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UNIVERSITY OF THE WITWATERSRAND

FACULTY OF MEDICINE

SCHOOL OF PUBLIC HEALTH

RESEARCH REPORT

DETERMINANTS OF VACCINATION COVERAGE AMONG CHILDREN AGED 12-23 MONTHS IN RURAL KWAZULU-NATAL

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Masters in Science (Medicine) in Population - based Field Epidemiology

JULY 2008

DECLARATION

I, James Nganga Ndirangu declare that this research report is my own work. It is being submitted for the degree of Master of Science in Medicine in the field of Population – Based Field Epidemiology in the University of Witwatersrand, Johannesburg. It has not been submitted before any degree or examination at this or any other University.

Signature: _____

Full Name: James Nganga Ndirangu

15th day of April, 2008

DEDICATION

This work is dedicated to my lovely mother, Jane Thairu, for her prayers throughout my stay away from home.

I also dedicate it to Grace Wambui, my wife, who has supported me throughout my study period.

ABSTRACT

To evaluate the impact of maternal HIV-infection on routine childhood immunization coverage, comparison was made on the immunization status of children born to HIV-infected and HIV-uninfected women in rural KwaZulu Natal. The study population was all children enrolled in the routine demographic surveillance system as at 31st December 2005 (n=18,171) in Africa Centre Demographic Surveillance Area. Sampling of subjects was done based on the dates of birth that were between the period 1st Jan 2004 and 31st December 2005 (n=2,020). This was further divided based on maternal HIV status namely; 236 HIV (+), 777 HIV (-) and 1,007 HIV (unknown). The main outcome measure was the percent of complete routine childhood immunizations recommended by the WHO as assessed from the Road-to-Health cards or maternal recall during household interviews. For all vaccines, children born to HIV-infected mothers had lower immunization coverage than children born to HIV-negative mothers (78.21% vs. 86.52%). The children of mothers who were HIV-infected were 31-55% (*P*-value <0.020) less likely to be immunized compared to children of mothers who were HIV-uninfected.

We conclude that maternal HIV-infection is associated with childhood under immunisation. VCT health workers should encourage HIV-infected mothers to complete childhood immunization. Improving access to immunization services could benefit vulnerable populations such as children born to HIV-infected mothers.

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DEFINITION OF TERMS

APGAR score- a simple and repeatable method to quickly and summarily assess the health of newborn children immediately after childbirth. It is determined by evaluating the newborn baby on five simple criteria on a scale from zero to two and summing up the five values thus obtained.[1]

Resident members – Are members of the households within the Africa Centre DSA who have been residing within those households for a period exceeding four months. [49]

Primary road - a road that forms the major routes between the major urban centres.[48] In the South African context, it is known by as N-series.

Mobile clinic points– Designated points throughout the district (e.g. primary schools, shopping centers, churches etc) that are visited twice monthly by a mobile clinic. The services offered during this visits are; family planning services, child immunization, antenatal care and treatment of chronic illnesses. [48]

ACRONYMS AND ABBREVIATIONS

BCG Bacillus Calmette Guerin

OPV Oral Polio Vaccine

DTP Diphtheria Tetanus Pertusis

DSA Demographic Surveillance Area

ACDIS Africa Centre Demographic Information System

DHS Demographic Health Survey

GIS Geographic Information System

EPI Expanded Programme on Immunization

WHO World Health Organization

UNICEF United Nations International Children's Emergency Fund

CHF Child Health Form

ARV Anti-retroviral

VCT Voluntary Counseling and Testing

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

In this chapter, background information including the importance and general coverage of vaccination is reviewed. The problem statement and justification for the study is explained. The published literature on the possible determinants of vaccination coverage is reviewed and the chapter ends by describing the aims and objectives of the study.

1.1 Background information

The Expanded Programme on Immunization was started in 1974 by WHO/UNICEF for less developed countries. It was called "expanded" for two reasons. First, polio and measles vaccines were added to BCG and DTP vaccines. Second, the proportion of children in developing countries who were immunized was substantially increased.[2] Immunization has led to spectacular reductions in mortality in both developed and developing countries.[3] Vaccines, which protect against disease by inducing immunity around the world, are widely and routinely administered based on the common-sense principle that it is better to prevent people from falling ill than to treat them once they do. Suffering, disability and preventable death are avoided.

It is estimated that immunization averted about two million deaths of infants in 2003 as well as an additional 600,000 hepatitis-B related deaths that would have occurred in adulthood (from cirrhosis and cancer).[4] Routine immunization is now provided in developing countries and many parts of sub-Saharan Africa against Measles, Polio, Diphtheria, Tetanus, Pertussis, Hepatitis-B and Tuberculosis. The global coverage of infants in 2004 with 3 doses of DTP

vaccine was 78%, 3 doses of polio vaccine 80% and one dose of measles 76%. Further, by 2004, a total of 153 countries had integrated Hepatitis-B vaccination.[5]

The use of conjugate vaccines for the prevention of *Haemophilus influenza* type b (Hib) disease in children has substantially decreased the burden of disease in developing countries.[6,7,8] However, they are not used in some developing countries due to their high cost and because Hib remains under-recognized as a cause of severe disease and death.[9] South Africa was the first country in Africa to self-finance and incorporate the Hib vaccine into its routine child immunization schedule from July 1999.[10] Since its incorporation, the number of Hib cases, among children below one year of age decreased by 65%, from 55 cases in 1999-2000 to 19 cases in 2003-04. This is based on the number of cases reported to the national surveillance system [11]

The national vaccination status schedule in South Africa includes BCG, OPV, DTP, Hib, Hepatitis B and Measles vaccine. These vaccines are provided free of charge at local clinics and community health centers in South Africa. All children have a right to basic health care, of which immunization is one of the components. The Expanded Programme on Immunization in South Africa aims for 90% full immunization coverage amongst children at 1 year of age. According to the 2003 statistics, the routine immunization coverage was 82%, which was above the WHO recommendation for routine immunization coverage of 80%.[12] The routine vaccination schedule in South Africa for children's first year of life is shown in the table below:

Table 1: National vaccination schedule for children under 1 year of age in South Africa

Age	**Vaccine**
Birth	BCG, Polio0
6 weeks	Polio1, DTP1, HepB1, Hib1
10 weeks	Polio2, DTP2, HepB2, Hib2
14 weeks	Polio3, DTP3, HepB3, Hib3
9 months	Measles

Immunization is a proven tool for controlling and even eradicating disease. However, the determinants of vaccination coverage are thought to vary with different settings, for instance, across social groups, distance traveled to health care facilities, distance traveled to transport infrastructure, maternal HIV status or with varying maternal education level. Thus, it is imperative to examine these factors that determine vaccination coverage so as to advocate for interventions that will increase childhood vaccination coverage.

This study assessed the vaccination coverage and the determinants of this coverage in rural KwaZulu-Natal (Hlabisa district). However, for data reasons, we could not include vaccination against *Haemophilus influenza* type b (Hib), which may also prevent a relatively large number of childhood deaths. [13]

1.2 Problem statement

Routine child vaccination has been known to reduce infant mortality by preventing diseases. However, a previous study conducted in Hlabisa health district indicated that 76% of children had received all the vaccines due to a 12-month-old child, and 78% of these had received all

doses by 12 months of age.[14] The study aims at investigating why some children were vaccinated while others were not in an area served by Africa Centre.

1.3 Justification

Vaccination coverage rates are accepted as an indicator of the performance and adequacy of primary paediatric health care services[15] and are also a useful tool in program management and decision making.[16] Vaccination coverage has been shown to be primarily hampered by difficulty in assessing primary care, complex transport requirements and by user characteristics, such as parental education, late birth order, household structure and socio-economic status in other rural areas.[17,18,19] A clear understanding of these factors will assist in strengthening the primary paediatric health care services in the Africa Centre Demographic Surveillance Area (DSA) which also has a high HIV prevalence (40%) among mothers attending prenatal clinics.[20]

1.4 Hypothesis

- There is no difference in vaccination coverage by maternal HIV status.
- There is no difference in vaccination coverage by distance from the household to the nearest fixed clinic, mobile clinic point and primary road.

1.5 Literature review

Infant mortality has traditionally been viewed as an indicator of the social and economic well-being of a society. It reflects not only the magnitude of those health problems which are directly responsible for the death of infants but the effect of a multitude of other factors,

including prenatal and post-natal care of mother and infant, and the environmental conditions to which the infant is exposed.[21] Due to the association between child immunization and child survival[4], a large component of the factors affecting child survival also affect child immunisation for instance maternal HIV status, maternal education level, access to health care facility, socio-economic status of the household where the child is brought up among others.

Maternal HIV Status

A previous study conducted in Rakai District, Uganda showed that the percent coverage for all childhood vaccines was lower among children born to HIV-infected mothers than children born to HIV-uninfected mothers. The difference was greatest for measles and DTP3, with coverage being 7% lower for children of HIV-infected mothers.[22] Coverage was also affected by whether a mother had knowledge of her HIV status. The odds of being under immunized, for children of both HIV-infected and HIV-uninfected mothers who did not know their status, increased to 1.56 (95% CI 0.86-2.83) & 1.68 (95% CI 1.07- 2.63) respectively, while the odds of children born to HIV-infected women who knew their status was doubled to 2.21 (95% CI 1.14-4.29). This implies that the risk of under immunization increases not only with HIV-infection but also with the knowledge of maternal HIV status. This could be due to the fact that women who are HIV-infected tend to change their health seeking behaviour when they know their HIV-status and this may negatively affect their child's heath. The impact of learning about their HIV-infection may cause psychological effects like depression which have a direct effect on their child-care.

Maternal Education

Widespread awareness of the importance of mother's education on their children's health is commonplace in research. For instance, Caldwell argued that maternal education is the single most significant determinant of child health and child mortality and no other factor has such impact. Maternal education cannot thus be employed as a proxy for general social and economic change but must be examined as an important factor in its own right.[23]

Some possible links and pathways that result in greater utilization of modern health services are; education is associated with greater knowledge of the protective functions of child immunization and greater awareness of proper immunization schedules.[24] Schooling equips women with special skills and dispositions that significantly predict the use of medical services and changes in household health behaviour.[25] Potential health benefits from delayed and lower fertility among an educated woman enable greater investments in the child.[26] Finally, education endows a woman with the ability to access relevant health services, interact effectively and assimilate information relating to family planning, prenatal care, childhood immunizations and nutritional needs.[27]

Distance to health care facility

Geographic accessibility can be measured by the following factors: the physical separation that limits contact, represented as Euclidean distance; distance along a road network; travel time or travel costs.[28] Stronger associations have been found with road distance and estimated travel time than with Euclidean distance.[29] Further, there is a cogent argument that Euclidean distance is a sub-optimal measure of isolation since it ignores physical barriers such as rivers, swamps, hills, road and traffic system and socio-cultural factors. These can greatly influence the actual distance traveled.[30]

Travel time models have some limitations when compared to actual distances travelled. Travel time assumes ubiquitous coverage of public transport which is unlikely in a rural setting. It is usual to wait hours for another bus or taxi. Similarly, it assumes public transport is used on average behaviour while this differs from area to area. Further, travel time differs with age and sex. These individual factors are not accounted for in travel time.[28]

Distance to the clinic, a proxy measure of accessibility, has been found to affect immunization coverage in 2006 in Kenya[31]. Close proximity to the clinic was also associated with an increased likelihood of vaccination, with immunization coverage declining with increasing distance from vaccination clinics in Egypt[32] and in Pakistan.[33] A possible explanation of this could be that visibility of a clinic may attract a parent's attention and/or act as a reminder to the parent of the immunization status of the child.

A study that investigated the accessibility and utilization of clinics in Hlabisa district, rural South Africa showed that the mean travel time to the nearest clinic is 77 min (median 81 min) and that 64.8% of the homestead travel at least one hour to attend a clinic. Compared with other districts in South Africa and Africa, this suggests that patients in the district travel 80% longer than the reported provincial coverage and that the proportion of the population who live in the vicinity of more than one hour travel time to health care facility is double the national rural average.[28]

Travel time to clinic is only a proportion of the total time expenditure in getting health care. Studies in South Africa measure the time taken to receive a treatment as 42 minutes[34] and estimate that 35% of patients wait for an hour or more to receive primary health care.[35] Other studies in Africa show that people spend more time waiting to receive treatment than

travelling to clinic with an average waiting time of 150-160 minutes.[36] Travel time becomes an indicator of vaccination coverage because where the majority of mothers/caregivers have to make a journey to a health facility, they may prefer more accessible alternate sources of child care.

Urban-rural differentials

Urban-rural differences in vaccination coverage have been previously observed in Niger and Nigeria. In Niger, only 1 in 10 rural children have received all the eight immunizations compared to half of urban children while the overall vaccination coverage levels in rural areas are less than half of those for urban children for BCG and measles. Further, due to higher drop out rates from the health system in rural areas in Niger, coverage levels for the third dose of DPT and polio are less than one-quarter of the rates seen in urban areas.[37] In Nigeria, rural-urban differences in vaccination coverage, though marked, are not as large as those seen in Niger. In the case of BCG and measles vaccines, rural coverage levels are about two-thirds of the levels in urban areas.[33] In Eastern Turkey, measles vaccination was found to be higher in urban regions than suburban and rural regions.[38]

Socio-economic status

Previous studies have shown that socio-economic status of the family play an important role in determining vaccination compliance with higher socio-economic status being associated with higher rate of vaccination.[39,40] In Bangladesh, children of relatively better-off households (owning 4-6 household articles) had an 80% higher chance of being fully immunized compared to the economically disadvantaged group (owning at most one household article).[41] This may be due to the fact that children who are poor are hardest to reach by the health

services and parents may encounter more barriers to reach them compared to those of better socio-economic status. However, other studies have found no difference in vaccination rates with respect to socio-economic status.[18, 34]

Other factors

Sex discrimination in child immunization has been found to exist in rural Bangladesh with female children being 30% less likely to be fully vaccinated compared to male children.[41] Similar findings have been reported in other studies. [42,43]

Marital status of the mother has been found to play an important role in predicting child health in developing countries. [44,45] In Central Asia, the risk of under vaccination for children of unmarried mothers was 70% higher than for married mothers.[40] This may be due to the fact that in many societies, marriage provides a better social life which may be associated with better child health.

CHAPTER 2: METHODOLOGY

2.1 Study aims and objectives

Primary objective

The main aim of this study was to investigate why some children are vaccinated while others are not.

Secondary objective

1. To determine the vaccination coverage among children aged 12-23 months in the Africa Centre Demographic Surveillance Area (DSA).

2. To investigate whether maternal HIV status influences vaccination coverage in children aged 12-23 months when controlling for maternal age, maternal education, household wealth, the child's sex, birth order, and the distance from the household to the nearest fixed clinic, mobile clinic point and primary road.

2.2 Research design

This was an analytical cross-sectional study of children recruited and followed up from 1st January 2000 to 31st December 2005. The study utilized primary data collected twice per year at Africa Centre DSA.

2.3 Study area and study population

Hlabisa health sub-district is located within the rural district of Umkhanyakude in northern KwaZulu Natal (Appendix 1), covering an area of 1,430 km^2. The sub-district is about 250 km

north of the city of Durban (the third largest city in South Africa). Since 1998, the Africa Centre for Health and Population studies has maintained a Demographic Information System (ACDIS) in KwaZulu-Natal, the largest province South Africa, stretching from the southern borders of Swaziland and Mozambique to the Eastern Cape border in the south. Its headquarters are located near Mtubatuba in Hlabisa sub-district. Births, deaths, migrations, marriages, and socioeconomic status are recorded on some 11,000 households in a 438 square kilometer area of the Hlabisa sub-district. The total population surveyed was approximately 90,000 Zulu speaking people, of whom 3.3% were located in a formal urban township (KwaMsane), 19.9% in peri-urban areas (informal settlements with a population density of more than 400 people per km^2), and the remaining 76.8% were classified as living in a rural area.[46] The rural population lives in scattered homesteads that are not concentrated in villages or households, as is the case in many parts of Africa.

The community, like many others in the province of KwaZulu Natal is in the throes of an unprecedented health crisis, with HIV prevalence close to 40 percent in women attending prenatal clinics.[20] In the sub-district, there is a central community hospital and 13 fixed clinics which provide the bulk of the primary health care in Hlabisa. In addition, 30 mobile clinic points are visited twice monthly, and 130 community health workers are each expected to visit regularly a group of assigned homesteads.[47] To access primary health care, two-thirds of the population walks to clinics, while the remaining one-third uses public transport. A negligible number (0.4 %) use their own transport to access care.[48]

The whole population of children, born between 1st Jan 2000 and 31st Dec 2005, in the 11,000 households in the Demographic Surveillance System, was included. The age group was chosen because the WHO recommends that if vaccination coverage is to be investigated, the children

should be older than 11 months of age. This is because by this age, they have received all the vaccines that are due to them in their first year of life.

Secondly, this was consistent with other surveys on vaccination and more so with the DHS. Thus comparisons between the Demographic Surveillance Area with provincial results and also other studies done in different countries could be done.

2.4 Sample size

The sample included all children born between 1st Jan 2004 and 31st Dec 2005, in Africa Centre which totalled to 3,058 children. This was from a total of 18,171 children born between 1st Jan 2000 and 31st Dec 2005, whose vaccination information was available in the ACDIS. We could not include all the 18,171 children because data on socio-economic status and maternal HIV status information were available from the year 2004 and these were important independent variables that were explored in this study.

Out of the 3,058, 2,020 (66%) were included in the logistic regression analysis because they had complete information on the independent variables. The rest (n=1,038) were dropped because they had missing information on independent variables. For the purposes of this analysis, we categorized maternal HIV status as; HIV Positive 236 (12%), HIV Negative 777 (38%) and HIV unknown 1,007 (50%).

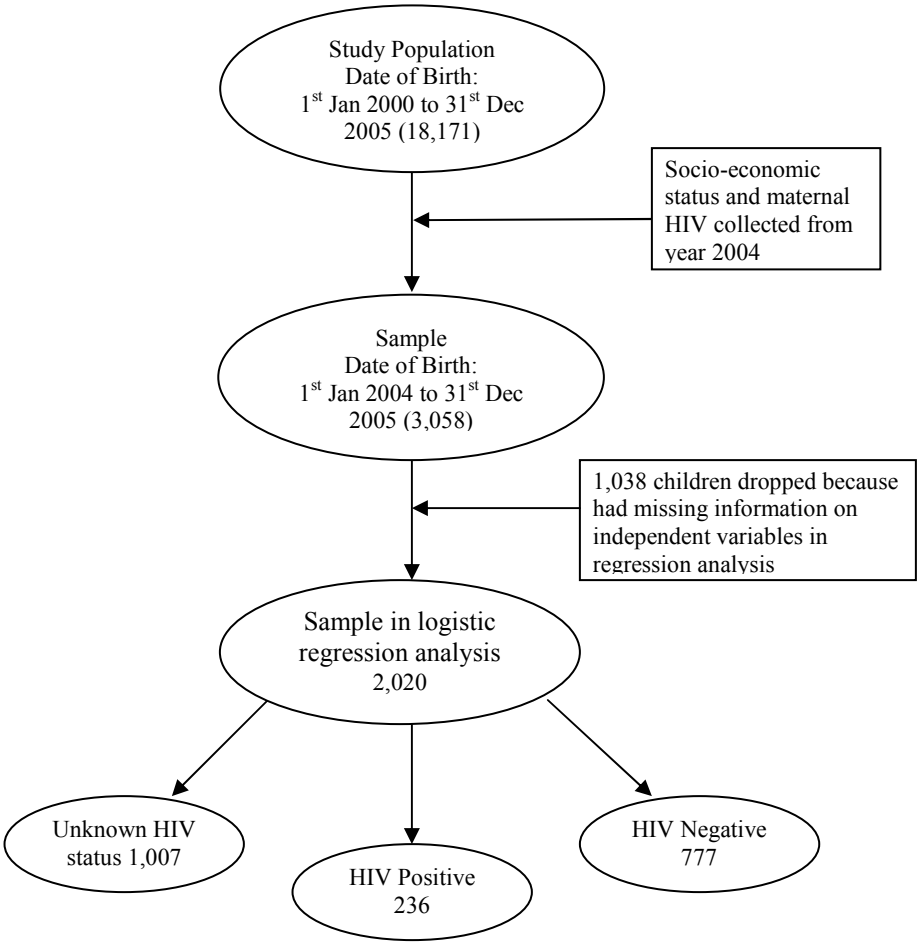

Figure 1 Summary of sampling and sample size selection

2.5 Data sources

2.5.1 Data

Data were obtained from the Africa Centre Demographic Information System (ACDIS) in South Africa. ACDIS has two separate cycles of data collection – household and individual. During the household data collection cycle, a set of questionnaires are routinely administered every six months (Table 2) to a key informant in each household.[49] Information recorded are

key attributes and events regarding physical structures, household and individuals and their relationship to each other. Additional modules administered include; household socio-economic data, individual socio-economic data and child grants. The HIV surveillance comprises part of the individual data collection cycle, undertaken annually, and requires an interview with the eligible persons due to the sensitivity of the questions.

Table 2: Data collected at each routine household visit, 2000 and ongoing

Subject	Types of information
Homestead	Latitude, longitude
	Owner
	Number of households
Household	Formation and dissolution
	Household head
Individual	Individual details: inc. date of birth, sex, parents
	Household membership(s)
Household members	Update household list: members who join, leave or die Residency status, marital and partnership status. Relationship to household head
Births	Pregnancy outcomes: abortions, still and live births. Delivery environment: inc. assistance, place birth weight, APGAR
Deaths	Location and care provision at time of death. Open description of circumstances
Migrations	Details of place of origin or destination
	Type of migration, e.g. household or individual migration
Child health	On first birthday: vaccination history

2.5.2 Immunization data

A Child Health Form (CHF) is used to collect immunization data at Africa Centre (Appendix 4). This form is only filled in for children who are between 1 year and 4 years of age and are resident in the households within the DSA.

Data on immunization has been collected annually since 2000, and once retrospectively for all children ever born between 1995 and 2000 to mothers who were residents in the ACDIS DSA in 2000. Immunization data, including the dates of immunization, are available for the following vaccines: BCG, Diphtheria-Tetanus-Pertussis (DTP), Oral Polio Vaccine (OPV), Hepatitis B (HepB) and measles vaccinations. These vaccines are the complete set of vaccines included in the South African National Childhood Immunization Schedule (Table 1), with the exception of the *Haemophilus influenzae* type B (Hib) vaccine, which has recently been added to the ACDIS data collection schedule as from January 2008.

2.5.3 HIV surveillance data

Data were used from the first round (January to December 2004) and the second round (January to December 2005) of a prospective population-based HIV survey. During data collection process (Appendix 5), teams of two trained fieldworkers visited each eligible individual in his or her household. Fieldworkers revisited households up to four times to contact absentees. If a subject no longer lived at the household, the field worker handed the case to a specially trained tracking team that made up to 10 attempts to find the individual in his or her new residence. After written informed consent, the field workers collected blood by finger stick and prepared dried blood spots for HIV testing according to the Joint United Nations Programme on HIV/AIDS (UNAIDS) and World Health Organization (WHO) Guidelines for Using HIV Testing Technologies in Surveillance.[50] HIV status was determined by antibody testing with a broad-based HIV-1/HIV-2 enzyme-linked immunosorbent assay (ELISA; Vironostika, Organon Teknika, Boxtel, the Netherlands) followed by a confirmatory ELISA (GAC-ELISA; Abbott, Abbott Park, Illinois, USA).

2.5.4 Household asset data

A household assets index is used as a measure of wealth. Household assets indices are valid proxies of wealth in rural Africa as shown by Morris and colleagues.[51] The household assets included in this analysis are: Household furnishings (Bed, sofa, table/chair), bicycle, block-maker, car, electric stove with oven, electric hot plate, electric kettle, fridge/freezer, gas cooker, lorry/tractor, motorcycle/scooter, radio, sewing machine, telephone, cellphone, television set, video cassette recorder and wheelbarrow. Wealth index was calculated from these assets using the principal component analysis method.[52] Households are categorised households as either belonging to the poorest 40%, the middle 40% or the wealthiest 20% on the assets index scale.

2.6 Measurements

Vaccination coverage

The main outcome measure was complete vaccination for children who are aged 12-23 months. The vaccinations given by the first year of life are; measles vaccine, Diptheria-Tetanus-Pertusis (DTP3), Haemophilus influenzae type B (Hib), Poliomyelitis (Polio 3), Hepatitis B (HepB3) and BCG vaccine. Each of these was treated as separate dependent variables. BCG in South Africa is given at birth and if not it is given at any other time the child is presented to the clinic. Though Polio is given at the same time with DTP, Hib & HepB (6, 10 & 14 weeks), unlike the latter, it can be administered though routine immunization or through immunization campaigns. Measles is administered much later on, at 9 months of age and it can be administered through routine immunizations or through immunization

campaigns. The age cut-off corresponding to the first birthday was chosen because WHO recommends that vaccination should be assessed for children after this age.[4] This allows a three months period for children to receive measles immunization.

To allow an appraisal of the trends in timeliness of vaccines given as children get older, four categories were used. For each vaccine, the proportion of children receiving their vaccines on/before their due dates, within 28 days after their due date, within 42 days of the due date and after 42 days of the due date were calculated. This method has been used in other rural areas of South Africa.[53]

Determinants of vaccination coverage

The determinants of vaccination included as independent variable were; maternal education, maternal HIV status, maternal age, shortest distance from the household to the health care facility (mobile/fixed), shortest distance from the household to the nearest primary road, economic status of the household (wealth index) and sex of child.

Maternal education was included because the association between a mother's education and the likelihood of her child being vaccinated is well documented.[30,33,54,55] We also included distance to health care facility because various studies have found an association between distance to health facility and vaccination coverage.[16,26,32,56] Socio economic status, measured in terms of household wealth, was included as an independent variable because children from the poorest households, who also live furthest from the health facilities, incur indirect costs (in terms of travel time to health facilities) making it difficult to avail themselves for services

that exist in the community.[16,40] Maternal HIV status was included as an independent variable because given the high HIV prevalence of women visiting prenatal clinics[43] in the study area, it was important to investigate the effect of maternal HIV status on vaccination coverage. Further, maternal HIV status has been documented to be associated with vaccination coverage.[20]

The difference between our study and the Rakai study in Uganda that investigated maternal HIV status and vaccination coverage[22] was that; the Rakai study was based on participants who visited a Voluntary Counseling and Testing (VCT) centre while our study was population-based and participants were visited in their homes by community interviewers and tested for HIV after consenting. Further, the Rakai sample included children aged 6 to 35 months of age while our sample was children aged 12-23 months of age. The Rakai study adjusted the interaction between HIV-infection and maternal knowledge of HIV status, for number of antenatal visits, knowledge that a child should complete immunization by nine months of age, belief that it is permissible to immunize a symptomatic child born to an HIV infected mother and usual immunization venue (government or other). Our study adjusted for distance to health care facility among other factors because of the general weakness associated with the HIV-related disease which makes it more difficult for the HIV-positive mother to bridge the distance to the health facility.

A mother was defined as HIV-infected if she had a positive HIV test before/at the birth of the child for which immunization was to be assessed for the purposes of this study.

Vaccination coverage was calculated based on the standard Demographic and health survey definition. The numerator was the number of children aged 12-23 months at the time of the

survey who had received specified vaccine(s), at any time before the survey, according to information from a mother Road-to-Health card or report by respondent. The mothers report was used only when no card was shown to the interviewer or there was no record of the vaccination. In the absence of both the Road-to-Health card and the mothers report, the child was treated as not having been vaccinated for the purposes of this study.

The denominator was the total number of children aged between 12-23 months at the time of the survey.

2.7 Quality control

A CHF form is only filled in for Children who are between 1 year and 4 years and are resident in the households within the DSA.

When a second visit is being made to the household, two pieces of information exist, on the case report forms of that particular household, that help avoid double filling the CHF forms.

1. Last Visit date to the household
2. Age of the children in the household.

The effect of this is that: if the age of the child at the last visit was 12 months and above, then a field worker does not bother with a CHF form. However, if the age of a child at the last visit was less that 12 months, then the field worker can find out the current age of the child, and if the child is 12 months and above, as of the second visit date, then he/she fills in a CHL form.

2.8 Data cleaning

During data cleaning, we used the premise that vaccinations were given in sequence. For instance; DTP1 - DTP2 - DTP3. We compared the dates when DTP2 was administered to ensure it was after DTP1 was given. Where the dates indicated that DTP1 was given after DTP2, we compared the dates of administration of DTP1 with those of OPV1 and HepB1, since they are administered at the same time, and made the corrections to DTP1 as appropriate. This was done across all the vaccines that are administered at the same time, namely; OPV, DTP and HepB. Secondly, we checked for the dates when OPV0 & BCG vaccines were given to ensure this was within a few days after birth or at birth.

2.9 Data processing methods and analysis

Data processing

The data were captured raw from the household interviews and hand delivered to the Data Centre. This was in the form of case report forms. Data in the center is normally captured using SQL 2000 and was then transferred to STATA 9.2 for cleaning and analysis. Data cleaning was done to check for missing values, incorrect dates, skip patterns as required by the questionnaire. This was ensured for accuracy and completeness of the data before analysis.

Data Analysis

The primary response variable was vaccination status (1=fully vaccinated; 0=partially vaccinated). Differences in proportions were compared using the chi-square or Fisher's exact tests as appropriate. Education level was dichotomized as 1-7 (primary school) years and >7 years (post primary school), as per the school life in South Africa. Maternal age was dichotomized as <25 and >25 years. Wealth index was dichotomized as poorest 40%, the

middle 40% or the wealthiest 20% on the assets index scale. These categories of relative wealth have been used in other studies in poor provinces in South Africa. [57,58]

The association between Maternal HIV status, distance to health facility, distance to primary road, maternal education level, maternal age and socio-economic status with vaccination status were examined in the bivariate analysis. For multivariate analysis, we controlled for factors that were significant in the univariate analysis in addition to factors that were not significant in the univariate but were found significant in other rural areas in the developing countries. These included maternal age, maternal education, birth order and sex of the child which appeared in all models.

Logistic regression was preferred because the independent variables were continuous and categorical in nature. Further, the dependant variable (vaccination status) was dichotomous. Sequential logistic regression was used to explore the effect of the independent variables on vaccination status. Maternal HIV status was considered to be a more important predictor variable, followed by distance to health care facility and to the primary road (model 1). The other independent variables were then subsequently adjusted for in model l and a comparison of the two models done to find out the best fit.

2.10 Ethics

The primary project was cleared by an ethics committee in KwaZulu Natal University at baseline (2000). Application for recertification is logged annually with the same Ethics committee, the last recertification being in November 2006, ethics clearance number E009/00.

Approval from the University of Witwatersrand Committee for Research on Human Subjects was also obtained; M061028. Permission was obtained from Africa Centre for the use of their dataset after filling in a data user agreement formed which was signed by my supervisor and I. Study participants were identified using their study IDs instead of their real names during data extraction. This was maintained during analysis and reporting.

For the participants in the HIV surveillance, HIV test results were obtained confidentially in a number of counselling centres which have been set up for that purpose in the survey area. A linked, anonymous voluntary HIV testing system with pre- and post-result counselling that used confidential personal pin numbers and handheld computers for result communication had been established.[49]

CHAPTER 3: RESULTS

3.1 Immunization coverage

Routine immunization coverage of five vaccinations from 2000 to 2006 is shown in Figure 3.1.1. BCG vaccine has the highest mean immunization coverage, 92.3% (95% CI 88.4-96.2), while measles vaccine is recorded the lowest mean immunization coverage, 79.1% (95% CI 76.0-82.2). Immunization coverage for the two vaccines is statistically different ($P<0.001$). This can be attributed to the time difference between administrations of the two vaccines. BCG is given at birth while measles is given much later – 9 months. Besides, babies who were not given BCG vaccine at birth are immunized whenever they are taken to the clinic during the first year or for the next immunization visit, at 6 weeks of age. This could account for BCG having the highest vaccination coverage.

All vaccinations have the highest coverage in the years 2001-2002, and then have been on the decline reaching the lowest levels in 2006. This trend is significant for OPV3 at $P=0.03$ and HepB3 at $P=0.04$ while BCG and DTP3 were at boarder line significance, at $P=0.05$ and $P=0.06$ respectively. Similar trends were observed in the national vaccination estimates as reported by UNICEF/WHO.[59]

It is noteworthy that 2068 (67.6%) of all the children sampled (n=3058) had been fully vaccinated with BCG, OPV3, DTP3, HepB3 and measles, by the end of their first year of age.

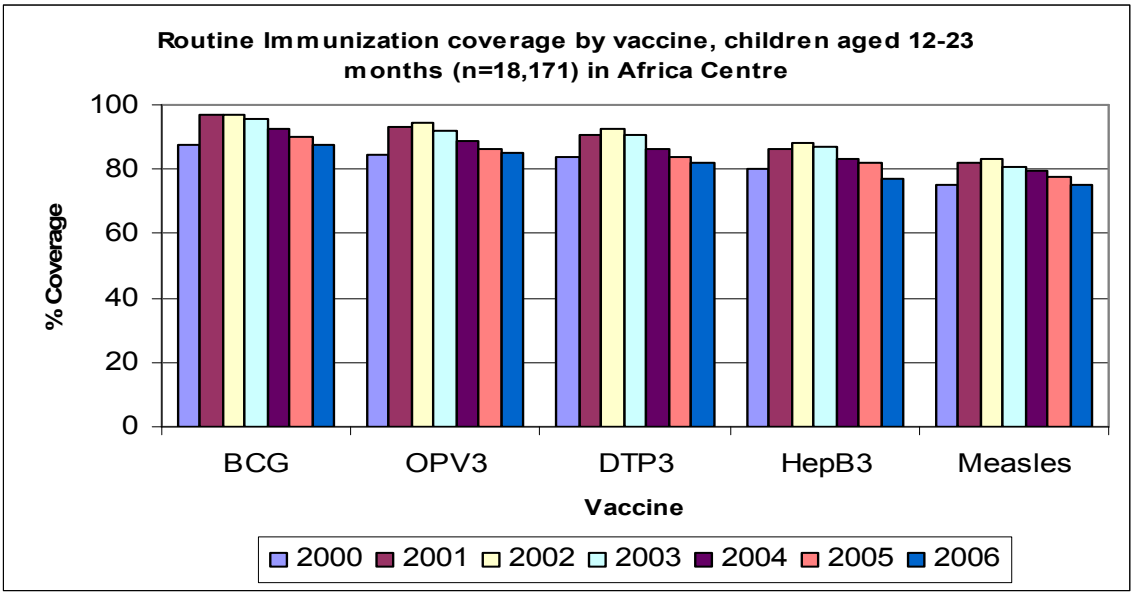

Figure 2 Percent of immunization coverage by vaccine type among children aged 12-23 months at the time of interview, Africa Centre DSA South Africa

A comparison of the mean vaccination coverage between an area served by Africa Centre and the mean national vaccination estimates, as reported by UNICEF/WHO[59], was done (Table 3). There were no significant differences observed between vaccination coverage in the Africa Centre DSA and the national estimates across all vaccines (*P*-values>0.05). Except for BCG vaccine, whose coverage was 3.9% higher in the Africa Centre DSA compared to the national estimates; all the other vaccines had lower coverage in the Africa Centre DSA than nationally (Table 3).

Table 3: Comparing the mean vaccination coverage in Africa Centre DSA and the mean national estimates for the period 2000-2006

Vaccine	DSA (%)	95% CI	National (%)	95% CI	*P*-values
BCG	92.33	88.44 – 96.22	88.43	80.86 – 95.99	0.254
OPV3	89.01	85.22 – 92.79	91.29	84.67 – 97.91	0.432
DTP3	87.13	83.34 – 90.93	91.14	84.40 – 97.89	0.196
HepB3	83.46	79.70 – 87.22	90.00	83.46 – 96.54	0.051
Measles	79.07	75.98 – 82.16	82.14	75.44 – 88.84	0.304

Timeliness of vaccination

The results indicate that across all vaccines, 13% to 34% of all children received their vaccines according to the immunization schedule, depending on the vaccine, with the majority of them receiving their vaccines within 28 days of their due dates.

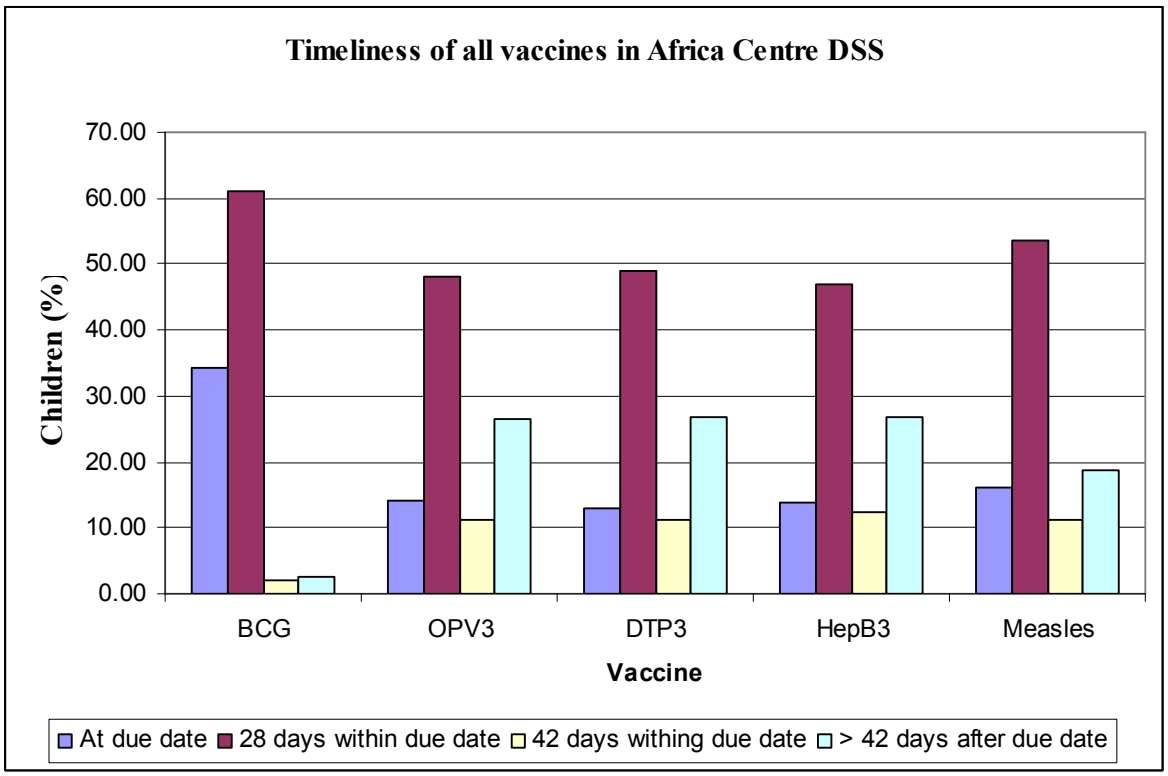

Figure 3 Distribution of all vaccines, showing a decrease in timeliness of vaccines, Africa Centre DSA South Africa

3.2 Characteristics of the sample

The majority of the mothers (64%) had post-primary education (Table 4). The median age of the mothers was 24 years (ranging from 13-54). There were an equal number of male and female children in the sample. No statistical differences were observed between the total number of children vaccinated (3058) and the number of children included in the regression analysis (2020) (Table 4). The average distance from a household to a fixed clinic was 3.2 kms, while the average distance from a household to a mobile vaccination point was 5.7 kms.

Table 4: Characteristics of the sample population

Variable	Total children vaccinated, % (*n*=3058)	Included in regression, % (*n*=2020)	*P*-value
Sex of child			
Female	50.1	50.1	
Male	49.9	49.9	0.973
Maternal Education			
Primary Education	35.9	36.2	
Post primary education	64.1	63.8	0.837
Maternal Age (years)			
Under 20	22.9	22.8	
20-29	50.7	49.6	
30+	26.4	27.6	0.609
Wealth index of household			
Poorest	40.0	39.8	
Middle	40.0	40.2	
Wealthiest	20.0	20.0	0.985
	Mean, 95% CI	Mean, 95% CI	*P*-value
Distance to fixed clinic (km)	3.13, (3.06-3.21)	3.19, (3.11-3.28)	0.251
Distance to mobile clinic point (km)	5.81, (5.69-5.93)	5.74, (5.62-5.88)	0.488
Distance to primary road (km)	7.74, (7.48-8.02)	7.76, (7.47-8.05)	0.952

3.3. Maternal HIV status

Of the 3,058 mothers included in the survey, 1217 (40%) knew their HIV status while 1841 (60%) did not know their HIV status. Among the mothers aged less than 20 years, 33% were HIV Positive compared to 13% who were HIV Negative, the rest being of unknown status (Table 4). There was no differential effect of wealth index of the households between HIV Negative and positive groups. The HIV Positive women lived closer to a fixed clinic (2.98 kms vs. 3.31 kms) and a mobile vaccination point (5.75 kms vs. 6.10 kms) compared to those who were HIV Negative.

Table 5: Characteristics of the sample by maternal HIV status

Variable	HIV Positive, % (*n*=236)	HIV Negative, % (*n*=777)	*P*-value
Sex of child			
Female	48.9	49.9	
Male	51.1	50.1	0.770
Maternal Education			
Primary Education	38.7	37.4	
Post primary education	61.3	62.6	0.709
Maternal Age (years)			
Under 20	32.8	13.2	
20-29	43.8	58.6	
30+	23.4	28.1	<0.001
Wealth index of household			
Poorest	44.2	40.0	
Middle	40.9	40.4	
Wealthiest	14.9	19.6	0.188
	Mean, 95% CI	Mean, 95% CI	*P*-value
Distance to fixed clinic (km)	2.98, (2.76-3.21)	3.31, (3.18-3.44)	<0.001
Distance to mobile clinic	5.75, (5.56-5.95)	6.10, (5.74-6.48)	0.001

point (km)			
Distance to primary road (km)	8.28, (7.83-8.73)	7.37, (6.57-8.17)	<0.001

3.4 Determinants of vaccination coverage

Tables 6: Adjusted odds for BCG vaccination among children aged 12- 23 months in Africa Centre DSA, 2006 (n=2020)

BCG vaccine	Univariate			Multivariate		
Characteristic	**OR**	**95% CI**	**P-value**	**aOR**	**95% CI**	**P-value**
Maternal HIV Status						
Negative	1.00			1.00		
Unknown	0.82	(0.57-1.15)	0.256	0.80	(0.55-1.15)	0.239
Positive	0.49	(0.31-0.78)	0.003	0.45	(0.28-0.72)	0.001
Sex						
Females	1.00			1.00		
Males	1.24	(0.90-1.71)	0.194	1.27	(0.92-1.77)	0.139
Maternal Age (years)						
Linear age	1.01	(0.98-1.03)	0.492	1.02	(0.99-1.05)	0.171
Maternal Education (years)						
Primary education	1.00			1.00		
Post primary education	0.94	(0.36-2.44)	0.894	0.73	(0.51-1.05)	0.089
Wealth index						
Poorest	1.00			1.00		
Medium	1.28	(0.77-2.10)	0.341	1.37	(0.93-2.01)	0.102
Wealthiest	1.50	(0.89-2.53)	0.130	1.83	(1.06-3.16)	0.030
Birth order						
First borne	1.00			1.00		
Second and older borne	1.26	(1.01-1.55)	0.032	0.79	(0.53-1.17)	0.244
Fixed clinic distance (kms)	1.02	(0.93-1.11)	0.722	1.01	(0.91-1.12)	0.792
Distance to mobile clinic point (km)	0.99	(0.93-1.04)	0.622	0.90	(0.82-0.99)	0.035
Distance from a primary road (kms)	0.99	(0.96-1.01)	0.210	0.96	(0.93-0.99)	0.039

OR=odds ratio, aOR=adjusted odds ratio, 95% CI=95% confidence interval

In multivariate logistic regression analysis, living further from a primary road and a mobile clinic point were associated with being significantly less likely to receive BCG vaccine (Table 6), adjusted for maternal HIV status, maternal education, maternal age, wealth index, child's sex, birth order, distance to health facility and to a primary road. Children born to mothers who are HIV Positive were significantly less likely to be vaccinated with BCG compared to those born to HIV Negative mothers. Further, children born to wealthier households were also significantly more likely to be vaccinated with BCG compared to those born in the poorest households. Being second born or older was also associated with higher likelihood of vaccination with BCG vaccine in the univariate but not in the multivariate.

Table 7: Adjusted odds for Polio vaccination among children aged 12- 23 months in Africa Centre DSA, 2006 (n=2020)

OPV3 vaccine	**Univariate**			**Multivariate**		
Characteristic	**OR**	**95% CI**	**P-value**	**aOR**	**95% CI**	**P-value**
Maternal HIV Status						
Negative	1.00			1.00		
Unknown	0.79	(0.58-1.09)	0.156	0.81	(0.60-1.09)	0.169
Positive	0.53	(0.34-0.80)	0.003	0.56	(0.37-0.85)	0.006
Sex						
Females	1.00			1.00		
Males	1.24	(0.90-1.71)	0.194	1.07	(0.80-1.14)	0.634
Maternal Age (years)						
Linear age	0.99	(0.98-1.01)	0.913	1.01	(0.99-1.04)	0.228
Maternal Education (years)						
Primary education	1.00			1.00		
Post primary education	0.94	(0.36-2.44)	0.894	0.97	(0.72-1.32)	0.877
Wealth index						
Poorest	1.00			1.00		
Medium	1.28	(0.77-2.10)	0.341	1.51	(1.08-2.11)	0.014
Wealthiest	1.50	(0.89-2.53)	0.130	1.72	(1.08-2.75)	0.022
Birth order						
First borne	1.00			1.00		
Second and older borne	1.12	(0.93-1.36)	0.235	0.76	(0.54-1.08)	0.137
Fixed clinic distance (kms)	1.02	(0.93-1.11)	0.722	1.02	(0.93-1.12)	0.624

Distance to mobile clinic point (km)	0.99	(0.93-1.04)	0.622	0.89	(0.83-0.96)	0.006
Distance from a primary road (kms)	0.99	(0.96-1.01)	0.210	0.95	(0.92-0.98)	0.001

OR=odds ratio, aOR=adjusted odds ratio, 95% CI=95% confidence interval

In the multivariate logistic regression analysis, living further from a primary road and a mobile clinic point were associated with being significantly less likely to be vaccinated with Polio vaccine (Table 7), adjusted for maternal HIV status, maternal education, maternal age, wealth index, child's sex, birth order, distance to health facility and to a primary road. Other factors associated with polio vaccination included; maternal HIV status and wealth index. Children born in wealthier/medium families were more likely to be vaccinated with polio compared to those born in poorer families while those born to HIV Positive mothers were less likely to be vaccinated compared to those born to HIV Negative mothers.

Table 8: Adjusted odds for Diphtheria vaccination among children aged 12- 23 months in Africa Centre DSA, 2006 (n=2020)

DTP3 vaccine	**Univariate**			**Multivariate**		
Characteristic	**OR**	**95% CI**	**P-value**	**aOR**	**95% CI**	**P-value**
Maternal HIV Status						
Negative	1.00			1.00		
Unknown	0.83	(0.62-1.09)	0.187	0.79	(0.59-1.07)	0.133
Positive	0.58	(0.39-0.86)	0.007	0.56	(0.37-0.85)	0.006
Sex						
Females	1.00			1.00		
Males	1.24	(0.90-1.71)	0.194	1.05	(0.81-1.37)	0.695
Maternal Age (years)						
Linear age	1.00	(0.98-1.02)	0.839	1.00	(0.98-1.02)	0.839
Maternal Education (years)						
Primary education	1.00			1.00		
Post primary education	0.94	(0.36-2.44)	0.894	0.94	(0.71-1.25)	0.688

Wealth index						
Poorest	1.00			1.00		
Medium	1.28	(0.77-2.10)	0.341	1.46	(1.07-2.00)	0.016
Wealthiest	1.50	(0.89-2.53)	0.130	1.68	(1.08-2.59)	0.019
Birth order						
First borne	1.00			1.00		
Second and older borne	1.11	(0.92-1.32)	0.275	0.83	(0.60-1.14)	0.257
Fixed clinic distance (kms)	1.02	(0.93-1.11)	0.722	1.01	(0.92-1.09)	0.805
Distance to mobile clinic point (km)	0.99	(0.93-1.04)	0.622	0.88	(0.82-0.95)	0.002
Distance from a primary road (kms)	0.99	(0.96-1.01)	0.210	0.95	(0.92-0.97)	0.001

OR=odds ratio, aOR=adjusted odds ratio, 95% CI=95% confidence interval

In the multivariate logistic regression analysis, living further from a primary road and a mobile clinic point were associated with being significantly less likely to be vaccinated with Diphtheria vaccine (Table 8), adjusted for maternal HIV status, maternal education, maternal age, wealth index, child's sex, birth order, distance to health facility and to a primary road. Other factors associated with Diphtheria vaccination included; maternal HIV status and wealth index. Children born in wealthier/medium families were more likely to be vaccinated with Diphtheria compared to those born in poorer families while those born to HIV Positive mothers were less likely to be vaccinated with Diphtheria compared to those born to HIV Negative mothers.

Table 9: Adjusted odds for Hepatitis vaccination among children aged 12- 23 months in Africa Centre DSA, 2006 (n=2020)

HepB3 vaccine	**Univariate**			**Multivariate**		
Characteristic	**OR**	**95% CI**	**P-value**	**aOR**	**95% CI**	**P-value**
Maternal HIV Status						

Negative	1.00			1.00		
Unknown	0.78	(0.61-1.01)	0.058	0.75	(0.57-0.98)	0.035
Positive	0.67	(0.46-0.97)	0.036	0.63	(0.43-0.93)	0.020
Sex						
Females	1.00			1.00		
Males	1.24	(0.90-1.71)	0.194	1.01	(0.79-1.28)	0.925
Maternal Age (years)						
Linear age	1.00	(0.98-1.02)	0.640	1.01	(0.99-1.03)	0.204
Maternal Education (years)						
Primary education	1.00			1.00		
Post primary education	0.94	(0.36-2.44)	0.894	0.86	(0.67-1.12)	0.292
Wealth index						
Poorest	1.00			1.00		
Medium	1.28	(0.77-2.10)	0.341	1.36	(1.02-1.80)	0.033
Wealthiest	1.50	(0.89-2.53)	0.130	1.70	(1.15-2.52)	0.008
Birth order						
First borne	1.00			1.00		
Second and older borne	1.13	(0.95-1.34)	0.152	0.85	(0.63-1.14)	0.283
Fixed clinic distance (kms)	1.02	(0.93-1.11)	0.722	1.02	(0.95-1.11)	0.530
Distance to mobile clinic point (km)	0.99	(0.93-1.04)	0.622	0.88	(0.82-0.94)	<0.001
Distance from a primary road (kms)	0.99	(0.96-1.01)	0.210	0.95	(0.94-0.98)	0.001

OR=odds ratio, aOR=adjusted odds ratio, 95% CI=95% confidence interval

In the multivariate logistic regression analysis, living further from a primary road and a mobile clinic point were associated with being significantly less likely to be vaccinated with Hepatitis vaccine (Table 9), adjusted for maternal HIV status, maternal education, maternal age, wealth index, child's sex, birth order, distance to health facility and to a primary road. Other factors associated with Hepatitis vaccination included; maternal HIV status and wealth index. Children born in wealthier/medium families were more likely to be vaccinated with Hepatitis compared to those born in poorer families while those born to HIV Positive mothers were less likely to be vaccinated with Hepatitis compared to those born to HIV Negative mothers.

Table 10: Adjusted odds for Measles vaccination among children aged 12- 23 months in Africa Centre DSA, 2006 (n=2020)

Measles vaccine	Univariate			Multivariate		
Characteristic	**OR**	**95% CI**	**P-value**	**aOR**	**95% CI**	**P-value**
Maternal HIV Status						
Negative	1.00			1.00		
Unknown	0.86	(0.68-1.09)	0.215	0.79	(0.62-1.02)	0.071
Positive	0.73	(0.51-1.02)	0.066	0.69	(0.48-1.00)	0.052
Sex						
Females	1.00			1.00		
Males	1.24	(0.90-1.71)	0.194	0.91	(0.73-1.14)	0.408
Maternal Age (years)						
Linear age	1.00	(0.98-1.02)	0.577	1.01	(0.99-1.02)	0.330
Maternal Education (years)						
Primary education	1.00			1.00		
Post primary education	0.94	(0.36-2.44)	0.894	0.93	(0.73-1.19)	0.590
Wealth index						
Poorest	1.00			1.00		
Medium	1.28	(0.77-2.10)	0.341	1.38	(1.06-1.80)	0.015
Wealthiest	1.50	(0.89-2.53)	0.130	1.63	(1.13-2.36)	0.008
Birth order						
First borne	1.00			1.00		
Second and older borne	1.06	(0.91-1.25)	0.418	0.94	(0.72-1.24)	0.699
Fixed clinic distance (kms)	1.02	(0.93-1.11)	0.722	1.02	(0.95-1.09)	0.518
Mobile clinic point distance (kms)	0.99	(0.93-1.04)	0.622	0.95	(0.89-1.01)	0.112
Distance from a primary road (kms)	0.99	(0.96-1.01)	0.210	0.98	(0.96-1.00)	0.081

OR=odds ratio, aOR=adjusted odds ratio, 95% CI=95% confidence interval

In the multivariate logistic regression analysis, children born to mothers who were HIV Positive were less likely to be vaccinated with measles vaccine compared to those born to HIV Negative mothers, (Table 10), adjusted for maternal HIV status, maternal education, maternal age, wealth index, child's sex, birth order, distance to health facility and to a primary road. Children born in wealthier/medium families were also more likely to be vaccinated with measles compared to those born in poorer families adjusting for the same factors.

CHAPTER 4: DISCUSSION

Vaccination coverage has been used as a proxy measure of health service utilization in Africa[10]. We investigated the effect of maternal HIV status on vaccination coverage in children aged 12-23 months when controlling for accessibility to the fixed clinic, mobile clinic points and primary road and other maternal and child characteristics. We focused on this because there is limited research on immunization coverage among children born to HIV-positive mothers.

The findings from our analysis can be summarized as follows: children born to HIV-positive mothers are between 31-55% less likely to be immunized compared to those born to HIV-negative mothers. Children living near mobile clinic points are between 10-12% more likely to be immunized; those living near the primary road are 4-5% more likely to be immunized whereas children from wealthier households are between 1.63-1.83 times more likely to be immunized.

This study confirms the hypothesis that immunization coverage is lower among children born to HIV-positive mothers compared to HIV-negative mothers. Also that distance to health care facility and to primary road affects the likelihood of vaccination. This is especially so in the Africa Centre DSA where people have to walk for 3 to 8 kms to access any kind of health care.[48]

4.1 Immunization coverage

The results indicate that the WHO recommended coverage for routine immunization of 80% routine coverage[60] was attained in the Africa Centre DSA across all vaccines except for measles. The routine vaccination coverage in the study area also attained at least 80% DTP3 coverage, a strategic goal defined in the EPI Regional Strategic Plan, 2001-2005, as set by the WHO. Only 22 countries (48%) in Africa attained the WHO recommended level by mid-2005.[61] Measles coverage in the study area would be categorized as high routine coverage (>75%) by the standards of the regional EPI. Overall coverage in the Africa Centre DSA was not significantly different from South Africa's national coverage as reported by the WHO.[62]

Vaccination coverage differentials among different socio-economic groups, namely the poorest, medium and wealthiest, were observed in the multivariate analysis. A study of health inequalities in Northern Ghana observed that children in the poorest quintiles were less likely to have received measles vaccination.[16] However the plausible reason for the differential effect could be that the wealthiest households appear to be more likely to live near the fixed clinics and also close to the primary roads compared to those living in the poorest households (appendix 6). The poor thus depend on mobile clinic points, which are closer to them, or have to travel to fixed clinics for immunization. Increasing mobile vaccination points will thus reduce these indirect costs and hence reduce these inequalities of vaccination among the different socio-economic groups.

4.2 Maternal HIV status

Maternal HIV status was found to positively and significantly affect vaccination coverage across all the vaccines, in our study area. Children born to HIV-positive mothers were less likely to be vaccinated compared to those born to HIV-negative mothers. A previous study in Rakai district Uganda showed that children born to HIV-infected mothers had lower immunization coverage compared to children born to HIV-negative mothers.[25] Further, maternal HIV status has been found to be associated with child survival in South west Uganda. Children born to HIV-positive mothers and those born during the period when their mothers seroconverted were four times more likely to die compared to those born to HIV-negative mothers.[63] This could be because maternal HIV status is associated with higher maternal mortality.

A mother whose health is adversely affected by virtue of her HIV status could find it more difficult to walk to a health care facility and have her child vaccinated, compared to a more healthy mother. This may cause the child to be deprived of maternal care, which involves immunization. The role of the extended family is important in such a case, to ensure the continued support of the child, though the child support which is given in this case might not be as adequate as the mother would give. This is especially common in settings with high HIV prevalence which may cause increased burden of childcare among relatives living in already resource constrained settings.[64]

In this study, we cannot comment on the effect of the child's HIV status on their likelihood of vaccination. However, previous studies have shown that irrespective of their

own infection status, all children born to mothers who were at an advanced level of HIV or who died during follow-up were at considerably increased risk of death compared to those whose mothers survived or were at a less advanced stage of the disease. This association was especially strong for uninfected children.[65]

Another plausible explanation could be that mothers who are HIV-positive have lower scores of perception to general health, physical functioning and overall quality of life.[66] This may have a negative effect on the health seeking behaviour of the mother where she may prefer to use her resources for other household purposes other than improving her health and that of her child.

Further, mothers who are HIV-positive are faced with a challenge of distribution of scarce economic resources. They either use the scarce resources to seek health care for themselves or for their children or to feed their households. This burden is further increased if their children are HIV-positive and in need of extra care, as well as the fear of leaving orphaned children. HIV-positive women are also more vulnerable than others because they will have diminishing strength with which to continue functioning in their roles as mothers and caretakers of the family. [64]

4.3 Distance to health care facility

The results shown here are based on the actual distance from the household to a fixed clinic or a mobile clinic point or a primary road. Distance to fixed clinic was not found to be significant. However, distance to primary road was positively associated with

vaccination coverage except for measles vaccine. Children living further from a primary road were less likely to be vaccinated. A probable explanation would be that a mother/caregiver who is taking a child for vaccination would have to overcome the distance to primary road. From there public transport can be used to get the clinic. The time spent while using public transport is of no consequence, so long as a mother/caregiver gets to the primary road and hence is able to access the transport. One study done at the Africa Centre DSA found that though the majority of the people walk to their nearest facility, one-third of the population use public transport.[67]

We found that distance to the primary road was significant for BCG, DTP3, HepB3 and OPV3 vaccines, but it was not significant for measles vaccine. This could possibly be due to the fact that BCG, DTP3, HepB3 and OPV3 are administered much closer to birth (within the first four months after birth) while measles is administered much later than 9 months. More attention is given to a child at this early age compared to when a child is older. This is evident from the fact that the mean immunization coverage for these vaccines is higher compared to that of measles vaccine. The mother/caregiver would therefore make every effort to overcome the distance to the primary road for the sake of her child's' health at this tender age.

Distance to the mobile clinic point is positively associated with vaccination coverage. BCG is administered only once whereas OPV3, DTP3 and HepB3 are administered three times at specified intervals. These subsequent visits to the clinic need advance planning and an appreciation of the importance of receiving vaccines at the right intervals. BCG is

given at birth or at any subsequent visit to the clinic before the child is 12 months and hence the diminishing effect of distance to mobile clinic points.

Mobile clinic points are located near poor people who live further from the fixed clinics (appendix 6). Thus mobile clinic points could be bridging the gap of mothers living in poor households walking for very long distances to get to fixed clinics. Such a mother would have to weigh the opportunity cost of waiting for the scheduled time(s) of a mobile clinic versus travelling a long distance to attend a fixed clinic. This however assumes that mobile clinics in the study area have consistent planning and there are no disparities in the quality of service between the fixed and the mobile clinic. Such disparities can occur when health workers in the mobile clinics have long days when they have to deal with the numerous clients. This may cause them to rush their services or lose their patience when handling the clients. Quality of the health care services has been found to affect their utilization.[68]

It is noteworthy that mothers' education was not significantly associated with immunization coverage across all the vaccines. This has been found in other studies.[36] In our study area, 64% of the mothers had post-primary education, while the rest had primary education and below. This indicates that the literacy level in our study area is higher than most rural areas in developing countries.

In the Africa Centre DSA, there were no gender differences in immunization coverage, as found in other studies.[36] This is a representation of actual practice where there is no

gender discrimination in relation to child immunization. The gender ratio in our study was 1: 0.99 which is equal to the average gender ratio in South Africa[69], an expression of equal preference of children.

4.4 Limitations

In the light of the above findings, the methodology has some limitations. All vaccinations are recorded on an individual's vaccination card (Road-to-Health card) kept by the mother. In the absence of a Road-to-Health card, maternal spontaneous vaccination recall was used. This may cause recall bias since the mother may not adequately recall the precise vaccines and the vaccination dates. However, this has been used in other studies estimating immunization coverage in other settings.[25,70] Moreover; a study in Egypt showed that using 'card plus history' is a commonly used source of vaccination information because mother's reports of their children's vaccination status are of remarkable quality - even among uneducated mothers. [70]

In our study, only 42.5% of the respondents had vaccination cards. This is much lower compared to the SADHS which shows that 75% of children aged 12-23 months had road-to-health cards.[69] Had our survey relied on immunization cards only, we were unlikely to cover a large population of children in our study area. HIV status of the mother was available for only 1217 out of 3058 (40%) of the sample. To solve this problem of a small sample size, we also included respondents whose HIV status was unknown.

Data is collected once every six months from a key informant in the household. This may introduce recall bias since the informant may not recall accurately the information concerning all the members of the household over a period of the last six months.

HIV surveillance is not conducted on all the resident members within the demographic surveillance area. It is collected voluntarily on members of the household who consent to be included in the survey. This reduced the sample size of the mothers who knew their HIV status. HIV status of the mother was available for only 1217 out of 3058 (40%) of the sample. For purposes of our analysis, we included both groups of mothers who had known and unknown HIV status. Therefore the strength of the association for unknown group is an estimate between the range for HIV Negative and Positive status and could not be quantified to reflect the true picture.

Further, our study defined maternal HIV Positive status as having had a positive HIV test before/at the birth of the child for which immunization was to be assessed. However, a mother might have become infected after birth, with consequent negative effects on child's health and immunization status, but was considered HIV Negative for the purposes of this study. This may underestimate the real numbers of HIV positive mothers compared with HIV negative mothers.

The sampling strategy used in this study could have introduced selection bias. Out of 18, 171 children whose vaccination information was available, only 2,020 were analysed because they had complete information on the independent variables.

Vaccination data did not include *Haemophilus influenzae* type B (Hib) vaccine which was routine in EPI since 1999. This is because data on Hib vaccine was only collected in the ACDIS as from January 2008.

CHAPTER 5: CONCLUSION

This study leads to the conclusion that children living near a mobile clinic point and near a primary road network were more likely to be vaccinated compared to those whose households were located further. Children born to HIV-positive mothers were less likely to be vaccinated compared to those born to HIV-negative mothers. Immunization coverage improves with wealth: children from the less poor households being more likely to be vaccinated compared to those in the poorest households. There is no gender difference among children in the society in terms of vaccination status.

Immunization has without doubt been shown to improve child survival, and given the fact that vaccines are given free of charge in sub-Saharan Africa, it is imperative to address the determinants that are barriers to vaccination coverage. Vaccination coverage especially in developing countries is further hampered by the HIV/AIDS epidemic. This is not only because the children born to HIV-positive mothers are less likely to be immunized, but also because their survival rate is reduced by virtue of their mothers' increased risk of death as a result of their HIV Status. Further, these children are at high risk of mother-to-child transmission of HIV infection during birth.

CHAPTER 6: RECOMMENDATIONS

Interventions aimed at HIV-positive mothers are well needed especially in the rural areas. ARV rollouts need to be intensified especially in these areas where there are scarce resources and hence the burden of HIV is higher. Alongside the ARV rollouts, socio mobilisation aimed at increasing the demand for immunization could be done to reduce the differentials in immunization of children due to maternal HIV status. These include conducting trainings to health educators, such as VCT workers, on vaccination schedules and on vaccine policies. These VCT workers would then encourage HIV-infected mothers to complete childhood immunisation.

Given the primacy of distance to the health care facility in vaccination coverage coupled with coverage differentials by socio-economic status, steps to improve access especially to the poor need to be taken. Mobile clinics are one of the interventions that have without doubt helped reduce health utilization differentials among the different socio economic groups. It has targeted the poor who have limited access to fixed clinics. There is need however to increase the number of vaccination points in the study area to cater for the differentials in vaccination across the social economic groups. These mobile vaccination points should be located further from the cities and should target the poorest areas within the study site. Further, intensive outreach services including placement of community health workers within communities with limited access to heath care facilities can be adopted to reduce prevailing socio economic differentials in vaccination.

There is also need for continued community awareness on immunization. The health workers should continue disseminating information to the members for instance on the importance of the timely completion of immunizations. Heath workers can target mothers coming for ante-natal clinic and educate them on the benefits of vaccination of their unborn children.

There should be periodic limited and targeted mass campaigns (mop ups) in the high-risk populations. This includes areas within the sub-district that have the poorest EPI vaccination coverage, poor surveillance information, densely populated areas and people living in areas with heavy migration.

To improve the quality of immunization services, the local authorities should establish a mechanism of tracking children who have defaulted their vaccinations.

Further research into this subject is needed. For instance qualitative research exploring reasons why mothers do not take their children to be vaccinated. Drop out rates were observed, in this study, to be between (OPV3, DTP3, HepB3) and measles ranging between 9% and 15%. A further investigation of factors associated with these drop-out rates is necessary. This is because drop-out rates are used as a measure of the quality of vaccination services.

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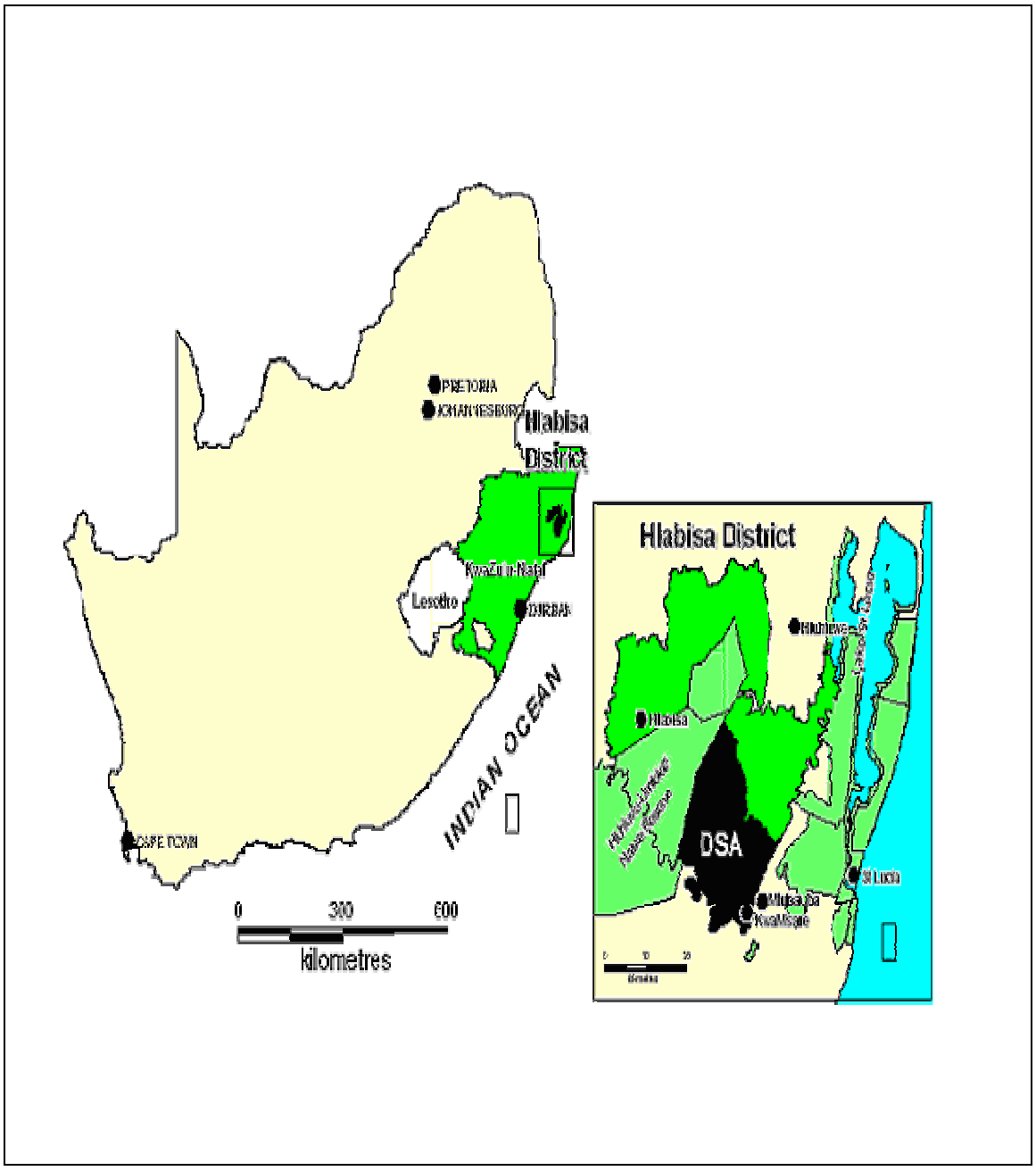
APPENDICES

APPENDIX 1
Location of Hlabisa District and the DSA within South Africa



APPENDIX 2
Child Health Form Questionnaire

Section 4. Child health (immunization)

Part A - Vaccination facility

➢ COMPLETE THIS SECTION FOR ANY LIVE BIRTH IN THE LAST 12 MONTHS. INCLUDE CHILDREN THAT ARE NOW DEAD. RECORD TWINS/TRIPLETS IN SEPARATE COLUMNS. YOU WILL NEED TO CHECK QUESTIONS 1,2 AND 3 IN SECTION 2.

Now I would like to ask you some questions about immunization and the health of your children born in the last year. We will start with last born child.

Q		Last child born in the last 12 months	Next-to-last child born in the last 12 months
1	RECORD THE LINE NUMBER OF THE CHILD FROM SECTION 2 (PREGNANCY RECORD)	LINE NUMBER ☐☐	LINE NUMBER ☐☐
2	ENTER THE FIRST NAME AND WHETHER THE CHILD IS NOW ALIVE OR DEAD FROM SECTION 2	NAME _____ Alive ☐ Dead ☐	NAME _____ Alive ☐ Dead ☐
3	Was (NAME) taken to a clinic for vaccination?	Yes ☐ No ☐→ (Complete next column or go to Part B)	Yes ☐ No ☐→ (Go to Part B)
4	On what date was (NAME) first taken for vaccination?	☐☐☐☐ ☐☐ ☐☐ (Y Y Y Y M M D D)	☐☐☐☐ ☐☐ ☐☐ (Y Y Y Y M M D D)
5a	To which facility was (NAME) first taken for vaccination?	SETTING ☐☐☐ DK ☐ LOCATION ☐☐☐ DK ☐ Health facility BS ID ☐☐☐☐☐ DK ☐	SETTING ☐☐☐ DK ☐ LOCATION ☐☐☐ DK ☐ Health facility BS ID ☐☐☐☐☐ DK ☐

5b. Was the place where (NAME) was vaccinated in a rural or urban area?

Urban area ☐ → Formal ☐ Informal ☐ DK ☐
Rural area ☐ → Tribal area ☐ Commercial farm ☐ Other ☐ DK ☐
DK ☐
(Specify area type)

5c. What was the name of the health facility?

Health Facility Name

5b. Was the place where (NAME) was vaccinated in a rural or urban area?

Urban area ☐ → Formal ☐ Informal ☐ DK ☐
Rural area ☐ → Tribal area ☐ Commercial farm ☐ Other ☐ DK ☐
DK ☐
(Specify area type)

5c. What was the name of the health facility?

Health Facility Name

Part B - Vaccination history

➢ COMPLETE THIS SECTION FOR ANY CHILD BORN SINCE JANUARY 1995 WHO SURVIVED UNTIL AT LEAST ONE YEAR OF AGE. RECORD TWINS/TRIPLETS IN SEPARATE COLUMNS.
➢ YOU WILL NEED TO CHECK QUESTIONS 1,8,9 AND 10 IN SECTION 2.

Now I would like to ask you some questions about immunization and the health of your children born in the last five years who lived until their first Birthday. We will start with the youngest.

Q		Last born child alive or who died after first birthday	Next-to-last born child alive or who died after first birthday
1	RECORD THE LINE NUMBER OF THE CHILD FROM SECTION 2 (PREGNANCY RECORD)	LINE NUMBER ☐☐	LINE NUMBER ☐☐
2	ENTER THE FIRST NAME AND WHETHER THE CHILD IS NOW ALIVE OR DEAD FROM SECTION 2	NAME _____ Alive ☐ Dead ☐	NAME _____ Alive ☐ Dead ☐
3	Do you have a card where (NAME'S) vaccinations are written down? IF YES: May I see it please?	Yes, seen ☐ Yes, not seen ☐ No ☐ Don't know ☐ (Go to q.5)	Yes, seen ☐ Yes, not seen ☐ No ☐ Don't know ☐ (Go to q.5)

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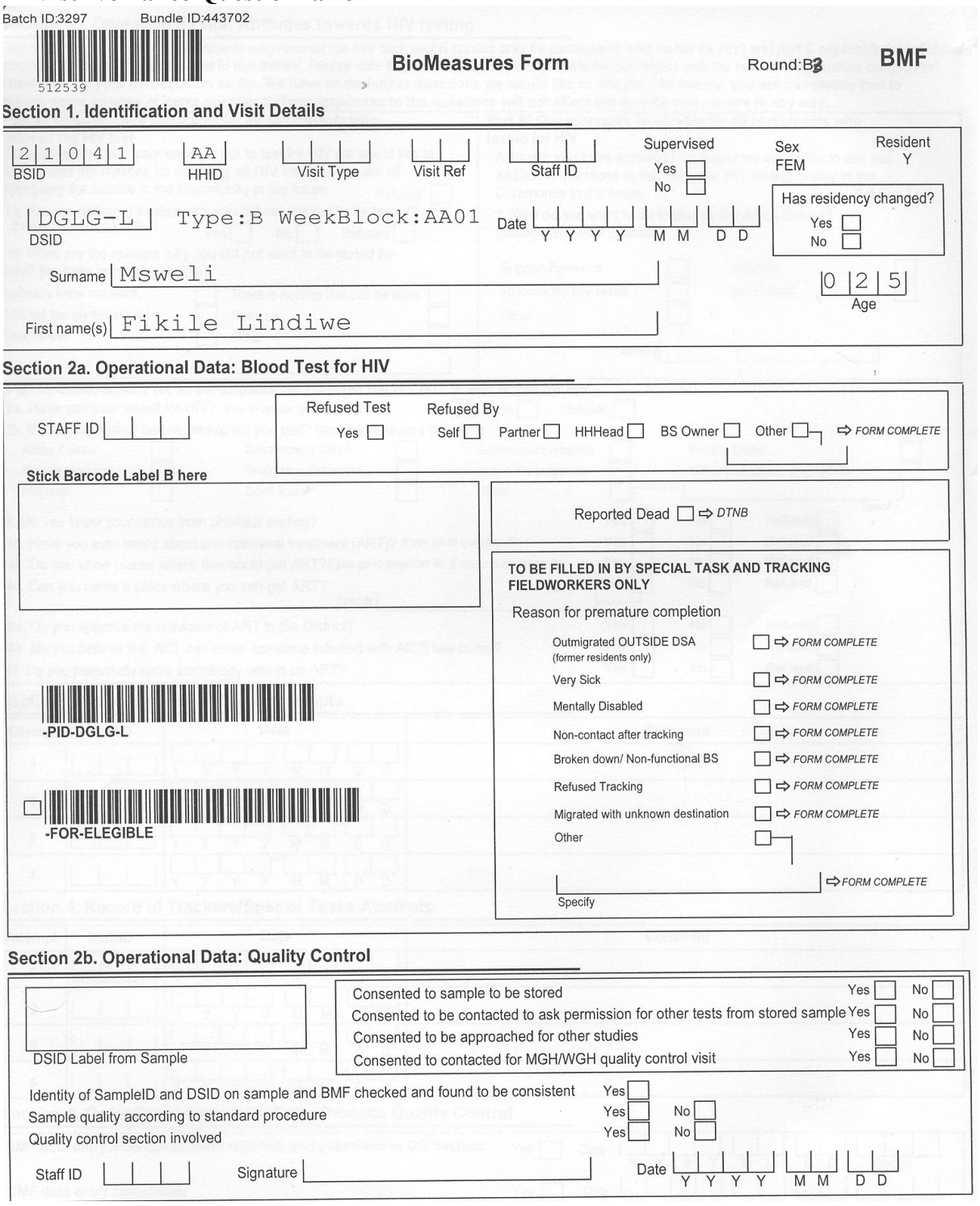
Section 4 continued

4	**RECORDING VACCINATIONS** COPY VACCINATION DATE FOR EACH VACCINE FROM THE CARD WRITE '00' IN THE YEAR COLUMN IF THE CARD SHOWS THAT A VACCINE WAS GIVEN BUT NO DATE IS RECORDED WRITE 'NONE' IN THE YEAR COLUMN IF THE NO VACCINE WAS GIVEN BCG Polio 0 (at birth) Polio 1 Polio 2 Polio 3 DTP 1 DTP 2 DTP 3 Hepatitis B1 Hepatitis B2 Hepatitis B3 Measles	YEAR MONTH DAY BCG P0 P1 P2 P3 D1 D2 D3 H1 H2 H3 Meas (GO TO NEXT COLUMN; OR IF NO MORE BIRTHS GO TO SECTION 5)	YEAR MONTH DAY BCG P0 P1 P2 P3 D1 D2 D3 H1 H2 H3 Meas (GO TO SPARE SHEET; OR IF NO MORE BIRTHS GO TO SECTION 5)
5	SPONTANEOUS VACCINATIONS RECALL - ONLY IF VACCINATION CARD IS NOT SEEN. Please tell me if (NAME) received any of the following vaccinations:		
5a	A BCG vaccination against tuberculosis, that is, an injection in the right arm or shoulder that caused a scar?	Yes ☐ No ☐ DK ☐	Yes ☐ No ☐ DK ☐
5b	Polio vaccine, that is, drops in the mouth?	Yes ☐ No ☐ (Go to Q5e) DK ☐	Yes ☐ No ☐ (Go to Q5e) DK ☐
5c	How many times?	Number of times ☐ DK ☐	Number of times ☐ DK ☐
5d	When was the first polio vaccine given, just after birth or later?	Just after birth ☐ Later ☐ DK ☐	Just after birth ☐ Later ☐ DK ☐
5e	DTP vaccination, that is, an injection usually given at the same time as polio drops?	Yes ☐ No ☐ (Go to Q5g) DK ☐	Yes ☐ No ☐ (Go to Q5g) DK ☐
5f	How many times?	Number of times ☐ DK ☐	Number of times ☐ DK ☐
5g	An injection to prevent measles?	Yes ☐ No ☐ DK ☐	Yes ☐ No ☐ DK ☐
5h	An injection to prevent hepatitis B?	Yes ☐ No ☐ (Go to Section 5) DK ☐	Yes ☐ No ☐ (Go to Section 5) DK ☐
5i	How many times?	Number of times ☐ DK ☐ (GO TO NEXT COLUMN; OR IF NO MORE BIRTHS GO TO SECTION 5)	Number of times ☐ DK ☐ (GO TO SPARE SHEET; OR IF NO MORE BIRTHS GO TO SECTION 5)

APPENDIX 3
HIV surveillance Questionnaire



Batch ID:3297 Bundle ID:443702

512539

BioMeasures Form Round:B3 **BMF**

Section 1. Identification and Visit Details

BSID: 21041 HHID: AA Visit Type: Visit Ref: Staff ID:

Supervised: Yes ☐ No ☐

Sex: FEM Resident: Y

DSID: DGLG-L Type:B WeekBlock:AA01 Date: Y Y Y Y M M D D

Has residency changed? Yes ☐ No ☐

Surname: Msweli

Age: 025

First name(s): Fikile Lindiwe

Section 2a. Operational Data: Blood Test for HIV

STAFF ID

Refused Test: Yes ☐

Refused By: Self ☐ Partner ☐ HHHead ☐ BS Owner ☐ Other ☐ ⇨ FORM COMPLETE

Stick Barcode Label B here

Reported Dead ☐ ⇨ DTNB

-PID-DGLG-L

☐ -FOR-ELEGIBLE

TO BE FILLED IN BY SPECIAL TASK AND TRACKING FIELDWORKERS ONLY

Reason for premature completion

- Outmigrated OUTSIDE DSA (former residents only) ☐ ⇨ FORM COMPLETE
- Very Sick ☐ ⇨ FORM COMPLETE
- Mentally Disabled ☐ ⇨ FORM COMPLETE
- Non-contact after tracking ☐ ⇨ FORM COMPLETE
- Broken down/ Non-functional BS ☐ ⇨ FORM COMPLETE
- Refused Tracking ☐ ⇨ FORM COMPLETE
- Migrated with unknown destination ☐ ⇨ FORM COMPLETE
- Other ☐ ⇨ FORM COMPLETE

Specify

Section 2b. Operational Data: Quality Control

DSID Label from Sample

- Consented to sample to be stored Yes ☐ No ☐
- Consented to be contacted to ask permission for other tests from stored sample Yes ☐ No ☐
- Consented to be approached for other studies Yes ☐ No ☐
- Consented to contacted for MGH/WGH quality control visit Yes ☐ No ☐

Identity of SampleID and DSID on sample and BMF checked and found to be consistent Yes ☐

Sample quality according to standard procedure Yes ☐ No ☐

Quality control section involved Yes ☐ No ☐

Staff ID Signature Date: Y Y Y Y M M D D

Section 2c. Operational Data: Attitudes towards HIV testing

Part A is only applicable for participants who refused the HIV test; part B applies only for participants who tested for HIV; and part C applicable for individuals who refused HIV test or consented to test forHIV. Please note that this section is not applicable for individuals with the outcome "Premature completion".

Thank you for your participation so far. We have some further questions we would like to ask you. As before, you are completely free to answer some or none of these questions. Your responses to the questions will not affect the service you receive in any way.

Part A) Questionnaire applicable for all participants who refused the HIV test

Although we respect your decision not to test for HIV we would like to understand the reasons for declining an HIV test with the aim of improving the service in the Community in the future Refused ☐

1a. Are you willing to explain why you did not wanted to be tested? *If No or Refused go to Q2a* Yes ☐ No ☐ Refused ☐

1b. What are the reasons why you did not want to be tested for HIV? (multiple answers possible)

I already know my result	☐	There is nothing that can be done	☐
I do not like my blood taken	☐	Refused	☐
Don't know	☐	Other	☐

Specify _____

Part B) Questionnaire applicable for all participants who tested for HIV

Although you have agreed to be tested we would like to ask you additional questions to help improve HIV testing quality in the Community in the future Refused ☐

1. Why do you want to be tested by the Africa Centre? (multiple answers possible)

Support Research	☐	Refused	☐
To know my HIV result	☐	Don't know	☐
Other	☐		

Specify _____

Part C) Questionnaire for all participants who refused the HIV test or who tested for HIV

2a. Have you ever tested for HIV? *If no or refuse go to question 3* Yes ☐ No ☐ Refused ☐

2b. If you have tested before, where did you test? (multiple answers possible)

Africa Centre	☐	Government Clinic	☐	Government Hospital	☐	Private Clinic	☐
Private Hospital	☐	Workplace/Employer	☐	Insurance purposes	☐	Other institutions (e.g. NGO)	☐
Refused	☐	Don't know	☐	Other	☐		

Specify _____

3. Do you know your status from previous testing?	Yes ☐	No ☐	Refused ☐
4a. Have you ever heard about anti-retroviral treatment (ART)? *If yes go to question 4b*	Yes ☐	No ☐	Refused ☐
4b. Do you know places where one could get ART? *If yes go to question 4c, if no go to question 4d*	Yes ☐	No ☐	Refused ☐
4c. Can you name a place where you can get ART?	Yes ☐	No ☐	Refused ☐
Specify _____			
4d. Do you approve the provision of ART in the District?	Yes ☐	No ☐	Refused ☐
4e. Do you believe that ART can make someone infected with AIDS feel better?	Yes ☐	No ☐	Refused ☐
4f. Do you personally know somebody who is on ART?	Yes ☐	No ☐	Refused ☐

Section 3. Record of FieldWorker Attempts

Attempt	StaffID	Date	Comment
1	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	
2	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	
3	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	
4	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	

Section 4. Record of Trackers/Special Tasks Attempts

Attempt	StaffID	Date	Comment
1	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	
2	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	
3	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	
4	☐☐☐	☐☐☐☐ ☐☐ ☐☐ Y Y Y Y M M D D	

Section 5. Operational Data: Data Entry Process Quality Control

BMF data entry incomplete, form rejected, and submitted to QC Section: Yes ☐ Date ☐☐☐☐ ☐☐ ☐☐ ☐☐☐ Y Y Y Y M M D D StaffID

BMF data entry completed: Yes ☐ Date ☐☐☐☐ ☐☐ ☐☐ ☐☐☐ Y Y Y Y M M D D StaffID

APPENDIX 4
Ethics approval from KwaZulu Natal University

UNIVERSITY OF
KWAZULU-NATAL

Research Office
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Nelson R Mandela School of Medicine
Private Bag 7, Congella 4013
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769
Fax: 27 31 2604609
Email: [redacted]
Website: [redacted]

21 December 2006

Professor A J Herbst
Africa Centre

Fax : 035 550 7565

PROTOCOL: A socio-demographic platform for population-based reproductive health research in a rural health district of KwaZulu-Natal. (GC Solarsh, Paediatrics) A J Herbst, Africa Centre. Ref: E009/00

RECERTIFICATION RATIFICATION NOTICE

Dear Professor A J Herbst

Further to our letter to you dated 29 November 2006, this letter serves to notify you that at a full sitting of the Biomedical Research Ethics Committee Meeting held on **12 December 2006**, the Committee RATIFIED the sub-committee's decision to approve the Recertification of the above study dated 13 November 2006.

Yours sincerely

SURAIYA BUCCAS
Ethics Research Administrator

SB/sn

UNIVERSITY OF
KWAZULU-NATAL

Research Office
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Nelson R Mandela School of Medicine
Private Bag 7, Congella 4013
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769
Fax: 27 31 2604609
Email: buccas@ukzn.ac.za
Website: www.ukzn.ac.za

29 November 2006

RECERTIFICATION APPLICATION APPROVAL NOTICE

Name & Address of PI: **Professor A J Herbst**

Protocol: A socio-demographic platform for population-based reproductive health research in a rural health district of KwaZulu-Natal. (GC Solarsh, Paediatrics) A J Herbst, Africa Centre.

Reference Number: **E009/00**

Approved: 29 November 2006

Expiration of Ethical Approval: 01 December 2007

I wish to advise you that your application dated **13 November 2006** for the above protocol has been noted and approved by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

If any modifications or adverse effects occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received a BREC approval letter for the change.

A full sitting of the Committee will be advised of this decision at a meeting to be held in **February 2007.**

Yours sincerely

SURAIYA BUCCAS
Ethics Research Administrator

SB/sn

APPENDIX 5
Ethics approval from University of The Witwatersrand Human Research Ethics Committee

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ndirangu

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M061028**
PROJECT	To Investigate the Determinants of Childhood Vaccination Coverage, in Rural South Africa (Hlabisa Districy)
INVESTIGATORS	Mr JN Ndirangu
DEPARTMENT	School of Public Health
DATE CONSIDERED	06.10.27
DECISION OF THE COMMITTEE*	APPROVED UNCONDITIONALLY

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 07.06.13 **CHAIRPERSON** .....
(Professors PE Cleaton-Jones, A Dhai, M Vorster, C Feldman, A Woodiwiss)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr KS Tint

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX 6
Relationship between wealth index categories and distance (to fixed clinic, mobile clinic and primary road)

Comparing distance to the fixed clinic by wealth index of the household

Wealth index of household	Mean	95% CI	Wealth index of household	Mean	95% CI	*P*-value
Poorest	4.09	(3.95-4.21)	Medium	2.95	(2.83-3.06)	<0.001
Poorest	4.09	(3.95-4.21)	Wealthiest	1.94	(1.80-2.07)	<0.001

Comparing distance to mobile clinic by wealth index

Wealth index of household	Mean	95% CI	Wealth index of household	Mean	95% CI	*P*-value
Poorest	4.37	(4.21-4.54)	Medium	5.99	(5.79-6.18)	<0.001
Poorest	4.37	(4.21-4.54)	Wealthiest	7.98	(7.76-8.22)	<0.001

Comparing distance to primary road by wealth index

Wealth index of household	Mean	95% CI	Wealth index of household	Mean	95% CI	*P*-value
Poorest	10.35	(9.92-10.78)	Medium	7.23	(6.77-7.69)	<0.001
Poorest	10.35	(9.92-10.78)	Wealthiest	3.69	(3.22-4.17)	<0.001