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Analysis of Malaria and HIV/AIDS Data from the 2006 Uganda Demographic Health Survey

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ANALYSIS OF MALARIA AND HIV/AIDS DATA FROM THE 2006 UGANDA DEMOGRAPHIC HEALTH SURVEY

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Thesis Submitted to the Faculty of Graduate and Postdoctoral Studies
In partial fulfilment of the requirements for the degree of Master of Science in Biostatistics [1]

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[1]The program is a joint program with Carleton University, administered by the Ottawa-Carleton Institute of Mathematics and Statistics

Your file Votre référence
ISBN: 978-0-494-73775-0
Our file Notre référence
ISBN: 978-0-494-73775-0

Abstract

Despite the fact that extensive research has been done on malaria and HIV/AIDS, they are still major public health problems in Uganda with annual estimates of 10 million cases and 43,000 deaths for malaria and an HIV prevalence of 5.4% that has not changed since 2008. In this thesis, malaria prevalence and the associated risk factors in children below the age of five was investigated. Data from the Uganda Demographic Health Survey were analyzed on 7,336 children. Logistic regression was used to examine the risk factors of malaria. Malaria prevalence decreased with use of bed nets, an increase in the child's wealth status, an increase in the mother's education level and also with an increase in the child's age. Interactions between age and wealth index, and residence and wealth index were significantly associated with malaria prevalence. Prevalence was also higher among rural residents. It is suggested that malaria control measures be targeted to less advantaged groups of people.

Knowledge of prevention and transmission of HIV/AIDS among 2,386 adult men and 8,531 adult women in Uganda was also examined in the thesis using the Uganda Demographic Health Survey. Logistic regression was used to examine determinants of knowledge of prevention and transmission of HIV/AIDS. Knowledge was generally higher among the men. Knowledge also increased with increases in wealth status and educational attainment. It is suggested that health education especially among women must underlie intervention programs to influence prevention and transmission of HIV/AIDS in Uganda.

Acknowledgements

This thesis has been successfully done and its goals achieved with a lot of effort from many special persons whom I would like to express my deep gratitude.

Firstly, I want to extend my sincere thanks to my supervisor Dr. Mayer Alvo for his co-operation, guidance and constructive criticisms throughout the course of the thesis and also for his great advice and patience throughout the course of my Masters Degree at the University of Ottawa. I would also want to thank Professor Rafal Kulik for helping me learn how to use LATEX and also for his great encouragement.

Gratitude also goes to my friends whose support played a great part in the success of this report. Credit goes to Department of Mathematics and Statistics most especially Dr. Benoit Dionne who was always ready to solve my LATEX problems and the rest of the administration staff for their contribution in terms of stationary and computer facilities. Credit also goes to my parents Mr. and Mrs. Kalule and my Aunt Annette Katende for their parental care and professional support during my stay in Ottawa.

Above all, I would like to thank the almighty God because without him, nothing is possible.

Dedication

I dedicate this thesis to my parents Mr. and Mrs. Kalule for being my greatest source of inspiration. May God's blessings be upon you always.

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List of Acronyms

ABC Abstain Be faithful and Use a condom

ACT Artemisinin Combined Therapy

AIDS Acquired Immune Deficiency Syndrome

HIV Human Immunodeficiency Virus

IPT Intermittent Preventive Treatment

IMCI Integrated Management Of Childhood Illness

ITNs Insecticide Treated Mosquito Nets

IRS Indoor Residual Spraying

UBOS Uganda Bureau Of Statistics

UDHS Uganda Demographic Health Survey

UNHS Uganda National Household Survey

UNOCHA United Nations Office for the Coordination of Human Affairs

UNAIDS The Joint United Nations Programme on HIV/AIDS

UNICEF United Nations Children's Fund

RBM Roll Back Malaria

SAS Statistical Analysis Systems

WHO World Health Organization

Part 1 : Malaria Prevalence and the associated Risk Factors in children under five years of age in Uganda

Chapter 1

INTRODUCTION

Malaria is one of the world's most common diseases caused by a parasite called Plasmodium, which is transmitted via the bites of infected mosquitoes. In the human body, the parasites multiply in the liver, and then infect red blood cells. Symptoms of malaria include fever, headache, and vomiting, and usually appear between 10 and 15 days after the mosquito bite. If not treated, malaria can quickly become life-threatening by disrupting the blood supply to vital organs (WHO, 2006). Despite the fact that extensive research has been done on malaria, it remains a major public health problem in Uganda with annual estimates of 10 million cases and 43,000 deaths, of which 91% of the deaths are in children below five years of age (Nankabirwa et al, 2009). It is one of the major causes of childhood illness in Uganda, and fever is one of its major manifestations (UDHS, 2006). For hundreds of years malaria has been one of the most important human diseases in the world. An eradication campaign in the 1950s and 1960s was effective in eliminating the disease from some parts of Europe and North America, and reducing it in other places. Notwithstanding this success, malaria still kills over a million people each year and causes between 300 and 500 million clinical cases. According to the world health organization, approximately 80% of the deaths and 90% of the clinical cases occur in sub-Saharan Africa, where

young children and pregnant women are particularly at risk. In older children, malaria has a similar course as in adults. However, in children below the age of five years, particularly infants, the disease tends to be atypical and more severe. In the first two months of life, children may not contract malaria or the manifestations may be mild with low-grade parasitemia, due to the passive immunity offered by the maternal antibodies. In endemic and hyper endemic areas, the parasite rate increases with age from 0 to 10% during the first three months of life to between 80 and 90% by one year of age and the rate persists at a high level during early childhood. The mortality rate is highest during the first two years of life. By school age, a considerable degree of immunity would have developed and asymptomatic parasitemia can be as high as 75% in primary school children. Malaria also disproportionately affects poor countries and communities, and hinders socioeconomic progress of individuals, households and countries. Factors contributing to this worsening malaria situation are demographic and socioeconomic factors. These factors include climatic change, type of residence, age, education levels of care givers, having/using bed nets, migration and increasing resistance to available drugs (Jennyhill et al, 2007).

Intensive research has been done on the effect of using insecticide treated bed nets and malaria prevalence in children under five in Uganda. However the influence of using mosquito treated nets is still unclear due to the significant increasing mosquito resistance to insecticides, including DDT and pyrethroids, particularly in Africa. Despite other recent research efforts to describe the distribution of malaria vectors, their behavior, and vector control measures in the country, extensive information regarding the epidemiology of malaria in young children in Uganda has been limited (a vector is a carrier that transmits a disease from one party to another). There is also little understanding of the relative importance of economic factors that contribute to people acquiring the disease in communities where malaria is endemic. Some researchers contend that, predisposing characteristics such as age, knowledge of malaria, education and sizes of households significantly affect the incidence of malaria

(Mensah and Kumaranayake 2004). This study will therefore examine the prevalence and distribution of malaria among children under five years of age in Uganda using the Uganda Demographic Health Survey(UDHS) data, identify major risk factors associated with this parasitemia and also investigate if there are any interactions between risk factors that influence malaria prevalence using bivariate and multivariate methods of analysis.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature to outline what has been known so far on malaria prevalence and the associated risk factors not only in Uganda but also in other parts of the world.

Malaria is a major threat to public health in Africa, and remains the leading cause of death in children under 5 years in this region, Bryce et al (2005) report that 94% of deaths due to malaria worldwide occur in Africa. However, national and international malaria control programs have been implemented, including: the Integrated Management of Childhood Illness (IMCI); the Roll Back Malaria initiative; and the Global Fund (WHO, 2006). Major progress in the prevention and treatment of malaria has been reported through the adoption of Artemisinin combined therapy (ACT) from several countries; the use of insecticide treated bed nets; and Intermittent Preventive Treatment (IPT) for pregnant women and children. However, despite the existence of effective treatment and protective measures, malaria continues to be of concern. In an attempt to address this concern, a research-action project was initiated in rural communities in Benin (West Africa), integrating child fever representations

and perceptions of parents of children less than 5 years on malaria control. A literature review to determine current aspects of child malaria control interventions was carried out to inform the process. McCombie (1996) reported that care-seeking in the event of fever is very poor and many cases of fever have non-specific treatment at home. He recommended that home-based management of malaria be improved in order to reduce the progression of cases to severe forms. Although WHO promotes a malaria home management initiative, it is arguable as to whether this initiative addresses peoples' interests. Williams and Jones (2004) contend that it is not people's lack of knowledge that determines their health care seeking behavior in the event of fever, but several other factors (economic, socio-political, and social status). These factors include use of bed nets, type of residence and income levels.

2.2 Prevalence, Incidence and Determinants of Malaria

It should be noted that epidemic malaria is derived from interactions of vectors, parasites and various environmental and anthropogenic determinants. Malaria epidemics afflict immunological vulnerable populations, straining the capacity of health facilities and causing case fatality rates to increase five-fold or more during outbreaks. The demographic profile may translate into larger economic consequences, although the full economic impact of epidemic malaria remains undefined. A study was conducted in Benin on how to conceive and establish the importance of economic factors that contributed to malaria transmission (Mensah and Kumaranayake 2004). According to this study, despite the endemic malaria situations, there was still little understanding of the relative importance of economic factors that contribute to people acquiring the disease in communities where malaria was endemic. The researchers contended that, predisposing characteristics of household heads such as age, knowledge of malaria, education and size of household significantly affect the incidence of

malaria as anticipated by economic theory. A study by Asenso - Okyere (1994) on malaria in four districts namely Kojo Ashong, Barekese, Barekuma and Oyereko all from the Greater Accra Region of Ghana revealed that factors that were perceived as causing malaria included malnutrition, mosquitoes, excessive heat, excessive drinking, flies, fatigue, dirty surroundings, unsafe water, bad air and poor hygiene. Almost all the adolescents at that time had no idea how the disease was spread from person to person, while the symptoms of clinical malaria were also frequently considered to be yellowish eyeball, chills and shivering, headache, a bitter taste, body weakness and yellowish urine.

2.3 Malaria and Age

Malaria infection is common in Sub-Saharan Africa, but death directly attributed to the parasite is comparatively rare, largely because of acquired functional immunity. Unlike the human immunodeficiency virus (HIV) and the acquired immune deficiency syndrome (AIDS) or tuberculosis, infection with the malaria parasite is almost always universal in a population, and the presence of the pathogen is not a sufficient marker of disease. Individuals who die from malaria represent the public health costs of developing immunity at a population level. These deaths are concentrated among those with poorly developed immunity, and generally young children bear the brunt of the mortality burden. Individuals born into areas of stable Plasmodium falciparum transmission frequently acquire and clear infections without becoming ill, but most will, at some stage in their lives, develop an overt clinical response to infection, often manifested as fever. These clinical events may lead to severe complications, which may resolve naturally, require medical intervention, or result in death. Many individuals naturally acquire functional immune responses to severe disease and death early in life; immunity to the milder consequences of infection occurs later in childhood, but the ability to sterilize blood-stage infection probably does not occur until adulthood.

Results from a study carried out in Aminu Kano Teaching Hospital, in Nigeria showed that, of the 280 children sampled whose clinical condition suggested malaria infection, 92 (32.9%) were positive for malaria. Eighty three (90.2%) of the infected positive cases were infected with Plasmodium falciparum while nine (9.8 %) were infected with Plasmodium malaria. The age group 1 - 5 years had the highest prevalence of 44.9% while 0 - 5 months, 6 - 11 months, 6 - 10 years and 11 - 14 years recorded 35%, 33%, 11.8% and 24.3% respectively. The highest mean parasite density of 83, 120 per microliter of blood was recorded in the 11 - 14 years age group. 19.4% of the study population had parasite densities higher than the critical value of 10,000 parasites per microliter. There was no significant difference in degree of parasitemia in relation to the gender. The age specific parasite rates in the 0 - 5 months old was high (30%). This is contrary to report from a previous study in Ghana that reported a low malaria transmission in this age group and attributed it to passively transferred maternal antibodies (Marsh, 1993). However, in this age group the mean parasite density was low (4,450 per microliter). This confirms that maternal antibodies still convey some protection against parasite multiplication or progression of disease and so reduces the risk of severe malaria in this group of patients. The parasitemia in the first year of life in this study most likely represents first infection and is a good indicator of recent transmission of malaria. The results also showed that the mean parasite density increases with the ages of the patients with the 11 - 14 years age group having 83,120 per microliter. There was no statistical difference in parasitemia in relation to gender as malaria does not depend on it but rather on the degree of exposure and availability of infectious female Anopheles mosquito (Adeleke, 2007).

2.4 Malaria and Poverty

In Africa, malaria is largely a disease of the rural populations, and often these communities are home to some of the poorest of the poor in Africa. There is increasing

evidence that strategies promoted to prevent infection, such as insecticide-treated bed-nets, are not reaching the poor when cost-retrieval is part of the strategy. The recent Kenyan Demographic and Health Survey showed that less than 7% of children described as living in households at the lowest wealth index quartile sleep under an insecticide-treated bed net compared with 35% of children in the top wealth quartile households (http://www.measuredhs.org/). Similar findings have been reported for Uganda (Mugisha and Arinatwe 2003). In Tanzania, poor children were less likely to receive anti-malarials when febrile than children from wealthier families (Schellenberg et al. 2003). A household survey in Malawi focused on low-income households whose mean annual income was 115 US dollars and where the costs of malaria prevention and treatment represented about 20% of annual income (Ettling et al. 1994). Child mortality rates are also known to be higher in poorer households and malaria is responsible for a substantial proportion of these deaths. In a demographic surveillance system in rural areas of the United Republic of Tanzania, under-5 mortality following acute fever (much of which would be expected to be due to malaria) was 39% higher in the poorest socioeconomic group than in the richest (Mwageni, 2002). A survey in Zambia also found a substantially higher prevalence of malaria infection among the poorest population groups (Roll Back Malaria [RBM] National Secretariat, 2001). A 2001 Uganda demographic health survey showed the same results and also found an association between wealth index and education levels of care givers. Poorest households are more likely to have less educated care givers. The 2001 Uganda demographic health survey found the child's mother's education level to be one of the determinants of malaria prevalence. The knowledge gained through education will not only enable mothers to have a greater awareness of sanitation and more hygiene way of living, eating and providing more but also to have improved skills and self confidence to marry late, take up well paid jobs, break traditional rules and be more exposed to media and other information which may have a favorable impact on malaria prevention (Suwal, 2000).

2.5 Malaria and Climate

The development of both the vector and parasite is temperature dependent. The optimum temperature range for parasite development in the female Anopheles (sporogony) is between 25°C and 30°C, and development ceases below 16°C. Intermittent low temperatures delay sporogony, and the period immediately after the infective bite by the mosquito on an infected human host is the most sensitive to drops in temperature. Above 35°C sporogony slows down considerably. Extremely high temperatures are associated with the development of smaller and less fecund adult mosquitoes. Thermal death of mosquitoes occurs at 40°C to 42°C. Altitude and temperature are strongly correlated: with every 100-meter increase in altitude, the temperature drops by 0.5°C. Overall, the use of altitude as a marker of endemicity or disease risk is vague, yet there is a tendency within the literature to refer to highland malaria in East Africa and the Horn of Africa. Numerous studies have demonstrated the association between Anopheles gambiae sensus lato (the most important vector of P. falciparum in Africa) abundance and rainfall. Without surface water the female Anopheles cannot lay eggs. Rainfall is also related to humidity and saturation deficit, both affecting mosquito survival (adult vector longevity increases with humidities over 60%) (Dean T. Jamison, 2006).

2.6 Malaria Prevention

Insecticide-treated bed nets (ITNs) are amongst the most effective tools at disposal for reducing malaria transmission and mortality. A series of trials in Africa have shown that proper mosquito net use reduces malaria incidence among children by anywhere from 14 to 63%. With ITN use, all cause-mortality in children has been shown to decline by 25% in Gambia, 33% in Kenya, and 17% in Ghana. Based on findings such as these, the promotion of ITN use has become a central element of national and

international efforts against malaria. While the evidence based on the effectiveness of ITNs in reducing malaria transmission has grown rapidly in recent years, utilization rates for ITNs in most African countries have not. In most malaria endemic regions, fewer than 10% of children or pregnant women regularly sleep under ITNs. For example, based on the Uganda Demographic and Health Survey (UDHS, 2001), it was estimated that only 13% of households in Uganda owned a mosquito net and only 8% of the under-fives usually used them. Those who used insecticide-treated mosquito nets were even fewer. This Uganda Demographic and Health Survey data was used to explore the relationship between mosquito net use and sleeping arrangement among the under-fives (Mugisha et al, 2003). A study by Caroline et al, 2003 on malaria morbidity showed significant decline in younger children at both altitudes (low and highland areas) after introduction of treated nets. Data on mild malaria morbidity was re-assuring in indicating that treated nets are about equally beneficial to young children, and not disadvantageous to older children, whether the initial transmission is intense or more moderate. Thus we consider that the present World Health Organization (WHO) policy of encouraging high coverage with effectively treated nets all over Africa is the correct one and there is no justification for focusing only on hypo-endemic highland areas. The Ministry of Health Uganda has adopted Indoor Residual Spraying (IRS) as one of the most effective interventions for prevention and control of malaria. IRS is the application of long-acting chemical insecticides on the walls and roofs of all houses and domestic animal shelters in a given area, in order to kill the adult vector mosquitoes that land and rest on these surfaces. The primary effects of IRS towards curtailing malaria transmission are: i) to reduce the life span of vector mosquitoes so that they can no longer transmit malaria parasites from one person to another, and ii) to reduce the density of the vector mosquitoes. In some situations, IRS can lead to the elimination of locally important malaria vectors. Some insecticides also repel mosquitoes and by so doing reduce the number of mosquitoes entering the sprayed room, and thus human-vector contact. Indoor residual spraying

(IRS) is one of the primary vector control interventions for reducing and interrupting malaria transmission. In recent years, however, it has received relatively little attention. Recent data re-confirms the efficacy and effectiveness of IRS in malaria control in countries where it was implemented well (WHO, 2006).

2.7 Conclusion

All studies from the malaria journal and other articles that examined malaria prevalence and its determinants were included in the literature review. The key words used in the search included, "malaria prevalence", "children under five years of age", "malaria risk factors", "Uganda" and "Sub saharan Africa". Most of the studies that examined risk factors of malaria prevalence in the literature review were done in other countries like Benin, Ghana, Nigeria, Kenya e.t.c. and their findings may or may not be directly applicable to the Uganda situation because of the differences in level of knowledge, attitudes, practices and economy among the different African countries. Studies from Uganda all concentrated on one risk factor, bed net ownership. Also among the studies from other countries that looked at other risk factors, none addressed influence of interactions between risk factors or the joint effect of risk factors on malaria prevalence. Despite all the research done from the above studies, there still seemed to be little understanding of the importance of socioeconomic and demographic factors that contribute to acquisition of disease in communities. Although the general concept of looking and independent effects of risk factors in relation to malaria prevalence can be of importance, there is a need to address the joint effect of these factors to provide a better description of the relationship between the malaria prevalence and the risk factors.

Chapter 3

MATERIALS AND METHODS

This chapter presents the objectives, subject population, sample design, methods of data collection and the different levels of statistical analysis.

3.1 Research questions/objectives

1. To determine the prevalence of malaria among children under five years of age
2. To determine the use of mosquito bed nets by demographic and socioeconomic factors
3. To examine the association between demographic and socioeconomic factors and malaria prevalence
4. To examine interactions between demographic and socioeconomic factors that influence malaria prevalence

3.2 Source of Data

Data used in this study was from the fourth cycle of the Uganda Demographic and Health Survey (UDHS) carried out in 2005/2006. Data were collected from early May

2006 to early October 2006 on a nationally representative sample of about 10,000 households. All women aged 15-49 years in these households and all men aged 15-54 years in one-third of the households selected randomly were eligible to be interviewed. The 2006 UDHS was a population-based cross-sectional survey that provided data to monitor the population and health situation in Uganda. Specifically, the 2006 UDHS collected information on household characteristics, fertility levels and preferences, awareness and use of family planning methods, childhood mortality, maternal and child health, maternal mortality, breastfeeding practices, nutritional status of women and young children, malaria prevention and treatment, women's status, domestic violence, sexual activity, and awareness and behavior regarding AIDS and other sexually transmitted infections in Uganda. In addition the UDHS collected data on all of the internationally recognized malaria indicators including household ownership of insecticide-treated mosquito nets and their use by children under five years of age and pregnant women, intermittent preventive treatment against malaria during pregnancy and the type and timing of treatment of high fever in children under five years of age and indoor residual spraying of insecticide to kill mosquitoes.

3.3 Sample Design

The Uganda Demographic Health Survey used a cross-sectional survey design. Cross sectional studies are usually conducted to estimate the prevalence of the outcomes of interest for a given population or population sample, commonly for the purposes of public health planning. Data can also be collected on individual characteristics, including exposure to risk factors, alongside information about the outcomes. In this way cross-sectional studies provide a 'snapshot' of the outcome and the characteristics associated with it, at a specific point in time.

The UDHS sample was designed so as to allow separate estimates at the national level and for urban and rural areas of the country. The following shows the districts

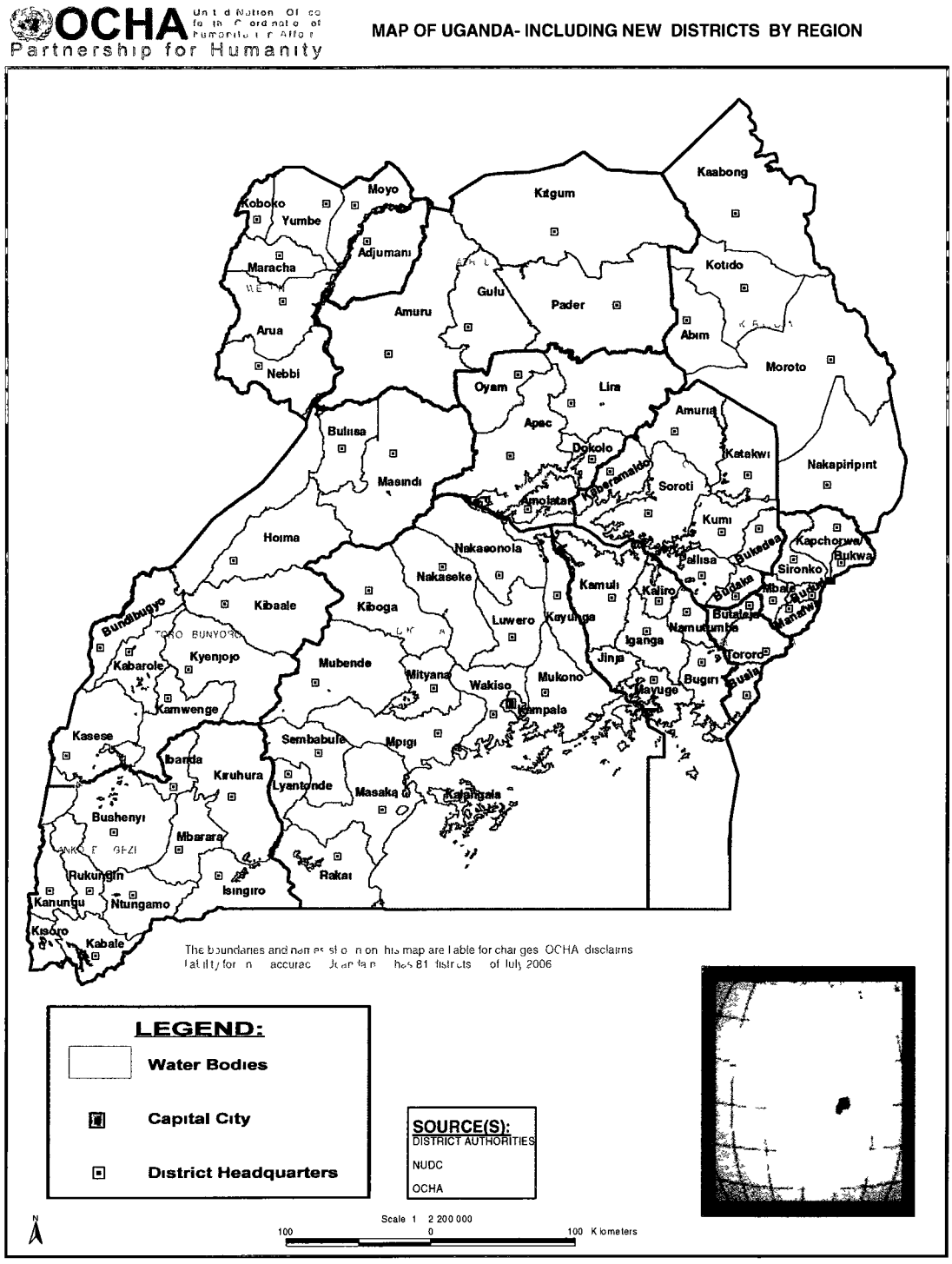
included in the regional sampling strata:

- Central 1: Kalangala, Masaka, Mpigi, Rakai, Sembabule and Wakiso.
- Central 2: Kayunga, Kiboga, Luwero, Mubende, Mukono, Nakasongola Kampala: Kampala.
- East Central: Bugiri, Busia, Iganga, Jinja, Kamuli, Mayuge.
- Eastern: Kapchorwa, Mbale, Pallisa, Sironko, Tororo, Kaberamaido, Katakwi, Kumi, and Soroti.
- North: Apac, Gulu, Kitgum, Lira, Pader, Kotido, Moroto, Nakapiripirit (Estimates for this region include both settled and IDP populations).
- Karamoja area: Kotido, Moroto, and Nakapiripirit.
- IDP: IDP camps in Apac, Gulu, Kitgum, Pader, and Lira districts.
- West Nile: Adjumani, Arua, Moyo, Nebbi, and Yumbe.
- Western: Bundibugyo, Hoima, Kabarole, Kamwenge, Kasese, Kibaale, Kyenjojo, and Masindi.
- Southwest: Bushenyi, Kabale, Kanungu, Kisoro, Mbarara, Ntungamo, and Rukungiri.

A representative probability sample of 9,864 households was selected for the 2006 UDHS survey. The sample was selected in two stages. In the first stage, 321 clusters were selected from among a list of clusters sampled in the 2005-2006 Uganda National Household Survey (UNHS). This matching of samples was conducted in order to allow for linking of 2006 UDHS health indicators to poverty data from the 2005-2006 UNHS. The clusters from the Uganda National Household Survey were in turn selected from the 2002 Census sample frame. For the UDHS 2006, an additional 17 clusters were

selected from the 2002 Census frame in Karamoja in order to increase the sample size to allow for reporting of Karamoja-specific estimates in the UDHS. Finally, 30 Internally Displaced Persons camps were selected from a list of camps compiled by the United Nations Office for the Coordination of Human Affairs (UNOCHA) as of July 2005, completing a total of 368 primary sampling units. In the second stage, households in each cluster were selected based on a complete listing of households. In the 321 clusters that were included in the UNHS sample, the lists of households used were those generated during the UNHS listing operations April-August 2005. The UNHS sampled 10 households per cluster. All ten were purposively included in the UDHS sample. An additional 15 to 20 households were randomly selected in each cluster. The 17 additional clusters in Karamoja were listed, and 27 households were selected in each cluster. The selected Internally Displaced Persons camps were divided into segments due to their large size, and then a listing operation was carried out in the selected segment, with 30 households selected in each camp from the segment listed. All women age 15-49 who were either permanent residents of the households in the 2006 UDHS sample or visitors present in the household on the night before the survey were eligible to be interviewed. In addition, in a sub-sample of one-third of all the households selected for the survey, all men aged 15-54 were eligible to be interviewed if they were either permanent residents or visitors present in the household on the night before the survey. Indicators such as total fertility rate, childhood mortality rates and health, and the maternal mortality ratio require a larger sample size than other indicators. These indicators were all calculated from the data provided by female respondents only. For this reason, the number of male respondents(2503) required in the sample was lower than the number of female respondents(8531).

Figure 3.1: Map of Uganda by region



3.4 Methods of Data collection

Three questionnaires were administered for the 2006 UDHS: the Household Questionnaire, the Women's Questionnaire, and the Men's Questionnaire. The content of the questionnaires was based on the model questionnaires developed for the MEASURE DHS Program. The MEASURE DHS(demographic and health surveys) project has provided technical assistance to more than 240 surveys in over 85 countries, advancing global understanding of health and population trends in developing countries. The Uganda Bureau of Statistics (UBOS) adapted the questionnaires to reflect the population and health issues relevant to Uganda through a series of meetings with various stake holders from government ministries and agencies, non-governmental organizations and international donors. The questionnaires were then translated into six local languages (Ateso-Karamojong, Luganda, Lugbara, Luo, Runyankore-Rukiga, and Runyoro-Rutoro) and pretested during January and February 2006. The Household Questionnaire was used to list all the usual members and visitors in the selected households. The main purpose of the Household Questionnaire was to identify women and men who were eligible for the individual interview. Some basic information was collected on the characteristics of each person listed, including age, sex, education, and relationship to the head of the household. For children under age 18, survival status of the parents was determined. The Household Questionnaire also collected information on characteristics of the household's dwelling unit, such as the source of water, type of toilet facilities, materials used for the floor of the house, ownership of various durable goods, and ownership and use of mosquito nets. Care and support services received by orphans and other vulnerable children were also collected in the Household Questionnaires. Finally, the Household Questionnaire was used to document the respondents' decision as to whether to volunteer to give blood samples for vitamin A deficiency (VAD) testing as well as to record the height, weight, and hemoglobin measurements of women aged 15-49 years, men aged 15-54 years, and chil-

dren aged 6-59 months. The Women's Questionnaire was used to collect information from all women age 15-49 who were asked questions on the following topics:

- Background characteristics (education, residential history, media exposure, etc.).
- Birth history and childhood mortality
- Knowledge and use of family planning methods
- Fertility preferences
- Antenatal and childbirth care
- Breastfeeding and infant feeding practices
- Vaccinations and childhood illnesses
- Marriage and sexual activity
- Woman's work and husband's background characteristics
- Awareness and behavior regarding AIDS and other sexually transmitted infections (STIs)
- Maternal mortality
- Domestic violence

The Men's Questionnaire was administered to all men aged 15-54 living in every third household in the 2006 UDHS sample. The Men's Questionnaire collected much of the same information found in the Women's Questionnaire, but was shorter because it did not contain a detailed reproductive history or questions on maternal and child health or nutrition, or maternal mortality.

3.5 Inclusion Criteria

In this malaria study, only data on children less than five years of age was extracted from the 2006 UDHS database. Information on children under five was provided by the child's mother or guardian during the survey. This included demographic characteristics of the child, socioeconomic characteristics, and information on the child's health and nutritional status. A total of 7664 children under five were included in the survey. A separate data set was created for the analysis in which only the required variables were extracted from the large data base using the KEEP command in the SAS code.

3.6 Variables included in the Study

The variables included malaria prevalence, which was answered by the question "has your child had fever in the last two weeks?" The answer was either "yes", "no" or "I do not know". Those who answered "I do not know", a total of 328 were excluded from the study. Results were not presented on these 328 cases and no data imputation was done for these cases. Other variables included age of child, sex of the child, mother's education level, type of residence, wealth index and bed net use and ownership. The UDHS did not collect information on household income or consumption. However, information on household assets was used to create an index representing the wealth of the households interviewed. The wealth index is a proxy for long-term standard of living of the household. Household assets used to calculate the wealth index included consumer items such as a refrigerator, television, and car; dwelling characteristics such as floor material; type of drinking water source; toilet facilities; and other characteristics that are related to wealth status. It should however be noted that this index is the same for all respondents in the same household.

Table 3.1: Variables included in analysis:

Variables	Codes in analysis
Sex of child	1-Male, 2-Female
Age of child	< 12 months, 1 year, 2 years, 3 years and 4 years
Type of residence	1-Urban, 2-Rural
Mother's education level	No education, Primary, Secondary, Higher
Wealth index	Poorest, Poorer, Middle, Richer, Richest
Ownership of a bed net	0-No, 1-Yes
Slept under a net	0-No, 1-Yes

'Slept under a net' means Slept under a bed net night prior the survey'

3.7 Methods of data analysis

All the analyses were done using SAS(Statistical Analysis System) ,version 9.2.

3.7.1 Univariate analysis

Univariate analysis explores each variable in a data set, separately. This analysis is carried out with the description of the pattern of response to a single variable. At the univariate level of analysis of the data, descriptive statistics were used. Here frequency distributions of respondents' main(independent) variables under study were presented. These included the child's mother's levels of education, type of residence, age, wealth index, sex of the child and bed net owner ship. Distributions of wealth index, education levels and residence type were also obtained by bed net ownership.

3.7.2 Bivariate analysis

Bivariate analysis is the simultaneous analysis of two variables and is usually undertaken to see if one variable, such as gender, is related to another variable like malaria

prevalence. There are many methods of bivariate analysis which include the chi-square test, univariate regression, correlation coefficients and contingency tables. In the bivariate analysis we used the chi-square test and the univariate logistic regression explained below.

The chi-square statistic is a quantitative measure used to determine whether a significant association exists between two categorical variables first, by determining what the distribution of observations (frequencies) would look like if no relationship existed and, second by quantifying the extent to which the observed distribution differs from that determined in the first step. The chi-square test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. It was therefore used to assess the relationship between malaria prevalence and the independent variables like gender, age of child, type of residence, mother's education level, wealth index and bed net ownership. The general form of the chi-square test is:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}, \tag{3.7.1}$$

where O_{ij} are observed frequencies(of malaria prevalence) for variable categories, and E_{ij} are expected frequencies. Here r is the number of categories of the independent variables and c is the number of categories of the dependent variable(malaria prevalence). To perform a chi-square test (or any other statistical test), we first must establish our null hypothesis. In this study, our null hypothesis was that the independent variables had no significant relationship to malaria prevalence. The p value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true was used. A large observed chi-square value leading to a p-value less than 0.05 indicated that the independent variable was significantly associated to malaria prevalence.

3.7.3 Univariate and multivariate logistic regression

The statistical analysis of dichotomous outcome variables is frequently conducted with the use of logistic regression methods. Logistic regression models the relationship between a binary response variable and a set of predictors. These predictors can be categorical or continuous variables. The goal of a logistic regression analysis is to find the best fitting, and yet biologically reasonable, model to describe the relationship between an outcome (e.g.malaria prevalence) and a set of independent variables. In the bivariate analysis of data the univariate logistic regression was also used to establish the relationship between malaria prevalence and the independent variables. The simplest type of regression model is the univariate logistic regression model, in which there is one response or dependent variable, and one predictor or independent variable. The description of this logistic model is as follows; Let

$$\pi(x) = Pr(Y = 1|X = x) = 1 - Pr(Y = 0|X = x), \tag{3.7.2}$$

Y denotes a dichotomous outcome variable, which may assume values "1" if the event occurs e.g. having malaria, and "0" otherwise and Pr stands for probability. The logistic regression model in the case of one predictor can be written as;

$$\log \frac{\pi(x)}{(1 - \pi(x))} = \beta_0 + \beta_1 x \tag{3.7.3}$$

In the above univariate model $\pi(x)$ is the probability of having malaria, and x is the independent variable which may be categorical. For example bed net ownership has 2 categories, $(0 - No)$ and $(1 - Yes)$. The ratio $\frac{\pi(x)}{(1-\pi(x))}$ provides the odds in favor of the event. Parameter β_0 would therefore give the log odds of having malaria for a respondent without a bed net (i.e. when x =0) and β_1 would show how these odds differ respondents with bed nets (i.e. when x =1). The model can also be written in terms of odds as

$$\frac{\pi(x)}{(1 - \pi(x))} = \exp(\beta_0 + \beta_1 x), \tag{3.7.4}$$

or in terms of probability of the outcome (having malaria) occurring as

$$\pi(x) = \frac{\exp(\beta_0 + \beta_1 x)}{1 + \exp(\beta_0 + \beta_1 x)}. \tag{3.7.5}$$

Conversely the probability of the outcome not occurring is

$$1 - \pi(x) = \frac{1}{1 + \exp(\beta_0 + \beta_1 x)}. \tag{3.7.6}$$

In fitting a univariate logistic model to our data set, the two unknown parameters β_0 and β_1, are estimated using the maximum likelihood method. Since the observations are assumed to be independent, the likelihood function is given by

$$L(\beta_0, \beta_1) = \prod_{i=1}^{n} \pi(x_i)^{y_i}[1 - \pi(x_i)]^{1-y_i}. \tag{3.7.7}$$

The estimation of β_0 and β_1 requires the maximization of the likelihood function or, equivalently, the maximization of the natural logarithm of the likelihood function denoted by:

$$\log[L(\beta_0, \beta_1)] = \sum_{i=1}^{n} [y_i \log[\pi(x_i)] + (1 - y_i) \log[1 - \pi(x_i)]]. \tag{3.7.8}$$

The maximization of $\log[L(\beta_0, \beta_1)]$ results in solutions β_0 and β_1 which are called the maximum likelihood estimates. The maximum likelihood estimate of $\pi(x)$ estimates the conditional probability that an event occurs.

Multivariate analysis is the simultaneous analysis of three or more variables and it is frequently done to refine the bivariate analysis taking into account the possible influence of other variables on the original bivariate relationship. Only variables that were significantly associated to malaria prevalence at the bivariate stage were included in the multivariate logistic regression analysis. The multivariate logistic model is like an extension of the univariate model and can be written as;

$$\log \frac{\pi(x)}{(1 - \pi(x))} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k, \tag{3.7.9}$$

where $\mathbf{x}' = (x_1, \cdots, x_k)$.

In terms of probability the model can be written as

$$\pi(x) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k)}, \tag{3.7.10}$$

which gives the probability of the outcome event given the predictor values $x_1, x_2, \ldots, x_k$, where k is the number of independent variables(predictors). Notice that regardless of the number of predictor values, if they are all set to zero, then we have

$$\pi(0) = \frac{\exp(\beta_0)}{1 + \exp(\beta_0)}, \tag{3.7.11}$$

which is also the same for the univariate model explained above. The parameter β_0 sets the "baseline" event rate, through the above function, when all predictor values are set equal to zero. Positive values of β_0 give probabilities greater than 0.5, while negative values of β_0 give probabilities less than 0.5, when all independent variables are set to zero. In the univariate cases the coefficient β_1 is such that e^{β_1} is the odds ratio for a unit change in X, and in general, for a change of z units, the Odds Ratio $= e^{z\beta_1}$. The interpretation for coefficients of the multivariate model follow the same pattern. The coefficients/parameter estimates (β_i) were estimated using the maximum likelihood method as explained above for the univariate model. An odds ratio is a way of comparing whether the probability of a certain event is the same for two groups. An odds ratio of 1 implies that the event is equally likely in both groups. An odds ratio greater than 1 implies that the odds of getting a value 1 (yes) on a dependent dichotomous variable are greater for the given category than for the reference category. An odds ratio less than 1 indicates that the reference category is associated with greater odds of getting "yes" on the dependent variable. The odds ratios in the logistic models were accompanied by their 95% confidence intervals. A confidence interval (CI) is a particular kind of interval estimate of a population parameter e.g. odds ratio. Instead of estimating the parameter by a single value, an interval likely to include the parameter is given. Thus, confidence intervals are used to indicate the reliability of an estimate. How likely the interval is to contain

the parameter is determined by the confidence level e.g. 95%. Increasing the desired confidence level will widen the confidence interval.

The backward elimination procedure was used to select variables to get the best multivariate logistic regression model to fit the data. Backward elimination is one of several computer-based iterative variable-selection procedures. It begins with the most complex model containing all the independent variables of interest with all their possible interactions and sequentially removes terms in accordance with some criteria. For example if there are three variables x_1, x_2 and x_3 the most complex model would be written as;

$$\log \frac{\pi(x)}{(1-\pi(x))} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_{12} x_1 x_2 + \beta_{13} x_1 x_3 + \beta_{23} x_2 x_3 + \beta_{123} x_1 x_2 x_3. \tag{3.7.12}$$

Then, at each step, it selects the term for which its removal has the least damaging effect on the model fit (that is the variable/term with the smallest Wald-chi square value or the largest p-value). The process stops when any further deletion leads to a significantly poorer fit.

To make statistically valid population inferences from our sample data, standard errors in the regression models were computed using procedures that took into account the complex nature of the sample design (a measure of the amount of sampling error in a regression coefficient and depends on the sample size and model assumptions). Without taking into account sample weights and clusters, estimated values underestimate the population value, negating the validity of resulting statistical significance tests. In the survey logistic regression procedure in SAS, 9.2, the WEIGHT statement was added. When a WEIGHT statement appears, each observation in the input data set is weighted by the value of the WEIGHT variable. When the WEIGHT statement is not specified, each observation is assigned a weight of 1. Weights, w_i were normalized by multiplying them by $\frac{n}{\sum_{i=1}^{n} w_i}$, where n is the sample size, so that they add up to the actual sample size. The CLUSTER and STRATA statement were also

added to account for clustering and stratification. The SAS procedure used Taylor series linearization to adjust for variances.

Logistic regression diagnostics

The final model selected by backward elimination process was tested for general goodness of fit. The assessment of the model fit was done using the Hosmer-Lemeshow test. The Hosmer-Lemeshow test evaluates goodness of fit by creating g ordered groups of subjects and then compares the numbers in each group observed to the number predicted by the logistic regression model. The g ordered groups are created based on their estimated probability; those with estimated probability below 0.1 form one group, and so on, up to those with probability 0.9 to 1.0. Each of these categories is further divided into two groups based on the actual observed outcome variable (success, failure). The expected frequencies for each of the cells are obtained from the model. The Hosmer-Lemeshow goodness of fit statistic was obtained by calculating the Pearson chi square statistic from a $2 * g$ table of observed and expected frequencies where g is the number of groups. The number of risk groups may be adjusted depending on how many fitted risks are determined by the model. The chi square test is a large sample test requiring in practice expected cell frequencies of at least five. The general form of the statistic is:

$$\chi^2_{H_L} = \sum_{i=1}^{g} \frac{(O_i - N_i\hat{\pi}_i)^2}{N_i\hat{\pi}_i(1-\hat{\pi}_i)} \tag{3.7.13}$$

where, for the ith group, N_i is the total number of subjects, O_i is the total frequency of event outcomes, and $\hat{\pi}_i$ represents the average estimate probability of an event outcome. Large values of $\chi^2_{H_L}$ and correspondingly small p-values would indicate lack of fit of the model (Richard J. Rossi, 2010).

Influence plots were used to detect influential observations and to quantify their effects on various aspects of the maximum likelihood fit. Pregibon (1981) suggests using the index plots of several diagnostic statistics to identify influential observations

and to quantify the effects on various aspects of the maximum likelihood fit. In an index plot, the diagnostic statistic is plotted against the observation number. In general, the distributions of these diagnostic statistics are not known, so cutoff values cannot be given for determining when the values are large. However, the INFLUENCE options in the MODEL statement and the PLOTS option in the logistic statement provide displays of the diagnostic values, allowing visual inspection and comparison of the values across observations. In these plots, if the model is correctly specified and fits all observations well, then no extreme points should appear. The diagnostics included the leverage which is useful in detecting extreme points in the design space where they tend to have larger values, the Pearson Residuals and Deviance Residuals which are useful in identifying observations that are not explained well by the model (in logistic regression Residual = 1- Estimated probability), the C and CBAR which are confidence interval displacement diagnostics that provide scalar measures of the influence of individual observations on the parameter estimates and the DIFDEV and DIFCHISQ which are diagnostics for detecting ill-fitted observations; in other words, observations that contribute heavily to the disagreement between the data and the predicted values of the fitted model. DIFDEV is the change in the deviance due to deleting an individual observation while DIFCHISQ is the change in the Pearson chi-square statistic for the same deletion. Deviance can be regarded as a measure of lack of fit between model and data and is equal to -2 times the log-likelihood ratio of the reduced model compared to the full model. Here the full model is a model with a parameter for every observation so that the data is fit exactly. The DFBETAS plots were used to assess the effect of an individual observation on each estimated parameter of the fitted model. For each parameter estimate, the procedure calculates a DFBETAS diagnostic for each observation. The DFBETAS diagnostic for an observation is the standardized difference in the parameter estimate due to deleting the observation. An outlier or extreme point may indicate bad data. For example, the data may have been coded incorrectly or entered incorrectly. If it can be determined

that an outlying point is in fact erroneous, then the outlying value should be deleted from the analysis (or corrected if possible). In some cases, it may not be possible to determine if an outlying point is bad data. Outliers may be due to random variation or may indicate something scientifically interesting. In any event, we typically do not want to simply delete the outlying observation. However, if all plots point to a particular outlier, models should be compared with this case in and out of the model. If the model does not change significantly after removal of an observation, the baseline model should be interpreted (Aviva, 2009).

Chapter 4

RESULTS

4.1 Descriptive analysis

4.1.1 Frequency distributions of socioeconomic and demographic characteristics

Table 4.1 below shows the socioeconomic and demographic characteristics of the study sample. The study sample included only children below five years of age, with the majority less than 12 months old (21.5%). There were more females (51%) than males (49%) in the sample. The rural residents formed the largest group (88.9%). The majority of the children's mothers stopped at the primary level of education (63.5%) and (22.6%) had received no formal education at all. Wealth index was a difficult variable to quantify. There was available at household level a record of possessions like radios and cars. Also available were the size, condition and materials used for constructing the house. This information was used to compute an index which was then categorized into poorest, poorer, medium, richer and richest wealth status. The minority of the respondents were of richest wealth status (15.9%).

Table 4.1: Socioeconomic and demographic characteristics of the study sample

Predictors	N=7336	
SEX	**Number**	**Percentage(%)**
Male	3594	(49.0)
Female	3742	(51.0)
AGE(months)		
Less than 12	1576	(21.5)
12	1555	(21.2)
24	1459	(19.9)
36	1362	(18.6)
48	1384	(18.9)
MOTHER'S EDUCATION		
No education	1661	(22.6)
Primary	4659	(63.50
Secondary	833	(11.4)
Higher+	183	(2.5)
RESIDENCE		
Urban	813	(11.1)
Rural	6523	(88.9)
WEALTH INDEX		
Poorest	1653	(22.5)
Poorer	1659	(22.6)
Middle	1482	(20.2)
Richer	1379	(18.8)
Richest	1163	(15.9)
OWN A BED NET		
No	4669	(63.6)
Yes	2667	(36.4)

4.1.2 Distributions of age, residence type, wealth index and education levels by bed net ownership

The distributions of the above predictors within each category of bed net ownership are shown in table 4.2 below. The younger children were more likely to own bed nets compared to the older children. As expected the richest respondents were also more likely to own bed nets compared to other categories of wealth index. Results of education level were surprising with the most educated having the smallest percentage of ownership. Bed net ownership was more than twice as likely in rural residents compared to the urban residents.

Table 4.2: The distributions of the malaria predictors by bed net ownership

Predictors	Own bed net:	$N = 2667$	No bed net:	$N = 4669$
Sex	Number	(%)	Number	(%)
Male	1308	(49.04)	2286	(48.96)
Female	1359	(50.96)	2383	(51.04)
Age(months)				
Less than 12	580	(21.75)	996	(21.33)
12	573	(21.48)	981	(21.01)
24	546	(20.47)	914	(19.58)
36	488	(18.30)	874	(18.72)
48	480	(18.00)	904	(19.36)
Mother's education				
No education	434	(16.27)	1228	(26.30)
Primary	1628	(61.04)	3031	(64.92)
Secondary	472	(17.70)	361	(7.73)
Higher+	133	(4.99)	49	(1.05)
Residence				
Urban	560	(21.00)	253	(5.42)
Rural	2107	(79.00)	4416	(94.58)
Wealth Index				
Poorest	521	(19.54)	1132	(24.25)
Poorer	535	(20.06)	1124	(24.07)
Middle	392	(14.70)	1091	(23.37)
Richer	473	(17.74)	905	(19.38)
Richest	746	(27.97)	417	(8.93)

4.2 Bivariate analysis

Some demographic and socioeconomic characteristics were studied relative to malaria prevalence and Table 4.3 shows the results. The chi-square test was used to assess the relationship between each predictor and malaria prevalence as in a two way contingency table. Forty two percent of males and 43% of females had malaria. Malaria prevalence increased with age up to 24 months and declined thereafter. Malaria prevalence decreased with an increase in education level of the child's mother. Malaria prevalence was higher among rural residents (44.4%) compared to urban residents (26.6%). Children of the lowest wealth status were observed to have the highest malaria prevalence 49.4% and the richest had the lowest prevalence 34.7%. Malaria prevalence was not affected by bed net use and ownership. Age of the child, mother's education, wealth index and type of residence were found to be significantly associated with malaria prevalence at the bivariate level of analysis. Bed net ownership and sex were not significantly associated with malaria prevalence at the bivariate level of analysis with p values greater than 0.05. The crude odds ratios and 95% confidence intervals of the risk factors were also calculated by univariate logistic regression explained in the methods part and are shown in table 4.4. Age was modeled as categorical variable in order to differentiate the probability of having malaria among the different age categories. Modeling age as a continuous variables would imply that estimated odds ratios would apply to a one unit increase in the variable. Bivariate analysis was done to determine whether there was an empirical association between malaria prevalence and the independent variables. The bivariate analysis was then extended to a multivariate analysis to evaluate the association.

Table 4.3: Percentage of children who had malaria by socioeconomic and demographic characteristics

PREDICTORS	MALARIA $N = 3112$			chi^2	P-VALUE
OWN BED NET	Number	(%)	Weighted total		
No	1969	(42.2)	4669	0.3632	0.6700
Yes	1143	(42.9)	2667		
SEX					
Male	1506	(41.9)	3594	0.7643	0.4089
Female	1606	(42.9)	3742		
AGE(months)					
Less than 12	639	(40.5)	1576	150.0860	< 0.0001
12	821	(52.8)	1555		
24	675	(46.3)	1459		
36	540	(39.6)	1362		
48	437	(31.6)	1384		
MOTHER'S EDUCATION					
No education	717	(43.2)	1661	31.2715	0.0001
Primary	2035	(43.7)	4659		
Secondary	313	(37.6)	833		
Higher+	47	(25.7)	183		
WEALTH INDEX					
Poorest	816	(49.4)	1653	82.6916	< 0.0001
Poorer	763	(46.0)	1659		
Middle	564	(38.1)	1482		
Richer	566	(41.0)	1379		
Richest	403	(34.7)	1163		
SLEPT UNDER NET					
No	2318	(42.4)	5466	0.0040	0.9654
Yes	794	(42.5)	1870		
TYPE OF BED NET					
No net	2318	(42.4)	5466	2.1748	0.5583
Treated	414	(40.9)	1012		
Untreated	380	(44.3)	858		
RESIDENCE					
Urban	216	(26.6)	813	93.1700	< 0.0001
Rural	2896	(44.4)	6523		

Table 4.4: Crude Odds ratios and 95% confidence intervals of malaria prevalence

Variables	Crude Odds Ratios	Confidence Intervals		
	(Standard Error)	Lower	Upper	P-value
SEX				
Male (Reference)				
Female	1.042 (0.0500)	0.945	1.150	0.4090
AGE(months)				
Less than 12 (Reference)				
12	1.639 (0.0787)	1.405	1.912	< 0.0001
24	1.263 (0.0778)	1.084	1.471	< 0.0001
36	0.964 (0.0824)	0.820	1.133	0.6560
48	0.677 (0.0870)	0.571	0.803	< 0.0001
MOTHER'S EDUCATION				
No education (Reference)				
Primary	1.021 (0.0738)	0.883	1.180	0.7796
Secondary	0.793 (0.1070)	0.643	0.978	0.0300
Higher+	0.465 (0.2153)	0.305	0.710	0.0004
RESIDENCE				
Urban (Reference)				
Rural	2.197 (0.1229)	1.727	2.796	< 0.0001
WEALTH INDEX				
Poorest (Reference)				
Poorer	0.874 (0.0839)	0.741	1.030	0.1085
Middle	0.631 (0.0889)	0.530	0.751	< 0.0001
Richer	0.713 (0.0973)	0.590	0.863	0.0005
Richest	0.544 (0.1041)	0.443	0.667	< 0.0001
SLEPT UNDER NET				
No (Reference)				
Yes	1.003 (0.0786)	0.860	1.170	0.9654
TYPE OF BED NET				
No net (Reference)				
Treated	0.941 (0.0919)	0.786	1.127	0.5112
Untreated	1.081 (0.1060)	0.878	1.331	0.4627
OWN A BED NET				
No (Reference)				
Yes	1.030 (0.0695)	0.899	1.180	0.6701

4.3 Multivariate analysis

The results of the bivariate analysis are not conclusive; for example variables significantly associated to the outcome at the bivariate level, may not be associated at the multivariate level. That is why multivariate analysis is conducted to refine the bivariate analysis, taking into account the possible influence of other variables on the original bivariate relationship. Multivariate analysis is also used to test the joint effects of two or more variables upon a dependent variable. Backward elimination was used to fit a good model to the data. The backward elimination process started with 15 terms with the most complex model having a four factor interaction term. The final model chosen had the following variables; Age of the child, type of residence, wealth index, mother's education level and two interactions. The first interaction was between wealth index and type of residence and the second was between wealth index and age of the child. Interactions among predictors are indicated by the symbol "$*$". The results of the backward elimination process are presented in table 4.5 below which shows the order in which insignificant effects were eliminated based on the criterion explained in the methods section.

Table 4.5: Model formation process / summary of stepwise selection.

Step	Removed	DF	Wald-chi-square	P-value
1	$B8 * V102 * V190 * V106$	16	2.2504	1.0000
2	$B8 * V102 * V106$	12	6.3074	0.8998
3	$B8 * V190 * V106$	42	38.7134	0.6160
4	$B8 * V102 * V190$	16	13.7450	0.6177
5	$B8 * V102$	4	2.1747	0.7037
6	$V102 * V190 * V106$	9	11.2131	0.2614
7	$V102 * V106$	3	1.1703	0.7601
8	$V190 * V106$	12	18.7913	0.0937
9	$B8 * V106$	12	17.3442	0.1371

'DF' means 'Degrees of freedom'

B8 represents age of child, V102(Type of residence), V106(Mother's education), and V190(Wealth index)

Table 4.6: Results of final multivariate logistic regression with 4 independent variables and two interactions

Parameter	DF	Estimate	SE	Chi-Square	P-value
Intercept	1	-1.5274	0.1714	79.3766	< 0.0001
Age(years)					
< 1 (Reference)					
One	1	0.4021	0.1559	6.6545	0.0099
Two	1	0.0314	0.1487	0.0445	0.8329
Three	1	-0.3588	0.1382	6.7405	0.0094
Four	1	-0.6043	0.1629	13.7634	0.0002
Wealth index					
Poorest(Reference)					
Poorer	1	1.2872	0.4346	8.7731	0.0031
Middle	1	0.4463	0.4730	0.8900	0.3455
Richer	1	0.3373	0.3146	1.1493	0.2837
Richest	1	0.2412	0.2450	0.9691	0.3249
Residence					
Urban (Reference)					
Rural	1	1.5787	0.1828	74.5595	< 0.0001
Mother education					
No education(Reference)					
Primary	1	0.0756	0.0775	0.9534	0.3288
Secondary	1	0.0512	0.1223	0.1753	0.6755
Higher +	1	-0.5102	0.2303	4.9079	0.0267
Age and wealth index					
Poorest < 12 months(Reference)					
Poorer 1 year old	1	-0.0662	0.2116	0.0979	0.7544
Medium 1 year old	1	0.3466	0.2360	2.1558	0.1420
Richer 1 year old	1	0.1285	0.2587	0.2467	0.6194
Richest 1 year old	1	0.1804	0.2548	0.5013	0.4789
Poorer 2 year old	1	0.2471	0.1980	1.5576	0.2120
Medium 2 year old	1	0.4542	0.2292	3.9266	0.0475
Richer 2 year old	1	0.3075	0.2301	1.7866	0.1813
Richest 2 year old	1	0.1190	0.2571	0.2144	0.6433
Poorer 3 year old	1	0.1102	0.2266	0.2365	0.6267
Medium 3 year old	1	0.6151	0.2376	6.6993	0.0096
Richer 3 year old	1	0.5409	0.2273	5.6631	0.0173
Richest 3 year old	1	0.4709	0.2591	3.3015	0.0692
Poorer 4 year old	1	-0.1878	0.2450	0.5875	0.4434
Medium 4 year old	1	0.3625	0.2430	2.2240	0.1359
Richer 4 year old	1	0.5346	0.2467	4.6983	0.0302
Richest 4 year old	1	0.5623	0.2665	4.4496	0.0349

Continued on next page

Parameter	DF	Estimate	SE	Chi-Square	P-value
Residence and wealth index					
Poorest urban residents(Reference)					
Poorer rural residents	1	-1.4956	0.4252	12.3750	0.0004
Medium rural residents	1	-1.3104	0.4653	7.9303	0.0049
Richer rural residents	1	-0.9518	0.2994	10.1048	0.0015
Richest rural residents	1	-0.7052	0.2342	9.0645	0.0026

'DF' means 'Degrees of freedom'

'Medium' represents 'the middle or average wealth index'

Table 4.7: Results of final multivariate logistic regression with age and wealth collapsed into two categories.

Parameter	DF	Estimate	Standard Error	Chi-Square	P-value
Intercept	1	-0.4643	0.3429	1.8329	0.1758
Age(years)					
0 to 2 (Reference)					
3 to 4	1	-0.6610	0.0814	65.9494	< 0.0001
Residence					
Urban (Reference)					
Rural	1	0.5745	0.3431	2.8035	0.0941
Wealth index					
Poor (Reference)					
Above average+(Rich)	1	-0.5189	0.3741	1.9240	0.1654
Mother's education					
No education (Reference)					
Primary	1	0.0840	0.0750	1.2537	0.2629
Secondary	1	0.0671	0.1170	0.3286	0.5665
Higher +	1	-0.4290	0.2193	3.8283	0.0504
Age and wealth index					
Poor less than 2 year old (Reference)					
Rich greater than 2 year old	1	0.3642	0.1017	12.8287	0.0003
Residence and wealth index					
Poor urban residents (Reference)					
Rich urban residents	1	0.0961	0.3742	0.0659	0.7974

Results of the final model are shown in Tables 4.6-4.8. By definition, if a variable is involved in an interaction then there is not a single odds ratio estimate for it. Rather, the odds ratio for the variable depends on the level(s) of the interacting variable(s). The interaction effects in the final model were therefore examined using conditional odds ratios and the odds ratios are presented in Table 4.8. The results

Table 4 8: Odds ratios for final multivariate logistic regression with their 95% confidence intervals

Effect	Odds ratio	95%Confidence Limits	
AGE*WEALTH			
Age[3-4]+Rich (Reference)			
Age[0-2]+Poor	2 054	1 731	2 437
Age[0-2]+Rich	1 346	1 169	1 549
Age[3-4]+Poor	1 060	0 888	1 266
RESIDENCE*WEALTH			
Rural residence+Rich (Reference)			
Urban residence+Poor	0 563	0 287	1 103
Urban residence+Rich	0 511	0 391	0 668
EDUCATION			
No education (Reference)			
Primary	1 088	0 939	1 260
Secondary	1 069	0 850	1 345
Higher+	0 651	0 424	1 001

showed that children less than or equal to 2 years old in the rich wealth index were 1 3 times more likely to have malaria compared to older children (3 and 4 years) with the same wealth status [OR=1 346, 95% Confidence intervals (1.169, 1.549)]. Rich urban residents were less likely to have malaria compared to rich rural residents [OR=0 511, 95% Confidence intervals (0.391, 0.668)]. The rural poor category was set to zero because it was a linear combination of other variables (It was a linear combination of the poor young children plus the poor old children minus the poor urban residents). Age and wealth categories were collapsed to make model interpretation easier. Closeness of the exposure effect was considered in collapsing variables. Categories assumed to have the same outcome effect were collapsed together.

4.4 Logistic regression diagnostics

After a logistic regression model was fitted, a global test of goodness of fit of the final model was performed using the Hosmer-Lemeshow test.

Hosmer and Lemeshow Goodness-of-Fit Test:

Chi-Square =4.7026; Degrees of Freedom=7; P-value=0.6962

The Hosmer and Lemeshow Goodness-of-Fit test divided subjects into groups based on predicted probabilities, and then computed a chi-square from observed and expected frequencies. The p-value=0.6962 was computed from the chi-square distribution with 7 degrees of freedom and indicated that the logistic model was a good fit. If the Hosmer and Lemeshow goodness of fit test yielded a p value of 0.05 or less, we would have rejected the null hypothesis that there was no difference between the observed and predicted values of the dependent variable. We failed to reject this null hypothesis which implied that the model estimates fitted the data at an acceptable level.

Table 4.9: Partition for the Hosmer and Lemeshow test.

	Malaria=Yes			Malaria=No	
Group	Total	Observed	Expected	Observed	Expected
1	797	199	205.09	598	591.91
2	764	279	274.30	485	489.70
3	954	350	353.85	604	600.15
4	758	269	292.00	489	466.00
5	617	256	264.64	361	352.36
6	1306	590	578.67	716	727.33
7	738	387	389.32	351	348.68
8	76	43	41.36	33	34.64
9	1326	718	727.19	608	598.81

The index plots of the Pearson residuals and the deviance residuals in Figure 4.1 below indicated that all cases were well accounted for by the model. The index plot of the leverage suggested that a few cases between case 3700 and 4000 were

extreme points in the design space. The other index plots also pointed to these few cases having a larger impact on the coefficients and goodness of fit. The index plots of DFBETAS (Figures 4.3 and 4.4) indicated that the same cases were causing instability in four of the parameter estimates. It should be noted that in any set of data, at least three observations will be the most extreme. Deleting cases with the largest residuals or most extreme values almost always improves the fit of the model, however outliers should only be dropped if and only if it is obvious that the outlier is due to incorrectly entered data. After deletion of these outliers, there was no significant change in model parameters. Therefore conclusions made about the final model (original model with outliers) were justified.

Figure 4.1: Influence plots of Residuals, Leverage, and CI Displacement C

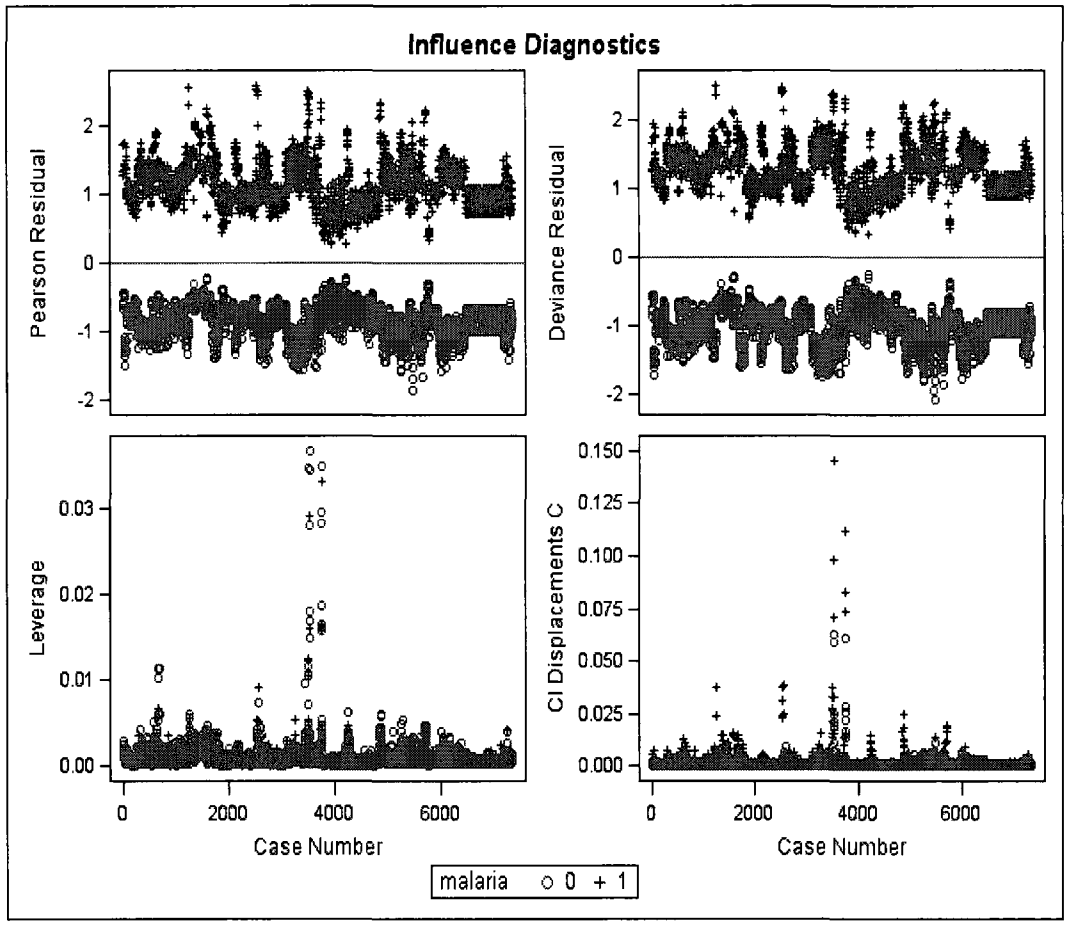


Figure 4.2: Influence plots of CI Displacement CBar, Change in Deviance and Pearson Chi-Square

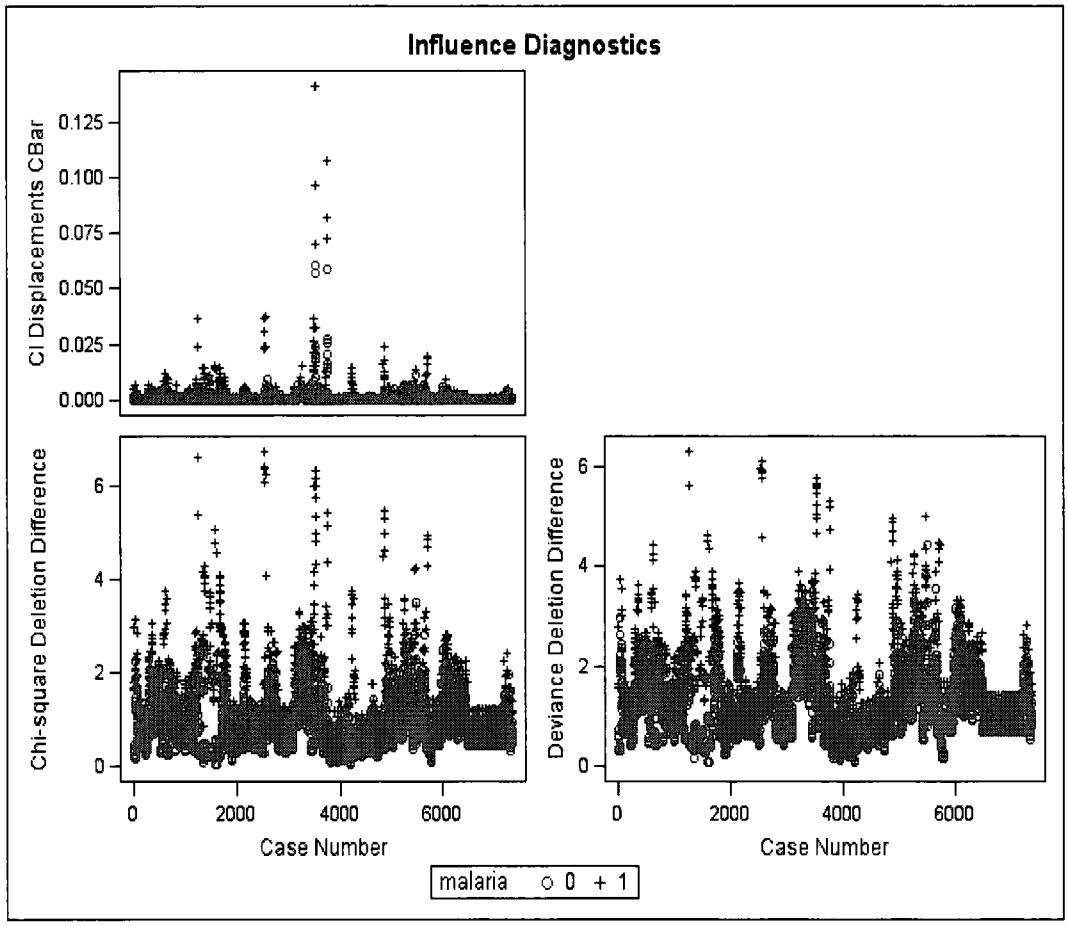


Figure 4.3: DFBETAS Plots of age(B8), type of residence(V102), and education level of child's mother(V106)

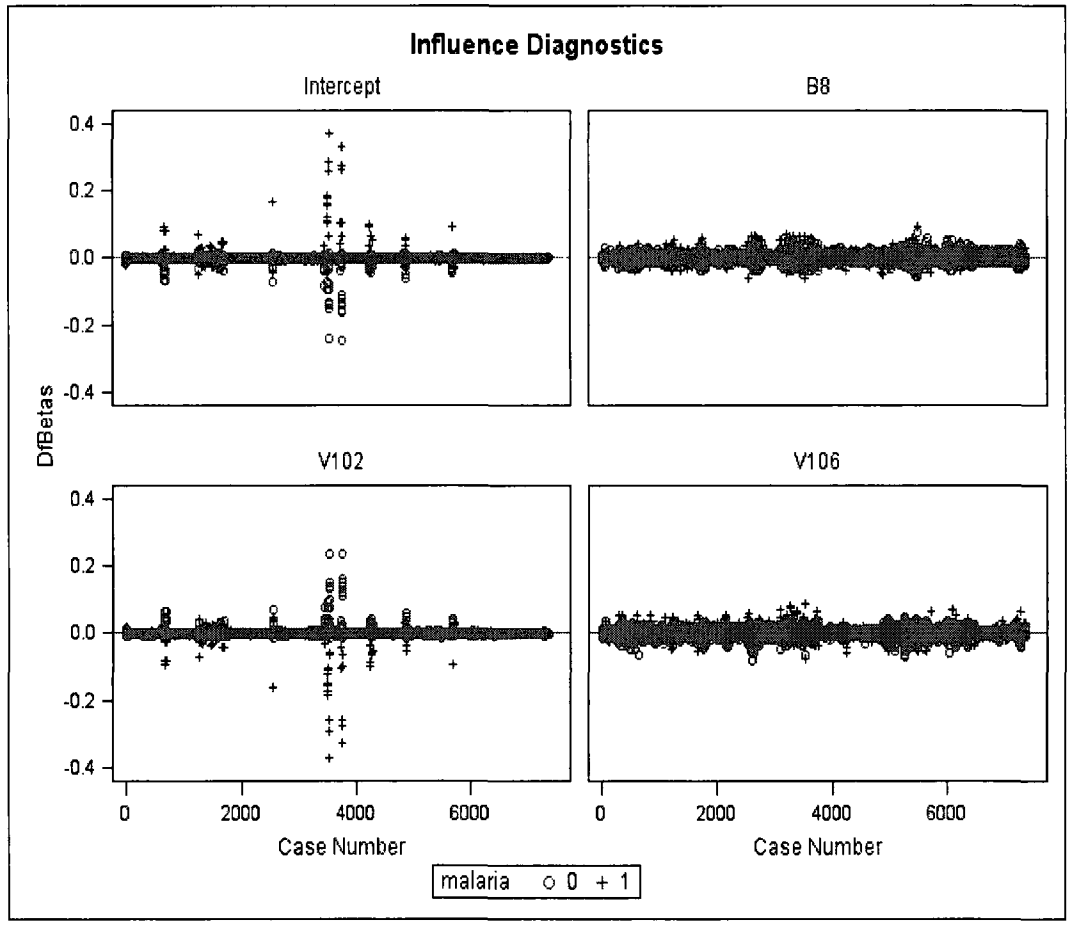
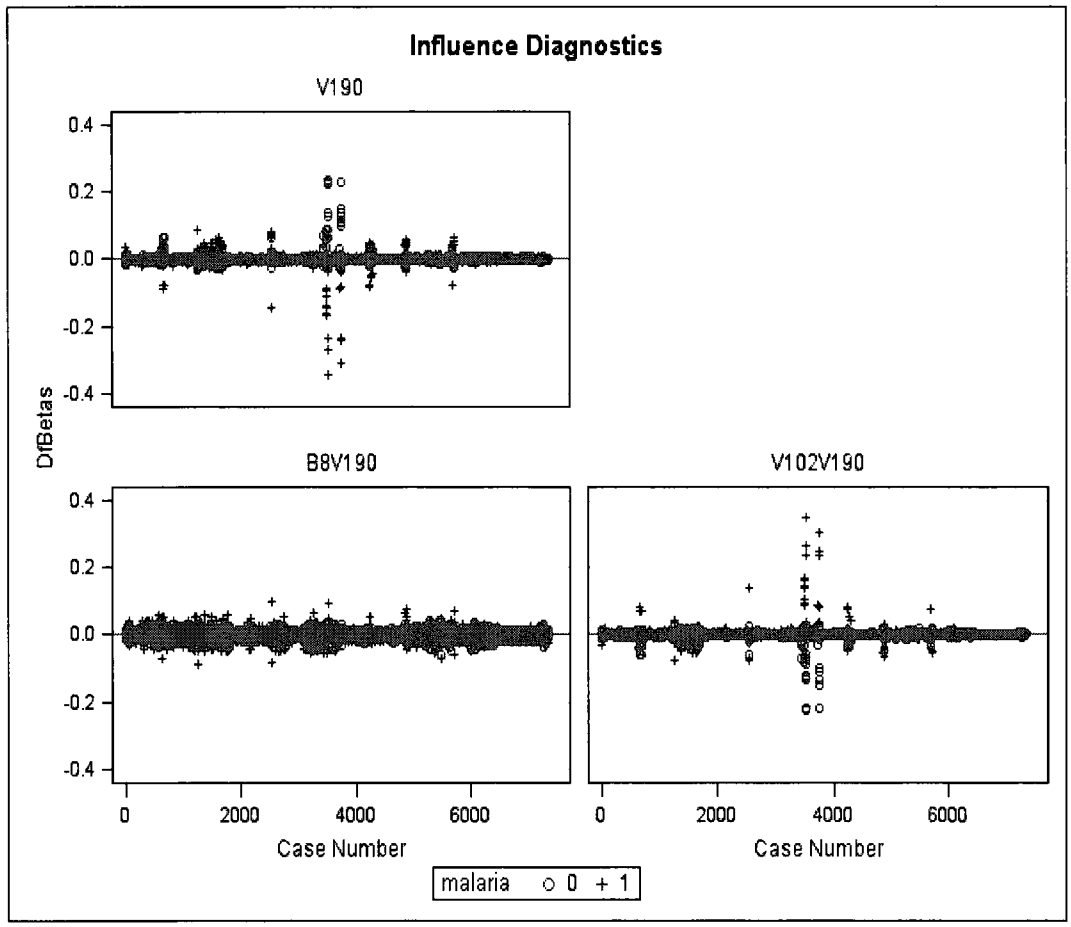


Figure 4.4: DFBETAS Plots of wealth index(V190) and the interaction effects



4.4.1 Conclusion

In chapter 4 the risk factors of malaria prevalence in children under five years of age in Uganda were examined at bivariate and multivariate stages of analysis. Age of the child, mother's education, wealth index and type of residence were found to have significant associations with malaria prevalence at the two levels of analysis. Interactions between age and wealth index and residence and wealth index were also found to have a significant relationship with malaria prevalence. Bed net ownership and use had no significant association with malaria prevalence.

4.5 Discussion

Population-based cross-sectional studies serve an important public health role in planning since they provide contemporary estimates of infection prevalence and intervention coverage and can identify factors whose manipulation could further prevent or control malaria in endemic populations. The results from the study show that, in Uganda, malaria infection remains highly prevalent (42%) among children under five with no difference in prevalence by gender. Mosquito net ownership remains unacceptably low, with only 36% of households owning at least one mosquito net which is much lower than the government Malaria Control Programme's stated aim of 85% by 2010. Mosquito net use was found to be lowest among older children (18%), an observation also reported during individual studies in Tanzania (Killen et al, 2007), South Central Somalia (Noor et al, 2008), Ethiopia (Shargie et al, 2008) and Nigeria (Afolabi et al, 2009), and in the analysis of data from other national household surveys. Although data were not explicitly collected on where participants acquired their bed nets, such variation by age group may be the consequence of net distribution programmes that have historically focused on providing nets to young children and pregnant women during routine clinic visits or mass-catch-up immunization campaigns. The findings

may additionally be explained by household sleeping patterns with older children sleeping together on separate beds from younger children and their mothers. The results also show that sleeping under a net is not associated with malaria prevalence (p value 0.9654), which is the complete opposite of a study by Pullan et al, 2006 on the same population (p value 0.06). This may be because the question regarding net use the single night before the survey did not accurately capture the net use over a longer period. The results showed that children of highest wealth status were less likely to have malaria compared to those of lowest wealth status [Odds ratio= 0.544, 95% confidence interval (0.443, 0.667)]. Children of most educated mothers were also less likely to have malaria compared to those of mothers with no formal education [Odds ratio= 0.465, 95% confidence intervals (0.305, 0.710)]. These results agree with results from previous studies conducted in both rural and peri-urban settings that have reported increased risk of malaria infection in children living in poor housing (Gamage et al, 1991) and with low socio-economic status (Graves et al, 2009). However, findings from Kenya suggest that while asset data (as used in our wealth index) may effectively capture differences in socio-economic status at national scales, expenditure data (which was not collected) may be a more appropriate measure in rural settings (Chuma et al, 2009). Our results also suggested that the least poor were more likely to own and use bed nets than their poorer counterparts. This pro-rich bias in net ownership is similar to that found in studies conducted in comparable settings, including Tanzania (Mushi et al, 2003), Kenya (Noor et al, 2007), Ghana (Grabowsky et al, 2005) and the Gambia (Wiseman et al, 2006), suggesting that the inequities estimated in this study are typical of those found in low-income settings.

Several studies on risk factors of malaria infection have looked at independent effects of different risk factors in the absence of the other factors. However this study also examined influence of interactions between risk factors on the malaria prevalence. An interaction in epidemiology refers to the joint effect of two or more risk factors on disease, while an independent effect is the effect of each factor in the absence of

other factors on disease. It is well established that increases in child's age, mother's education and wealth index reduce the risk of malaria infection among children in developing countries. Not explored, however, are interactions between these factors which could also have significant associations with malaria prevalence. The study found two interactions that were significantly associated to malaria prevalence, one between age and wealth index and the other between residence and wealth index. The results showed that children aged 2 or less in the rich wealth index were 1.3 times more likely to have malaria compared to the rich older children(3 and 4 years) [OR=1.346, 95% Confidence intervals (1.169, 1.549)] and also that the rich urban residents were less likely to have malaria compared to the rich rural residents [OR=0.511, 95% Confidence intervals (0.391, 0.668)] . The presence of interactions can have important implications for the interpretation of statistical models. If an interaction exists in the data there are several advantages for including the multiplicative term. First, if an interaction does in fact exist and is not included in the estimation, this introduces a specification error in the form of omitted variable bias. Estimation of a model that fails to account for the interaction will not provide an accurate estimation of the true relationship between the dependent and independent variables. A model that includes the interaction term provides a better description of the relationship between the independent and dependent variables. Second, the inclusion of the product term will offer a more accurate estimation of the relationship and explain more of the variation in the dependent variable. Finally, including a product term according to Friedrich (1982) is a "low-risk strategy" in that if the product term is significant then keep it in the model otherwise one can drop the product term out of the model by the backward elimination process.

There may be additional risk factors that were not addressed in this study. A study in Tigray region in Ethiopia by Ghebreyesus et al (2000) is very relevant, although it estimated incidence of malaria in children under 10 rather than prevalence (Incidence means the number of new episodes of health-related events that commence

during a specified period of time in a specified population while Prevalence means the total number of health-related events that exist in a specified population at a particular point in time, regardless of when these began or how long they have existed). In multivariate regression there were seven significant risk factors for malaria incidence (earth roof, open eaves, windows, single sleeping rooms, no separate kitchen, animals sleeping in the house, proximity to mosquito breeding sites, altitude and use of irrigated land). Deressa et al (2007) also showed that sharing the house with livestock increased the risk of fever. Some of these factors may be captured in our socioeconomic/wealth index, but these studies suggest that the household asset-related questions in the standard UDHS questionnaire should be evaluated and possibly modified to include additional relevant items. Tilaye and Deressa (2007) observed that proximity to breeding sites increased the risk of malaria in Ethiopia, a factor that is difficult to assess in large household surveys but could be investigated further in future. Other studies in East Africa have also found correlations between extremely high temperatures, rainfall and the development of mosquitoes and these could also be further investigated in future.

There are a number of policy implications from this study. The observed inequalities in ownership of bed nets across socioeconomic groups suggest that, in order to dramatically increase universal coverage, the costs associated with acquiring a net must be reduced. Current distribution strategies in Uganda are focused on young children and pregnant women, following a mixed model that includes both the commercial sector and civil society organizations. These strategies should be extended to also target older children to increase bed net ownership among the older children. For example, provision of free or heavily subsidized ITNs through schools and encouragement of residential (boarding) schools to provide nets in dormitories, coupled with a skills-based health education, would help to ensure that children develop the knowledge, attitudes and skills necessary to reduce their malaria risk.

From our study, malaria prevalence was generally higher in the rural areas, and

many studies have shown that most rural communities are located near mosquito breeding sites, suggesting that some form of larval control may prove a helpful supplement to use of insecticide-treated nets. There was also evidence that increased risk of malaria was associated with less education, and lower wealth index, thus control measures in Uganda should be mainly targeted to these less advantaged groups.

The survey results presented here also contribute to improving and evaluating the malaria control program in Uganda. Surveys such as this one also assess in a rigorous way the coverage of interventions such as net distribution and spraying and educational programs on prevention, and indicate gaps needing to be filled. Finally, the results provide much-needed clear baselines for follow-up surveys of intervention coverage and prevalence in order to demonstrate the decline of malaria in Uganda.

There were clear limitations with this study. This study was based on the responses given by women interviewed. Therefore, it is susceptible to the limitations of reports mostly reporting bias and recall bias. Second, this was a cross-sectional survey conducted during a period of expected peak malaria transmission which may have contributed to the high prevalence rates detected. Third, the data obtained from this type of study does not provide temporal information to determine risk throughout the year or from one year to the next. Fourth, measurement of wealth index should have been more accurate if family size and family weekly expenditure were used to measure wealth index. This should be considered in future. Finally, the questionnaire design did not enable us to evaluate fully the other factors that may be inherently associated with malaria risk.

4.5.1 Conclusion

Understanding the determinants of malaria risk like demographic and socioeconomic factors mentioned in the study including other factors like housing construction, climate and altitude may enable the tailoring of malaria control interventions in Uganda.

Given the manageable size of the country and the overwhelming determination of its people, it should be feasible for Uganda, with sustained momentum, to roll back malaria significantly in a relatively short period of time.

Part 2 : Knowledge Of Prevention and Transmission Of HIV/AIDS Among Adults in Uganda

Chapter 5

INTRODUCTION

The human immunodeficiency virus (HIV) is a retrovirus that infects cells of the immune system, destroying or impairing their function. As the infection progresses, the immune system becomes weaker, and the person becomes more susceptible to infections. The most advanced stage of HIV infection is acquired immunodeficiency syndrome (AIDS). It can take 10-15 years for an HIV-infected person to develop AIDS; antiretroviral drugs can slow down the process. HIV is transmitted through unprotected sexual intercourse (anal or vaginal), transfusion of contaminated blood, sharing of contaminated needles, and between a mother and her infant during pregnancy, childbirth and breastfeeding (WHO, 2010). HIV/AIDS is a major public-health problem in Uganda and throughout sub-Saharan Africa. Although the prevalence of HIV infection among adults aged 15-49 years in Uganda decreased from 18.3% in 1992 to 6.7% in 2005 and then to 5.4% in 2008, acquired immunodeficiency syndrome (AIDS) continues to be the leading cause of death among adults in Uganda (Asamoah et al, 2004; Cohen, 2004 and Slutkin et al, 2006). Following those years of near miraculous reversal of HIV/AIDS prevalence that won Uganda many international accolades, there is general fear that the country is slowly but steadily slipping back into the danger zone. The country is no longer being cited as the HIV/AIDS success story

it once was. Rather, the mention of Uganda in international HIV/AIDS circles is followed by statistics that show a country whose HIV prevalence rate has stagnated at about 5.4% in the last three years, according to the latest combined UNAIDS, UNICEF, WHO HIV Epidemiological fact sheet. There are many theories as to why the HIV prevalence in Uganda is rising again. These include the donor-prescribed shift from ABC (Abstinence, Be faithful, use a Condom)-based prevention programs to abstinence-only prevention programs. Antiretroviral drugs seem to have changed the perception of AIDS from a death sentence to a treatable, manageable disease, consequently reducing the fear surrounding HIV, and in turn leading to an increase in risky behavior (United Nations Programme on HIV/AIDS, 2007). Despite the high knowledge of the existence of HIV, this knowledge does not match with individual beliefs, attitudes and perceptions towards HID/AIDS prevention, transmission, control and care measures. There is a need to intensify HIV/AIDS control programs in order to bridge gaps identified in several studies. These beliefs, attitudes and perceptions towards HID/AIDS transmission and prevention are also determined by people's demographic and socioeconomic characteristics (Kasasa et al, 2004). Much research had been done on knowledge and perceptions of HIV/AIDS in Uganda yet many questions remain about the level of HIV/AIDS knowledge among Uganda youth and their ability and willingness to make use of that knowledge to reduce HIV/AIDS risk. In a country with high HIV prevalence, understanding the level of HIV/AIDS prevention and transmission knowledge and the factors influencing this knowledge could have important and far-reaching implications on a public health phenomenon that threatens to negatively impact numerous aspects of society, ranging from health and mortality to economic productivity. This thesis will examine HIV/AIDS prevention and transmission knowledge among adults in Uganda. It will examine the difference in knowledge between men and women and also between other demographic and socioeconomic factors.

Chapter 6

LITERATURE REVIEW

This chapter reviews existing literature to outline current knowledge of prevention and transmission of HIV/AIDS and determinants of this knowledge among adults.

6.1 Introduction

The high incidence of HIV/AIDS in sub-Sahara Africa has been widely documented (Taylor et al, 2003; WHO/UNICEF/UNAIDS, 2002; Eaton et al, 2003 and Piot, 2000). Of the more than 40 million people afflicted with HIV/AIDS worldwide, 30 million are estimated to live in this region of Africa (WHO/UNICEF/UNAIDS, 2002). This represents about 70% of the global disease burden even though this region of Africa only accounts for about 10% of the global population (Eaton et al, 2003). The most afflicted sub-Saharan African nations include Botswana, Côte d'Ivoire, Ethiopia, Kenya, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Zambia. The unique challenges in combating the continuing spread of the disease in the region of Africa have been discussed by various groups and individuals (WHO/UNICEF/UNAIDS, 2002; Eaton et al, 2003; Piot, 2000 and Butler, 2000). It is also widely documented that half of all new infections with

HIV/AIDS now occur in young people under the age of 25. While the spread of the virus may be slowing among other members of the global community, increases in incidence of the disease appear to be the norm among youth all over the world (Morris et al, 2003). Of the more than six billion people in the world today, one billion are between the ages of 15-24. Half of the population of sub-Saharan Africa is under 18 years of age. One third of those living with HIV/AIDS in the region are between the ages of 15-24 (WHO/UNICEF/UNAIDS, 2002). Unless there is global commitment to decreasing the incidence of this contagion in this region of the world, Africa may remain the reservoir for HIV/AIDS transmission in the foreseeable future. A dearth of knowledge about HIV/AIDS etiology among young people globally constitutes a major challenge to the control of this scourge. Most people become sexually active in adolescence. The need to admit that young people are having sex but lack the proper knowledge to protect themselves is particularly important in the war against HIV/AIDS. Young people are now the epicenter and bear a disproportionate burden of this pandemic (WHO/UNICEF/UNAIDS, 2002). Surveys continue to indicate that lots of people, especially the youth between 15 and 24 years, harbor serious misconceptions about HIV and how it is transmitted (Cohall et al, 2001).

6.2 Knowledge of HIV/AIDS

Recent studies among youth in South Africa and other African countries have found at least moderate levels of knowledge about HIV/AIDS but important gaps in HIV/AIDS knowledge remain (Shisana et al, 2005; Eaton et al, 2000; Barden et al, 2004; Slonim-Nevo, 2005; Smith, 2004 and Terry et al, 2006) . Condoms, abstinence, and monogamy or limiting the numbers of partners are the most frequently named methods of preventing HIV/AIDS, although condoms are mentioned far more often than the other methods (Pettifor et al, 2004 and Zambuko et al, 2005). The relationship between HIV/AIDS knowledge and behaviors has been debated. Engagement in high

risk HIV/AIDS behaviors (e.g., multiple sex partners, inconsistent condom use) despite knowledge about HIV/AIDS has been found in some studies of youth in Africa, but other studies have found positive associations between HIV/AIDS knowledge and HIV/AIDS prevention behaviors (Macphail et al, 2001; Tillotson, 2001; Magnani et al, 2002; Peltzer et al, 2003 and Maswanya et al, 1999). Further, recent evidence on the sexual behaviors of young South Africans indicates that preventive behaviors (condom use and fewer sexual partners) have increased (Zambuko et al, 2005; Pettifor et al, 2005 and Simbayi et al, 2004). This suggests that campaigns to increase knowledge about HIV/AIDS may be having an effect on behaviors and underscores the importance of assessing knowledge about HIV/AIDS prevention. Besides risky behaviors, a number of other factors may be correlated with level of HIV/AIDS knowledge among young people in Africa. Young people who know someone living with HIV/AIDS or who died of the disease may be more knowledgeable about the disease than others (Barden-O'Fallon et al, 2004). Youth who have completed more grades in school may have received more information about HIV/AIDS than others; a positive association between educational attainment and HIV/AIDS knowledge has been found in some African studies (Eaton et al, 2000 and Barden et al,2004). School enrollment status may be important as well because youth who are in school may have more current exposure to HIV/AIDS education and prevention methods than youth who are not. Educational attainment and school enrollment status also may serve as proxies for socioeconomic status. In addition, we might expect older youth to be more knowledgeable about HIV/AIDS prevention than younger youth (Slonim et al, 2005 and Maswanya et al, 1999), but some studies have found no association between age and HIV/AIDS knowledge (Eaton et al, 2000). Finally, evidence about the relationship between gender and HIV/AIDS knowledge is also mixed, with South African studies all showing no gender effects, effects favoring males, or effects favoring females (Eaton et al, 2000; Slonim et al, 2005 and Maswanya et al, 1999).

A recent United Nations Fund for Population Activities report stressed the fact

that discussing sex is taboo in many countries, thus denying a large number of people, especially the 15 - 24 age group, the necessary information to negotiate safe sex (IBPD, 2004). Pratt, et al (2000) reported on the role of religious organizations in Kenya that are "avowedly against offering sex education in the classrooms." (p. 137). Taylor and colleagues (2003) have stressed cultural and religious mores in their "Multifactorial Intervention Model for HIV/AIDS Prevention." (p. 99). The need to develop a culturally sensitive educational intervention program (if one is to succeed in reversing HIV/AIDS etiology in Nigeria) is inferred. Thus, educational intervention programs in communities must include families and religious organizations as well as traditional leaders. A great deal of information on HIV/AIDS transmission is advertised on televisions and radios, and taught in schools. However the majority of the population in Africa are poor and do not have access to education and the media. Most who have heard of HIV have learned of it from friends hence increasing the misconceptions about HIV/AIDS.

6.3 Myths and Misconceptions about Prevention and Transmission

There are many contemporary myths and misconceptions about HIV prevention and transmission and they originate from many parts of the world. Some are about the demographics of the virus and claim that HIV/AIDS is a Black Person's Disease only or that it only affects IV drug users. There is also the misconception in parts of Africa that there are young "virgin" prostitutes or special villages free from AIDS. There is also the speculation that HIV/AIDS is worse in Africa because Africans are hyper-sexual. Others come from theories on the origins of the virus. Some people think that HIV was engineered by the American government for the purposes of exterminating Africans, African Americans and homosexuals. Others think that HIV was sent by

God as punishment for sin. Other myths and misconceptions are about prevention and transmission. Among these are the misconceptions that only promiscuous people contract HIV, women cannot transmit HIV to men, people with HIV look sickly or have body odor, and that HIV does not cause AIDS. One very dangerous misconception about transmission is that two HIV positive people do not need to use condoms during intercourse. This misconception is dangerous because infection with multiple strains of the virus can occur. Paranoia has led to many myths. Some of those myths claim that HIV-positive criminals are lurking, ready to stab victims, that AIDS can be contracted from a toilet seat, and that hugging an HIV-infected person will lead to infection. People also believe that HIV can be transmitted through kissing, or eating from the plate of an infected person, mosquito bites and shaking hands with an HIV/AIDS patient (Richardson, 2008).

According to a study on HIV/AIDS Knowledge, Attitudes, and Opinions among Adolescents in The River States of Nigeria, of the 90 respondents, only 70% of respondents correctly stated that a healthy looking person could still harbor the human immunodeficiency virus while almost 30% either disagreed or were not sure. Even though it is now common knowledge that the HIV agent cannot be transmitted through mosquito bites, 32% of respondents agreed that mosquitoes were a good vehicle for HIV transmission. In sub-Sahara Africa where mosquitoes are endemic, this misconception is significant because it implies a defeatist attitude: regardless of what one does, one is subject to HIV infection as a resident of a mosquito-infested region. It also poses a compliance challenge for any educational intervention effort targeted at this group. The same study showed that about 35 % were not in favor of an HIV positive teacher continuing to meet with his or her classes while 16% had no opinion. It is clear that victims may choose not to disclose their HIV status for fear of being ostracized by society (Ben Wodi, 2005).

According to another study on HIV/AIDS prevention, control and care among adults in Kampala district Uganda, protestants (10%) were less likely to agree that

HIV infected individuals should be kept out of the community, more males (66%) than females (60%) believed that ARVs were effective against HIV/AIDS. Level of education and positive belief of the effect of ARVs on HIV/AIDS were directly related ($p < 0.05$). Married individuals were less supportive of teaching children (12-14years) how to use condoms (p=0.025). More males (19%) than females (11%) believed that an HIV positive mother should have a baby (Kasasa et al, 2004).

6.4 Conclusion

All Studies reviewed from several articles that examined any kind of HIV/AIDS knowledge were included in the literature review. The key words used in the search included, "HIV/AIDS", "knowledge", "knowledge of prevention", "knowledge of transmission", "adults", "youths", "Uganda", "Africa" and "Sub saharan Africa". Of all the studies included in the literature, only one was from Uganda, which could mean that research in this area has not been extensive in Uganda or that what has been done has not been published. The literature review failed to provide evidence that the knowledge of prevention and transmission of HIV/AIDS and the determinants of knowledge had been adequately explored. There is great need to understand knowledge levels and patterns among different groups to guide the future decisions of Ugandans.

Chapter 7

MATERIALS AND METHODS

This chapter presents the research objectives, source of data, sample design, methods of data collection and the different levels of statistical analysis.

7.1 Research questions/objectives

1. To determine the level of knowledge of prevention and transmission of HIV/AIDS among adults in Uganda

2. To investigate differences in knowledge among men and women

3. To examine the association between demographic/socioeconomic factors and knowledge of prevention and transmission of HIV/AIDS

4. To examine interactions between demographic and socioeconomic factors that influence knowledge of prevention and transmission of HIV/AIDS

7.2 Source of data, sample design, methods of data collection

Data used in this study was from the fourth cycle of the Uganda Demographic and Health Survey (UDHS) carried out in 2005/2006. It was the same data used for the malaria study above, therefore the sample design and methods of data collection were the same as explained in the materials and methods section of the malaria study.

7.3 Inclusion Criteria

In this HIV/AIDS study, only data for male and female respondents of ages 15-49 years was extracted from the 2006 UDHS database. In this survey both men and women had their own questionnaires (as mentioned in the methods of data collection) so each had a separate data set. A total of 2386 men and 8531 women were included in the study. From each of the two data sets, a different data set with only the required variables was extracted for analysis using the KEEP command in SAS code.

7.4 Variables included in the study

In the 2006 UDHS, respondents were asked whether or not they had heard of AIDS. Those who answered no were excluded at the bivariate and multivariate level of analyses (a total of 4 male respondents and 93 female respondents were excluded.) We chose one variable to test the knowledge of prevention of HIV/AIDS which was answered by the question "Can one reduce the chance of getting AIDS by condom use?". One variable was also chosen to test the knowledge of transmission of HIV/AIDS among men and women which was answered by the question "Can one get AIDS from mosquito bites?". The answers to both questions were either "yes", "no" or "I do not know". In the analysis, those who answered "I do not know" were added to

those who answered "no". It was assumed that they simply did not know. Other variables included age, type of residence, wealth index, and highest level of education achieved by the respondent.

7.5 Methods of data analysis

All analyses were done using the SAS statistical package. Data was extracted to get the required variables for the study of HIV knowledge of prevention and transmission among adults. Univariate, bivariate and multivariate types of analysis were used. At the univariate level of analysis, descriptive statistics were used. Here frequencies and percentage distributions of respondents' main (independent) variables under study were presented. These included age, type of residence, educational level and wealth index. At the bivariate level the chi-square test was used to test the different hypotheses and establish relationship between knowledge of transmission and prevention of HIV/AIDS and the independent variables. The formula for the chi-square is given by equation (3.7.1). In the final stage binary logistic regression was used to assess the relative importance of the variables. Only variables that were significant at the bivariate stage of analysis were considered for the regression analysis. Logistic regression models were used to analyze data at this stage because of the categorical nature of the dependent variables. There were a total of four models, two for knowledge of prevention of HIV/AIDS through condom use with one for the women and the other for the men, and the other two for the knowledge of transmission of HIV/AIDS in men and women. The logistic regression model was the same as the one explained in equation (3.7.9) above, with $\pi(x)$ representing the probability of agreeing to using condoms as an HIV/AIDS prevention method and mosquito bites as a means of transmission of HIV/AIDS. Model parameters were estimated using the maximum likelihood method. The variables included in the final models were selected through the backward elimination process. The final models were then tested for general good-

ness of fit using the Hosmer-Lemeshow test explained before. Influence plots were used to detect influential observations and to quantify their effects on various aspects of the maximum likelihood fit. In these plots, if the model is correctly specified and fits all observations well, then no extreme points should appear.

Chapter 8

RESULTS

8.1 Descriptive analysis

8.1.1 Frequency distributions of socioeconomic and demographic characteristics

Table 8.1 shows the socioeconomic and demographic characteristics of the study sample. The study sample included both men and women between ages $15 - 49$. The Uganda Demographic Health Survey sampled more women (8531) than men (2386). Considering age in both men and women the youngest group (15-19) was most represented compared to the oldest group (44-49). Type of residence of the respondents was considered according to whether it was rural or urban. The rural residents formed the largest group among the women (83.10%) and among the men (83.08%). Men were generally more educated compared to the women with (19.34%) of women having no formal education and only (4.85%) of men with no formal education. There was available at household level a record of possessions like radios and cars. Also available were the size, condition and materials used for constructing the house. This information was used to compute an index which was then categorized into poorest,

Table 8.1: Socioeconomic and demographic characteristics of the study sample

Predictors	WOMEN		MEN	
AGE(years)	Number	(%)	Number	(%)
15-19	1936	(22.69)	595	(24.95)
20-24	1710	(20.04)	402	(16.84)
25-29	1414	(16.57)	350	(14.65)
30-34	1217	(14.27)	356	(14.90)
35-39	939	(11.01)	311	(13.04)
40-44	735	(8.61)	210	(8.81)
45-49	580	(6.80)	162	(6.81)
EDUCATION				
No education	1650	(19.34)	116	(4.85)
Primary	5062	(59.34)	1551	(65.01)
Secondary	1488	(17.45)	571	(23.92)
Higher+	331	(3.88)	148	(6.22)
RESIDENCE				
Urban	1442	(16.90)	404	(16.92)
Rural	7089	(83.10)	1982	(83.08)
WEALTH INDEX				
Poorest	1542	(18.07)	378	(15.84)
Poorer	1635	(19.17)	496	(20.77)
Middle	1615	(18.93)	422	(17.69)
Richer	1622	(19.01)	506	(21.22)
Richest	2117	(24.82)	584	(24.48)

poorer, medium, richer and richest wealth status. There were no major differences in men and women according to categories of wealth index with more respondents falling in the richest category; (24.82%) in women and (24.48%) in men. The men and women do not come from the same household.

8.2 Bivariate analysis

8.2.1 Knowledge of prevention of HIV/AIDS

In the 2006 UDHS, men and women were specifically asked if one can reduce the risk of acquiring HIV/AIDS through consistently using condoms, limiting sexual intercourse to one uninfected partner who has no other sex partners, and abstaining from sexual intercourse. Condom use was considered for this study to test knowledge of prevention of HIV/AIDS. Only respondents who had heard of HIV/AIDS answered questions on knowledge of prevention and transmission of HIV/AIDS. Four of the male respondents and 93 of the females had never heard of AIDS and were excluded from the analysis below. The results of knowledge of HIV prevention methods for women and men are shown in Tables 8.2 and 8.3 below. Knowledge of HIV/AIDS prevention by use of condoms was generally higher among urban residents among the women; however there was no difference among the men. Considering age, knowledge of ways to prevent HIV/AIDS tended to be highest among men age 30-34 (88%); however, among women, knowledge was higher in the age group 20-24 (73.73%). Knowledge of the HIV prevention method of condom use generally increased with educational attainment and wealth quintile among men and women. Education levels and wealth index were significantly associated to knowledge of HIV prevention in both men and women, however age and residence were only significant among the women and insignificant among the men, with p values of 0.0609 and 0.6278 for age and residence respectively.

Table 8.2: Percentage of Women who agreed that use of condoms reduces HIV/AIDS risk by Socioeconomic and demographic characteristics.

PREDICTORS	CONDOM USE $N = 5949$			chi^2	P-VALUE
AGE	Number	Percentage	Total		
15-19	1383	(72.48)	1908	54.0825	< 0.0001
20-24	1249	(73.73)	1694		
25-29	1003	(71.69)	1399		
30-34	842	(69.75)	1207		
35-39	616	(66.31)	929		
40-44	508	(69.78)	728		
45-49	348	(60.73)	573		
RESIDENCE					
Urban	1108	(77.48)	1430	40.5549	0.0036
Rural	4841	(69.08)	7008		
EDUCATION					
No education	875	(54.3)	1610	345.9637	< 0.0001
Primary	3566	(71.09)	5016		
Secondary	1226	(82.73)	1482		
Higher+	282	(85.45)	330		
WEALTH INDEX					
Poorest	892	(59.63)	1496	251.0571	< 0.0001
Poorer	1051	(64.76)	1623		
Middle	1083	(67.60)	1602		
Richer	1213	(75.29)	1611		
Richest	1710	(81.20)	2106		

'CONDOM USE' means; 'number of women who say HIV can be prevented by consistent use of condoms'

Table 8.3: Percentage of Men who agreed that use of condoms reduces HIV/AIDS risk by Socioeconomic and demographic characteristics.

PREDICTORS	CONDOM USE $N = 2005$			chi^2	P-VALUE
AGE	Number	Percentage	Total		
15-19	482	(81.28)	593	15.0892	0.0609
20-24	336	(83.79)	401		
25-29	306	(87.43)	350		
30-34	313	(88.17)	355		
35-39	267	(85.85)	311		
40-44	172	(81.90)	210		
45-49	129	(79.63)	162		
RESIDENCE					
Urban	335	(82.92)	404	0.5823	0.6278
Rural	1670	(83.46)	1978		
EDUCATION					
No education	80	(70.16)	114	32.5248	< 0.0001
Primary	1284	(82.89)	1549		
Secondary	509	(89.14)	571		
Higher+	132	(89.19)	148		
WEALTH INDEX					
Poorest	284	(75.53)	376	28.0900	0.0002
Poorer	421	(85.22)	494		
Middle	357	(84.60)	422		
Richer	429	(84.78)	506		
Richest	514	(88.01)	584		

'CONDOM USE' means 'number of men who say HIV can be prevented by consistent use of condoms'

8.2.2 Knowledge of transmission of HIV/AIDS

In the UDHS both men and women were asked if they thought AIDS could be transmitted through mosquito bites. Tables 8.4 and 8.5 below show the results in women and men respectively by socioeconomic and demographic characteristics. Knowledge of HIV/AIDS transmission by mosquito bite was generally higher among urban residents in both men and women. Rural residents were more likely to agree that HIV/AIDS was transmitted through mosquito bites. Knowledge of the HIV transmission generally increased with educational attainment and wealth quintile among men and women with the richest and most educated groups less likely to agree to the fact that HIV/AIDS is spread through mosquito bites. Considering age, patterns were less clear for both men and women. Type of residence, education levels and wealth index were all significantly associated with knowledge of HIV transmission by mosquito bite in both men and women, however age only had a significant association in women [p value for age in men 0.1177].

Table 8.4: Percentage of Women who agreed that HIV/AIDS is spread through mosquito bites by Socioeconomic and demographic characteristics.

PREDICTORS	MOSQUITO BITES $N = 2260$			chi^2	P-VALUE
AGE	Number	Percentage	Total		
15-19	569	(29.88)	1908	19.932	0.0140
20-24	463	(27.33)	1694		
25-29	337	(24.09)	1399		
30-34	327	(27.34)	1207		
35-39	226	(24.33)	929		
40-44	201	(27.61)	728		
45-49	137	(23.91)	573		
RESIDENCE					
Urban	272	(19.02)	1430	52.4789	< 0.0001
Rural	1988	(28.37)	7008		
EDUCATION					
No education	478	(29.67)	1610	135.3696	< 0.0001
Primary	1484	(29.59)	5016		
Secondary	267	(18.02)	1482		
Higher+	31	(9.39)	330		
WEALTH INDEX					
Poorest	510	(34.09)	1496	160.6862	< 0.0001
Poorer	533	(32.84)	1623		
Middle	412	(25.72)	1602		
Richer	432	(26.82)	1611		
Richest	373	(17.71)	2106		

'MOSQUITO BITES' means 'number of women who say HIV can be transmitted through mosquito bites'

Table 8.5: Percentage of Men who agreed that HIV/AIDS is spread through mosquito bites by Socioeconomic and demographic characteristics.

PREDICTORS	MOSQUITO BITES $N = 927$			chi^2	P-VALUE
AGE	Number	Percentage	Total		
15-19	214	(36.09)	593	11.1102	0.1177
20-24	173	(43.14)	401		
25-29	137	(39.14)	350		
30-34	137	(37.15)	355		
35-39	108	(38.59)	311		
40-44	83	(39.52)	210		
45-49	75	(46.30)	162		
RESIDENCE					
Urban	124	(32.54)	404	13.3567	0.0093
Rural	803	(40.60)	1978		
EDUCATION					
No education	75	(65.79)	114	185.9268	< 0.0001
Primary	713	(46.03)	1549		
Secondary	122	(21.37)	571		
Higher+	17	(11.49)	148		
WEALTH INDEX					
Poorest	166	(44.15)	376	32.5994	0.0003
Poorer	216	(43.72)	494		
Middle	182	(43.13)	422		
Richer	187	(36.96)	506		
Richest	176	(30.14)	584		

'MOSQUITO BITES' means 'number of men who say HIV can be transmitted through mosquito bites'

8.3 Multivariate analysis

8.3.1 Knowledge of prevention of HIV/AIDS

Model formation processes

Only variables that had a significant association with knowledge of HIV prevention via condoms at the bivariate stage of analysis were selected for multivariate analysis. Among women all the variables (age, education, residence and wealth index) were significantly associated with knowledge of HIV via condoms prevention at the bivariate stage of analysis; however among men only education and wealth were significant. All these variables with all their possible interactions were entered into the backward elimination process explained in section 3.7.3 to find a good model to test knowledge of HIV prevention. For the women, the variables selected for the final model by backward elimination were age, education, residence, wealth index and two interactions-one between age and education and the other between residence and wealth index. For the men, the chosen variables were education and wealth index (the interaction was dropped through backward elimination). The tables below show the order in which variables were eliminated by the backward elimination process.

Table 8 6 Model formation process/ summary of stepwise selection[WOMEN]

Step	Removed	DF	Wald-chi-square	P-value
1	$Age * Residence * Education * Wealth$	29	3 6840	1 0000
2	$Age * Education * Wealth$	61	46 0595	0 9223
3	$Age * Residence * Wealth$	23	15 5001	0 8758
4	$Age * Residence * Education$	18	11 2642	0 8828
5	$Residence * Education * Wealth$	9	7 8436	0 5500
6	$Residence * Education$	3	3 4588	0 3261
7	$Education * Wealth$	12	15 7487	0 1473
8	$Age * Residence$	6	9 5018	0 1473
9	$Age * Wealth$	24	35 9560	0 0554

'DF' means 'Degrees of freedom'

Table 8 7 Model formation process/ summary of stepwise selection[MEN]

Step	Removed	DF	Wald-chi-square	P-value
1	$Education * Wealth$	12	16 2301	0 1809

'DF' means 'Degrees of freedom'

Final multivariate logistic regression models to test knowledge of HIV/AIDS prevention

Variables age, education and wealth index were collapsed into two categories each in the final women's model to make model interpretation easy. Closeness of the exposure effect was considered in collapsing variables. For age, respondents 15-34 years were put in the younger adults category and respondents 35-49 were in the older adults category. For education respondents who had no education and those who stopped at the primary level of education were categorized as less educated and those with secondary and higher levels of education were collapsed to form the more educated group. For the wealth index, poorest and poorer respondents formed the poor category while the middle, rich and richer respondents were collapsed to form the rich category. By definition, if a variable is involved in an interaction then there is not a single odds ratio estimate for it. Rather, the odds ratio for the variable depends on the level(s) of the interacting variable(s). For women, results show that least educated older [34-49] adults were less likely to agree to use of condoms as a prevention method compared to the more educated older adults [35-49] [OR=0.388, 95% Confidence interval (0.269, 0.562)]. The poor female rural residents were also less likely to agree to use of condoms as a prevention method compared to the rich female rural residents [OR=0.617, 95% Confidence interval (0.536, 0.710)]. For the men, knowledge of HIV prevention increased with educational attainment. Male respondents with the highest level of education were 3 times more likely to have correct knowledge of HIV/AIDS prevention via condom use compared to those with no education [OR =2.8, 95% confidence interval (1.39, 5.67)]. For wealth, the richest male were 1.9 times more likely to have correct knowledge of HIV/AIDS prevention via condom use compared to the poorest male respondents [OR=1.855, 95% confidence interval (1.23, 2.80)].

Table 8 8 Results of final multivariate logistic regression for women with age, education and wealth collapsed into two categories

Parameter	DF	Estimate	Standard Error	Chi-Square	P-value
Intercept	1	1 1239	0 4265	6 9452	0 0084
Age(years)					
15-34 (Reference)					
35-49	1	-0 2209	0 0618	12 7887	0 0003
Residence					
Urban (Reference)					
Rural	1	-0 6074	0 4341	1 9582	0 1617
Wealth index					
Poor (Reference)					
Above average+(Rich)	1	-0 1835	0 4317	0 1807	0 6708
Education					
Less educated (Reference)					
More Educated	1	0 6705	0 0880	58 0582	< 0 0001
Age and education					
Less educated less than 34 year old (Reference)					
More educated greater than 34 year old	1	0 2751	0 1881	2 1394	0 1436
Residence and wealth index					
Poor urban residents (Reference)					
Rich rural residents	1	0 6663	0 4366	2 3291	0 1270

Table 8 9 Odds ratios for final multivariate logistic regression for women with 95% confidence intervals

Effect	Odds ratio	95%Confidence Limits
AGE*EDUCATION		
Age[35-49]+More education (Reference)		
Age[15-34]+No education	0 484	(0 331, 0 708)
Age[15-34]+More education	0 947	(0 653, 1 375)
Age[35-49]+No education	0 388	(0 269, 0 562)
RESIDENCE*WEALTH		
Rural residence+Rich (Reference)		
Urban residence+Poor	1 133	(0 484, 2 650)
Urban residence+Rich	0 943	(0 749, 1 187)
Rural residence+Poor	0 617	(0 536, 0 710)

Table 8.10: Results of final multivariate logistic regression for men with two variables wealth index and education level.

Parameter	DF	Estimate	Standard Error	Chi-Square	P-value
Intercept	1	0 4822	0 2359	4 1792	0 0409
EDUCATION					
No Education (Reference)					
Primary	1	0 6738	0 2240	9 0448	0 0026
Secondary	1	1 1242	0 2333	23 2292	< 0 0001
Higher +	1	1 0302	0 3595	8 2103	0 0042
WEALTH INDEX					
Poorest (Reference)					
Poorer	1	0 6085	0 1752	12 0655	0 0005
Middle	1	0 4874	0 2047	5 6671	0 0173
Higher	1	0 4677	0 1893	6 1066	0 0135
Highest	1	0 6179	0 2104	8 6275	0 0033

Table 8.11: Odds ratios for final multivariate logistic regression for men with two variables wealth index and education level.

Effect	Odds ratio	95%Confidence Limits	
EDUCATION			
No education (Reference)			
Primary	1 962	1 265	3 043
Secondary	3 078	1 948	4 862
Higher+	2 802	1 385	5 668
WEALTH INDEX			
Poorest (Reference)			
Poorer	1 838	1 304	2 595
Middle	1 628	1 090	2 432
Higher	1 596	1 102	2 313
Highest	1 855	1 228	2 802

8.3.2 Results of Logistic Regression Diagnostics

A global test of goodness of fit of the final model was performed using the Hosmer-Lemeshow test and it showed that women's model was not a good fit [chi square= 26.4385, Degrees of Freedom(DF)=8 and p-value=0.0009]. The small p-value for the women's model could be explained by the large sample size for the women considering the fact that the Hosmer-Lemeshow test is very sensitive to sample size. The index plots of the Pearson residuals and the deviance residuals of the women's model in Figure 8.1 below indicated that all cases were well accounted for by the model. The index plot of the leverage suggested that a few cases between case 3500 and 4500 were extreme points in the design space. The other index plots also pointed to these few cases having a larger impact on the coefficients and goodness of fit. The index plots of DFBETAS (Figures 8.3 and 8.4) indicated that the same cases were causing instability in two of the parameter estimates. It should be noted that in any set of data, at least three observations will be the most extreme. Deleting cases with the largest residuals or most extreme values almost always improves the fit of the model, however outliers should only be dropped if and only if it is obvious that the outlier is due to incorrectly entered. Given the very small number model inadequacies observed in the women's model, the original model was taken as the final model. The conclusions made about the original model were therefore justified.

Table 8.12: Partition for the Hosmer and Lemeshow test for women.

	Condom=Yes			Condom=No	
Group	Total	Observed	Expected	Observed	Expected
1	892	374	436.50	518	455.50
2	835	462	478.64	373	356.36
3	846	563	543.15	283	302.85
4	801	528	537.01	273	263.99
5	877	581	604.70	296	272.30
6	830	603	599.32	227	230.68
7	877	667	662.80	210	214.20
8	848	669	665.35	179	182.65
9	860	698	706.73	162	153.27
10	772	669	678.88	103	93.12

Figure 8.1: Influence plots of Residuals, Leverage, and CI Displacement C for the women

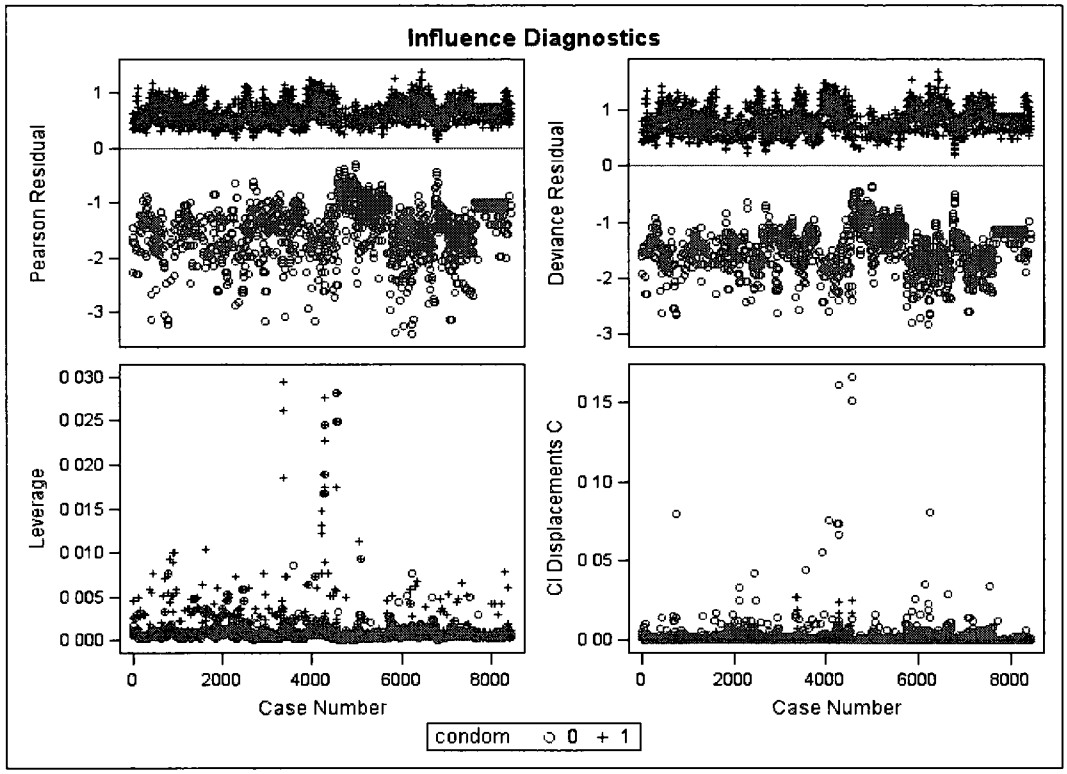


Figure 8.2: Influence plots of CI Displacement CBar, Change in deviance and Pearson Chi square for the women

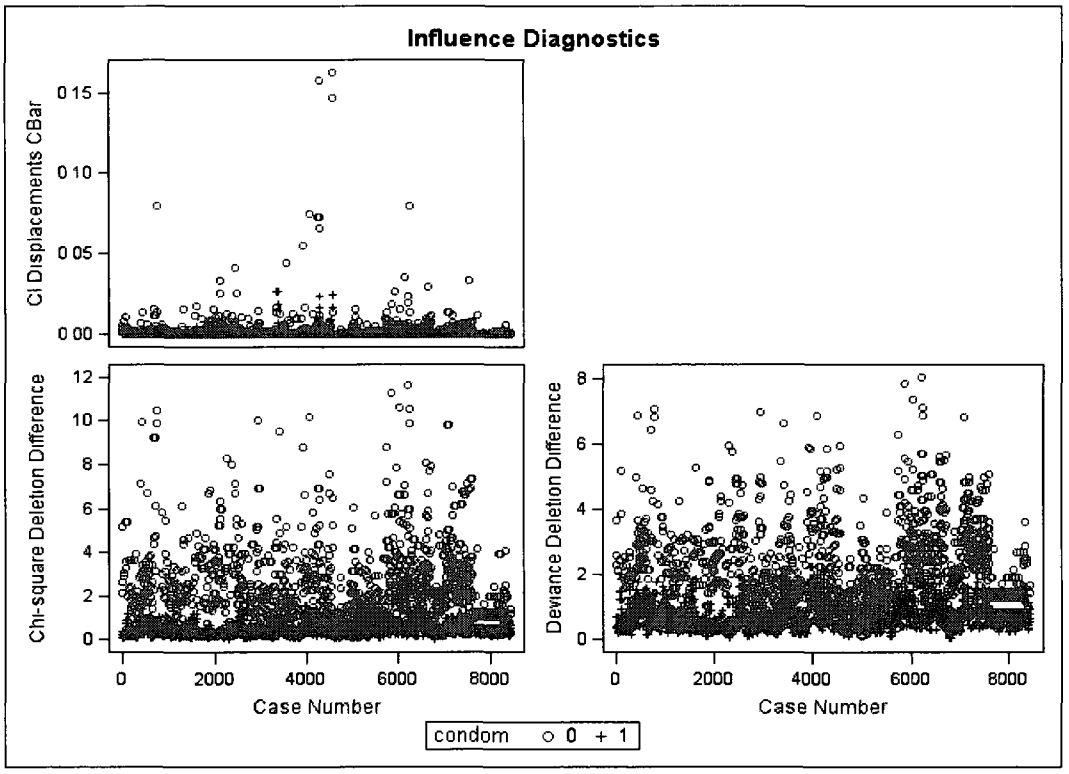


Figure 8.3: DFBETAS Plots of age, type of residence(V102), and educational attainment for the women

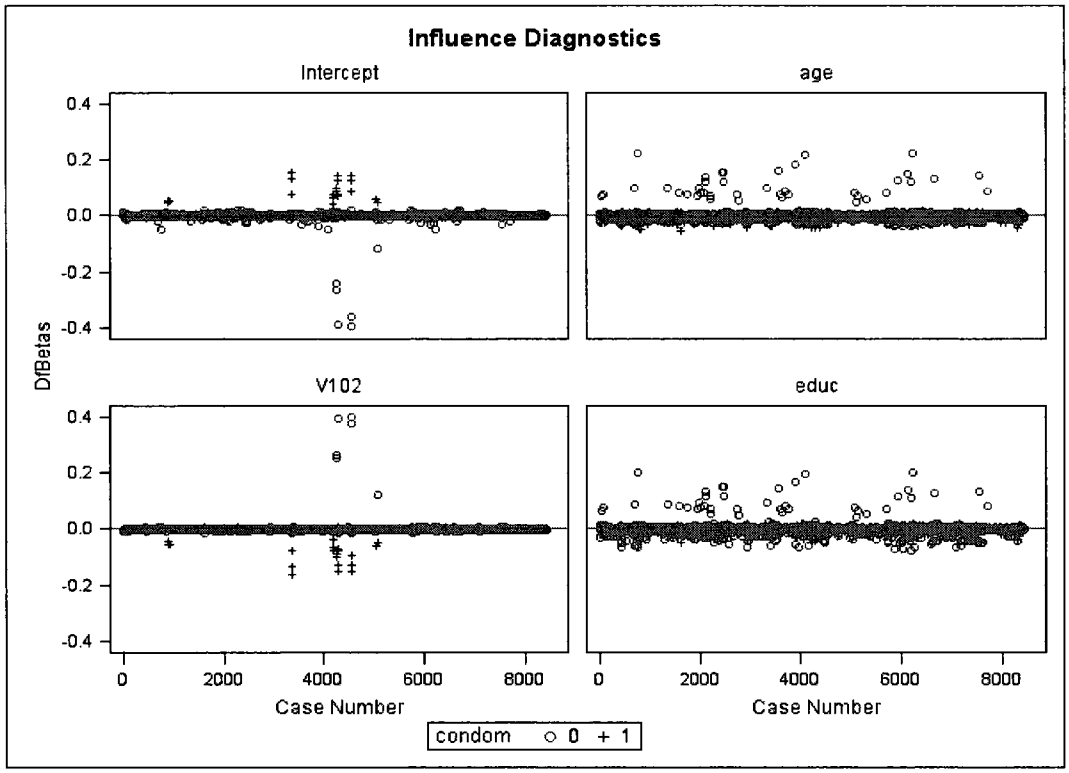


Figure 8.4: DFBETAS Plots of wealth index and the interaction effects for the women

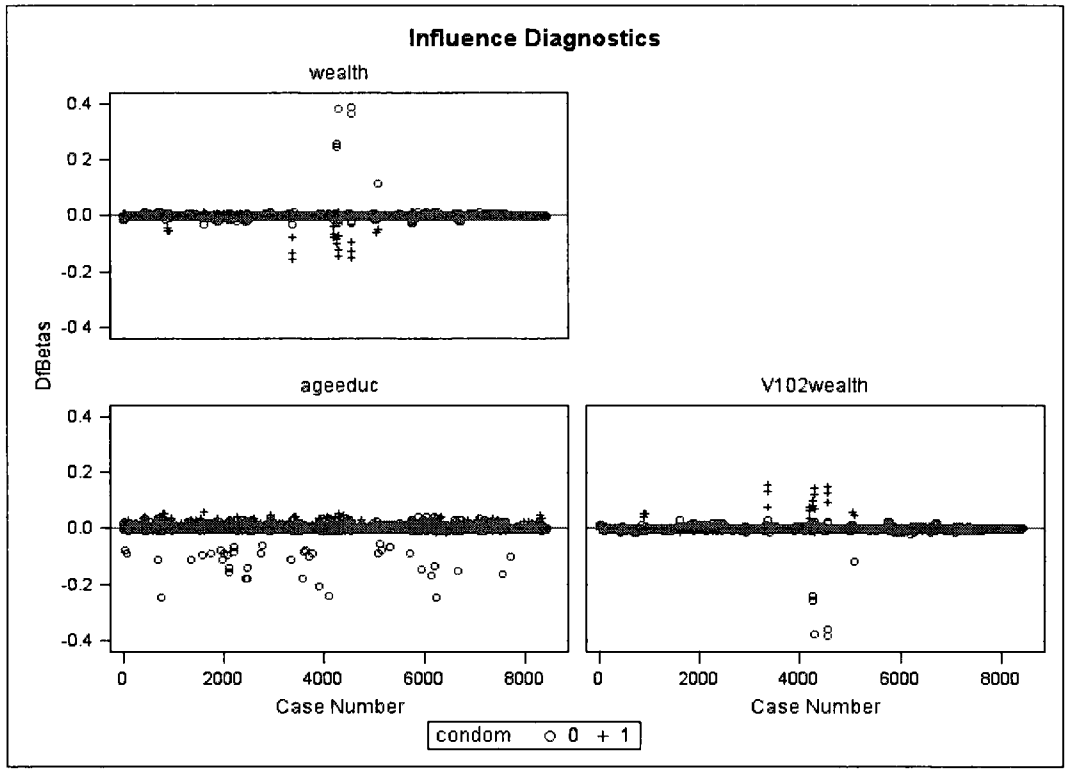


Table 8.13: Partition for the Hosmer and Lemeshow test for men.

	Condom=Yes			Condom=No	
Group	Total	Observed	Expected	Observed	Expected
1	130	84	88.81	46	41.19
2	330	252	251.00	78	79.00
3	348	297	290.43	51	57.57
4	298	248	249.72	50	48.28
5	377	318	321.87	59	55.13
6	248	220	212.55	28	35.45
7	237	209	210.65	28	26.35
8	180	166	161.38	14	18.62
9	234	201	211.16	33	22.84

A global test of goodness of fit of the men's final model was performed using the Hosmer-Lemeshow test as shown in Table 8.13 above. The model for the men was a good fit [chi square= 10.3667, DF=7 and p-value=0.1687]. The index plots of the Pearson residuals and the deviance residuals of the men's model in Figure 8.5 below indicated that case 991 was not accounted for by the model. The index plot of the leverage suggested case 500 was an extreme point in the design space. The other index plots also pointed to case 991 having a larger impact on the coefficients and goodness of fit. The index plots of DFBETAS (Figures 8.7) indicated that case 991 was causing instability in two of the parameter estimates. This observation was deleted and a new model was re-run. The new model was not significantly different form the baseline model. The conclusions made about the original men's were therefore justified.

Figure 8.5: Influence plots of Residuals, Leverage, and CI Displacement C for the men

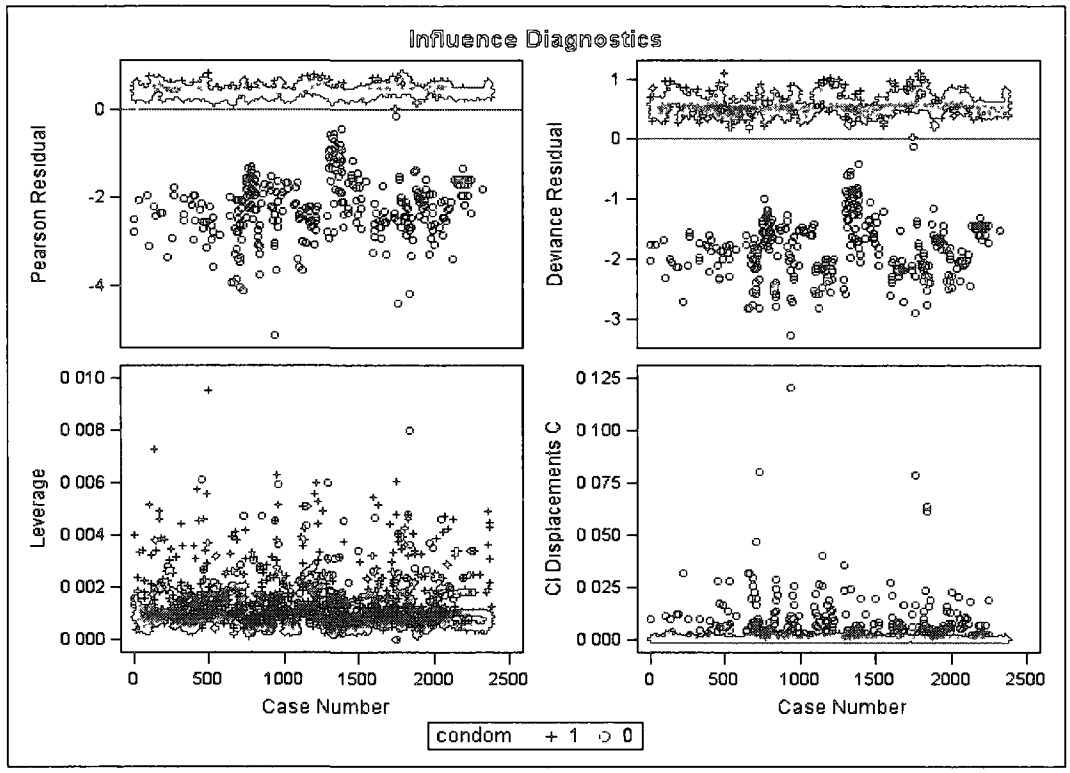


Figure 8.6: Influence plots of CI Displacement CBar, Change in deviance and Pearson Chi square for the men

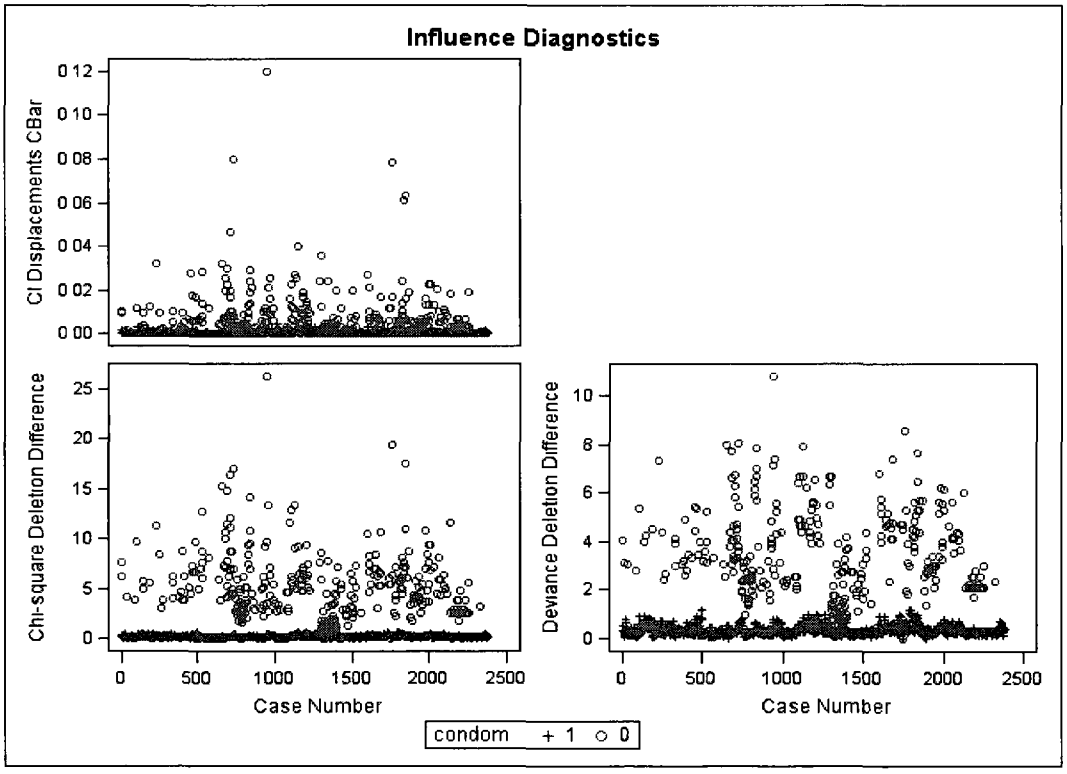
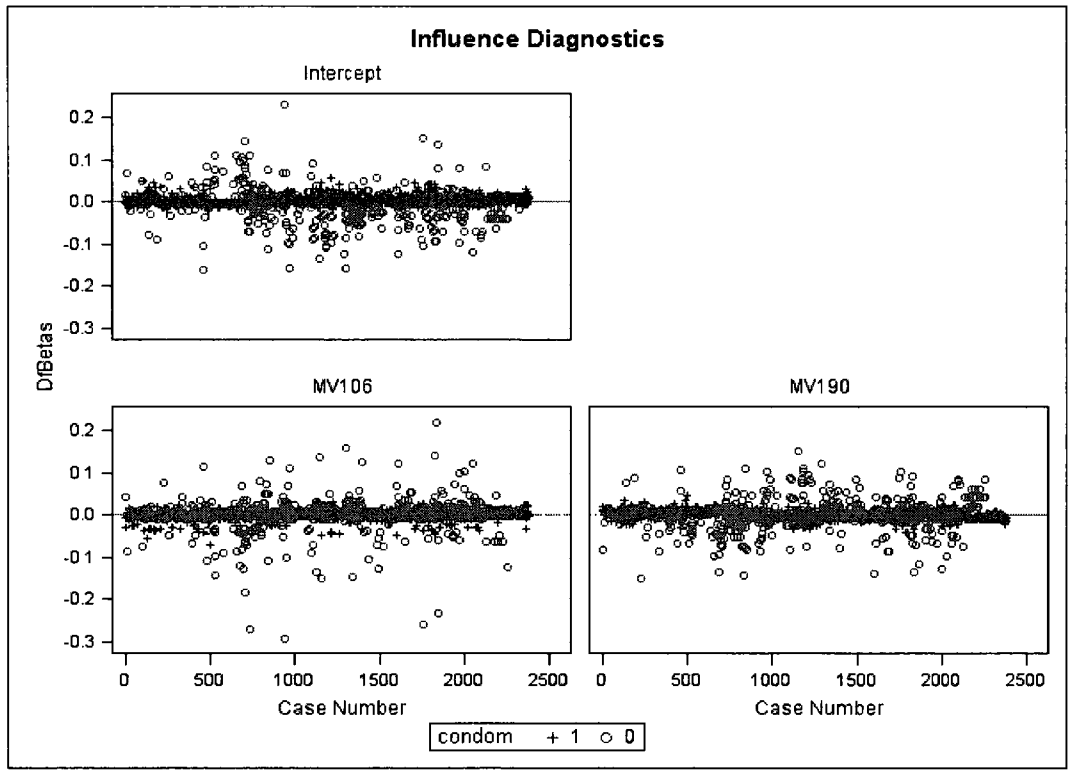


Figure 8.7: DFBETAS Plots of educational attainment(MV106), and Wealth index (MV190) for the men



8.3.3 Knowledge of transmission of HIV/AIDS

Model formation processes

Only variables that had a significant association with knowledge of HIV transmission by mosquito bite at the bivariate level were selected at the multivariate stage of analysis. Among the women again all the variables (age, education, residence and wealth index) were significantly associated to knowledge of HIV/AIDS transmission by mosquito bite at the bivariate stage of analysis; however among the men only residence, education and wealth were significant. All these variables with all their possible interactions were entered into the backward elimination process to find a good model to test knowledge of HIV transmission. The tables below show the order in which variables were eliminated. For the women's model, the variables selected for the final model were age, education, residence and wealth index and two interactions one between age and residence and the second between education and wealth index. For the men only education was chosen for the final model by the backward elimination process.

Table 8 14: Model formation process/ summary of stepwise selection[WOMEN].

Step	Removed	DF	Wald-chi-square	P-value
1	$Age * Residence * Education * Wealth$	29	3.8646	1.0000
2	$Age * Education * Wealth$	61	31.4248	0 9994
3	$Age * Residence * Wealth$	23	12.9145	0.9538
4	$Age * Residence * Education$	18	14.8106	0.6749
5	$Age * Wealth$	24	26.8489	0.3115
6	$Residence * Education * Wealth$	9	10 7707	0 2918
7	$Residence * Wealth$	4	3 1705	0 5297
8	$Age * Education$	18	20.7266	0.2934
9	$Residence * Education$	3	5.5000	0 1386

'DF' means 'Degrees of freedom'

Table 8.15: Model formation process/ summary of stepwise selection[MEN].

Step	Removed	DF	Wald-chi-square	P-value
1	$Residence * Education * Wealth$	8	0.0077	1.0000
2	$Education * Wealth$	12	8.4194	0 7516
3	$Residence * Wealth$	4	3 7472	0.4413
4	$Wealthindex$	4	1.6526	0.7993
5	$Residence * Education$	3	5.6963	0 1274
6	$Residence$	1	0.0005	0.9825

'DF' means 'Degrees of freedom'

Final multivariate logistic regression models to test knowledge of HIV transmission

Variables age, education and wealth index were again collapsed into two categories each in the final women's model. From the women's model results showed that younger[15-34] female rural residents had less knowledge of transmission compared to the older[34-49] female rural residents because they were 1.3 times more likely to agree to mosquito bites as a means of HIV transmission [OR=1.290, 95% Confidence interval (1.131, 1.471)]. The least educated female poor respondents had less knowledge of transmission compared to the more educated rich female respondents because they were 2.5 times more likely to think of mosquito bites as an HIV/AIDS transmission method [OR=2.465, 95% Confidence interval (2.001, 3.037)]. For the men's model, knowledge of transmission by mosquito bite increased with an increase in male educational attainment; the most educated males were less likely to agree to mosquito bites as a form of HIV transmission [OR=0.07, 95% confidence interval (0.04, 0.14)] compared to male respondents with no formal education.

Table 8.16: Results of final multivariate logistic regression for women with age, education and wealth collapsed into two categories.

Parameter	DF	Estimate	Standard Error	Chi-Square	P-value
Intercept	1	-0 8668	0 1354	41 0020	< 0 0001
Age(years)					
15-34 (Reference)					
35-49	1	0 1688	0 1703	0 9826	0 3215
Residence					
Urban (Reference)					
Rural	1	0 3068	0 1278	5 7588	0 0164
Wealth index					
Poor (Reference)					
Above average+(Rich)	1	-0 3993	0 0720	30 7552	< 0 0001
Education					
Less educated (Reference)					
More Educated	1	-1 2331	0 2455	25 2254	< 0 0001
Age and Residence					
< 34 year old urban residents (Reference)					
> 34 year old rural residents	1	-0 4234	0 1840	5 2936	0 0214
Education and wealth index					
Poor Less educated (Reference)					
Rich more educated	1	0 7301	0 2603	7 8689	0 0050

Table 8.17: Odds ratios for final multivariate logistic regression for women with 95% confidence intervals

Effect	Odds ratio	95%Confidence Limits	
AGE*RESIDENCE			
Age[35-49]+Rural residence (Reference)			
Age[15-34]+Urban residence	0 949	0 728	1 237
Age[15-34]+Rural residence	1 290	1 131	1 471
Age[35-49]+Urban residence	1 124	0 821	1 537
EDUCATION*WEALTH			
More educated+Rich (Reference)			
Less educated+Poor	2 465	2 001	3 037
Less educated+Rich	1 654	1 372	1 994
More educated+Poor	0 718	0 433	1 191

Table 8.18: Results of final multivariate logistic regression for the men

Parameter	DF	Estimate	Standard Error	Chi-Square	P-value
Intercept	1	0 6477	0 2616	6 1284	0 0133
EDUCATION					
No Education (Reference)					
Primary	1	-0 8079	0 2643	9 3431	0 0022
Secondary	1	-1 9467	0 2763	49 6339	ı 0001
Higher +	1	-2 6517	0 3382	61 4697	ı 0001

Table 8 19: Odds ratios of final multivariate logistic regression for the men.

Effect	Odds ratio	95%Confidence Limits	
EDUCATION			
No education(Reference)			
Primary	0 446	0 266	0 748
Secondary	0 143	0 083	0 245
Higher+	0 071	0 036	0 137

8.3.4 Results of Logistic Regression Diagnostics

A global test of goodness of fit of the final model was performed using the Hosmer-Lemeshow test and it showed that the women's model was a good fit with [chi square= 8 2161 Degrees of Freedom=7 and p-value=0.3139]. The index plots of the Pearson residuals and the deviance residuals of the women's model in Figure 8.8 below indicated that about 10 cases were not well accounted for by the model. The index plot of the leverage suggested that one case between case 4000 and 4100 was an extreme points in the design space. The other index plots also pointed to other few cases having a larger impact on the coefficients and goodness of fit. Given the women's large sample size, some extreme points could have occured purely by chance. Given that the overall test for goodness fit showed no lack of fit. It was concluded that the model inadequacies were not justified and could have occurred by chance. The conclusions made about the original model was therefore justified.

Table 8.20: Partition for the Hosmer and Lemeshow test for women.

	Mosquito=Yes		Mosquito=No		
Group Total	Observed	Expected	Observed	Expected	
1	856	112	123.70	744	732.30
2	983	182	178.23	801	804.77
3	449	88	98.75	361	350.25
4	914	223	209.33	691	704.67
5	148	36	37.04	112	110.96
6	1952	527	540.77	1425	1411.23
7	963	296	295.22	667	667.78
8	17	9	5.65	8	11.35
9	2156	802	783.83	1354	1372.17

Figure 8.8: Influence plots of Residuals, Leverage, and CI Displacement C for the women

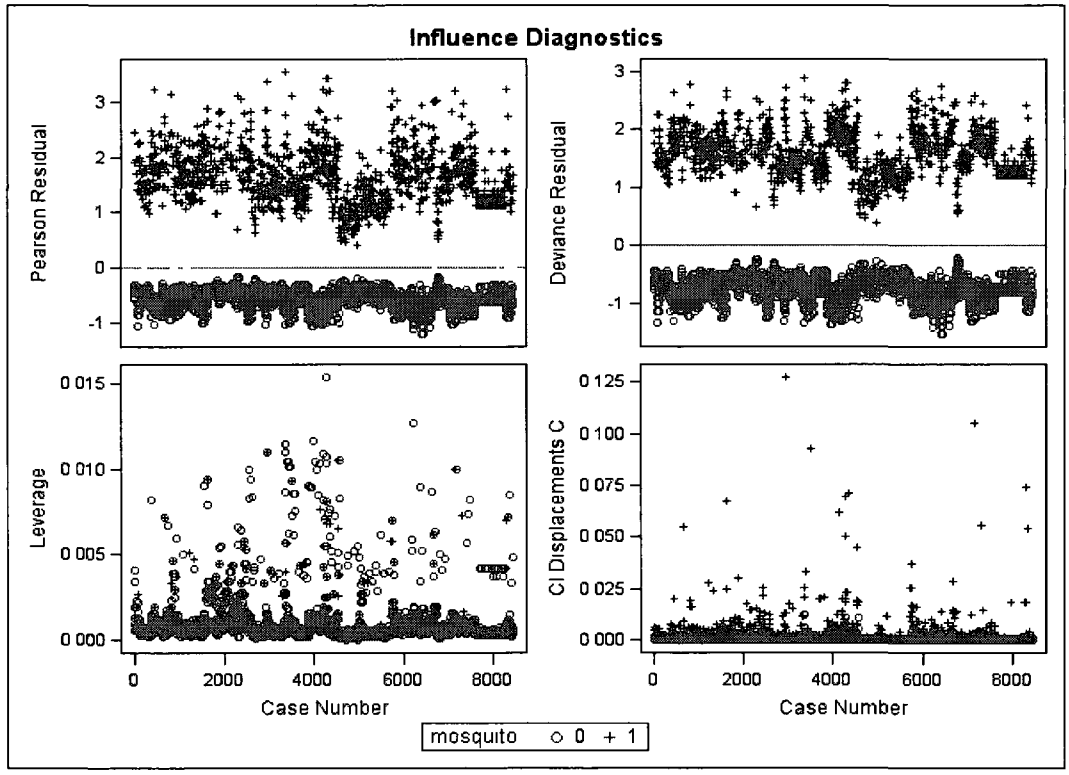


Figure 8.9: Influence plots of CI Displacement CBar, Change in deviance, and Pearson Chi square for the women

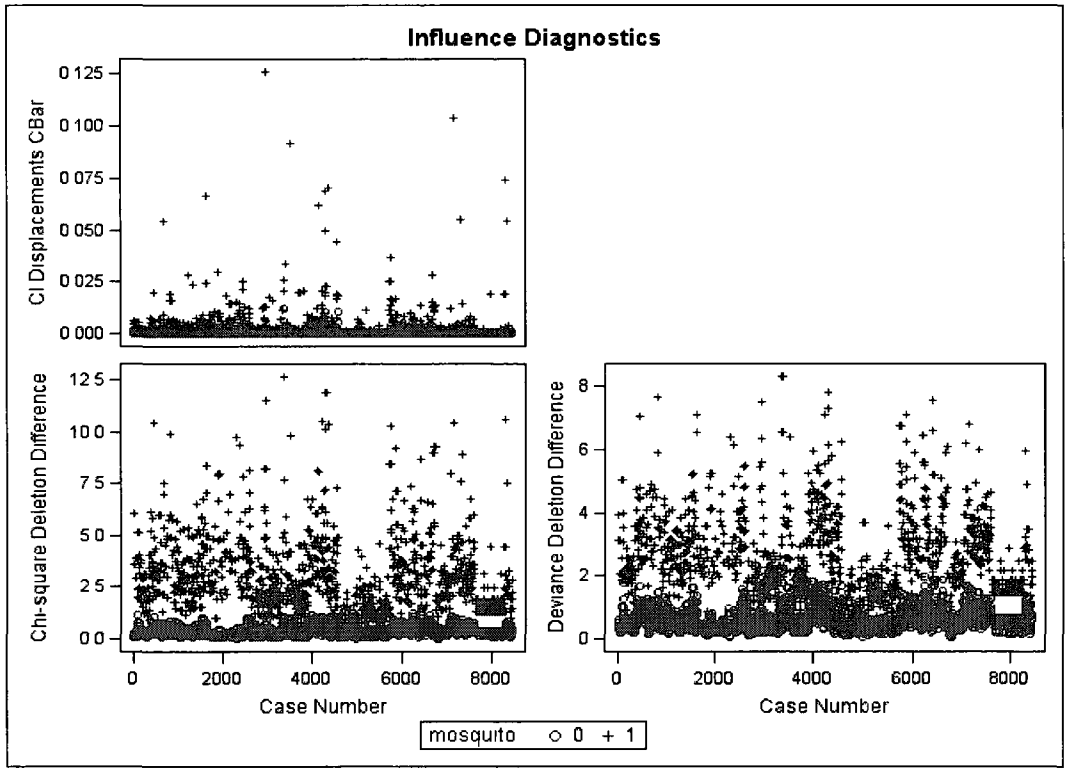


Figure 8.10: DFBETAS Plots of age, type of residence(V102), and educational attainment for the women

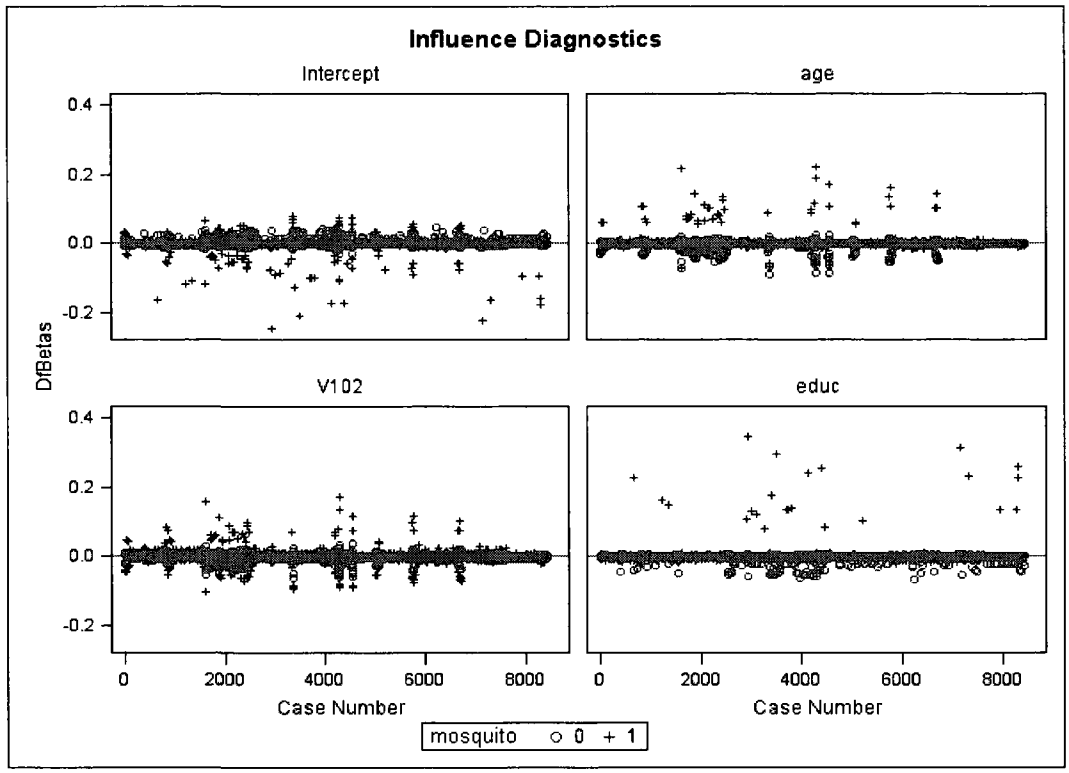
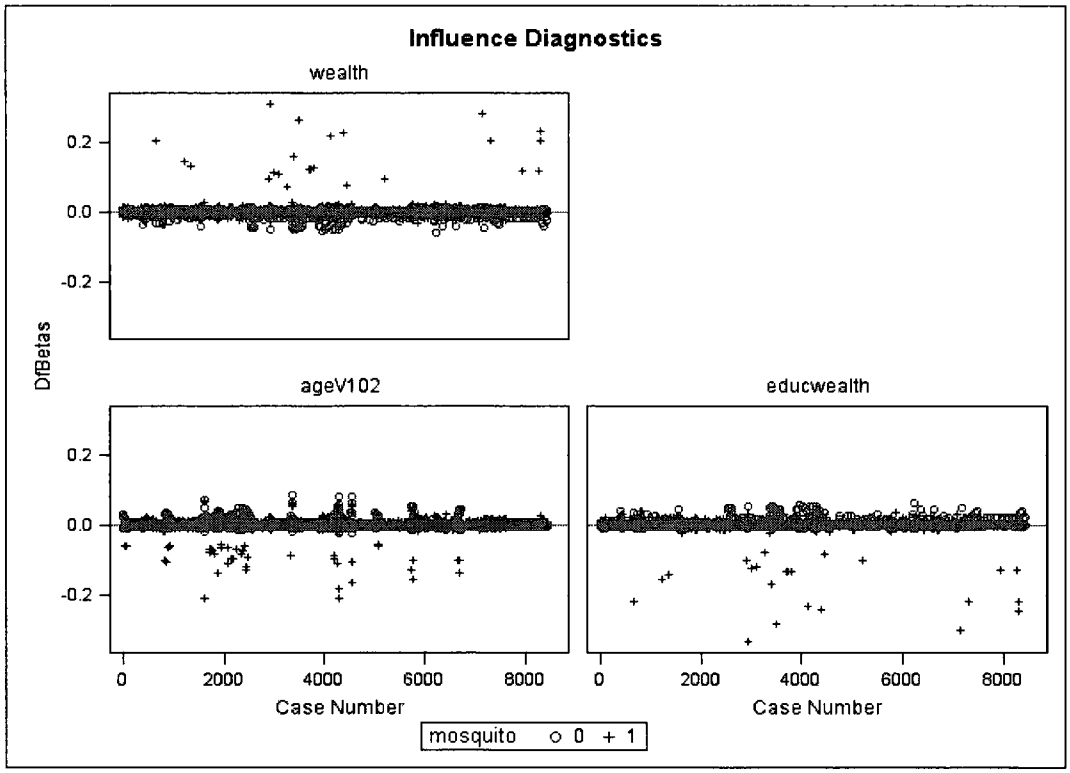


Figure 8.11: DFBETAS Plots of wealth index and the interaction effects for the women



A global test of goodness of fit of the men's final model was performed using the Hosmer-Lemeshow test as shown in Table 8.21 above. The model for the men was a good fit [chi square= 0.8093, DF=7 and p-value=0.6672]. The influence plots however showed a very small number model inadequacies which were assumed to have occurred by chance. The conclusions made about the original men's were therefore justified.

Table 8.21: Partition for the Hosmer and Lemeshow test for men.

	Mosquito=Yes		Mosquito=No		
Group	Total	Observed	Expected	Observed	Expected
1	155	20	18.41	135	136.59
2	570	120	122.17	450	447.83
3	1527	710	702.48	817	824.52
4	130	89	85.34	41	44.66

Figure 8.12: Influence plots of Residuals, Leverage, and CI Displacement C for the men

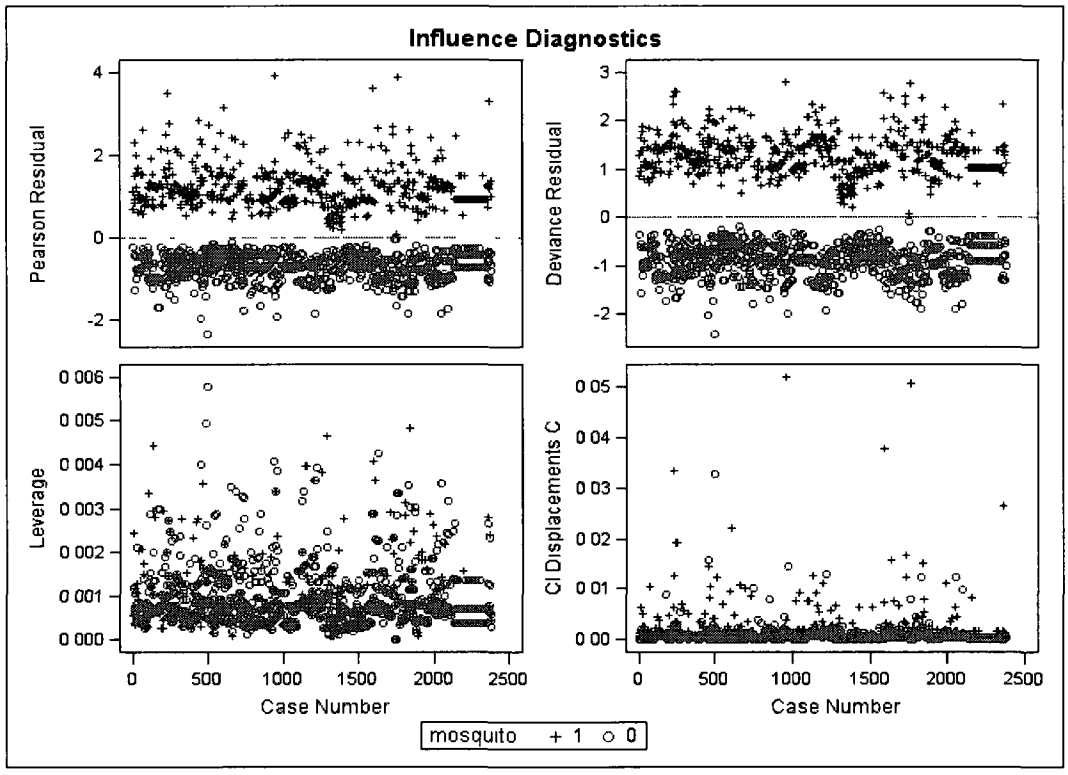


Figure 8.13: Influence plots of CI Displacement CBar, Change in deviance, and Pearson Chi square for the men

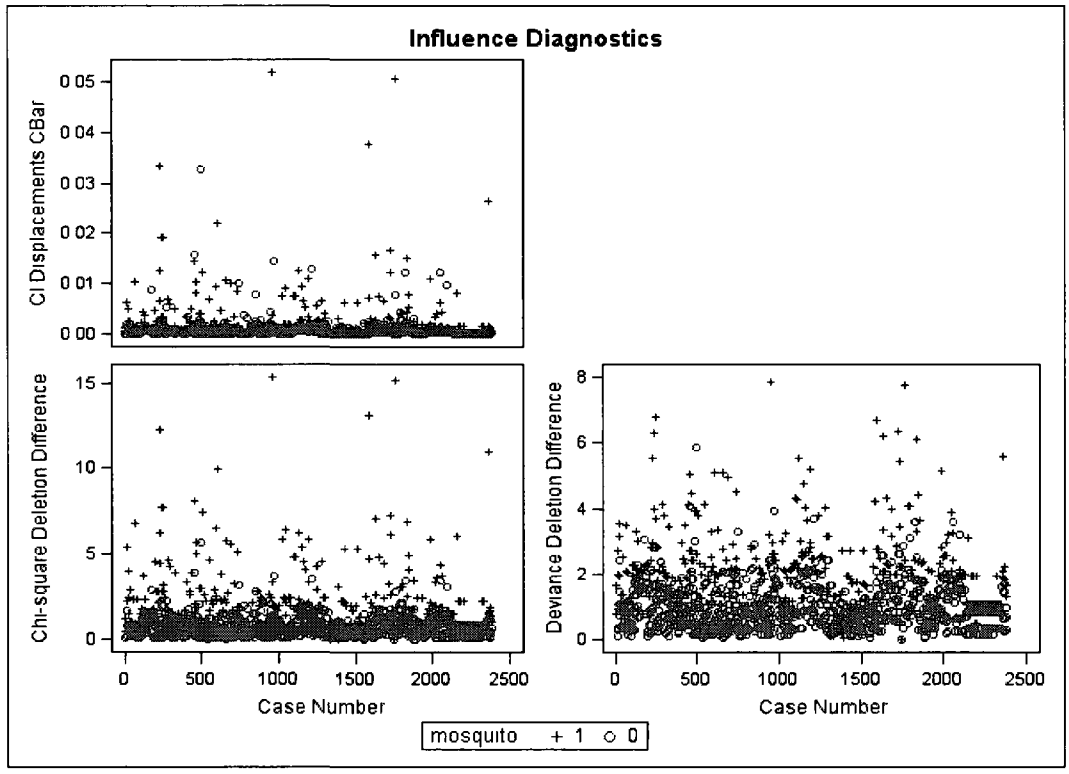
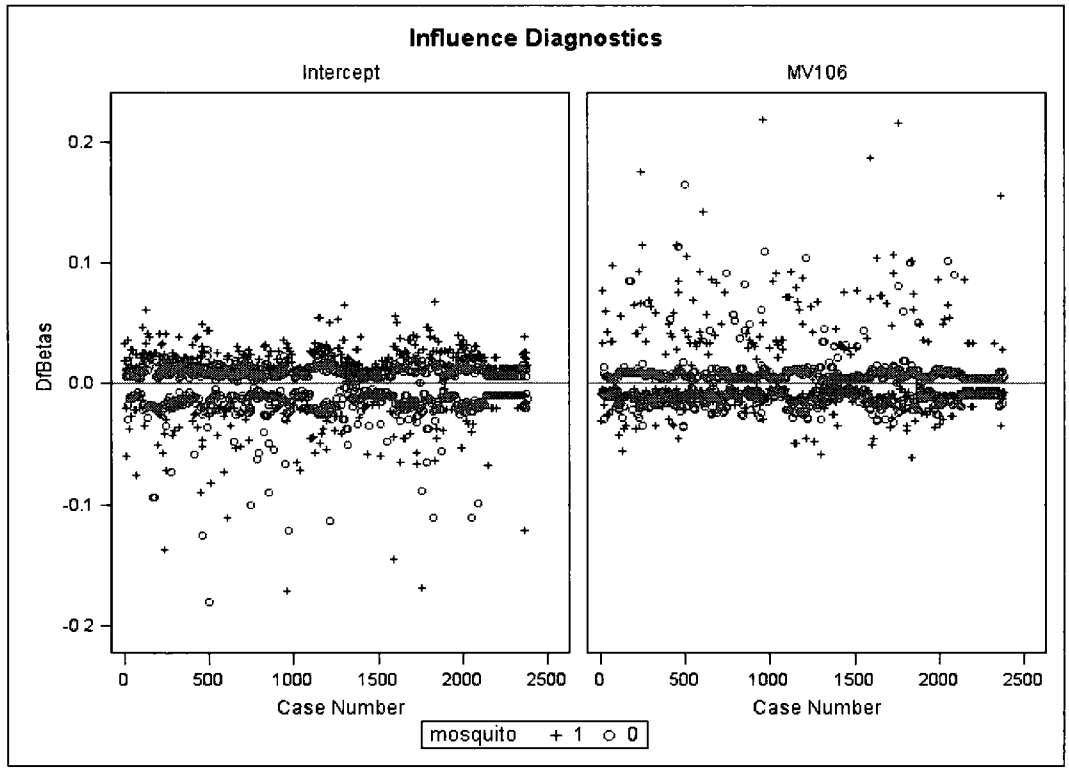


Figure 8.14: DFBETAS Plots of educational attainment(MV106) for the men



8.4 Discussion

Uganda in East Africa was the epicenter of the HIV/AIDS epidemic in Africa until 1993. However, through several educational intervention strategies and the consequent sensitization of the Ugandan population to the enormity of this contagion, there has been a significant decline in the disease burden. Of particular significance is the consistent evidence of declining trends in HIV prevalence for the younger age groups. Prevalence rates of HIV/AIDS among 24 year olds dropped by more than 60% between 1993 and 2000. Uganda's AIDS and HIV infection rates have plummeted from 30% to 5% in slightly more than a decade because of an effective HIV/AIDS educational intervention program. Uganda's HIV-fighting mantra is referred to as ABC: Abstain, Be faithful or use a Condom. The government launched a massive campaign on radio, television, and in newspapers to encourage people to get tested and to follow the ABCs (Wax, 2003). The 1995 and 2000-2001 Uganda Demographic Health surveys as well as the 2004-2005 Uganda HIV/AIDS sero-Behavioral Survey have shown that general awareness of HIV/AIDS among men and women is almost universal. It is not surprising, therefore, that in the 2006 Uganda Demographic Health Survey, when men and women were asked if they had ever heard of HIV/AIDS, 99% of the women and 99.9% of the men answered "yes". However, knowledge about HIV/AIDS prevention methods and HIV/AIDS transmission methods was low. This could be explained by the fact that most of the campaigns on radios, television and schools do not reach all populations most especially rural residents and the poor Ugandans who cannot afford going to school and having luxuries like radios and televisions.

The study results provide additional evidence to the dire need for education about HIV/AIDS prevention and transmission targeted to all adults most especially the women and the less advantaged people in Uganda for example; the rural residents, the poor and the less educated. Most importantly, the sample indicates that 84% of the men agreed to use of a condom as a prevention method and for the women only

70% agreed. Equally less reassuring, these survey results strongly suggest that 39% of men and 27% of women believe that a person can get infected with HIV/AIDS through mosquito bites. Men were generally more educated compared to the women with (19.34%) of women having no formal education compared to (4.85%) of the men. The results also showed that knowledge of prevention and transmission of HIV/AIDS in both men and women increased with an increase in education attainment and wealth status. Considering knowledge of prevention among men, the wealthiest were 1.8 times more likely to agree to condom use as a prevention method compared to the poorest [OR= 1.855, 95% confidence interval (1.228, 2.802)] and the highly educated were 3 times more likely to agree to condom use as a prevention method compared to the uneducated [Odds ratio= 2.802, 95% confidence intervals (1.385, 5.668)]. Among the women the least educated between 35 and 49 years of age were less likely to agree to condom use as an HIV/AIDS prevention method compared to the most educated women in the same age group [OR= 0.388, 95% confidence interval (0.269, 0.562)]. These observations on wealth status and education have been reported in other studies in Zambia (Slonim-Nevo et al, 2005) and Tanzania (Maswanya et al, 1999). It is important to build on this knowledge of the disease by dispelling counterproductive misinformation and encouraging behavior that can reduce personal risk and further spread of the disease. This would involve a multi-sectorial partnership with government, communities and teaching institutions in comprehensive HIV/AIDS educational intervention programs in the region targeting the poor, less educated and rural residents.

All of the studies that have looked at determinants of HIV/AIDS knowledge have only considered independent effects of these determinants or predictors. This study also looked at interaction between factors among men and women which had influence on knowledge. For the women, interactions between age and education and the other between residence and wealth index had significant influence on knowledge of use of condoms as an HIV/AIDS prevention methods and interactions between age

and residence type and the other between education and wealth index had significant influence on knowledge of HIV/AIDS transmission methods. For the men there were no interactions between factors that had significant influence on respondent's knowledge. Adding interaction terms in models provides an accurate estimation of the true relationship between the dependent and independent variables.

There are many additional risk factors that we did not address in this study. Pratt et al (2000) reported the significant influence of religion on knowledge of HIV/AIDS prevention methods. Another study in Uganda (Kasasa et al, 2007) also showed that Protestants had more knowledge of HIV/AIDS prevention methods compared to the Catholics. The same study also reported marital status having significant influence on knowledge of prevention. These factors could be considered by future researchers.

8.5 Conclusion and Recommendations

The findings from the baseline surveys in Uganda confirm that some of the factors that increase HIV knowledge risks among adults are context-specific. While some issues can be addressed by increasing HIV/AIDS awareness, knowledge and prevention skills, others are due to gender-based, sociocultural factors. Thus it is clear that a supportive environment is required to facilitate behavioral change. Both community mobilization strategies and individually-focused behavior change strategies will be necessary to increase knowledge of prevention and transmission.

It is also clear that the HIV/AIDS pandemic in sub-Saharan Africa is driven by poverty and also that the war on HIV/AIDS in the region will not be won until socioeconomic constraints and gender subordination in these nations have been addressed. The education of men about women's status must take center stage throughout the region. Poverty reduction (especially among women heads of households) through international initiatives and increased literacy of women (in particular young girls)

is very essential for controlling the disproportionate burden of the contagion among women in Uganda. Human development that focuses on health education and skills development (especially for girls and women) must underlie any intervention program to influence the knowledge of prevention and transmission of HIV/AIDS in sub-Saharan Africa.

8.6 Methodological Issues

The LOGISTIC procedure in SAS is well known and allows for much flexibility and creativity in the model selection process e.g. the backward selection procedure used above. There are many features that allow us to call for additional information which helps us in selecting an appropriate model. We are able to access statistics related to goodness of fit (e.g. Hosmer-Lemeshow test), residual plots, etc. Additionally, it also allows for automatic set up of all interaction terms between all parameters of interest. Therefore, a model can be selected based on all possible terms in very concise and systematic manner. However, some drawbacks have been reported for these methods: for model selection procedures, they are typically unstable and sensitive to small perturbations in the data. Addition or deletion of a small number of observations can change our chosen model markedly. Standard errors of regression coefficients are sometimes biased, confidence intervals may be too narrow and p-values may be small. Goodness of fit statistics are also sensitive to sample size and weighting schemes. Automatic model selection methods are crucial, and the key for statistics and data analysis, however models may need validation and correction for selection effects by expertise which should be considered in the future (Steyerberg et al, 2001).

Proper analysis of survey data is difficult. This is explained by the fact that, most statistical software packages provide statistical programs based on simple random sampling and there is a lack of statistical theory for some statistical methods for complex survey data. These problems could lead to biased variance estimates and

confidence intervals. Solutions have been suggested like the use of normalized weights in analysis which produce valid point estimation. This is however not enough. More procedures in SAS have been developed to analyze survey data without ignoring sample designs. However, these procedures require a lot of information (e.g. on sample design, clusters used, etc.) which is sometimes not available for confidentiality reasons. In the above analysis, the sample weights and clusters were incorporated to protect against biased estimates.

8.7 Conclusion of the Malaria and the HIV/AIDS study

HIV/AIDS and malaria are two of the most important infectious diseases in Uganda. They are both diseases of poverty and at the same time causes of poverty mainly affecting the uneducated. By 2000, over 25 million children and adults were living with HIV/AIDS, and 16 million people had died of the disease. Malaria is also of great importance in Africa, where over 90% of the 10 million annual cases and 43,000 annual deaths occur primarily in children under the age of 5. Any interaction between these two diseases is of tremendous public health importance. The malaria study in the thesis looked at malaria prevalence in children under five and the associated risk factors. The presented results showed that children from poorer households with less educated care givers were at greater risk for malaria. This implies that the fight against malaria has to be escorted by the fight against poverty and improvement of education on malaria prevention targeting the less advantaged groups. The HIV/AIDS study looked at knowledge of prevention and transmission of HIV/AIDS among adults. The presented results again showed that education levels and wealth status played a great role in knowledge. The most educated and richest had more knowledge of HIV/AIDS prevention and transmission methods.

Overall, what is clear is that approaches to increase malaria prevention skills and HIV/AIDS knowledge need to cut across all socioeconomic strata of society and they need to be tailored to the specific groups with particular attention to the vulnerabilities faced by youth and women. Thus it is clear that a supportive environment is required to facilitate behavior change. Both community mobilization strategies and individually-focused behavior change strategies will be necessary if programs are to address these ranges of issues effectively.

1. Approaches should include face to face education about these health problems and not through the use of media. Use of media has not been successful in informing people about malaria and HIV/AIDS because not everybody can own a television or a radio. Poverty reduction schemes have to be improved in order to reach the people who cannot provide collateral security to get loans.

2. In addition to targeting teachers for provision of life-skills training to pupils, HIV/AIDS and Malaria awareness programs should also seek to increase the participation of parents/guardians, community leaders and religious leaders. This will require capacity building for these groups in order to increase their HIV/AIDS and malaria -related knowledge and skills.

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