lieu.

L'usage de la MOUSTIQUAIRE est abordé à travers 4 questions :

PRESENCE : Cette question est posée à tout le monde et les réponses possibles sont 1=Oui, la moustiquaire est présente dans la chambre où dort l'individu ; 2=Non, il n'y a pas de moustiquaire ; 9=Ne sait pas.

INTACT : Si la réponse à la question précédente (PRESENCE) est égale à 1, alors l'enquêteur pose cette question et les réponses possibles sont 1=Oui la moustiquaire est intacte ; 2=Non la moustiquaire n'est pas intacte ; 9=Ne sait pas.

MILDA : On cherche à savoir s'il s'agit d'une Moustiquaire Imprégnée à Longue Durée d'Action. Si c'est le cas, l'enquêteur inscrit 1=Oui, sinon il inscrit 2=Non ; S'il ne sait pas il inscrit 9=Ne sait pas.

UTILISATION : Il s'agit de savoir si l'individu dort effectivement sous la moustiquaire. Les réponses possibles sont 1=Oui la moustiquaire est effectivement utilisée ; 2=Non la moustiquaire n'est pas utilisée ; 9=Ne sait pas.

Le lieu de procuration est aussi à préciser ex : Poste de santé, Pharmacie, autres lieux

FICHE NAISSANCE OU MORT-NE

Cette fiche est à renseigner lorsque une femme a répondu par 1=OUI à la question NAIS/MN apparaissant sur le listing de surveillance démographique. C'est quand il s'agit d'une femme âgée de 12 à 54 ans qui entre les deux passages a eu une grossesse qui s'est terminée par une naissance, un mort-né ou une fausse couche.

On commence par renseigner les informations de localisations en recopiant les mêmes valeurs que celles pré-imprimées sur le listing de la concession en cours d'enquête, pour les rubriques suivantes : DISTRICT, POSTE DE SANTE, VILLAGE, CONCESSION, MENAGE.

ENQUETEUR : l'enquêteur indique son numéro d'identification et son nom

REPONDANT : Inscrire le numéro d'identification et le nom du répondant
DATE DE VISITE: date de passage dans la concession

ENFANT : l'enquêteur inscrit le nom du nouveau-né s'il s'agit d'une naissance vivante.
L'enquêteur n'écrit rien s'il s'agit d'un mort-né ou d'une fausse couche.
Le numéro d'identification n'est pas renseigné au moment de l'enquête. Il sera attribué par le système informatique à la remontée des questionnaires.

SEXE : l'enquêteur inscrit 1 si c'est un garçon, 2 si c'est une fille, 9 ne sait pas
DATE DE NAISSANCE : date de naissance de l'enfant
MERE : l'enquêteur inscrit le numéro d'identification de la mère ; ce numéro est lu sur le listing de concession car la mère réside déjà dans la concession et ses informations sont donc pré-imprimées. Il inscrit aussi le nom de la mère.

Cas particulier d'une mère qui est arrivée en immigration entre les deux passages. Cette mère n'est donc pas pré-imprimée sur le listing. Cependant une fiche ARRIVEE sera déjà remplie pour elle et un numéro d'identification ne lui sera attribué que plus tard.

PERE : Le père peut être résident ou bien non-résident. S'il est résident dans la concession, l'enquêteur recopie les informations connues ; s'il est arrivé en immigration entre les deux passages, ou s'il habite une autre concession on reporte son nom et son numéro sera inscrit ultérieurement. S'il habite une autre concession l'enquêteur doit le spécifier en indiquant le nom du chef de concession et le nom du village de résidence.

L'ENFANT A Crié ou Respiré à la NAISSANCE : l'enquêteur inscrit 1 si l'enfant a crié ou respiré à la naissance, il inscrit 2 si cela n'est pas le cas. Noter que c'est la réponse à cette question qui permet de savoir si la grossesse s'est terminée par une naissance vivante (réponse 1=OUI) ou un mort-né ou fausse couche (réponse 2=NON).

MULTIPLICITE : l'enquêteur inscrit 1 si la naissance concerne un seul enfant, 2 s'il s'agit de 2 jumeaux, 3 s'il s'agit de triplets, …. La valeur 9 est réservée à la réponse Ne Sait Pas.

LIEU : l'enquêteur inscrit 1 si la délivrance a eu lieu à Domicile, 2 si elle a eu lieu dans une Structure de santé. La valeur 9 est réservée à la réponse Ne Sait Pas.

LIEN AVEC CHEF MENAGE : Indiquer le type de lien avec le chef de ménage (voir table des liens de parenté en annexe)

 RELIGION : indiquer la religion du nouveau-né. 1 : musulman, 2 : Chrétien, 3 : autres, 9 : ne sait pas

ETHNIE : indiquer l'ethnie du nouveau-né (voir table en annexe)

HOSPITALISATION : l'enquêteur inscrit 1 si l'enfant a passé au moins une nuit dans une structure de santé pour raison de maladie depuis sa naissance. Il inscrit 2 si l'enfant n'a pas passé de nuit dans une structure de santé pour raison de maladie.

VACCINATION : Au vue de la carte de vaccination, l'enquêteur recopie les informations relatives aux vaccins reçus depuis la naissance de l'enfant. Il indiquera le type d'antigène reçu, et la date de vaccination.

L'usage de la MOUSTIQUAIRE est abordé à travers 4 questions :
PRESENCE : Cette question est posée à tout le monde et les réponses possibles sont 1=Oui, la moustiquaire est présente dans la chambre où dort l'individu ; 2=Non, il n'y a pas de moustiquaire ; 9=Ne sait pas.

INTACT : Si la réponse à la question précédente (PRESENCE) est égale à 1, alors l'enquêteur pose cette question et les réponses possibles sont 1=Oui la moustiquaire est intacte ; 2=Non la moustiquaire n'est pas intacte ; 9=Ne sait pas.

MILDA : On cherche à savoir s'il s'agit d'une Moustiquaire Imprégnée à Longue Durée d'Action. Si c'est le cas l'enquêteur inscrit 1=Oui, sinon il inscrit 2=Non ; S'il ne sait pas il inscrit 9=Ne sait pas.

UTILISATION : Il s'agit de savoir si l'individu dort effectivement sous la moustiquaire. Les réponses possibles sont 1=Oui la moustiquaire est effectivement utilisée ; 2=Non la moustiquaire n'est pas utilisée ; 9=Ne sait pas.

FICHE ARRIVEE

Cette fiche est à renseigner lorsque l'enquêteur s'aperçoit qu'une personne vivant dans la concession n'est pas inscrite sur la liste pré-imprimée.

L'enquêteur commence par renseigner les informations de localisations en recopiant les mêmes valeurs que celles pré-imprimées sur le listing de la concession en cours d'enquête, pour les rubriques suivantes : DISTRICT, POSTE DE SANTE, VILLAGE, CONCESSION, MENAGE.

ENQUETEUR : l'enquêteur indique son numéro d'identification et son nom

REPONDANT: Inscrire le numéro d'identification et le nom du répondant. Il ne peut s'agir que d'un résident de la concession visitée.

DATE DE VISITE: date de passage dans la concession

IDENTITE : l'enquêteur inscrit le nom de la personne. Le numéro d'identification n'est pas renseigné au moment de l'enquête. Il sera attribué par le système informatique à la remontée des questionnaires.

SEXE : l'enquêteur inscrit 1 si c'est un homme, 2 si c'est une femme
Les réponses possibles sont donc 1=Homme, 2=Femme, 9=Ne sait pas

DATE DE NAISSANCE : l'enquêteur inscrit la date de naissance de la personne.

DATE D'ARRIVEE: l'enquêteur inscrit la date à laquelle la personne est arrivée dans la concession.
PROVENANCE : l'enquêteur inscrit le nom du lieu de provenance de la personne

MOTIF : l'enquêteur inscrit le motif de l'arrivée de la personne dans la concession. Il faudra clairement documenter la raison de la venue.

MERE : Si la mère ne réside pas dans la même concession, l'enquêteur inscrit uniquement le nom de la mère de la personne. Si la mère réside dans la même concession, alors les informations la concernant sont déjà pré-imprimées sur le listing. L'enquêteur inscrira alors son numéro d'identification et son nom.

Au cas où il s'agit d'une mère arrivée en immigration entre les deux passages, une fiche ARRIVEE sera remplie pour elle et un numéro d'identification lui sera attribué plus tard.

PERE : Le père peut être résident ou bien non-résident. S'il est résident dans la concession, l'enquêteur recopie les informations connues ; s'il est arrivé en immigration entre les deux passages, ou s'il habite une autre concession on reporte son nom et son numéro sera inscrit ultérieurement.

LIEN AVEC CHEF MENAGE : Indiquer le type de lien qui lie la personne au chef de ménage (voir la table des liens en annexe)

RELIGION : Indiquer la religion de la personne.

Les réponses possibles sont donc 1=Musulman, 2=Chrétien, 3=Autre, 9=Ne sait pas

ETHNIE: Indiquer l'ethnie de la personne (voir table de codification en annexe)

SITUATION MATRIMONIALE : Indiquer la situation matrimoniale de la personne

Les réponses possibles sont donc 1=Marié(e) monogame, 2=Marié(e) polygame, 3=Veuf(ve), 4=Divorcé(e), 5=Célibataire, 9=Ne sait pas

NIVEAU D'INSTRUCTION : indiquer la dernière classe fréquentée par la personne

Les réponses possibles sont donc 1=Primaire, 2=Secondaire, 3=Supérieur, 4=Pas été à l'école, 5=Arabe ou coranique, 6=Alphabétisation, 7=Pré-scolaire, 9=Ne sait pas

GROSSESSE : l'enquêteur pose la question s'il s'agit d'une femme 12 à 54 ans

Les réponses possibles sont donc 1=Oui, 2=Non, 9=Ne sait pas

HOSPITALISATION : l'enquêteur pose la question s'il s'agit d'un enfant de moins de 10 ans. Si l'enfant a passé au moins une nuit dans une structure de santé depuis le jour de son arrivée dans la concession, la réponse est 1 (Oui) ; sinon la réponse est 2 (Non).

Les réponses possibles sont donc 1=Oui, 2=Non, 9=Ne sait pas

VACCINATION : l'enquêteur demande la carte de vaccination s'il s'agit d'un enfant de moins de 10 ans. Il recopie les antigènes et dates d'administration des vaccins.

L'usage de la MOUSTIQUAIRE est abordé à travers 4 questions :

PRESENCE : Cette question est posée à tout le monde et les réponses possibles sont 1=Oui, la moustiquaire est présente dans la chambre où dort l'individu ; 2=Non, il n'y a pas de moustiquaire ; 9=Ne sait pas.

INTACT : Si la réponse à la question précédente (PRESENCE) est égale à 1, alors l'enquêteur pose cette question et les réponses possibles sont 1=Oui la moustiquaire est intacte ; 2=Non la moustiquaire n'est pas intacte ; 9=Ne sait pas.

MILDA : On cherche à savoir s'il s'agit d'une Moustiquaire Imprégnée à Longue Durée d'Action. Si c'est le cas l'enquêteur inscrit 1=Oui, sinon il inscrit 2=Non ; S'il ne sait pas il inscrit 9=Ne sait pas.

UTILISATION : Il s'agit de savoir si l'individu dort effectivement sous la moustiquaire. Les réponses possibles sont 1=Oui la moustiquaire est effectivement utilisée ; 2=Non la moustiquaire n'est pas utilisée ; 9=Ne sait pas.

RESIDENCE ANTERIEURE DANS LA ZONE : Si la personne a déjà résidé dans la zone de surveillance démographique(les 3 districts d'intervention), alors la réponse est 1(Oui) ; sinon la réponse est 2 (Non).

Les réponses possibles sont donc 1=Oui, 2=Non, 9=Ne sait pas

Si OUI, dans quelle LOCALITE ? _____

IRD-UMR 198 URMITE / INED-UR2&5   **Janvier 2009**

Observatoires de Population au Sénégal

Niakhar, Mlomp & Bandafassi

AUTOPSIE VERBALE

Nouveau-né/Enfant/Adulte H/Adulte F

Type de décès : ☐ **Nouveau-né**   ☐ **Enfant** ☐ |__|__|

☐ **Adulte femme** ☐ **Adulte homme** ☐ **Maternel**

Enquêteur : _____ |__|__|

Date de visite : |__:__|__:__|__:__:__:__|

Village : _____ |__|__|__|

Concession :_____ |__|__|__|

ou ménage ou carré

Identité :
|__|__|__|__|__|__|_____

Mére   :
|__|__|__|__|__|__|_____

Sexe : |___| Date de naissance :
|__:__|__:__|__:__:__:__|

                                             Date de décès : |__:__|__:__|__:__:__:__|

Répondant : _____ |__|__|

Age déclaré au décès (pour les nourrissons, préciser le nombre de jours ou de semaines) : _____ |__|__|__|

Lieu du décès : A domicile ☐ dans un établissement de santé ☐ autre lieu ☐ nsp ☐

|__|__|__|

Préciser lieu (sauf si Domicile)_____

Cause déclarée : _____ |__|__|

Quel est le nom local de la maladie : _____ |__|__|

(en langue diola, peulh, bédik, malinké, sérére, wolof, langue locale)

La personne a-t-elle consulté un guérisseur pour cette maladie: ☐ OUI ☐ NON

La personne a-t-elle consulté dans un établissement de santé : ☐ OUI ☐ NON

+ si oui,

quel établissement	où	à quelle date
|__|__|__|	|__|__|__|__|	|__|__|__| |__|__|__| |__|__|__|__|
|__|__|__|	|__|__|__|__|	|__|__|__| |__|__|__| |__|__|__|__|

La personne a-t-elle été hospitalisée : ☐ OUI ☐ NON

+ si oui,

quel établissement	où	à quelle date
|__|__|__|	|__|__|__|__|	|__|__|__| |__|__|__| |__|__|__|__|
|__|__|__|	|__|__|__|__|	|__|__|__| |__|__|__| |__|__|__|__|

Diagnostic recopié du registre _____

_____

Cause initiale (CIM-9) :   └─┴─┴─┘ . └─┘

Durée jusqu'au décès :   └─┴─┘

Si accident, utiliser la classification supplémentaire traumas (CIM-9) : └─┴─┴─┴─┘

HISTOIRE DE LA MALADIE AYANT CONDUIT AU DECES

(Faire la chronologie des événements qui se sont déroulés au cours de la maladie ou après l'accident ayant conduit au décès. En cas de symptômes particuliers faire décrire ou mimer par le répondant. Dans chaque cas préciser les traitements reçus et l'ordre de succession des événements).

S'AGIT-IL D'UN ACCIDENT : ☐ OUI ☐ NON

(si oui ne remplir que la page 1 et l'histoire actuelle)

HISTOIRE DES SYMPTOMES ET DES TRAITEMENTS :

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Quel a été le 1er symptôme :

_____

Ya-t-il eu une maladie avant ce premier

symptôme ? :——————————————————————

Combien de temps a duré la maladie qui a conduit au décès ? :

_____

Quels ont été dans l'ordre chronologique, les traitements reçus jusqu'au décès ?

Quel médicament/soin	Où / par qui	À quelle date
	L_I_I_I	L_I_I_I L_I_I_I L_I_I_I_I
	L_I_I_I	L_I_I_I L_I_I_I L_I_I_I_I
	L_I_I_I	L_I_I_I L_I_I_I L_I_I_I_I

D'AUTRES PERSONNES OU D'AUTRES ENFANTS ONT-ILS EU LES

MEMES SYMPTOMES A LA MEME PERIODE ☐OUI☐NON

→si oui, préciser dans quel village : _____

FIEVRE OU CORPS CHAUD ☐OUI ☐NON

Combien de temps cela a durée ? _____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

(cocher la case si le symptôme est présent)

La fièvre était-elle   très forte ?   ☐

                        moyenne ?   ☐

                        intermittente ?   ☐

                        continue ?   ☐

Avait-il des sueurs ?   ☐

Avait-il des frissons ?   ☐

Lui a-t-on donné des ACT (antipaludéens) au cours de la fièvre ?

☐ Oui →   combien de fois : _____|__|__|

           combien de comprimés chaque fois :   _____|__|__|

☐ Non

Lui a-t-on donnée un autre traitement en comprimés ou sirop ?

☐ Oui →   Lequel ? _____

☐ Non

A-t-il reçu une injection reçue pour cette fièvre :

☐ Oui →   Lieu : _____

           Date : |__|__| |__|__| |__|__|__|__|

☐ Non

DIARRHEE OU DYSENTERIE   ☐OUI ☐NON

Combien de temps cela a durée ? _____

Quand cela a-t-il commencé ?_____

Quand cela s'est il terminé ? _____

Combien avait-il de selles par jour ?_____ └─┴─┘

(Cocher la case si le symptôme est présent)

Les selles étaient-elles : comme de l'eau (incolore) ? ☐

                       comme des crachats ? ☐

                       avec du sang ? ☐

                       d'une autre couleur ? ☐

               →   préciser ?_____

SIGNES DE DESHYDRATATION ☐OUI ☐NON

Avait-il la bouche et la langue sèches ou était-il assoiffé ? ☐ **OUI**
    ☐**NON**

Avait-il les yeux enfoncés ? ☐ **OUI**
    ☐**NON**

Avait-il la fontanelle déprimée (*enfants de moins de 2 ans*) ☐ **OUI**
    ☐**NON**

VOMISSEMENTS ☐OUI ☐

NON

Combien de temps cela a-t-il durée ? _____

Quand vomissait-il au cours de la maladie ? _____

De quelle couleur étaient des vomissements ? _____

S'agissait-il de vomissements en jet (comme un robinet)?☐ **OUI** ☐**NON**

CRISES CONVULSIVES   ☐OUI☐NON

Combien y-a-t-il eu de crises (préciser sur quelle

période) ?_____

Combien de temps a durée de chaque

crise ?_____

Quand ces crises sont-elles survenues au cours de la

maladie ?_____

description :

Signe	Pendant la crise	
Avait-il des spasmes (mouvement brusque et incontrôlé)	☐	
Criait-il ou pleurait-il ?	☐	
Urinait-il ?	☐	
Se mordait-il la langue ?	☐	
Hypersalivait-il (bavait beaucoup) ?	☐	**Après la crise**
Respirait-il bruyamment ?	☐	☐
La fontanelle était-elle gonflée (enfants de moins de 2 ans)	☐	☐
Avait-il le cou tordu en arrière ?	☐	☐
Avait-il le corps raidi en arrière ?	☐	☐
Avait-il les jambes tendues ?	☐	☐
Avait-il les jambes pliées ?	☐	☐
Avait-il les bras tendus ?	☐	☐

Avait-il les bras pliés ?	☐	☐
Avait-il les poings fermés ?	☐	☐
Avait-il la bouche fermée ou crispée **(ne pouvait plus manger ou téter)**	☐	☐
Perdait-il connaissance ?	☐	☐
Durée de la perte de connaissance après la crise		moins d'une heure ☐ plus d'une heure ☐
Paralysie après la crise		☐

S'AGISSAIT-IL D'EPILEPSIE ☐**OUI** ☐**NON**

Depuis combien de temps faisait-il des crises ?

Etait-il soigné ?

    ☐ Oui →   Précises où ? _____

    ☐ Non

SIGNES NEUROLOGIQUES EN DEHORS   ☐OUI ☐NON

D'UN CONTEXTE DE CRISES CONVULSIVES

Y-a-t-il eu perte de connaissance ou coma ?   ☐OUI ☐NON

    ☐ Oui →   Quand au cours de la maladie ? _____

    → Si oui, Durée de la perte de connaissance_____

    ☐ Non

Y-a-t-il eu paralysie du corps ou d'un membre ?   ☐OUI ☐NON

    ☐ Oui →   Préciser quelle(s) partie(s) ? _____

    → Si oui, Durée de la paralysie ?_____

    ☐ Non

DIFFICULTES A RESPIRER   ☐OUI ☐NON

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

(Cocher la case si le symptôme est présent)

Respirait-il rapidement ?   ☐

Respirait-il difficilement (s'étouffait) ?   ☐

Respirait-il bruyamment ?   ☐

Avait-il la respiration sifflante ?   ☐

Avait-il les ailes du nez palpitantes ?   ☐

La peau rentrant entre les côtes ?   ☐

TOUX   ☐ OUI ☐

NON

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

(Cocher la case si le symptôme est présent)

Toux la nuit   ☐

Crachait après la toux   ☐

   → Si oui, les crachats étaient-ils comme du pus ?   ☐

      comme de la mousse ?   ☐

      avec du sang ?   ☐

      nauséabonds ?   ☐

   Vomissait après la toux ?   ☐

   Perdait sa respiration en toussant ?   ☐

   Faisait des quintes de toux (groupe de toux) ?   ☐

S'AGISSAIT-IL DE LA COQUELUCHE   ☐ OUI ☐ NON

Combien de temps après le début de la toux la personne est-elle

décédée ?_____

Un autre enfant de la concession avait-il la coqueluche à la même période ? ☐ OUI ☐ NON

   → Si non, où l'enfant décédé a-t-il été contaminé ? _____

BOUTONS   ☐ OUI ☐

NON

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

A quel(s) endroits du corps les boutons étaient-ils situés ? _____

_____

_____

Sur quelle partie du corps sont-ils apparus en premier ?_____

(Cocher la case si le symptôme est présent)

Sont-ils apparus	ensemble ?	☐
	les uns après les autres ?	☐
Etaient-ils	aplatis ?	☐
	saillants ?	☐
	grands ?	☐
	petits ?	☐
Contenaient-ils	de l'eau ?	☐
	du pus ?	☐
Ont-ils cicatrisé avant le décès ?		☐
La peau a-t-elle desquamée ?		☐

S'AGISSAIT-IL DE LA ROUGEOLE ☐OUI ☐NON

Combien de temps après l'éruption des boutons la personne est-elle

décédée ? _____

antérieur   postérieur
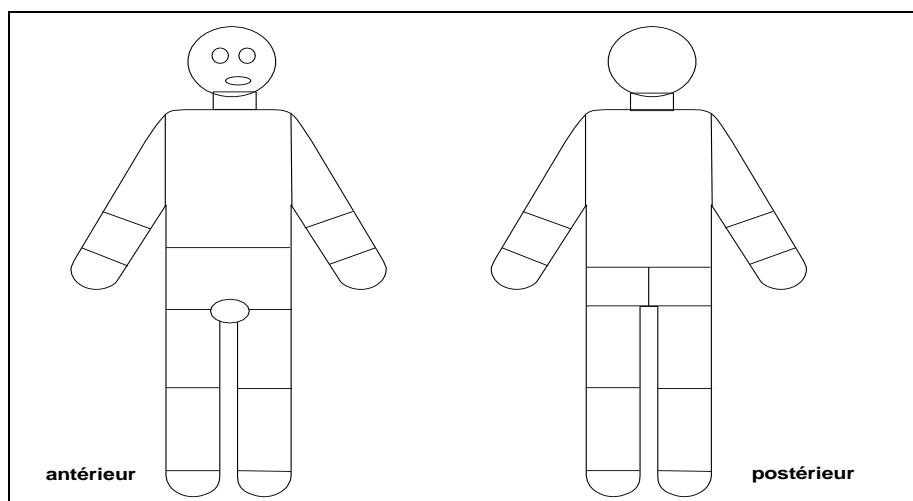
S'il n'a pas eu de boutons, préciser les symptômes qui ont permis de reconnaitre la rougeole

? ☐

_____

_____

_____

_____

PLAIES, BRULURES, ABCES   ☐**OUI**☐**NON**

Y-avait-il des plaies ?   ☐

   →si oui, étaient-elles infectées ?   ☐

Y-avait-il des brûlures ?   ☐

Y-avait-il des gonflements contenant du pus (abcès) ?   ☐

Pour les plaies, brûlures, abcès , indiquer la localisation sur le schéma corporel :

_____

_____

SAIGNEMENTS ☐ **OUI** ☐

NON

Où étaient localisés ses saignements ? _____

Combien de fois a-t-il saigné ? _____

Quand au cours de la maladie a-t-il saigné ? _____

OEDEMES (CORPS ENFLES) ☐ **OUI** ☐ **NON**

Combien de temps cela a-t-il durée ? _____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

Sur quelles parties du corps étaient-ils situés? _____

VENTRE GONFLE ☐ **OUI** ☐

NON

Combien de temps cela a-t-il durée ? _____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

Une ponction a-t-elle été pratiquée ? ☐ OUI ☐ NON

→ Si oui, dans quelle formation sanitaire ? _____

☐ Non

DIFFICULTES A URINER, PROBLEME URINAIRE, ☐ **OUI** ☐ **NON**

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

Avait-il des douleurs en urinant ?   ☐OUI ☐NON

COULEUR ANORMALE DES URINES   ☐OUI☐NON

De quelle couleur étaient ces urines ?_____

Quand au cours de ma maladie ? _____

COULEUR ANORMALE DES SELLES   ☐OUI☐NON

De quelle couleur étaient ces selles ?_____

Quand au cours de ma maladie ? _____

MAL AUX YEUX, COULEUR ANORMALE DES YEUX   ☐OUI☐NON

Quand au cours de la maladie ? _____

Avait-il les yeux   rouges   ?   ☐

                         jaunes ?   ☐

                         larmoyants ?   ☐

MAUX DE POITRINE, MAUX DE COTES ☐OUI ☐NON

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

MAUX DE TETE ☐OUI ☐
NON

☐NPS
(2ans)

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

AVAIT-IL DES BOURDONNEMENTS D'OREILLES ☐OUI ☐NON

AVAIT-IL DES TROUBLES VISUELS ☐OUI ☐NON

☐NPS
(2ans)

MAUX DE VENTRE ☐OUI ☐NON

Combien de temps cela a-t-il durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

AUTRES SYMPTOMES   ☐OUI☐

NON

Préciser lesquels : _____

Combien de temps ont-ils durée ?_____

Quand cela a-t-il commencé ? _____

Quand cela s'est-il terminé ? _____

SIGNES GENERAUX

Avait-il des démangeaisons, prurit ?   ☐

A-t-il maigri au cours de la maladie ?   ☐

Etait-il déjà maigre au début de la maladie ?   ☐

A-t-il arrêté de manger au cours de la maladie ?   ☐

La couleur de la paume des mains a-t-elle changé ?   ☐

Le corps a-t-il changé de couleur ?   ☐

La langue était-elle pâle ?   ☐

Mangeait de la terre ?   ☐

Etait-elle constipé ?   ☐

Avait-il très soif durant la maladie ?   ☐

D'autres personnes ou d'autres enfants ont-ils eu les mêmes symptômes à la même période ?☐OUI☐NON

    → Si oui, dans quel village ? _____

    ☐ Non

Remarque :

_____

_____

_____

_____

_____

_____

_____

LA PERSONNE S'OUFFRAIT-ELLE D'UNE MALADIE CHRONIQUE ☐OUI☐NON

→ Si oui, Quelle maladie ? _____

Depuis quand ? _____

Quels traitements ? _____

_____

S'AGIT-IL D'UN DECES AVANT 5 ANS ☐OUI ☐NON

→si Oui, l'enfant était-il sevré au moment du décès ? ☐**OUI** ☐**NON**

S'AGIT-IL D'UN DECES DE NOUVEAU-NE ☐OUI ☐NON

(survenu dans les 4 semaines suivant la naissance)

S'AGIT-IL D'UN MORT-NE ? ☐OUI ☐NON

S'AGIT-IL DU DECES D'UNE FEMME ENCEINTE ☐OUI ☐NON

S'AGIT-IL D'UN DECES D'UNE FEMME AGEE DE 12-49 ANS ☐OUI ☐NON

+ si, oui, date de terminaison de la dernière grossesse └─┴─┘ └─┴─┘ └─┴─┴─┘

LE RESTE DU QUESTIONNAIRE N'EST A REMPLIR QUE DANS LES CAS SUIVANTS :
Mort-né
Décès d'un nouveau-né (moins de 4 semaines)
Décès d'une femme ayant entre 12 et 49 ans, et ayant une grossesse moins d'un an avant son décès

GROSSESSES PRECEDENTES

Y a-t-il des problèmes pendant grossesses et/ou accouchements précédents ? ☐**OUI** ☐ **NON**

→ Si, oui, préciser lesquels ? _____

Une césarienne a-t-elle été pratiquée lors d'une grossesse précédente ? ☐OUI☐NON

HISTOIRE DE LA DERNIERE GROSSESSE

Combien de temps a duré la grossesse ?   └─┴─┘ mois

La mère a-t-elle été malade durant la grossesse **?**   ☐OUI☐NON

(Cocher la case si le symptôme est présent)

→si oui, Avait-elle :

Les jambes enflées ?   ☐

Les mains enflées ?   ☐

Le visage enflé ?   ☐

De l'hypertension artérielle ?   ☐

Des convulsions ?   ☐

De la fièvre   ?   ☐

Saignait—elle ?   ☐

A-t-elle été soignée au cours de la grossesse ?   ☐OUI☐NON

→si Oui, Quels soins ? _____

A-t-elle eu un régime particulier   ☐OUI☐NON

→si Oui, Lequel ? _____

A-t-elle été à la visite prénatale ?   ☐OUI☐NON

→si Oui, Où ? _____

A-t-elle reçu une injection contre le tétanos (VAT)   ☐OUI☐NON

→si oui, où , _____

ACCOUCHEMENT A LA SUITE DE LA DERNIERE GROSSESSE

L'accouchement a-t-il eu lieu ? domicile ?   ☐

                                  pendant le transport ?   ☐

                                  dans un établissement de santé ?   ☐

Si l'accouchement s'est déroulé dans un établissement de santé, préciser quel(le) était :

      La localité ? _____

      L'établissement ? _____

L'accouchement a-t-il présenté des difficultés ou des complications ?   ☐**OUI**☐**NON**

      →siOui, Lesquelles ? _____

L'accouchement s'est-il déroulé   Par voie normale   ☐

                                    Par césarienne   ☐

Combien de temps a duré le travail ? └┴┘ heures

S'agit-il d'une naissance multiple ?   ☐**OUI**☐**NON**

La tête est-elle venue la première ?   ☐**OUI**☐**NON**

La rupture de la poche des eaux s'est-elle faite plus de 12 heures

avant l'accouchement ?   ☐**OUI**☐**NON**

A-t-elle eu de la fièvre au-delà de 24 heures après l'accouchement ? ☐**OUI**☐**NON**

Le placenta est-il venu normalement et en entier ?   ☐**OUI**☐**NON**

      →si Oui à quel moment ?   Pendant travail ? ☐

                                 Après délivrance ? ☐

La femme a-t-elle saigné longtemps ?   ☐**OUI**☐**NON**

      →si Oui, Combien de temps ? _____

Quelle était la couleur du sang ? _____

ETAT DE L'ENFANT

(Cocher la case correspondante à la situation)

L'enfant était-il   Né vivant ?   ☐

                      Mort-né ?   ☐

                      Avorté ?   ☐

                      Non né ?   ☐

A-t-il crié rapidement après la naissance ?   ☐**OUI** ☐**NON**

A-t-il respiré normalement après la naissance ?   ☐**OUI** ☐**NON**

Etait-il   trop gros ?   ☐**OUI** ☐**NON**

               trop maigre ?   ☐**OUI** ☐**NON**

               trop petit ?   ☐**OUI** ☐**NON**

               trop grand ?   ☐**OUI** ☐**NON**

Avait-il la tête trop grosse ?   ☐**OUI** ☐**NON**

A-t-il uriné **?**   ☐**OUI** ☐**NON**

A-t-il déféqué **?**   ☐**OUI** ☐**NON**

En cas de mort-né, le foetus était-il macéré   **?**   ☐**OUI** ☐**NON**

Avait-il une malformation visible à la naissance ?   ☐**OUI** ☐**NON**

     →si Oui, Laquelle ? _____

A-il tété ?   ☐OUI ☐NON

→si Oui, s'est-il arrêté de téter après quels jours ? _____

REMARQUES :

_____

_____

_____

_____

_____

SURVEILLANCE SANITAIRE ET DEMOGRAPHIQUE DANS LES DISTRICTS DE BAMBEY, MBOUR RT FATICK

DISTRICT : _____   POSTE DE SANTE : _____
VILLAGE : _____   CONCESSION : |__|__|__|__| _____
MENAGE : |__|__|__|__| _____

FICHE ARRIVEE (Rounds 1-2-3)

Enquêteur : |__|__| _____

Date de Visite: __|__/__|__/__|__|__|__/

Répondant : |__|__|__|__|__|__|__| _____

Identité : |__|__|__|__|__|__|__| _____

Sexe : |___| Date de Naissance : __|__/__|__/__|__|__|__/
Date d'Arrivée : |__|__|__|__|__|__|__|__|
Provenance : _____

Motif : |___| _____

Mère : |__|__|__|__|__|__|__| _____

Père : |__|__|__|__|__|__|__| _____

Lien avec Chef de Ménage : |___| _____

Religion : |___|

Ethnie: |___|

Situation matrimoniale : |___|

Niveau d'instruction : |___|

Grossesse : |___| Si Femme 12 à 54 ans

Hospitalisation : |___| Si moins de 10 ans

Vaccins reçus : Si mons de 10 ans

|_____| __|__/__|__/__|__|__|__/ |_____| __|__/__|__/__|__|__|__/ |_____|
__|__/__|__/__|__|__|__/

|_____| __|__/__|__/__|__|__|__/ |_____| __|__/__|__/__|__|__|__/ |_____|
__|__/__|__/__|__|__|__/

Moustiquaire :   Moust.Presence   Intact   MILDA Utilisation lieu de procuration

                    |_____| |_____| |_____| |_____| |_____ |

Résidence antérieure dans la zone : |___| 1=Oui 2=Non

Si OUI , dans quelle localité ? _____

SURVEILLANCE SANITAIRE ET DEMOGRAPHIQUE DANS LES DISTRICTS DE BAMBEY, MBOUR RT FATICK

DISTRICT   :   _____   POSTE DE SANTE :
_____   VILLAGE   :   _____   CONCESSION
: |__|__|__|__| _____
MENAGE   : |__|__|__|__| _____

FICHE DEPART(Rounds 1-2-3)

Enquêteur : |__|___| _____

Date de Visite: __|__/__|__/__|__|__|__/

Répondant : |__|__|__|__|__|__|__| _____

Identité : |__|__|__|__|__|__|__| _____

Sexe : |___| Date de Naissance : __|__/__|__/__|__|__|__/
Date de départ : |__|__|__|__|__|__|__|__|
Destination : _____

Motif : |___| _____

Mère : |__|__|__|__|__|__|__| _____

Père : |__|__|__|__|__|__|__| _____

Lien avec Chef de Ménage : |___| _____

Religion : |___|

Ethnie: |___|

Situation matrimoniale : |___|

Niveau d'instruction : |___|

Grossesse : |___| Si Femme 12 à 54 ans

Hospitalisation : |___| Si moins de 10 ans

Birth Form

```
DISTRICT   :  _____           POSTE DE SANTE :
_____  VILLAGE   :  _____   CONCESSION
: |__|__|__|__| _____
MENAGE      :  |__|__|__|__| _____
```

FICHE NAISSANCE OU MORT-NE (Rounds 1-2-3)

Enquêteur : |__|___| _____

Répondant : |__|__|__|__|__|__|__| _____

Date de Visite: |__|__|__|__|__|__|__|__|

Enfant : : |__|__|__|__|__|__|__| _____

Sexe : |___| Date de Naissance : |__|__|__|__|__|__|__|__|

Mère : |__|__|__|__|__|__|__| _____

Père : |__|__|__|__|__|__|__| _____

L'enfant a crié ou respiré à la naissance : |___| 1=Oui 2=Non

Multiplicité : |___| 1=Simple 2=Jumeaux 3= Triplés

Lieu de Naissance : |___| 1=Domicile 2=Structure de santé

Lien avec Chef de Ménage : |___| _____

Religion : |___|

Ethnie: |___|

Hospitalisation : |___| Depuis la naissance

Vaccination : |_____| ____ /____/_____ Depuis la naissance

Moustiquaire :   Moust.Presence   Intact   MILDA   Utilisation

                  |_____| |_____| |_____| |_____|

Death form

DISTRICT   :   _____   POSTE DE SANTE :
_____ VILLAGE   : _____   CONCESSION
: |__|__|__|__| _____
MENAGE   : |__|__|__|__| _____

FICHE DECES (Rounds 1-2-3)

Enquêteur : |__|___| _____

Répondant : |__|__|__|__|__|__|__| _____

Date de Visite: |__|__|__|__|__|__|__|__|

Id Prénom et Nom : |__|__|__|__|__|__|__|
_____

Sexe : |___| Date de Décès : |__|__|__|__|__|__|__|__|

Mère : |__|__|__|__|__|__|__| _____

Père : |__|__|__|__|__|__|__| _____

Causes éventuelles   Lieu

Hospitalisation : |___|

Arrival-birth-death-departure forms updated

SYSTEME DE SURVEILLANCE DEMOGRAPHIQUE
DANS LES DISTRICTS DE BAMBEY, MBOUR ET FATICK
FICHE ARRIVEE Round6

Section 1 - Informations sur le ménage

District: ☐☐☐☐☐☐☐   Num PS: ☐☐

Poste de santé: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Num Village: ☐☐☐☐   Village: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Code Concession: ☐☐☐☐☐☐   Nom Chef Concession: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

ID Menage: ☐☐☐☐☐☐   Nom du chef de Ménage: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Code Enquêteur: ☐☐☐   Initiale Enquêteur ☐☐☐   Date de Visite : ☐☐ / ☐☐ / ☐☐☐☐   [jj/mm/aaaa]

ID Répondant ☐☐☐☐☐☐   Nom Répondant: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Section 2 - Informations sur le nouvel arrivant

ID de l'individu: ☐☐☐☐☐☐   Nom et Prénom de l'individu: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Sexe: ○ Masculin (1)   ○ Féminin (2)   Provenance: ☐☐☐☐☐☐☐☐☐☐☐☐☐

Date Naissance: ☐☐ / ☐☐ / ☐☐☐☐   précision date naiss: ☐ mois près(1)   ☐ année près(2)

Date arrivée: ☐☐ / ☐☐ / ☐☐☐☐   précision date arrivee: ☐ mois près(1)   ☐ année près(2)

Motif arrivée: ○ Changement d'adresse (62)   ○ Immigration (64)

Motif arrivée: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

ID Mère: ☐☐☐☐☐☐   Nom Mère: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Code lien CM: ☐☐   Lien CM: ☐☐☐☐☐☐☐☐☐☐

Religion: ☐☐   Ethnie: ☐☐   Situation matrimoniale: ☐☐   Niveau Instruction: ☐☐

Grossesse: ☐ Oui(1)   ☐ Non(2)   ☐ Ne sait pas(9)   Hospitalisation: ☐ Oui(1)   ☐ Non(2)   ☐ Ne sait pas(9)

Moust.Présence: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)   Intact: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)   MILDA: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)

Utilisation: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)   Lieu procuration ☐☐☐☐☐☐☐☐

BCG: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)
Date BCG: ☐☐ / ☐☐ / ☐☐☐☐

Penta: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas (9)
Date Penta: ☐☐ / ☐☐ / ☐☐☐☐

DTC/Polio: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas (9)
Date DTC Polio: ☐☐ / ☐☐ / ☐☐☐☐

Fièvre jaune : ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas (9)
Date Fièvre Jaune: ☐☐ / ☐☐ / ☐☐☐☐

Rougeole : ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas (9)
Date Rougeole: ☐☐ / ☐☐ / ☐☐☐☐

Autre vaccin : ☐ Oui(1) ☐ Non(2) ☐ NSP(9)
Date autre vaccin: ☐☐ / ☐☐ / ☐☐☐☐
Autre Vaccin Precisez: ☐☐☐☐☐☐☐☐☐☐☐

Résidence antérieure dans la zone: ☐ Oui(1)   ☐ Non(2)   ☐ Ne sait pas (9)

Si oui, dans quelle localité ? ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

fiche collectée lors du round passé : ☐ oui   ☐ non

27/05/2014   ARRIVEE_R6_2014   Form ID: 36904

SYSTEME DE SURVEILLANCE DEMOGRAPHIQUE
DANS LES DISTRICTS DE BAMBEY, MBOUR ET FATICK
FICHE DEPART Round6
Questionnaire à appliquer en cas de départ d'une personne présente lors du dernier passage
Ces informations sont confidentielles

Section 1 - Informations sur le ménage

District: ⬜⬜⬜⬜⬜⬜   **Num Poste:** ⬜⬜

Poste de santé: ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Num Village: ⬜⬜⬜⬜   **Village:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Code Concession: **Nom Chef Concession:**

⬜⬜⬜⬜⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

ID Menage: **Nom du chef de Ménage:**

⬜⬜⬜⬜⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Code Enquêteur ⬜⬜   **Initiale Enquêteur:** ⬜⬜⬜

ID Répondant   **Nom Répondant:**

⬜⬜⬜⬜⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Date de visite: ⬜⬜ / ⬜⬜ / ⬜⬜⬜⬜   [jj/mm/aaaa]

Section 2 - Informations sur l'individu absent

ID de l'individu: **Prénom et Nom de l'individu:**

⬜⬜⬜⬜⬜⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Sexe: ◯ Masculin (1)   ◯ Féminin (2)

Date Naissance: ⬜⬜ / ⬜⬜ / ⬜⬜⬜⬜   **précision date naiss:** ⬜ mois près(1)   ⬜ année près(2)

Date Départ: ⬜⬜ / ⬜⬜ / ⬜⬜⬜⬜   **précision date naiss:** ⬜ mois près(1)   ⬜ année près(2)

Destination: ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Type de départ: ◯ Changement d'adresse (61)   ◯ Emigration (63)

Motif départ: ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

ID Mère: **Nom Mère:**

⬜⬜⬜⬜⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

ID Père: **Nom Père:**

⬜⬜⬜⬜⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Lien CM:

Code lien CM: ⬜⬜   ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Religion: ⬜⬜   **Ethnie:** ⬜⬜   **Situation matrimoniale:** ⬜⬜   **Niveau Instruction:** ⬜⬜

Grossesse: ⬜ Oui(1)   ⬜ Non(2)   ⬜ Ne sait pas(9)   **Hospitalisation:** ⬜ Oui(1)   ⬜ Non(2)   ⬜ Ne sait pas(9)
(Si femme de 12 à 54 ans)   (Si moins de 10 ans)

fiche collectée lors du round passé : ⬜ oui   ⬜ non   59799

**SYSTEME DE SURVEILLANCE DEMOGRAPHIQUE
DANS LES DISTRICTS DE BAMBEY, MBOUR ET FATICK**

FICHE DECES Round6

Questionnaire à appliquer en cas de décès (même pour les enfants décédés à l'accouchement)
Ces informations sont confidentielles

Section 1 - Informations sur le ménage

District: ⬜⬜⬜⬜⬜⬜ **Num Poste:** ⬜⬜

Poste de santé: ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Num Village: ⬜⬜⬜⬜ **Village:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Code Concession: ⬜⬜⬜⬜⬜⬜ **Nom Chef Concession:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

ID Menage: ⬜⬜⬜⬜⬜⬜ **Nom du chef de Ménage:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Code Enquêteur ⬜⬜ **Initiale Enquêteur:** ⬜⬜⬜

ID Répondant ⬜⬜⬜⬜⬜⬜ **Nom Répondant:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Date de Visite: ⬜⬜ / ⬜⬜ / ⬜⬜⬜⬜ [jj/mm/aaaa]

Section 2 - Informations sur l'individu décédé

ID de l'individu décédé: ⬜⬜⬜⬜⬜⬜⬜ **Nom et prénom de l'individu décédé:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Sexe: ◯ Masculin (1)   ◯ Féminin (2)

Date Naissance: ⬜⬜ / ⬜⬜ / ⬜⬜⬜⬜ [jj/mm/aaaa]   **précision date naiss:** ⬜ mois près (1)   ⬜ année près (2)

Date décès: ⬜⬜ / ⬜⬜ / ⬜⬜⬜⬜ [jj/mm/aaaa]   **précision date décès:** ⬜ mois près (1)   ⬜ année près (2)

Quel âge avait-il à son décés? *(ne calculez pas)*
(en année si >12 mois; en mois si < 12; en jours si < 28 jrs;)   ⬜⬜ [age en année]   ⬜⬜ [age en mois]   ⬜⬜ [age en jours si enfant de moins d'un mois]

ID Mère: ⬜⬜⬜⬜⬜⬜ **Nom Mère:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

ID Père: ⬜⬜⬜⬜⬜⬜ **Nom Père:** ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Causes éventuelles décès: ⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜⬜

Lieu de décès: ⬜ Structure de sante (1)   ⬜ Maison (2)   ⬜ Autres (3)

Hospitalisation: ⬜ Oui (1)   ⬜ Non (2)   ⬜ Ne sait pas (9)   (cocher la bonne réponse)

fiche collectée lors du round passé : ⬜ oui   ⬜ non

21275

SYSTEME DE SURVEILLANCE DEMOGRAPHIQUE DANS LES DISTRICTS DE BAMBEY, MBOUR ET FATICK
FICHE NAISSANCE OU ISSUE DE GROSSESSE Round6

Section 1 - Informations sur le ménage

District: ⬚⬚⬚⬚⬚⬚⬚   **Num Poste:** ⬚⬚

Poste de santé: ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Num Village: ⬚⬚⬚⬚⬚   **Village:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Code Concession: ⬚⬚⬚⬚⬚   **Nom Chef Concession:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

ID Menage: ⬚⬚⬚⬚⬚   **Nom du chef de Ménage:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Code Enquêteur ⬚⬚   **Initiale Enquêteur:** ⬚⬚⬚   **Date de visite:** ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚ [jj/mm/aaaa]

ID Répondant ⬚⬚⬚⬚⬚   **Nom Répondant:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Section 2 - Informations sur l'enfant

ID de l'enfant: | 2 | 4 | 3 | 0 | 4 | 1 | 0 | **Nom et Prénom de l'enfant:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Sexe: ◯ Masculin (1)   ◯ Féminin (2)   [jj/mm/aaaa]

Date Naissance: ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚   **précision date naiss:** ☐ mois près(1)
                                           ☐ année près(2)

L'enfant a crié ou respiré à la naissance ou a montré un signe de vie : ☐ Oui(1)   ☐ Non(2)   ☐ Ne sait pas(9)

Si non : Mort-Né / Avortement : ☐ Avortement(1): (durée grossesse <24 semaines)   Si Oui (en vie): ☐ En vie (1)
                            ☐ Mort-né(2): durée de la grossesse >= 24 semaines   ☐ Ne sait pas(9)
                            ☐ Ne sait pas(9)

Multiplicité : ☐ Simple(1) ☐ Jumeaux(2) ☐ Triplés(3) ☐ Ne sait pas(9)   **Lieu de Naissance:** ☐ Domicile(1) ☐ Structure de santé(2) ☐ Autres(9)

ID Mère: ⬚⬚⬚⬚⬚   **Nom Mère:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

ID Père: ⬚⬚⬚⬚⬚   **Nom Père:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Code lien CM: ⬚⬚   **Lien CM:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Religion: ⬚⬚   **Ethnie:** ⬚⬚   **Hospitalisation depuis la naissance:** ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)

Moust.Présence: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)   **Intact:** ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)   **MILDA:** ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)

Utilisation: ☐ Oui(1) ☐ Non(2) ☐ Ne sait pas(9)   **Lieu procuration:** ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚

Carnet vaccination vu : ☐ Oui(1) ☐ Non(2)

vaccin1: ⬚   **vaccin2:** ⬚   **vaccin3:** ⬚
Date vaccin 1: ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚   **Date vaccin 2:** ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚   **Date vaccin 3:** ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚

vaccin4: ⬚   **vaccin5:** ⬚   **vaccin6:** ⬚
Date vaccin 4: ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚   **Date vaccin 5:** ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚   **Date vaccin 6:** ⬚⬚ / ⬚⬚ / ⬚⬚⬚⬚

fiche collectée lors du round passé : ☐ oui ☐ non

23/01/2015   NAISSANCE_R6_2014_v2   Form ID:43601

Pre-printed information: Dss Form updated

Ministère de la Santé et de la Prévention • Université Cheikh Anta Diop • IRD
Surveillance Sanitaire et Démographique dans les districts de Bambey, Mbour et Fatick

District	Poste de santé	Village / Quartier:	Hameau:	ID Nom et Prénom du Répondant
BAMBEY	BABA GARAGE	BABA GARAGE		_____ / _____

N° Concession	N° Ménage	Nbre Ménage	Nom chef concession	Nom chef ménage	Nom et Prénom de l'Enquêteur
0001 01	M-13101	1	SAMBA FALL	SAMBA FALL	_____

Date Visite: |__ /__ /__

Nom:	Date de naissance:	ID:	Sexa:	Lien:	Ethnie:	Situation matrimoniale:	Religion:	Niveau d'instruction:
SAMBA FALL	15/06/1942	258844	M	Chef Ménage (CM)	Wolof	Marié(e) Monogame	Musulman	Primaire

RESIDENT ☐ |__ /__ /__ Lieu _____

MOUSTIQUAIRE: ☐ INTACT: ☐ MILDA: ☐ UTILISE: ☐

Info DSS1   RESIDENT   1

Dernière classe fréquentée:

GORA FALL	15/06/1987	258850	M	vivant d'une mère/d'un père décédé(e)	Wolof	Célibataire	Musulman	Primaire

RESIDENT ☐ |__ /__ /__ Lieu _____

MOUSTIQUAIRE: ☐ INTACT: ☐ MILDA: ☐ UTILISE: ☐

Info DSS1   RESIDENT   1

Dernière classe fréquentée:

THIERNO FALL	15/06/1985	258860	M	vivant d'une mère/d'un père décédé(e)	Wolof	Marié(e) Monogame	Musulman	Pas été à l'école

RESIDENT ☐ |__ /__ /__ Lieu _____

MOUSTIQUAIRE: ☐ INTACT: ☐ MILDA: ☐ UTILISE: ☐

Info DSS1   RESIDENT   1

Dernière classe fréquentée:

IBRAHIMA FALL	15/06/1982	258866	M	vivant d'une mère/d'un père décédé(e)	Wolof	Célibataire	Musulman	Pas été à l'école

RESIDENT ☐ |__ /__ /__ Lieu _____

MOUSTIQUAIRE: ☐ INTACT: ☐ MILDA: ☐ UTILISE: ☐

Info DSS1   RESIDENT   2   15/12/2008

Dernière classe fréquentée: