8-12-2014

An Examination of the Differences in Risk Factors and their Association with Variations in HIV Prevalence between Cameroon, Coted'Ivoire, and Senegal

Lea Accalogoun

AN EXAMINATION OF THE DIFFERENCES IN RISK FACTORS AND THEIR ASSOCIATION WITH VARIATIONS IN HIV PREVALENCE BETWEEN CAMEROON, COTE D'IVOIRE, AND SENEGAL

by

LEA BRIGITTE ACCALOGOUN

A Thesis Submitted to the Graduate Faculty of Georgia State University

in Partial Fulfillment of the Requirements

for the degree of

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA

2014

TABLE OF CONTENTS

ACKNOWLEDGMENTS

I would like to thank the faculty and staff of the School of Public Health at Georgia State University for sharing their knowledge and skills. My special thanks go to my thesis committee members Dr. Richard Rothenberg and Dr. Ike S. Okosun for their expertise, patience, guidance, and advice during the completion of this thesis. My extra thanks to Dr. Ike S. Okosun for his guidance and advice throughout my public health study and for sharing his knowledge and expertise during my practicum in public health.

I thank my beloved daughter Emmanuella L.S. Agoumba and husband Alphonse Folly for their love, tremendous patience, and support during this journey. I am very grateful for the unconditional love, support and encouragement of my sisters Blandine and Marlene Accalogoun and all the other members of my family, of my husband's best friend forever Severin Assamoi, and of family friends Wilfried and Elvire Gangbo.

My heartfelt appreciation and gratitude are extended to my fellow graduate students and PhD candidates Reynolds A. Morrison and Francis B. Annor for their assistance during this research project. I would not end my statement without acknowledging first and foremost the help of Almighty God who made this journey in public health possible from the beginning to the end.

LIST OF TABLES

APPROVAL PAGE

AN EXAMINATION OF THE DIFFERENCES IN RISK FACTORS AND THEIR ASSOCIATION WITH VARIATIONS IN HIV PREVALENCE BETWEEN CAMEROON, COTE D'IVOIRE, AND SENEGAL

By

LEA BRIGITTE ACCALOGOUN

Approved:

_____

Committee Chair

_____

Committee Member

_____

Date

ABSTRACT

An Examination of the Differences in Risk Factors and their Association with Variations in HIV Prevalence between Cameroon, Cote d'Ivoire, and Senegal
(Under the direction of RICHARD ROTHENBERG, M.D., M.P.H. FACULTY MEMBER)

Background: Extensive evidence suggests there are large variations in the prevalence of HIV infection among Sub-Saharan African countries. Some studies associated these variations in HIV prevalence to differences in the rate of HIV spread while others attributed the variations to risky sexual behaviors. The purpose of this study was to examine differences in risk factors for HIV infection between Cameroon, Cote d'Ivoire, and Senegal, to determine the association between HIV status and risk factors within and among countries, and identify best predictive risk factors that help explain variations in HIV prevalence.

Methods: A cross-sectional study was conducted using nationally representative data from The Demographic and Health Surveys Program. Population-based samples of adults aged 15-49 representing 21,878 in Cameroon (2011), 14,682 in Cote d'Ivoire (2011-2012), and 20,102 in Senegal (2010-2011) were used in the study. Descriptive analysis and binary logistic regression were performed using IBM Statistical Package for the Social Sciences. Odds ratios and 95% confidence interval were calculated, and models were explored.

Results: There are statistically significant ($p<.001$) differences in HIV risk factors between Cameroon, Cote d'Ivoire and Senegal. More men and women were engaged in risky behaviors including having two and more sexual partners in the last 12 months in Cameroon (9.5%) and Cote d'Ivoire (9.3%) than men and women in Senegal (1.4%). The results of the multivariate analysis of the association between HIV status and country indicators and risk factors showed Cameroon at significantly greater increased odds (OR= 2.97; 2.18-4.03; $p<.001$) of HIV infection than Cote d'Ivoire (OR=2.57; 1.89-3.50; $p<.001$) in reference to Senegal. The fact that the country indicators are strong and significant indicates that not all the variation in HIV prevalence is explained by the risk factors but only some of it is. Additionally, the forward LR analysis suggests that Cote d'Ivoire has more risk factors (7) associated with HIV infection than Cameroon (5) or Senegal does (4).

Conclusion: There are differences in risk factors among the three countries and these differences can explain some of the variations in HIV prevalence. Further research is necessary to help capture variations in HIV prevalence that cannot be explained by differences in risk factors. These findings will help advance prevention efforts.

KEYWORDS: HIV, AIDS, risk factors, HIV infection, HIV prevalence, Sub-Saharan Africa

AUTHOR'S STATEMENT PAGE

In presenting this thesis as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to publish this thesis may be granted by the author or, in his/her absence, by the professor under whose direction it was written, or in his/her absence, by the Associate Dean, College of Health and Human Sciences. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without written permission of the author.

LEA BRIGITTE ACCALOGOUN

_____

Signature of Author

NOTICE TO BORROWERS

All theses deposited in the Georgia State University Library must be used in accordance with the stipulations prescribed by the author in the preceding statement.

The author of this thesis is:

Student's Name: LEA BRIGITTE ACCALOGOUN

Street Address: 6004 Craftsman Street
City, State, and Zip Code: Johns Creek, GA 30097

The Chair of the committee for this thesis is:

Professor's Name: Dr. R. Rothenberg
Department: School of Public Health
College: Health and Human Sciences
Georgia State University
P.O. Box 3995
Atlanta, Georgia 30302-3995

Users of this thesis who not regularly enrolled as students at Georgia State University are required to attest acceptance of the preceding stipulation by signing below. Libraries borrowing this thesis for the use of their patrons are required to see that each user records here the information requested.

NAME OF USER	**ADDRESS**	**DATE**	**TYPE OF USE (EXAMINATION ONLY OR COPY)**

CHAPTER I

INTRODUCTION

1.1Background

Human Immunodeficiency virus (HIV) has been in existence for centuries evolving from animal form (Simian immunodeficiency virus) to human version (CDC, 2014). The human version of the virus is in two forms: HIV-1 and HIV-2. These two types are responsible for the majority of HIV infection around the world. Paradoxically, HIV-1 and HIV-2 are mostly found in the Western African region (Gilbert et al. 2003; Leonard et al., 2000; Nsagha, 2012; Willems, 2009).

In the human body, the virus attacks cells of the immune system particularly T-cells or CD4 cells. When left untreated, HIV viruses can completely destroy CD4 cells to their lowest point (< 200 counts/mm^3) leaving then the body vulnerable to all kinds of infections and diseases. In the body, HIV follows three stages of development. The first stage also called acute retroviral syndrome occurs within 4 weeks of the moment the person was infected. During this initial phase, AIDS virus replicated at a rapid rate leading the viral load to reach its peak. At the acute stage, an infected person can easily transmit the virus and at a heavy load. During the second phase or also called stage of dormancy, or asymptomatic, or chronic HIV infection, the virus slows its course of replication. Accordingly, an individual who is affected by HIV can enjoy normal life and live longer with the assistance of drugs to stabilize his/her CD4 levels. In the last stage, also called acquired immunodeficiency syndrome (AIDS), the virus resumes its replication activity destroying along CD4 cells. This process weakens the immune system and makes the body susceptible to all opportunistic diseases. As

a result, an individual with AIDS who is ill with other diseases can die within year if no intensive treatment is provided (AIDS.Gov, 2013a; CDC, 2014).

The paths through which HIV transmission occurs also are critical for the development of effective prevention programs. According to AIDS.Gov (2013a) and CDC (2014), HIV transmission can occur through unprotected sexual contact (anal sex, vaginal sex, sexual transmitted infections, and multiple sexual partners), sharing of infected injection drug needles or syringes, mother-to-child transmission (during pregnancy, delivery, and breastfeeding), occupational exposure, and blood transfusion and organ transplant. Therefore, it is crucial that HIV infection be monitored to reduce its destructive effects and help save lives.

Since its debut, HIV has continued to spread and affect the lives of millions of people every year throughout the world. According to the 2013 report of the Joint United Nations Programme on HIV/AIDS (UNAIDS, 2013), an estimated 35.3 (32.2-38.8) millions of people worldwide were living with AIDS virus in 2012. Globally, 2.3 (1.9-2.7) millions people were newly HIV infected and an estimated 1.6 (1.4-1.9) millions lost their lives to AIDS in 2012.Unlike other parts of the world, Sub-Saharan Africa has remained the most affected by this epidemic with an estimated 25 (23.5-26.6) millions adults and children living with HIV in 2012. HIV incidence in the region was estimated to 1.6 (1.4-1.8) millions and deaths due to AIDS approximated 1.2 (1.1-1.3) millions in 2012 (UNAIDS, 2013). This vulnerability was blamed in part on the failure of many Sub-Saharan African countries to acknowledge HIV disease in its early debut, and promptly develop preventive and intervention measures, and health policies to protect lives (Weir et al., 2003; Ainsworth & Teokul, 2000). However, one country in the region, Senegal made the difference by standing

up early in the battle against HIV/AIDS particularly at the onset of its first six cases in 1986 (Foley and Nguer, 2010; Gilbert, 2008; Putzel, 2006; Willems, 2009).

1.1.1. Senegal

The immediate interest of Senegal in understanding the basics of AIDS virus and designing preventive measures and programs from the start has earned the support of political parties, religious and community leaders, and non-governmental organizations (Foley and Nguer,2010; Putzel, 2006; Willems, 2009). Accordingly, the National Committee for the Fight against HIV was established the same year to prevent HIV/AIDS from spreading throughout the country (Foley & Nguer, 2010, Willems, 2009). The adopted prevention strategies included blood transfusion screening, promotion of safer sexual behaviors and use of condoms, screening and treatment of sexually transmitted infections (STIs), sentinel surveillance system, and intervention programs for people at high risk (Desclaux, 2004; Foley & Nguer, 2010; Willems, 2009). Beyond these preventive measures, Senegal has also benefited from a certain number of factors including the presence in majority of the non virulent HIV strains in its society, political stability, cultural strongholds, efficient use of international funded resources, and leadership in international HIV research (Gilbert et al., 2003; Willems, 2009).

Since then, Senegal has consistently maintained low rate of HIV prevalence in the general population (Ansari & Gaestel, 2010; ANSD, 2012; UNAIDS, 2012, 2013). According to UNAIDS (2012), the estimated HIV prevalence in the adult population aged 15-49 was 0.5% (0.4%-0.6%). The report also indicated that the estimated new cases of HIV infections among Senegalese all ages have dropped from 4700 (3900-5700) in 2001 to reach 2000 (1300-3000) in 2012 (UNAIDS, 2013). Further, the record showed that the number of

deaths due to AIDS still accounted for the lowest in the Sub-Saharan region. Thus, the consistency in low HIV prevalence of Senegal has drawn the attention of the world which has set the country as a role model for the rest of the Sub-Saharan African countries.

1.1.2. Cameroon

Unlike Senegal, Cameroon has entered the HIV battle field late and in slow pace. In 1986, when Senegalese discovered its first six cases of HIV infection, Cameroon had been already facing 21 cases (Buvé et al., 2001). Despite the early presence of HIV infection in the country, no efforts were made to address the issue. Fifteen years later, the number of new HIV infections has skyrocketed to reach 560,000 (390,000-810,000); and the rate of HIV infection among adults and children was estimated to 6.9 (4.8-9.8) at the end of 2003 (UNAIDS, 2004a). Since then, many efforts have been made to stabilize and reduce the prevalence of HIV infection in the country. Preventive measures included coverage of antiretroviral therapy, monitoring of HIV Drug Resistance early warning indicators, STI/HIV education, promotion of family/peer communication about sexuality and HIV knowledge, promotion of sexual abstinence and fidelity, and condom use, (Dimbuene & Defo, 2011, Fokam et al., 2013, Njikam-Savage, 2005; Nkuo-Akenji et al., 2007). The latest global report estimated the new cases of HIV infections among people from Cameroon all ages to 45,000 (38,000-53,000) in 2012 (UNAIDS, 2013). This report was evidence of the tremendous preventive efforts that Cameroon has put forth to prevail the epidemic. As of 2012, the estimated number of adults aged 15 and over living with HIV has increased from 450,000 (410,000- 490,000) in 2001 to 540,000 (500,000- 590,000) in 2012. Also, HIV prevalence among people aged 15-49 was 4.5% (4.1%-4.9%). Unfortunately, there has been no decline

in the number of deaths due to AIDS over the past decade. Deaths due to AIDS has risen from 29,000 (26,000- 33,000) in 2001 to 35,000 (30,000- 40,000) (UNAIDS, 2012, 2013).

1.1.3. Cote d'Ivoire

Like Cameroon, Cote d'Ivoire has hesitated at the onset of HIV epidemic to take rigorous measures for prevention. By the end of 2003, the estimated number of adults and children living with HIV reached 570,000 (390,000-820,000) which led to an estimated HIV prevalence of 7.0% (UNAIDS, 2004b). The number of deaths due to HIV was estimated to 47,000 (30,000-72,000). Despite the state of the country in ongoing civil war, efforts were made to slow down the course of HIV infection in the general adult population. The progress made was reflected in the 2005 estimate of HIV prevalence which was 4.7% (INS, 2006; UNAIDS, 2006).

Despite this milestone, Cote d'Ivoire remained the country most affected by HIV in West Africa. Since then, many prevention programs were developed to help fight HIV and bring down the prevalence of HIV infection to the lowest level observed in many West African countries. A variety of prevention measures were implemented including monitoring and evaluation of sex workers, promotion of condom use and early antiretroviral therapy, behavior change and peer-to-peer education, STI screening and treatment, universal HIV screening, counseling and testing, care for people living with HIV, mother-to-child transmission, promotion of sexual abstinence and late sexual debut, and voluntary HIV testing and counseling (Anglaret et al., 2012; Jean et al., 2012; Jean et al., 2014; Koffi & Kawahara, 2008; Ndondoki et al., 2013; Vuylsteke et al., 2012a). This achievement was reflected in the 2008 estimates of HIV prevalence which was 3.9% (UNAIDS, 2009; Vuylsteke et al., 2012b). According to the latest Global Report (UNAIDS, 2013), Cote

d'Ivoire has trimmed down its adult HIV incidence by more than 50% from 2001 to 2012. Further, the prevalence of HIV among young adults (15-24) has decreased by 42% from 2001 to 2012. As of 2012, HIV prevalence of Cote d'Ivoire is 3.2% (2.8%-3.8%). Despite their considerable efforts in reducing the rate of HIV infection, challenges remain. Both Cameroon and Cote d'Ivoire are still in UNAIDS' priority list for ART coverage and mother-to-child transmission (UNAIDS, 2013).

1.2 Statement of the Problem

Despite the striking efforts of the three countries in trimming down adult HIV prevalence and incidence, challenges remain. HIV epidemic continues to unevenly affect the populations of Cameroon, Cote d'Ivoire and Senegal. Reasons for this disproportionateness are multiple and include but not limited to disparity in socio-demographic characteristics, sexual behaviors, risky behaviors, and HIV-prevention behaviors. Scrutinizing a selected number of these factors might help pinpoint relevant risk factors for each country to help advance prevention efforts. Working toward effective prevention measures will help minimize HIV prevalence and eliminate the gap between the three countries to fulfill UNAIDS' priority which is zero new HIV infections and zero AIDS-related deaths by 2015 and beyond.

1.3 Significance of the Study

Identifying key risk factors that contributed to differences in the prevalence of HIV infection in Cameroon, Cote d'Ivoire and Senegal might assist in framing effective HIV prevention programs and health policies to help close the gap and advance prevention efforts in the three countries. Even though several studies have explored HIV risk factors in Sub Saharan Africa, few have conducted an individual level of analysis of HIV risk factors between Cameroon, Cote d'Ivoire and Senegal. Also, limited research has explored the

contribution of risk factors in explaining differences in HIV prevalence between Cameroon, Cote d'Ivoire and Senegal.

1.4 Purpose of the Study

The purpose of the study was to examine differences in HIV risk factors that contributed to variations in the prevalence of HIV infection between Cameroon, Cote d'Ivoire, and Senegal. To achieve this goal, the study 1) identified and compared HIV risk factors between the three African countries 2) identified and compared the prevalence of HIV infection between the three countries, and assessed its distribution on risk factors by gender; 3) determined risk factors that are associated with the prevalence of HIV infection within and among countries; and 4) identified best predictors of HIV infection and their contribution to variations in HIV prevalence within each country. Tackling best predictive risk factors and their contribution might assist in shaping effective prevention interventions, and therefore advancing preventive efforts in each country to help eliminate the gap in HIV prevalence between the three countries.

1.5 Research Questions

This study explored the following questions to gain insight into risk factors that contributed to differences in HIV prevalence between Cameroon, Cote d'Ivoire, and Senegal.

1. Are there differences in risk factors between Cameroon, Cote d'Ivoire, and Senegal?
2. Does the status of HIV infection differ between Cameroon, Cote d'Ivoire and Senegal? Is HIV prevalence evenly distributed on risk factors by gender in each country?
3. What risk factors are associated with HIV prevalence in Cameroon, Cote d'Ivoire, and Senegal? What risk factors are associated with HIV prevalence among the three countries?
4. What are the best predictors for HIV infection in Cameroon, Cote d'Ivoire, and Senegal?

To what extent do best predictive risk factors contribute to variations in HIV Prevalence in Cameroon, Cote d'Ivoire and Senegal?

CHAPTER II

LITERATURE REVIEW

The aim of this study was to identify and compare HIV risk factors between Cameroon, Cote d'Ivoire, and Senegal to understand their differences and associations with HIV status of the three countries. Accordingly, this chapter focuses on the review of current literature including studies that addressed HIV issues in Sub-Sahara Africa particularly in Cameroon, Cote d'Ivoire and Senegal. The review also emphasizes risk factors that seem problematic in the three countries. The critical role that HIV knowledge, cultural norms and social forces, and behavior change theory play in HIV prevention efforts is also addressed.

2.1. HIV Transmission in Sub-Saharan Africa

A large body of research has documented variations in the prevalence of HIV infection among Sub-Saharan African countries (Bingenheimer & Geronimus, 2009; Buvé et al., 2002; Buvé et al., 2001). According to Buve et al., (2001), variations in the prevalence of HIV infection can be related to differences in the rate of HIV spread. Factors that identify the rate of HIV transmission in the population are complex and include sexual behavior patterns which are defined as the probability of exposure to HIV infection, the probability of HIV transmission defined as the odds that the transmission of the virus during sexual intercourse occurs, and the socio-demographic factors that enhanced it. In their study of four cities in Sub-Saharan Africa, Buvé et al. (2001) found considerable differences in the prevalence of HIV between Eastern/Southern Africa and West/Central Africa. They indicated that variations in the prevalence of HIV were due to differences in the rate of HIV spread. Another factor that also explained differences in the prevalence of male circumcision

In another study, Buve et al. (2002) found that HIV-1 epidemics that mostly occur in Sub-Saharan Africa are due to a complex interaction of behavioral and biological factors, and male circumcision. They indicated that sexual behavior patterns are shaped by cultural and socio-economic contexts and that traditional gender role is central in the vulnerability of women to HIV-1 infection. They highlighted the role of poverty, wars, and conflicts that weakened the region and made it susceptible to the high spread of HIV-1. They suggested that prevention strategies target gender discrimination and subordination. The authors urged law and policy makers, community leaders, and officials to understand the real issues underlining the susceptibility of women to HIV-1 in the region and therefore to take preventive and legal to improve women conditions. They concluded that unless the burdens of African economic development are solved it would remain difficult to convince young people to change their sexual behaviors.

2.2. Gender Inequality

Gender inequality constitutes an important issue to address for effective prevention of MTC to occur. In its last Global Report, UNAIDS (2013) pointed out that in the Sub-Saharan region, 57% of women were living with HIV by the end of 2012. In Sub-Saharan Africa, women were more likely to have HIV at early age than men leading to the higher HIV prevalence observed. Also, young females were less likely to report the use of condom during their last sexual intercourse. The report indicated that national surveys demonstrated young females aged 15-24 were more likely to have less accurate and comprehensive understanding of HIV than their peer males of same age. Added to their lack of appropriate level of education and biological make-up, women are subject to sex abuse and violence, and socio-economic imbalance, inaccessibility to services that left them vulnerable to HIV acquisition. In her study, Njikam

(2005) stated that nearly 64% of female students acknowledged taking high risk of having HIV infection by not being able to negotiate safer sex or insist on the use of condom with men because of their weak economic status.

2.3. HIV-related Risk Factors

2.3.1. Early Sexual Debut

Several studies have demonstrated the association between early sexual debut and an increased likelihood of HIV infection (Peltzer, 2010; Pettifor et al., 2009; Stöckl et al., 2014; Wand & Ramjee, 2012). Pettifor et al. (2009) investigated early sexual debut, forced sex with first sexual partner, and lack of condom use at first sex using a national representative survey of 7,692 participants aged 15-24. The findings showed that early debut was associated with factors that might increase the risk for HIV infection. Women and men who had had an older first sexual partner had increased odds of HIV infection compared to those who had not. They recommended intervention efforts that discourage early sexual debut and promote safer first sexual experience.

In another study, Wand and Ramjee (2012) conducted a follow up study on the effect of early sexual debut and HIV seroprevalence. There were 3492 sexually active women who were followed up on a period of three year and 1485 for a period of 2 years. The findings showed that age at first sex, an increased number of sexual lifetime partners, and lack of high school education and cohabitation all were associated with a potential risk of HIV infection. However, they indicated that this association might be due to an increased number of lifetime sexual partners. They suggested that prevention efforts be targeted towards delaying age at first sex. Stöckl et al. (2014) conducted a systematic review of 128 full text studies with all having large sample sizes. The final sample included 25 studies mostly cross-sectional. They found even after adjusting for socio-demographics that there was consistently significant association between

early sexually debut and HIV. However, the authors indicated that the increase in risk seemed not link to behavioral factors but more to biological factors.

2.3.2. Unprotected Sex/Condom Use

There is evidence that condom use is the way to control the spread of HIV and reduce the rate of new HIV cases. In their meta-analysis of HIV interventions for heterosexual African Americans, Darbes et al. (2008) reviewed 35 randomized controlled trials (RCTs) studies done from 1988 to 2005 with a total of 14, 682 participants who self reported on their HIV risk taking behaviors. The findings showed that behavioral interventions significantly lowered participants' willingness to engage in unprotected sex (OR= 0.75; 95% CI= 0.67, 0.84). They suggested the promotion of condom use and safer sex negotiation. Pettifor et al. (2009) investigated early sexual debut and associated HIV risk factors among women in South Africa. They found that the lack of condom use at first sex was coupled with increased odds of HIV. Mostly, the lack of condom use at first was associated with early sex debut and forced sex.

In another study on risky behaviors and condom use, Njikam-Savage (2005) investigated university students aged 20 and older in Cameroon. She found that university students' use of condoms varied according to the type of relationships. More than half of the students (52.5%) reported they used condoms with their primary partner to refrain from having STIs or unwanted pregnancy while 23.43% of students indicated they did not because they trusted their primary partner. Female students tended to use mixed methods, abstinence and condom depending on the type of relationships. However, abstinence seemed more common with females aged 25-29 (40%) compared to those who were in their 30s and over (8%) and under 24 years (16%). The concerns raised for the low use of condoms ranged from not falling for commercial profit-making to negative perception about condom including its promotion of infidelity.

Despite the striking progress of many countries in reducing the prevalence of HIV infections in their countries, the 2013 Global Report indicated that many countries including Cote d'Ivoire and Senegal have seen a decline in the use of condoms (UNAIDS 2013). In their study, Hearst and Chen (2004) found that consistent use of male condoms by a small number of people can have a great reduction effect on HIV spread than a larger number of individuals with inconsistent use. However, there are variations in how people perceived the use of condoms across countries and diverse ethnic and socio-groups (Drezin, Torres, & Daly, 2007). Therefore, they recommended that effective promotion of condoms should find ways to address socio-cultural, economic and financial, structural barriers, and legal policy challenges.

2.3.3. Multiple Sex Partners

It has been well-documented that multiple partnerships play a critical role in the spread of HIV infection. Multiple partnering increases a partner's risk of being infected with AIDS virus; and is defined as a sexual relationship that involves more than one partner (Ghys, 2009; Mah & Shelton, 2011). According to Mah & Shelton (2011), multiple partnering comes in multiple forms including serial monogamous and concurrent sexual partnerships. In serial monogamous, sexual partnerships do not overlap, which implies that one sexual relationship ends while the other begins. Accordingly, newly infected person cannot transmit HIV until s/he started another relationship. Ghys (2009) labeled this mechanism of HIV spread the "moving forward," In this process, the first partner is protected from getting HIV. As a result, individuals who are engaged in serial monogamous are not potent vehicle for HIV transmission. Rather, they are less likely to elevate the risk of their partner in getting HIV infection (Moris, 2001, Buvé, 2002, Ghys, 2009). However, if the infected individual entered a second relationship while staying in his first one, then the first partner is at high risk of HIV infection. Because the infected

person is moving forward and backward between both partners, it facilitates HIV spread among his or her partners (Ghys, 2009).

The 2013 Global Report (UNAIDS, 2013) pointed out that in several countries including Cote d'Ivoire, there is evidence of increase in risky behaviors and in the number of people who had multiple partners. In their chapter on prevention for women, Gay et al. (2012) indicated that multiple partnerships augmented a person's likelihood for HIV acquisition. They reported that a meta-analysis of 68 epidemiological studies found women with multiple partners to be three times more likely to have HIV infection than those without multiple partners. In some countries where HIV epidemic was generalized, many women in polygamous marriages were at high risk of HIV acquisition (Dunkle et al; Matovu et al., 2007, Negin et al., 2009 as cited in Gay et al, 2012, p.31). In a study of 1,137 women in Kenya, Negin et al. (2009) found that women in polygamous marriages were more likely to have HIV infection than those in monogamous marriages (as cited in Gay et al., 2012). However, other studies on polygyny in West Africa found no elevated risk of HIV acquisition (Reniers & Watkins, 2010; Reniers et al., 2010 as cited in Gay et al., 2012, p.31). Gay and his colleagues suggested that in developing prevention interventions women's context of partnership patterns be taken into consideration.

2.3.4. Concurrent Partnerships and Cumulative Concurrent Partnerships

There is well-known evidence that much of the transmission of HIV infection occurs through concurrent sexual partnering (UNAIDS, 2010; Buve et al, 2002; Mah & Shelton, 2011). Concurrent sexual partnerships play a vital role in the dynamics of HIV epidemics. According to Mah and Shelton (2011), concurrent sexual partnership is defined as any sexual relationship that overlaps during a period of time. This includes long-term overlap sexual partnering such as polygamy or quasi-polygamy or short term or isolated sexual partnership. Many studies indicated

that concurrent sexual partnering increases the rate of HIV spread in the population, and therefore may affect the prevalence of HIV infection in many African countries (Buve et al, 2002; Buve et al., 2001; Misha et al., 2009; Fishel et al, 2012;). However, Buve et al., (2001) indicated that the determinants of the rate of HIV transmission in the population are not simple as previously thought and depend on conditions including sexual behavior patterns, the probability of exposure to an infected partner, and the probability of spread of the virus during sexual intercourse. In their study of the association between differences in the rate of HIV spread and sexual behaviors and/or the probability of HIV spread during sexual intercourse in four African cities, the authors found that there was considerable differences in the prevalence of HIV between the four cities and that these differences can be explained by the differences in the rate of HIV transmission.

However, measuring concurrency of sexual partnership is more complex than expected. Despite the existence of theory that relates concurrent sexual partnerships to the size and rate of HIV transmission there has been no agreement on the definition of the concept and methods of measurement to use (Fishel et al., 2012).

In an attempt to find standardized indicators to evaluate concurrency partnerships, the UNAIDS Reference Group came up with some approach of definition (Fishel et al, 2012, Misha et al, 2009). According to the group, point prevalence of concurrent partnerships (primary indicator) is the proportion of women and men age 15-49 who were engaged in ongoing sexual intercourses with more than one ongoing sexual partnership at the point in time six months prior to the interview. Cumulative prevalence of concurrent partnerships (alternative indicator 1) is the proportion of women and men age 15-49 with overlapping sexual partnerships at any point in the past. The third indicator, proportion of multiple partnerships with concurrency in the past, is the

proportion of women and men age 15-49 with multiple sexual partnerships in the past year who had concurrent partnerships. In their study on sexual partnerships and HIV serostatus, Misha et al. (2009) analyzed DHS data from many countries including those in Sub-Saharan African and found based on those definition that men were more likely to have concurrent partnerships than women. However, they noticed that multiple partnerships reported in the last 12 months prior to the interview, were not actually concurrent. Further, the findings showed that only limited number of participants claimed to have overlapping partners for one year or longer.

In a similar study, and in an attempt to identify the best method that defines levels of sexual concurrency and interpret its association with HIV infection, Fishel et al., (2012) computed the three indicators of concurrent sexual partnerships, and then used them to examine concurrent sexual partnership behaviors of five Central and Southern African countries. Findings indicated that even though point of concurrent prevalence and cumulative concurrent prevalence can be used to identify levels of concurrency, careful consideration is needed. Because of the levels of complexity involved in the computation of concurrent sexual partnerships, one indicator should not be considered over the other. The three indicators measure different areas of concurrent sexual partnerships. Point of concurrent prevalence assesses long-term overlapping sexual partnerships while the cumulative concurrent prevalence estimates the total magnitude of overlapping sexual partnerships. The third, proportion of multiple partnerships assesses the proportion of multiple partnerships that are concurrent in the past year. Even though theory of concurrency supports point of prevalence as indicator the most associated with HIV infection spread, these findings remained inconclusive.

Similarly, in their study on concurrent sexual partnerships and HIV prevalence in five African countries, Lagarde et al. (2001) found that the prevalence of HIV infection was 1.0% in

Dakar, Senegal, 3.4% in Cotonou (Benin), 5.9% in Yaounde (Cameroon), 25.9% in Kisumu (Kenya), 28.4% in Ndola (Zambia). However, the proportion of sexual partnerships that were concurrent was higher in Yaounde (0.98) than in Kisumu (0.44), Cotonou (0.33), Ndola (0.26), and Dakar (0.18). They indicated that there was no evidence that suggested an association between concurrent sexual partnerships and the rate of HIV spread in the five African cities.

2.4. HIV/AIDS Prevention

2.4.1. HIV/AIDS Knowledge

Understanding the basics of HIV is central for any prevention efforts. Even though the majority of young in Sub-Saharan Africa have heard about HIV/AIDS and know about the destructive role of HIV, many young people still hold beliefs and misconceptions about HIV transmission and prevention (Bankole et al., 2004; Dimbuene & Defo, 2011; Njikam-Savage, 2005; Ojieabu, 2012). In her study, Njikam (2005) found that 60% of students had knowledge of the mode of transmission of HIV/AIDS. However, 32.19% of students perceived HIV/AIDS as a shameful disease. About 80% can correctly identify strategies for prevention. Unfortunately, these young adults didn't know how to translate their knowledge into protective action.

Ojieabou et al. (2012) explored the effect of educational status on HIV/AIDS knowledge, attitude and misconceptions of pregnant women in Nigeria. They investigated 403 pregnant women attending antenatal care at a teaching hospital in Sagamu, Nigeria. A structured questionnaire was administered to solicit their demographic information and inquired about their HIV/AIDS knowledge and attitudes toward people living with HIV/AIDS (PLWHA). The results indicated that pregnant women with higher educational level had better understanding of HIV/AIDS knowledge. The findings also pointed out that the majority of participants except

those with no education had an average knowledge about the cause. However, there was still a great deal of misconceptions among women with secondary education.

2.4.2. HIV Testing and Counseling

Testing for HIV infection is critical for effective prevention measures. Study showed that testing and counseling is an effective approach to secondary prevention for HIV-positive individuals (Matovu, 2010). Matova (2010) reviewed a number of studies about prevention methods in discordant couples. The review focused on six interrelated behavioral HIV prevention interventions that can be combined to lower HIV transmission risk in Sub-Saharan Africa. The section of testing and counseling revealed that many couples in Sub-Saharan Africa have not come together for testing or counseling nor know about each other's HIV status. Also, couples were not aware that HIV discordance was possible within couples. The author recommended that behavioral interventions focus on the promotion of couples' counseling, testing, and disclosure. Therefore, HIV testing should be strongly recommended for anyone who is exposed to any of the risk factors. Universal access to testing should also be promoted to ensure all people who are sexually active and at risk know their serostatus (Ndondoki et al., 2013; UNAIDS, 2013). Studies have demonstrated that voluntary counseling and testing can have an adverse effect in some HIV-negative clients.

2.4.3. Male Circumcision

A large body of research has documented the protective role of male circumcision in preventing HIV transmission. Bailey et al. (2007) conducted a randomized controlled trial (RCT) study of 2784 men aged 18-24 in Kisumu, Kenya over a period of 24 months to assess the protective role of male circumcision on HIV infection. 1391 men were assigned to an intervention group (circumcision) and 1393 men to a control group (delayed circumcision). HIV

testing, medical examinations and behavioral interviews were performed during follow-ups at 1, 3, 6, 12, 18, and 24 months. The findings indicated that the 2-year HIV incidence was 2.1% (95% CI= 1.2, 3.0) for men who were circumcised and 4.2% (95% CI= 3.0, 5.4) for those who had delayed circumcision. The relative risk (RR) was 0.47 (0.28, 0.72) which showed a protective effect of 53% (22%, 72%) for HIV infection. After adjusting for non-adherence and exclusion of 4 men, the protective effect of circumcision reached 60% (32%, 77%).

In another randomized controlled trial study, Gray et al. (2007) studied the impact of male circumcision on HIV incidence in men. A total of 4996 uncircumcised HIV negative men aged 15-49 were enrolled in the study. A random number of 2474 men were assigned for immediate intervention (circumcision) while the 2522 others were placed in the control group (delayed circumcision for 24 months). Participants were followed up with HIV testing, physical examination and interviews at 6, 12, 24 months. The results showed over a period of 24 months that HIV incidence among the circumcised group was RR= 0.66 per100 person-years while for the control group RR= 1.33 per 100 person-years.

Sielgfried et al., (2009) conducted three randomized controlled trials (RCTs) in three African countries, South Africa, Uganda, and Kenya from 2002 to 2006 to assess the impact of male circumcision on HIV infection. Large size of participants was used for the three RCTs. But all three trials were discontinued early due to significant outcome of the interim analyses. Survival estimates were combined for all three trials in a meta-analysis the random effects model. The findings indicated medical male circumcision lowers the acquisition of HIV infection for heterosexual males by 38% to 66% over a period of a year.

2.4.4. Cultural Norms and Social Forces

Many studies have stressed the cultural norms as factors that might facilitate the fight against HIV and the success of Senegal in consistently maintaining low HIV prevalence in the Sub-Saharan African region. In her study on the impact of Islam on HIV prevention among Senegalese university students, Gilbert (2008) investigated 234 undergraduate and graduate students from one of the national universities in Senegal. Even though the majority of students were urban, participants were from different ethnicity and religion. The final sample after exclusion criteria was 186 participants. The author's hypotheses were that higher religiosity would predict sexual abstinence, negligible experience with drug and alcohol. Because Senegal is a polygamous society with frequent premarital relationships and because condom use is a norm in the society, the author predicted that religion would have no effect on condom use or multiple sexual partnerships. A 15-minutes questionnaire that included youth religiosity scale and behavioral questions related to HIV prevention was administered. The findings supported the hypothesis that being versed in Muslim religion significantly increases the likelihood of sexual abstinence (OR= 1.13, $p<.001$). However, the findings showed that religion has no effect on the decision of people to use condoms or drugs, or abstaining from having multiple sexual partners. Gilbert concluded that high risk behavior taking falls beyond Islam's influence. Therefore, she suggested that both HIV prevention programs and the Muslim community find ways to address the internal conflict for more successful HIV prevention.

In another study, Ansari and Gaestel (2010) explored the perceptions of religion leaders on HIV/AIDS. A total of 87 religious leaders from various denominations were interviewed throughout the country between May and August 2008. The findings indicated that Muslim leaders were less likely to consider HIV/AIDS as a priority for leaders compared to Catholic or Protestant leaders. The results also showed that religious leaders tend to teach more HIV

prevention than recommendation for testing or educating the community for care and support for people living with HIV/AIDS.

2.4.5. HIV Treatment as Prevention

2.4.5.1 Antiretroviral Therapy (ART) As Prevention

The World's new vision of closing the gaps and eradicating HIV infection has speeded up and transformed the course of HIV prevention. Advances in HIV prevention have made it possible to consider HIV treatment as prevention and to avert the onward transmission of HIV infection. Accordingly, several studies have investigated the effectiveness of HIV treatment as prevention. Antiretroviral Therapy (ART) approach is found to be promising in preventing the transmission of HIV to sexual partners or drug using partners and therefore to control HIV epidemics. ART uses a variety of drugs to prevent viral DNA from replicating and invading the immune system.

There are five different types of antiretroviral (ARV) drugs used in the treatment of HIV infection (AIDS.gov, 2009). Nucleoside/Nucleotide reverse transcriptase inhibitors (NRTIs) block the ability of HIV to use enzyme "reverse transcriptase" to regenerate new viral DNA strands. On the other hand, non-nucleoside reverse transcriptase inhibitors (NNRTIs) act to alter enzyme "reverse transcriptase" and prevent it from functioning properly and replicating new copies of HIV. Protease inhibitors (PIs) interfere with enzyme protease's ability to cut long viral DNA strands into functional pieces for the production of new viruses. As the entry/fusion inhibitors are concerned, they prevent HIV from entering healthy CD4 cells or bonding to them. Finally, integrase inhibitors hinder enzyme integrase's ability to facilitate the insertion of HIV genetic materials into the host CD4 cells in order to generate new copies of HIV. Because of the role that each type of antiretroviral (ARV) drugs plays in the life cycle of HIV, it is

recommended that a combination of at least three ARV drugs from two types of ARV drugs be taken for the effective treatment of HIV infection.

A growing body of research points out that when initiated earlier, ART could decrease population-level incidence of HIV and death, and therefore be effective in preventing further HIV transmission. Anglaret et al. (2012) examined two cohorts of untreated HIV infected adults before and after availability of ART in Cote d'Ivoire. Both cohorts of 860 patients were followed up in similar condition, under similar procedures, and by same team for 8 years. The findings indicated that most deaths that occurred in these cohorts were due to tuberculosis and other bacterial diseases. Therefore, they suggested better diagnosis and supported early use of ART to reduce the incidence of opportunistic diseases and prevent death.

Cohen and colleagues (2013) examined 11 observational studies and 4 community randomized trials and found that ART considerably trimmed down HIV transmission to sexual partners. The randomized trials which used earlier initiation of ART in combination with condoms and counseling decreased the spread of HIV in heterosexual serodiscordant couples by 96.4%. This means that early use of ART could slow or suppress the viral load DNA from replicating and invading the immune system. The prevention of the viral load from expanding could lower the level of latent viral reservoir and minimize the risk for further spread of HIV infection to sexual partners.

Further, the examination of several natural experiment case studies in four countries (USA, Canada, France and Australia) showed that the reductions in community viral load were associated with the decline in new cases of HIV infection (Wilson, 2012). In France, the use of ART led to a decrease in HIV incidence of all major population groups except men who have sex

with men (MSM). In Canada, an association was found between a reduction in the rate of new cases of HIV infection and the surge in the rate of testing, ART coverage, and viral suppression.

Another exploration of a number of ecological studies and a randomized controlled trial suggests that suppressive antiretroviral therapy (ART) considerably lowers heterosexual HIV spread in stable, monogamous and discordant couples (Smith et al., 2012). The results showed an association between an increase use of ART and a decrease in HIV transmission. Provision of free ART was linked with a 53% reduction in the rate of HIV transmission.

More studies have demonstrated early use of ART as a potential route for the prevention of HIV epidemic (Boily et al., 2012; Buchbinder, 2012; Granish et al., 2009; Montaner, 2013). Granish et al. (2009) used mathematical models to examine a strategy of universal voluntary HIV testing and immediate treatment with ART. The study was based on representative data from South Africa representing 17% of all people living with HIV. The study hypothesis assumed that almost all transmission was heterosexual and intravenous drug use did not substantially contributed to the overall rates of HIV infection. The findings showed that annual universal voluntary HIV testing for all people older than 15 years combined with immediate ART after diagnosis could successfully reduce HIV transmission to the point of elimination by 2020. However, the authors warned about the implementation which could be labor intensive and overwhelmingly expensive. Also, they suggested that the approach be used in combination of other strategies. They recommended further mathematical modeling research and consultation.

Despite evidence of success of ART treatment, challenges remain. Cohen et al. (2013) indicated that not all individuals in their contagious stage could be located and given proper ART treatment. Also, there is no evidence yet to support the effectiveness of ART in preventing the spread of HIV infection with men who have sex with men (MSM) and people who inject drugs

(PWID). Further, in real world populations, the use of ART is subject to a number of barriers including non adherence to treatment, migration from higher HIV prevalence regions, emergence of marginalized groups, shifts in risky behaviors, difficulties identifying patients and keeping them in clinical care, differences in the effectiveness of ART due to variations in modes of HIV transmission, and increased prevalence of potential transmitters (Wilson, 2012). Therefore, there is a series of obstacles to overcome in order for ART treatment to be effective in trimming down HIV infectiousness.

Accordingly, many recommendations have been provided concerning the early and immediate use of ART. Cohen et al. (2013) suggest improved detection of HIV infection at all stages and continuing evaluation of early ART to appraise the benefit of HIV treatment as prevention. In order for treatment to be effective in controlling the HIV epidemic, the authors also recommend that universal access to antiretroviral therapy (ART) be provided and strict adherence to treatment be observed. In addition to the desire for universal access to ART, Wilson (2012) proposes that adequate health-care infrastructure be available and combination prevention approaches be used to lessen HIV incidence among all major groups. In 2013, the World Health Organization made specific recommendations regarding the initiation of ART as treatment of HIV infection for adolescents and adults. These recommendations has been adopted by many countries around the world (AVERT, 2014).

2.4.5.2. Pre-Exposure Prophylaxis (PrEP)

Pre-exposure prophylaxis is a new approach to HIV prevention in which HIV negative individuals who are highly exposed (a person with HIV positive partner, sex workers, MSM, injection drug users) take daily HIV drugs to minimize their risk of becoming infected

(AIDS.gov, 2013b). Accordingly, only people who do not have HIV infection but seem at high risk are given PreEP drugs.

A number of studies have investigated the effectiveness of PreEP drugs in reducing the risk of getting infected with HIV. Gupta et al. (2013) reviewed multiple clinical trials and reported that the use of PreEP drugs lowered the risk of HIV infection by 44-75%. However, two other clinical trials showed no efficacy of PreEP drugs in reducing the risk of HIV infections. Also, there is a concern that the use of these drugs could lead to the emergence of HIV drug resistance.

Supervie (2013) examined several clinical trials on PreEP and reported that only four of these studies (Caprisa 004, IPrEX, Partner PrEP, and TDF-2) showed significant reduction at the level of individuals. The Caprisa 004 clinical trial done in 2010 demonstrated that a vaginal microbicide gel with Tenofovir (TDF) can reduce the risk of HIV infection in heterosexual women by 39% (0.06-0.60) when used within 12 hours following a sexual intercourse. The 2010 iPrEX trial reported a reduction of the risk of getting HIV by 44% (0.15-0.63) among all heterosexual men participants when the daily intake of Truvada was observed. This reduction reached 92% (0.40-0.99) in men with detectable levels of the drug in their blood. In the Partner PrEP trial conducted in 2012, the decrease in the risk of becoming infected was 75% (0.55-0.81) among heterosexual discordant couples who took Truvada, and 67% (0.44-0.81) with couples who used TDF. This drop off was even higher to reach 90% in couples with detectable levels of the drug in their blood. The TDF-2 trial done in 2012 showed a reduction in the risk of being infected by 62% (0.21-0.83) when Truvada was taken. The effect of PreEP when used at the population level remains unclear.

2.4.5.3. Post-Exposure Prophylaxis (PEP)

This type of ART is of short term and administered shortly after suspected exposure to AIDS virus. PEP helps avoid seroconversion of HIV negative people to HIV infected. PEP is used mostly to address the issue of occupational exposure. The successful implementation depends on accurate self-identification of being exposed or being at risk of exposure, counseling on implications for incorrect self identification, educating on the determination of exposure source or risk, HIV testing, selection of suitable PEP regimen, administration of PEP within 72 hours of exposure, and completion of 28-days taking of PEP (AIDSTAR-ONE, nd). There is consensus that PEP when timely used is effective in preventing HIV transmission (Ellis et al., 2005; Siika et al., 2009; Weber et al., 2010). Siika et al. (2009), investigated 446 patients with occupational PEP and non-occupational PEP (nPEP) over a period of 5 years. The findings showed that those who accurately followed the recommendations and timely completed their PEP had their HIV test remained negative. They concluded that PEP and nPEP can be given in resource limited settings.

2.5. Behavior Changes in HIV Epidemiology

Despite the tendency that people are naturally resistant to change, behavioral changes do occur (Bingenheimer & Geronimus, 2009, Gay et al., 2012). In their review of literature, Gay et al., (2012) found that HIV prevalence lowered from a high 13.4% to nearly 7% in less than 10 years in Kenya. Similar decrease of prevalence was observed in Rwanda where in less than 7 years the country aggressively brought down its high HIV prevalence from 13% to 3%. Also, there was an increase in men's use of condoms to estimated 75%. The 2013 Global Report highlighted how some countries including Cote d'Ivoire had reduce their HIV prevalence to 50% from 2001 to 2012 (UNAIDS, 2013).

In their conceptualization of behavioral mechanisms in HIV, Bingenheimer & Geronimus (2009) indicated that considerable reductions in HIV prevalence may be achieved by small changes in behavior. Despite the current understanding that the control of HIV epidemics should involve a combination of biological or biomedical (other infectious diseases, ART, male circumcision) and behavioral mechanisms, the latter seems to bring by a large the most reduction in HIV epidemics. According to the conceptual framework that has shaped epidemiological thinking and research for decades, HIV transmission is an interplay of behavioral patterns (which define the likelihood of exposure to HIV), biological process (indicates the probability that an exposure turns to infection) and socio-demographic and biomedical factors (shapes the duration of infectiousness).

Accordingly, some HIV epidemiologists have focused their attention to the understanding of the biological mechanisms that govern the transmission of HIV while other group of researchers seeks for the identification and understanding of the paths of HIV transmission and patterns that shaped them (behavioral mechanisms). In their search for answers to the high rate of HIV prevalence and new infections in the Sub-Saharan region, many researchers stressed multiple partnerships, cultural practices, economic challenges, low condom use, and pre-marital sexual intercourses as the probable elements of explanation. Others found risky behaviors to be strongly associated with the likelihood of getting HIV. However, none of these research studies seemed to convincing until Southern African epidemiologists demonstrated the behavioral risk deep rooted within powerful social forces and demanded its change.

Therefore, Bingenheimer & Geronimus (2009) articulated that several claims have supported behavioral approaches as key in prevention interventions. Also, the conceptual framework that shaped these approaches is important for effective prevention interventions. The

first concept, the nonlinear relationship between behavioral risk and HIV prevalence at the population stipulates that small changes in behaviors may induce substantial reductions in HIV prevalence. The second claim is that people can and do modify their behaviors. In light of HIV threats, many individuals have changed their risky behaviors under the spectrum of fear when they realized many people including some of their relatives or acquaintances died from the infection. Also, many young adults have changed their behaviors in face of the spread of HIV infection. Similarly, at the population level responses to changes in HIV prevalence came swiftly when many Sub-Saharan African countries realized the threats of HIV on their population. Many examples including those of Cote d'Ivoire, Cameroon, South Africa, and Zambia were already emphasized. However, behavioral changes may not occur as rapidly as expected due to the individual and collective processes that shape behaviors.

Another concept that seems very important and should not be overlooked when designing prevention interventions is the behavior risk compensation. The model seems to undermine the progress in reduction of HIV prevalence. When people realized that using condoms can prevent them from getting HIV infection, they changed their behaviors by increasing their use of condoms but engaged in sexual intercourses with multiple partners.

CHAPTER III

METHODS AND PROCEDURES

3.1. Background

The purpose of the study was to examine and compare risk factors for HIV between three Sub-African countries to understand their differences and association with variations in HIV prevalence of the three countries. To achieve this goal, the study used secondary data pertaining to Cameroon, Cote d'Ivoire, and Senegal from The Demographic and Health Surveys Program (DHS).

3.2. Study Design and Data source

This study was a cross-sectional design and used approved datasets from DHS. The approved datasets were from Cameroon (2011), Cote d'Ivoire (2011-2012) and Senegal (2010-2011).

Demographic and Health Surveys (DHS)- DHS is a program of the United States Agency for International Development (USAID). DHS is funded in 1984 and for the purpose of solving global health challenges and promoting health and population trend understanding in developing countries. Since then DHS program has contributed to the development of more than 300 surveys implemented in over 90 countries. The program collects and makes available upon request accurate data that are nationally representative (DHS, 2014a).

DHS program uses three categories of core questionnaires to collect its primary data: A household questionnaire, individual women's questionnaire, and men's questionnaire. Household questionnaire was designed to gather information on characteristics of the household unit. The questionnaire also helps generate eligible members for further individual interview using the women's or men's questionnaire. Individual questionnaires collect information on a variety of topics including marriage, reproductive health and HIV/AIDS. Often, eligible women are of

reproductive age, which means between 15 and 49 years old whereas eligible men are 15-59 years or 15-54 depending on the country. DHS surveys gather basic demographic and health information, and may slightly vary from one country to the other consistent with the host country's priority. Also, DHS program yields model questionnaires that are modified over time. Accordingly, DHS surveys have evolved from its initial phase 1 (DHS I) to reach phase 6 (DHS VI) of its development (DHS, 2014b). This study used DHS Phase 6.

Multiple Indicator Cluster Survey (MICS)- is an international survey program initiated by United Nations Children's Funds (UNICEF). The survey program assists many countries in systematically collecting and analyzing data to produce statistically valid estimates of health indicators and other issues relevant to women and children. The program also helps countries monitor their national and global commitments including the Millennium Development Goals (UNICEF, 2012).

A combined DHS and MICS (DHS-MICS) survey was administered in the three countries between 2010 and 2012.

3.3. Study Subjects

3.3.1. Study Population

3.3.1a. Study Population of Cameroon

The DHS-MICS survey was carried out in Cameroon from January 2011 to August 2011 by the National Institute of Statistics (INS). It was a national survey conducted at the household and individual levels throughout the country. A total of 15,050 households were selected among which 14,354 households occupied by 15,852 women and 7,525 men were identified and eligible for interviews.

3.3.1b. Study Population of Cote d'Ivoire

The DHS-MICS survey was administered from December 2011 to May 2012 by the Ministry of Health and the Fight against AIDS in collaboration with the National Institute of Statistics (INS). It was a national survey implemented at the household and individual levels throughout the country. A total of 10,413 households were selected among which 9,873 households occupied by 10,848 women and 5,677 men were identified and eligible for interviews.

3.3.1c. Study Population of Senegal

The DHS-MICS survey was conducted from October 2010 to April 2011 by the National Agency of Statistics and Demography (ANSD). It was a national survey administered at the household and individual levels throughout the country. A total of 8,212 households were selected among which 8,029 households occupied by 16,931 women and 5,688 men were identified and eligible for interviews

3.3.2. Sampling Design and Study Sample of Cameroon

3.3.2a. Study Sample of Cameroon

A stratified national sample of 15,050 households was selected. The stratification was done to provide an adequate representation of the urban and rural areas as well as the 12 domains of study which corresponded to the 10 administrative regions.

The sampling procedure used "aréolaire" stratified two-phase cluster design (INS et ICF, 2012a). In the first stage or primary sampling unit, clusters or enumeration zones were selected throughout the country and drawn from the 2005 General Census of Population and Housing. Overall, 580 clusters were selected using a systematic sampling method with probability proportional to the number of household in the enumeration zone. The chosen clusters included 291 in urban areas and 289 in rural areas. An enumeration of households was done within each cluster which generated a list for the second-stage sampling. In the second-stage sampling, a

systematic sampling method with equal probability was used to choose from the list of households. All women aged 15-49, who lived in the selected households or who visited the households the night before the interview were eligible to participate. Also, one in every two households was selected for the men's survey. In Total 7,525 men were eligible for the interview. Further, all men and women who were eligible for the individual survey were also selected for blood testing for HIV.

In sum, among the 580 clusters, 578 were successfully surveyed and two inaccessible. A total of 15,050 households were chosen among which 14,354 households were identified for the interview. From this pool of households, 14,214 successfully participated in the survey leading then to 99.0% response rate. For individual interviews, 15,426 out of 15,852 women aged 15-49 and residing in the 14,214 households were successfully interviewed with a response rate of 97.3%. An overall 7191 of 7,525 eligible men aged 15-59 were also successfully interviewed with a response rate of 95.6%.

Thus, the sample size for women aged 15-49 was 15,426 and 7191 for men aged 15-59. This brought the total sample size to 22,617. However, this study focused on men and women aged 15-49. The final sample size for this study was 15,426 for women and 6452 for men leading to 21,878.

3.3.2b. Sampling Design and Study Sample of Cote d'Ivoire

A stratified national sample of 10,413 households was selected. The stratification was done to allow an adequate representation of the urban and rural areas as well as the 11 domains of study which corresponded to the 10 former administrative regions.

The sampling procedure used "aréolaire" stratified two-phase cluster design (INS et ICF, 2012b). In the first stage or primary sampling unit, clusters or census districts were drawn

throughout the country and from the 1998 General Census of Population and Housing. An update of the clusters was made which helped generate a complete list of households for the second-phase sampling. Overall, 352 clusters including 161 urban and 191 rural were selected using a systematic sampling with probability proportional to the number of census districts or households. In the second-phase sampling, a systematic sampling method with equal probability was used to select a consistent number of households. An average 27 households were selected from each cluster in the urban area and 32 in the rural area. All women aged 15-49, who lived in the selected households or who visited the households the night before the interview were eligible to participate. Also, one in every two households was eligible for the men's survey. Further, all men and women who were eligible for the individual survey were also identified for blood testing for HIV.

In sum, among the 352 clusters, 351 were successfully surveyed and one inaccessible. A total of 10,413 households were chosen among which 9,873 households occupied were identified for the interview. From this pool of households, 9,686 successfully participated in the survey leading then to 98.1% response rate. For individual interviews, 10,060 out of 10,848 women aged 15-49 and living in the 9,686 households were successfully interviewed with a response rate of 92.7%. An overall 5135 of 5,677 eligible men aged 15-59 were successfully interviewed with a response rate of 90.5%.

Thus, the sample size for women aged 15-49 was 10,060 and 5135 for men aged 15-59. This brought the total sample size to 15,195. However, this study used data only from men and women aged 15-49. Therefore, the final sample size for this study was 10,060 for women and 4622 for men leading to 14,682.

3.3.2c. Sampling Design and Study Sample of Senegal

A stratified national sample of 8,232 households was selected in hopes that 15,044 women aged 15-49 and men aged 15-59 would be interviewed. The stratification was implemented to accurately represent urban and rural areas of each region throughout the country.

The sampling procedure consisted of randomly stratified two-phase cluster design (ANSD, 2012). In the first phase or primary sampling unit or cluster, enumeration areas were drawn from the Census District (CD). A total of 28 sampling strata were generated with each stratum including urban and rural sections of each region. The first-phase sample was independently selected in each stratum. A systematic sampling method with probability proportional to sample size was used to yield 391 clusters among which 147 clusters in urban areas and 244 in rural areas. In the second phase, sample was independently selected within each primary unit or cluster. An enumeration of households in each cluster generated a list of households for the second-phase sampling. A systematic sampling method with equal probability was used to choose from the list of households. All women aged 15-49, who lived in the selected households or who visited the households the night before the interview were eligible to participate. Within each cluster, 21 households were chosen for the women individual interview. For the men's survey, only 8 out of 21 households were selected. All men aged 15-59 living in the selected households were eligible for interview.

Thus, 8,212 households were chosen among which 8,029 households were occupied and identified for the interview. From this pool of households, 7,902 successfully participated in the survey leading then to over 98.4% response rate. For individual interviews, 15,688 out of 16,931 women aged 15-49 and residing in the 7902 households were successfully interviewed with a response rate of 92.7%. The men's survey, which was administered in every three households, had a success response rate of 87% (4,929 out of 5,668 eligible men aged 15-59).

Blood samples were also collected from 5,326 women and 4,429 men. The collection of blood for HIV testing from representative samples of men and women provided nationally representative estimates of the rate of HIV prevalence in Senegal.

Thus, the sample size for women aged 15-49 was 15,688 and 4,929 for men aged 15-59. This brought the total sample size to 20,617. However, this study focused on men and women aged 15-49. The final sample size for this study was 15,688 for women and 4,414 for men leading to 20,102.

3.3.3. Inclusion/Exclusion Criteria

This study included all eligible men and women who successfully completed their blood test for HIV testing in each country. However, the study was limited to data of men and women aged 15-49 years only.

3.4. Study Variables

3.4.1. Dependent Variables

The dependent variable is HIV status. Participants' HIV status was diagnosed after a voluntary blood test for HIV was done. HIV consent statement was reviewed with and approved by each participant prior to HIV blood testing. Each country's ethical review committee reviewed and approved the testing protocol prior to blood testing. The testing consisted of collecting blood spots from a finger prick onto filter paper and carried to a laboratory for testing. The lab protocol involved an initial enzyme-linked immunosorbent assay (ELISA) test and then retesting of all positive and 5%-10% of negative tests with a second ELISA. For discordant results from the second ELISA, a new ELISA or Western Blot was conducted. Because of the

anonymity of the testing, participants were not provided with their results but were offered educational materials and referrals for free voluntary counseling and testing (VCT).

Even though individual blood test received a unique random identification number (bar code) that could be linked to the core questionnaire file, the results of blood testing were placed in a separated data file. Four types of HIV status emerged as the results of the blood test, 'HIV negative,' 'HIV positive,' 'HIV2 positive,' and "HIV1 and HIV2 positive." For the purpose of this study, the four categories were re-coded into two categories 'HIV negative' and 'HIV positive.'

3.4.2. Independent Variables

In this study, the following 13 independent variables were explored.

Gender- Men and women were interviewed with different sets of but mostly similar questionnaires. For women's questionnaire, additional questions pertaining to reproductive history, and child health and mortality were included. For the purpose of this study, only relevant data sets were used. This study merged both datasets from men and women in order to generate the gender variable which was coded 'male' and 'female.'

Age- Respondent's age was determined from the questions 'in what month and year were you born?' and 'how old were you at your last birthday?' The answers for both questions were compared and corrected if inconsistency occurred. DHS data includes two variables for age, the current age of participant and the age in 5-year groups. This study used the variable current age to calculate the median age but recoded the 5-year groups as '15-19,' '20-29,' '30-39,' and '40-49.'

Educational Level- Participants were asked if they ever attended school. Those who indicated "Yes" were followed up with a question "What is the highest level of school you attended:

primary, secondary, or higher?" The answers were categorized into four groups: 'No education,' 'Primary,' 'Secondary' and 'Higher.'

Current marital status- Participants were asked the following questions to help identify their marital status: "Are you current married or living together with a woman/man as if married?" "What is your marital status now: are you widowed, divorced or separated?" The answers were classified as 'Never in union,' 'Married,' 'Living with partner,' 'Widowed,' 'Divorced,' and 'No longer together/Separated.' This study regrouped the six categories into 4: 'Never in union,' 'Married/Living with partner,' 'Widowed/Divorced,' and 'No longer together/Separated.'

Wealth index- To identify the wealth index, respondents were asked about assets of the household including owning televisions and bicycles, materials for construction, types of water access and sanitation facilities. Because the wealth index is a composite measure of a household's cumulative living standard, it was calculated using the statistical method of principal components analysis. The results of the analysis were categorized into five groups 'Poorest,' 'Poorer,' 'Middle,' 'Richer,' and 'Richest.' This study regrouped the five categories into 3: 'Poor,' 'Middle,' 'Rich.'

Age at 1st sex- The question asked was "how old were you when you had sexual intercourse for the very first time?" Responses were coded 'Never had sexual intercourse,' 'Age in years' and 'First time when started living with first wife/partner.' This study used age at first sex imputed to eliminate inconsistency. The variable was re-coded 'Never had sex,' 'Before 15,' and '15+.'

Had any STI in last 12 months- The question was "During the last 12 months, have you had a disease which you got through sexual contact?" The answer format was 'Yes,' 'No,' or 'Don't know.' The study recoded by considering the 3rd category as missing.

Number of injections in last 12 months- The questions asked were "have you had an injection for any reason in the last 12 months?" If subjects said 'Yes,' the follow-up question was "How many injections have you had?" Responses were 'None,' 'Number of injections,' '90' if 90 or more, and 'Don't know.' In this study, the outcome was regrouped into 'None,' '1-4,' and '5+.'

Multiple sex partners excluding wives/husband- The question was "In total, with how many different people have you had sexual intercourse in the last 12 months?" The response was either 'Numerical,' 'Don't know,' or '95' if more than 95. The study recoded this variable as '0,' '1,' '2+.'

Total lifetime numbers of sex partners- Respondents were asked in total how many different people they have had sexual intercourse with in their lifetime. The response format was 'Numerical,' '95' if 95 and more, or 'Don't know.' The study recoded into '1,' '2,' '3+.'

Know a place to get HIV test- The question was "Do you know a place where people can go to get tested for the AIDS virus?" The response format was 'Yes' or 'No.'

E**ver been tested for HIV**- The question was "Have you ever been tested to see if you have the AIDS virus? The response format was 'Yes' or 'No.'

Condom used last time had sex with most recent partner- The question was "The last time you had sexual intercourse with the last sexual partner, was a condom used?" The response format was 'Yes' or 'No.'

3.5. Statistical Analysis

Data were managed and analyzed using IBM Statistical Package for Social Scientists (IBM SPSS) version 21 (IBM SPSS Inc. 2012). Data from individual women's questionnaires, men's questionnaire, and HIV testing results were merged using three coding identifications "Cluster number," "Household number" and respondent's "Line number." Participants aged less than 15

years or over 49 years old were excluded from data analysis. In this study, HIV sample weight was considered as a unit of analysis because of its association with both datasets (individual women and men). Accordingly, HIV sample weights were applied to all cases during descriptive analyses to make data results representative of the entire population in each country. Medians were calculated for two independent variables (Age at first union and age at first sex) and cross-tabulations were performed for frequency distributions of all selected independent variables and the dependent variable.

Binary logistic regression including univariate and multivariate analyses was conducted to help identify the association between selected HIV-related risk factors and HIV prevalence within each country and among the three countries. Odds ratios and 95% confidence interval were calculated for the univariate and multivariate logistic regression analyses. Statistical adjustments were made for confounding variables during the multivariate analysis. Forward Likelihood Ratio (LR) logistic regression was performed to help identify the best predictive risk factors of HIV infection in each country and understand the proportion of variation in HIV prevalence that could be explained by identified predictive risk factors.

CHAPTER IV

RESULTS

The purpose of this chapter is to depict the results of data analyses as related to the research questions. The objective of the study was to compare risk factors for HIV infection among three African countries, Cameroon, Cote d'Ivoire and Senegal to understand their differences; to identify factors that are associated with the prevalence of HIV infection within and among countries; and to determine what best predictive risk factors accounted for the variations in HIV prevalence of the three countries. Accordingly, this chapter presents the results relevant to the study questions into four sections: 1) Descriptive analysis of HIV risk factors between Cameroon, Cote d'Ivoire, and Senegal; 2) Descriptive analysis of HIV status of participants among the three countries; and the distribution of HIV prevalence on risk factors by gender in each country; 3) Binary logistic regression analysis- univariate and multivariate analyses of the association between selected risk factors and HIV prevalence in each country and multivariate analysis of the association between selected risk factors and HIV prevalence among countries; and 4) Forward stepwise likelihood ratio (Forward LR) analysis of best predictors of HIV prevalence within each country, and the contribution of best predictors to variations in HIV prevalence of each country.

4.1. Descriptive Analysis- Differences in Risk Factors for HIV between Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

The sample size for this study was 21,878 in Cameroon, 14,682 in Cote d'Ivoire, and 20,102 in Senegal and was used for the regression analysis. For the descriptive analysis and for making the results representative of the entire population, HIV sample weights were applied to the datasets of the three countries before medians were calculated, and frequency distributions using cross-

tabulation were explored. Accordingly, the weighted sample size was 13,503 for Cameroon, 8,560 for Cote d'Ivoire, and 9,430 for Senegal.

The results indicated significant differences ($p<0.001$) for all 13 variables across the three countries (Table 1). Even though more than half of the respondents in all three countries were females, there were significant differences in the representation across countries. A higher proportion of females were represented in Senegal (56.5%) compared to Cameroon (53.5%) or Cote d'Ivoire (52.7%). However, more males were represented in Cote d'Ivoire (47.3%) than in Cameroon (46.5%) or Senegal (43.5%).

Adults aged 20-29 represented the majority of the study population in all three countries. However, the level of participation differed from one country to another. A higher percent of adults aged 20-29 participated in Cote d'Ivoire (37.1%) compared to Cameroon (36.8%) or Senegal (36.6%).

Differences were more pronounced with the educational level status. In Cameroon, the majority of respondents were those with secondary education (45.5%) followed by individuals with primary education background (32.6%) whereas in Cote d'Ivoire and Senegal the majority of respondents has no education (44.3%, 48.2%, respectively) followed by individuals with primary education (26.5%, 24.8%, respectively) and those with secondary education background (24.9%, 24.6%, respectively).

More than half of participants in all three countries were married or living with a partner; however, a higher percent of those adults was involved in Cote d'Ivoire (56.1%) compared to Cameroon (54.8%) and Senegal (53.0%). The second majority of participants were 'never in union' adults with the highest proportion being in Senegal (43.8%) followed by those in Cote d'Ivoire (38.6%) and Cameroon (38.4%).

Interestingly, in the area of wealth index, the results showed that the majority of participants were rich in all three countries. However, there were differences between the levels of representation. More rich people (48.3%) were represented in Cameroon than in Senegal (47.6%) and Cote d'Ivoire (45.9%).

As shown in the table, the median age at first sex was similar in Cameroon (16 years) and Cote d'Ivoire (16 years) but lower in Senegal (15 years). However, the proportion of men and women who reported having their first sexual intercourse before the age of 15 was significantly ($p<.001$) higher in Cote d'Ivoire (17.4%) than in Cameroon (15.2%) and Senegal (11.0%). In Senegal, few participants (1.0%) reported having sexually transmitted infection (STI) in the last 12 months compared to those in Cameroon (4.2%) and Cote d'Ivoire (5.6%). Respondents who indicated they had received 5 and more injections in the last 12 months were significantly ($p<.001$) higher in Cameroon (10.8%) than in Cote d'Ivoire (5.7%) and Senegal (3.7%).

The proportion of men and women who claimed they had one partner in addition to their wife/husband was significantly ($p<.001$) higher in Cote d'Ivoire (24.2%) than in Cameroon (22.4%) or Senegal (8.1%). However, those who stated they had 2 and more sexual partners besides their spouse were similarly higher in both Cameroon (9.5%) and Cote d'Ivoire (9.3%) than in Senegal (1.4%). This last claim was consistent with the corresponding results of total lifetime numbers of sex partners. The percentage of adults who indicated they had 3 and more total lifetime sexual partners was significantly ($p<.001$) higher in Cameroon (58.0%) and Cote d'Ivoire (53.7%) than in Senegal (21.7%).

Table 1 Differences in Characteristics of Participants/Risk Factors between Cameroon (2011), Cote d'Ivoire (2011-2012, and Senegal (2010-2011)

Characteristics	Cameroon		Cote d'Ivoire		Senegal		p-value
	N	%	N	%	N	%	
Gender							<.001*
Male	6282	46.5	4051	47.3	4104	43.5	
Female	7221	53.5	4509	52.7	5326	56.5	
Age							<.001*
15-19	3198	23.7	1754	20.5	2311	24.5	
20-29	4968	36.8	3172	37.1	3447	36.6	
30-39	3203	23.7	2268	26.5	2218	23.5	
40-49	2134	15.8	1366	16	1454	15.4	
Educational level							<.001*
No education	2006	14.9	3796	44.3	4546	48.2	
Primary	4407	32.6	2266	26.5	2341	24.8	
Secondary	6148	45.5	2129	24.9	2316	24.6	
Higher	943	7.0	369	4.3	226	2.4	
Current marital status							<.001*
Never in union	5191	38.4	3303	38.6	4134	43.8	
Married/Living with a partner	7401	54.8	4798	56.1	4996	53	
Widowed/Divorced	396	2.9	173	2	255	2.7	
Separated/No longer living together	515	3.8	286	3.3	45	0.5	
Wealth index							<.001*
Poor	4423	32.8	3065	35.8	3008	31.9	
Middle	2555	18.9	1562	18.3	1934	20.5	
Rich	6526	48.3	3933	45.9	4488	47.6	
Median age at first sex	16 years		16 years		15 years		
Age at first sex							<.001*
Not had sex	2179	16.7	946	11.6	2762	30.4	
Before 15	1985	15.2	1424	17.4	1001	11	
15+	8856	68	5819	71.1	5308	58.5	
STI in last 12 months							<.001*
No	12831	95.8	8041	94.4	9333	99	
Yes	556	4.2	477	5.6	92	1	
Number of injections in last 12 months							<.001*
None	7953	58.9	5209	60.9	6332	67.3	
1-4	4083	30.3	2864	33.5	2735	29.1	
5+	1460	10.8	485	5.7	346	3.7	

Characteristics	Cameroon		Cote d'Ivoire		Senegal		p-value
	N	%	N	%	N	%	
Multiple sex partners in last 12 months							<.001*
0	9176	68.1	5687	66.5	8541	90.6	
1	3024	22.4	2064	24.2	762	8.1	
2+	1280	9.5	796	9.3	128	1.4	
Total lifetime numbers of sex partners							<.001*
1	2847	25.7	1986	26.7	3808	59.9	
2	1813	16.3	1455	19.6	1168	18.4	
3+	6437	58	3997	53.7	1377	21.7	
Know a place to get HIV test							<.001*
No	1640	12.6	2926	35.7	2851	31.4	
Yes	11410	87.4	5274	64.3	6225	68.6	
Ever been tested for HIV							<.001*
No	6858	51.1	5771	67.9	7061	74.9	
Yes	6562	48.9	2724	32.1	2369	25.1	
Condom used last time had sex with most recent partner							<.001*
No	7336	72.6	5200	77.7	4841	89.2	
Yes	2770	27.4	1490	22.3	587	10.8	

*p<.05

The results also indicated that a significantly (p<.001) higher percent of respondents in Cameroon reported to know a place to get tested for HIV (87.4%) than that in Senegal (68.6%) and Cote d'Ivoire (64.3%). However, only less than half of those participants across all three countries expressed they had ever been tested for HIV or used condoms last time they had sex with the most recent partner. The percentage of people who agreed to either such statement was significantly (p<.001) lower in Senegal (25.1%; 10.8%, respectively) than in Cote d'Ivoire (32.1%; 22.3%, respectively) or Cameroon (48.9%; 27.4%, respectively).

4.2 Differences in HIV Status among Countries and Distribution of HIV Prevalence on risk factors by Gender within Countries

This section provides answers to the study question #2. The section consists of two parts: Comparison of HIV status among the three countries and the distribution of HIV prevalence on risk factors by gender in each country.

4.2.1. Differences in HIV Status between Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

Table 2 displays the HIV status of participants aged 15-49 among countries. The results indicated that there was statistically significant differences (p<.001) between the three countries' HIV status. As expected, Senegal has the lowest HIV prevalence with only 0.7% of its adults aged 15-49 being HIV positive. The country with the highest HIV prevalence is Cameroon (4.3%) followed by Cote d'Ivoire (3.7%).

Table 2 Differences in HIV status between Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

Variable	Cameroon		Cote d'Ivoire		Senegal		p-value
	N	%	N	%	N	%	
HIV Serostatus							<.001*
HIV negative	12917	95.7	8241	96.3	9367	99.3	
HIV positive	584	4.3	317	3.7	63	0.7	

p<.05

4.2.2. Differences in the Distribution of HIV prevalence on risk factors by Gender in Cameroon, Cote d'Ivoire and Senegal

Table 3 depicts the distribution of HIV prevalence among men and women in relationship with risk factors in Cameroon, Cote d'Ivoire, and Senegal. As shown in the table, the prevalence of HIV infection was unequally distributed by gender in each country. The results indicated that in Cameroon, the prevalence of HIV infection among women (5.6%) was almost twice that of men (2.9%) whereas in Cote d'Ivoire and Senegal, the prevalence of HIV among women (4.6%; 0.8%, respectively) were one and a half times higher than that of men (2.7%; 0.5, respectively).

In Cameroon, HIV prevalence was significantly and unevenly distributed among men (p-values vary) and women ($p<.001$) on 9 out of the 13 selected risk factors. Men and women aged 30 and over were the most affected by HIV infection. However, the highest prevalence of HIV was observed among women aged 30-39 (8.6%) compared to men (5.6%). A higher HIV prevalence was seen among women with primary education (6.7%) or secondary education (6.3%) compared to their fellow men (3.1%; 2.5%, respectively). However, those who were the most affected by HIV were men with higher education background (5%). A greater HIV prevalence was recorded among women widowed and divorced (16.5%) or separated and no longer living together (16.3%) compared to their fellow men (6.5%; 5.1%, respectively). Also, more infected women were among rich people (6.8%) or middle class (5.8%) than men (3.3%; 2.6%, respectively) were. However, the distribution of HIV prevalence among men's wealth status was not statistically significant.

Further, in Cameroon, the prevalence of HIV was higher among women who had their first sex before the age of 15 (7.2%) than fellow men who did (4.4%). Also, HIV prevalence was noticeably higher among women who claimed to have STI during the last 12 months (11.5%) than their fellow men did (7.1%). A higher percent of infected women (8.2%) indicated they

received 5 and more injections in the last 12 months compared to their peer men (7.2%). Further, the prevalence of HIV was higher among women with one extra sexual partner (8.2%) or two extra sexual partners (8.0%) than among men with similar multiple sexual partners (3.2%; 2.7% respectively). However, the distribution of HIV prevalence among men with multiple sexual partners was not statistically significant. An even greater HIV prevalence (10.3%) was observed among women with 3 and more lifetime number of sexual partners compared to men with similar risky behaviors (3.9%). The prevalence of HIV was higher among women who reported they knew a place to get HIV test (6.3%) or had ever been tested for HIV (7.6%) than men with similar agreement (3.1%; 4.7%, respectively). Even though the distribution of HIV prevalence among men and women regarding their use of condom differed, the difference was not statistically significant.

In Cote d'Ivoire, the distribution of HIV infection among men and women was statistically significant with 7 out of the 13 risk factors. Even though there were differences in the distribution of HIV prevalence among men and women on educational level, STI in last 12 months, multiple sexual partners in last 12 months, and condom use with most recent sexual partner, the differences were not statistically significant. In the area of wealth and number of injections, the distribution of HIV prevalence was significant among men but not among women.

Like Cameroon, in Cote d'Ivoire, men and women in their thirties' and over were the most significantly ($p<.001$) affected by HIV infection. However, the highest prevalence of HIV was observed among women aged 40-49 (7.6%) compared to men (5.0%). A greater HIV prevalence was recorded among women widowed and divorced (17.3%) compared to their peer men (7.5%). Further, in Cote d'Ivoire, the prevalence of HIV was slightly lower among women who had sex before the age of 15 (4.4%) than women who had at 15 and over (4.9%). However,

a higher percentage of women who had their first sex before the age of 15 years were HIV positive (4.4%) than their fellow men were (3.1%). A higher percent of infected men (5.2%) indicated they had received 5 and more injections in the last 12 months compared to their peer who did not (1.9%). A greater HIV prevalence (7.3%) was observed among women with 3 and more total lifetime number of sexual partners compared to men with similar risky behaviors (3.6%). Further, the prevalence of HIV was higher among women who indicated they knew a place to get HIV test (5.8%) or had ever been tested for HIV (6.2%) than men with similar agreement (3.4%; 4.8%, respectively).

In Senegal, the distribution of HIV prevalence among men and women was statistically significant with only 5 out of the 13 risk factors. Even though there were differences in the distribution of HIV prevalence among men and women on STI in last 12 months, number of injections, knowledge of place to get tested for HIV, ever been tested, and condom used with most recent partner, the differences were not statistically significant. In the area of wealth, the distribution of HIV prevalence was significant among women while it was not among men. However, for multiple sexual partner behavior, the distribution of HIV prevalence was significant among men while it was not among women.

Like Cameroon and Cote d'Ivoire, in Senegal, men and women in their thirties' and over were significantly ($p<.001$) the most affected by HIV infection. However, the highest prevalence of HIV was observed among women aged 40-49 (1.9%) compared to fellow men (1.3%). A higher HIV prevalence was found among women with primary education (1.2%) or no education (1.0%) compared to their fellow men (0.1%; 0.9%, respectively). However, the group the most touched by HIV among men was those with no education (0.9%). A greater HIV prevalence was observed among women widowed and divorced (4.0%) compared to their peer men (1.9%).

Also, women with poor wealth index status had higher HIV prevalence (1.2%) than their fellow women with middle or rich wealth index status (0.8%; 0.5%, respectively).

Further, the prevalence of HIV was higher among women who had their first sex before the age of 15 (1.7%) than among fellow men (0%). Men who claimed they had two extra partners besides their wife had significantly ($p<.001$) higher HIV prevalence (2.5%) than men who had only their wife as sex partner (0.3%). A greater HIV prevalence (4.0%) was also observed among women with 3 and more total lifetime number of sexual partners than among men with similar risky behavior (1.2%).

Table 3 Differences in the Distribution of HIV Prevalence on Risk Factors by Gender (2011), Cote d'Ivoire (2011-2012) and Senegal (2010-2011)

Variable	Male			Female		
	Cameroon % p-value	Cote d'Ivoire % p-value	Senegal % p-value	Cameroon % p-value	Cote d'Ivoire % p-value	Senegal % p-value
**Gender	2.9	2.7	0.5	5.6 <.001*	4.6 <.001*	0.8<.001*
Age	<.001*	<.001*	<.001*	<.001*	<.001*	<.001*
15-19	0.4	0.1	0.0	2.1	0.8	0.2
20-29	1.7	0.8	0.3	5.3	4.6	0.6
30-39	5.6	3.7	0.7	8.6	6.2	1.1
40-49	5.4	5	1.3	6.7	7.6	1.9
Educational level	<.004*	=.563	=.006*	<.001*	=.053	=.017*
No education	1.8	2.9	0.9	2.8	5	1
Primary	3.1	3	0.1	6.7	4.9	1.2
Secondary	2.5	2.5	0.3	6.3	3.7	0.1
Higher	5	1.5	0.0	4.1	0.0	0.0
Current marital status	<.001*	<.001*	<.001*	<.001*	<.001*	<.001*
Never in union	1	0.7	0.2	2.1	2.9	0.4
Married/Living with a partner	4.6	4.5	1	5.3	4.7	0.8
Widowed/Divorced	6.5	7.5	1.9	6.5	17.3	4.0
Separated/No longer living together	5.1	3.1	0.0	6.3	6.3	0.0
Wealth index	=.114	=.043*	=.106	<.001*	=.079	=.041*
Poor	2.4	2.5	0.7	3.8	3.9	1.2
Middle	2.6	1.5	0.1	5.8	4.1	0.8
Rich	3.3	3.3	0.4	6.8	5.4	0.5
Age at first sex	<.001*	<.001*	=.007	<.001*	=.002*	=.004*
Not had sex	0.3	0.0	0.1	1.0	0.8	0.4
Before 15	4.4	3.1	0.0	7.2	4.4	1.7
15+	3.4	3.2	0.7	6.0	4.6	0.8
STI in last 12 months	<.001*	<.551	=.749	<.001*	=.210	=.056
No	2.7	2.8	0.4	5.3	4.4	0.8
Yes	7.1	2.1	0.0	1.5	6.0	2.9
Number of injections in last 12 months	<.001*	=.008*	=.437	=.001*	=.072	=.496
None	1.9	2.2	0.4	4.9	4.2	0.8
1-4	3.8	3.1	0.7	5.8	4.9	0.8
5+	7.2	5.2	0.6	8.2	7.6	1.6

Variable	Male			Female		
	Cameroon % p-value	Cote d'Ivoire % p-value	Senegal % p-value	Cameroon % p-value	Cote d'Ivoire % p-value	Senegal % p-value
Multiple sexual partners in last 12 months	=.624	=.064	<.001*	<.001*	=.168	=.315
0	2.8	3	0.3	4.9	4.3	0.8
1	3.2	2.7	1	8.2	5.7	1.9
2+	2.7	1.4	2.5	8	4.5	0.0
Total lifetime number of sexual partners	<.001*	=.001*	=.042*	<.001*	<.001*	<.001*
1	1.7	0.6	0.1	2.1	2.5	0.6
2	1.1	1.5	0.7	4.5	5.7	2.1
3+	3.9	3.6	1.2	10.3	7.3	4
Know a place to get HIV test	=.003*	=.004*	=.830	<.001*	<.001*	=.865
No	1.1	1.8	0.4	2.2	3	0.9
Yes	3.1	3.4	0.5	6.3	5.8	0.8
Ever been tested for HIV	<.001*	<.001*	=.373	<.001*	<.001*	=.809
No	1.5	2	0.4	3.2	3.7	0.8
Yes	4.7	4.8	0.6	7.6	6.2	0.9
Condom used last time had sex with most recent partner	=.078	=.003*	=.941	=.727	=.387	=.313
No	3.9	3.6	0.9	6	5	0.9
Yes	2.9	1.7	0.8	6.3	5.9	1.8

**Distribution of HIV prevalence on gender was done by country; p-values for the differences are displayed near women's HIV prevalence *p<.05

4.2 Binary Logistic Regression Analysis of the Association between Selected Risk Factors and HIV Status in Cameroon, Cote d'Ivoire and Senegal

Results of the binary logistic regression analysis helped answer the study question #3 and are presented in three sections. The first section depicts the results of the univariate logistic regression analysis of the association between selected risk factors and HIV prevalence in each country; the second section covers the results of the multivariate analysis of the association between selected risk factors and HIV prevalence in each country; and the third section presents

the results of the multivariate analysis of the association between selected risk factors and HIV prevalence among countries.

4.3. 1. Univariate Analysis of the Association between Selected Risk Factors and HIV Status in Cameroon, Cote d'Ivoire and Senegal

In Cameroon**,** the results of the univariate analysis showed 12 out of 13 selected risk factors as significantly associated with increased odds of HIV infection (Table 4). Only one risk factor, 'condom used last time with most recent partner' was significantly (p=.004) associated with reduced odds of HIV infection. As shown in the table, women were 2.03 times (OR=2.03; 95% CI= 1.70, 2.41; p<.001) more likely to have HIV infection compared to their fellow men. Adults aged 20 and over were also significantly (p<.001) associated with increased likelihood of HIV infection with the greatest increased odds being among people aged 30-39 (OR= 6.56; 95% CI= 4.66, 9.24; p<.001). Women and men with primary or secondary education background were significantly associated with increased odds of HIV infection (OR= 1.91; 95% CI=1.42, 2.56; p<.001 and OR= 1.52; 95% CI= 1.13-2.03; p=.005, respectively) compared to their counterparts with no education. Being in union or having been previously in union was also considered a risk factor for HIV infection with the greatest odds of HIV prevalence observed among widowed or divorced men and women (OR=9.47; 95% CI= 6.74, 13.30; p<0.001). Rich men and women were significantly associated with an increased prevalence of HIV infection (OR= 1.28; 95% CI= 1.06, 1.54; p<.011).

The results showed that adults who had their first sexual intercourse at early age (before 15) were at greater odds of being infected with HIV (OR=11.30; 95% CI= 6.38, 20.00; p<.001) than their peers who never had sex. Those who had STI in the last 12 months were 2.18 times more likely (OR= 2.18; 95% CI= 1.61, 2.95; p<.001) to have HIV infection compared to their fellows without STI infection. Men and women who reported having received injections in the

last 12 months were also associated with increased likelihood of HIV infection with the highest odds (OR= 2.39; 95% CI= 1.92, 2.98; p<.001) being among those who had received 5 and more shots.

Further, adults who were engaged in sexual intercourses with a partner other than their wife or husband were found to be significantly associated with increased odds of HIV infection (OR=1.26; 95% CI= 1.05, 1.51; p=.015). Also, men and women who had more than their wife or husband as lifetime sexual partners were significantly associated with increased odds of HIV infection with the greatest odds being among those with 3 and more lifetime sexual partners (OR=3.14; 95% CI= 2.40, 4.10; p<.001). Men and women who claimed to know a place to get HIV test (OR=2.40; 95% CI= 1.70, 3.39; p<.001) or have ever been tested (OR= 2.58; 95% CI= 2.17, 3.08; p<.001) were significantly associated with increased odds of HIV infection compared to their fellows who opposed it. However, those who indicated they used condom last time with their most recent partner were less likely to be associated with HIV infection (OR=0.73; 95% CI= 0.59, 0.91; p=.004)

In Cote d'Ivoire, the results of the univariate logistic analysis presented 9 out of 13 risk factors as significantly associated with increased likelihood of HIV infection (Table 4.3.1). 'Multiple sex partners in the last 12 months' (OR=0.45; 95% CI= 0.25, 0.81; p=.008) and 'condom used last time with most recent partner' (OR=0.67; 95% CI= 0.48, 0.94; p=.022) were found as protective factors against HIV infection. As shown in the table, women were 1.81 times (OR= 1.81; 95% CI= 1.42, 2.31; p<.001) more likely to have HIV infection than their fellow men. Adults aged 20 and over were significantly associated with increases in the likelihood of HIV infection with the greatest odds ratio recorded among individuals aged 40--49 (OR= 16.52; 95% CI=8.01, 34.07; p<.001).

The results of the unadjusted logistic regression analysis also suggested that in Cote d'Ivoire, being married or having previously been married was considered a risk factor for HIV infection with the greatest odds observed among widowed or divorced men and women (OR= 11.04; 95% CI=6.69, 18.23; p<.001). As shown in the table, wealthy men and women had 40% increased odds (OR= 1.40; 95% CI= 1.09, 1.81; p=.010) of being HIV positive compared to their fellows with poor wealth index. Men and women who reported having their first sex before 15 were significantly at greater odds of being HIV positive (OR=20.55; 95% CI= 5.01, 84.30; p<.001) than those who never had sex. Adults who indicated they had received 5 and more injections during the last 12 months had 123% higher odds (OR= 2.23; 95% CI= 1.50, 3.34; p<.001) of being infected with HIV than their fellows with no shots.

Further, having more than one lifetime sexual partner or having one lifetime sexual partner in addition to one's wife or husband was significantly associated with increased odds of HIV infection. The greatest odds was being among men and women with 3 and more lifetime sexual partners (OR=2.27; 95% CI= 1.65, 3.14; p<.001) compared to those with only one lifetime partner. Men and women who reported they knew a place to get AIDS test or had ever been tested for HIV showed significant association with increased likelihood of HIV infection (OR=2.36; 95% CI= 1.78, 3.13; p<.001 and OR=2.44; 95% CI= 1.94, 3.06; p<.001, respectively).

In Senegal, the results of the univariate analysis showed 7 out of 13 risk factors to be significantly associated with increased likelihood of HIV infection (Table 4.3.1). On the other hand, 'educational level' (OR=0.22, 95% CI= 0.09, 0.51; p<.001) and 'wealth index' (OR=0.48; 95% CI= 0.27, 0.83; p=0.008) were highlighted as protective factors against HIV infection. Women were 1.85 times (OR= 1.85; 95% CI=1.14, 2.99; p=.013) more likely to have HIV

infection than men. Adults in their twenties and over were associated with an increased HIV prevalence with the greatest increased odds found among people aged 40-49 (OR= 10.54; 95% CI=4.09, 27.16; p<.001). Further, widowed or divorced men and women were the most significantly associated with increased odds of HIV infection (OR=15.44; 95% CI= 6.63, 35.96).

Adults who indicated they had their first sexual intercourse before 15 were significantly associated with the greatest increased odds of HIV infection (OR=9.06; 95% CI= 3.39, 24.20; p<.001). Those who reported they had had STI in the last 12 months were associated with an increase in the odds of HIV infection (OR=5.27; 95% CI= 1.89, 14.71; p<.001). Further, men and women who had received 5 and more injections during the last 12 months had 156% higher odds (OR= 2.56; 95% CI= 1.09, 6.02; p=.031) of being HIV positive compared to their peers with no injections. Having more than one lifetime sexual partner or one additional lifetime sexual partner beside one's wife or husband was significantly associated with increased likelihood of HIV infection with the greatest odds being among individuals with 3 and more lifetime sexual partners (OR=2.59; 95% CI= 1.54, 4.35; p<.001).

Table 4 Univariate analysis of the association between selected risk factors and HIV status in Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

Variable	Cameroon			Cote d'Ivoire			Senegal		
	OR	95% CI	p-value	OR	95% CI	p-valu	OR	95% CI	p-value
Gender									
Male	1.00			1.00			1.00		
Female	2.03	1.70-2.41	<.001*	1.81	1.42-2.31	<.001*	1.85	1.14-2.99	=.013*
Age									
15-19	1.00			1.00			1.00		
20-29	3.62	2.56-5.11	<.001*	6.19	2.99-12.80	<.001*	2.93	1.10-7.82	=.032*
30-39	6.56	4.66-9.24	<.001*	11.73	5.71-24.09	<.001*	6.50	2.51-16.87	<.001*
40-49	5.73	4.00- 8.19	<.001*	16.52	8.01-34.07	<.001*	10.54	4.09-27.16	<.001*
Educational level									
No education	1.00			1.00			1.00		
Primary	1.91	1.42-2.56	<.001*	1.00	0.76-1.31	=.976	0.64	0.37-1.10	=.108
Secondary	1.52	1.13-2.03	=.005*	0.77	0.57-1.04	=.090	0.22	0.09-0.51	<.001*
Higher	1.36	0.87-2.12	=.172	0.58	0.27-1.24	=.160	0.57	0.08-4.18	=.584
Current marital status									
Never in union	1.00			1.00			1.00		
Married/ Living with a partner	3.13	2.49-3.92	<.001*	2.96	2.17-4.03	<.001*	4.25	2.24-8.08	<.001*
Widowed/ Divorced	9.47	6.74-13.30	<.001*	11.04	6.69-18.23	<.001*	15.44	6.63-35.96	<.001*
Separated									
No longer living together	7.10	5.06-9.95	<.001*	4.66	2.65-8.21	<.001*	0.00	0.00-..	=.998
Wealth index									
Poor	1.00			1.00			1.00		
Middle	1.24	0.99-1.55	=.064	0.98	0.70-1.38	=.926	0.59	0.34-1.03	=.065
Rich	1.28	1.06-1.54	=.011*	1.40	1.09-1.81	=.010*	0.48	0.27-0.83	=.008*
Age at first sex									
Never had sex	1.00			1.00			1.00		
Before 15	11.30	6.38-20.00	<001*	20.55	5.01-84.30	<001*	9.06	3.39-24.20	<.001*
15+	8.26	4.75-14.36	<001*	18.75	4.65-75.58	<.001*	4.99	1.99-12.50	=.001
STI in last 12 months									
No	1.00			1.00			1.00		
Yes	2.18	1.61-2.95	<.001	1.34	0.85-2.10	=.211	5.27	1.89-14.71	=.001*

Variable	Cameroon			Cote d'Ivoire			Senegal		
	OR	95% CI	p-value	OR	95% CI	p-valu	OR	95% CI	p-value
Number of injections in last 12 months									
None	1.00			1.00			1.00		
1-4	1.47	1.23-1.76	<.001*	1.27	0.99-1.62	=.058	1.30	0.82-2.07	=.266
5+	2.39	1.92-2.98	<.001*	2.23	1.50-3.34	<.001*	2.56	1.09-6.02	=.031*
Multiple sex partners in last 12 months									
0	1.00			1.00			1.00		
1	1.26	1.05-1.51	=.015*	1.00	0.77-1.31	0.992	1.49	0.79-2.82	=.221
2+	0.91	0.68-1.23	=.544	0.45	0.25-0.81	=.008*	1.67	0.45-6.88	=.477
Total lifetime numbers of sex partners									
1	1.00			1.00			1.00		
2	1.61	1.13-2.29	.008*	1.82	1.24-2.68	=.002*	2.40	1.38-4.18	=.002*
3+	3.14	2.40-4.10	<.001*	2.27	1.65-3.14	<.001*	2.59	1.54-4.35	<.001*
Know a place to get HIV test									
No	1.00			1.00			1.00		
Yes	2.40	1.70-3.39	<.001*	2.36	1.78-3.13	<.001*	1.15	0.72-1.85	=.560
Ever been tested for HIV									
No	1.00			1.00			1.00		
Yes	2.58	2.17-3.08	<.001*	2.44	1.94-3.06	<.001*	1.26	0.79-2.02	=.333
Condom used last time had sex with most recent partner									
No	1.00			1.00			1.00		
Yes	0.73	0.59-0.91	=.004	0.67	0.48-0.94	=.022*	0.93	0.42-2.05	=.858

*p<.05

4.3.2. Multivariate Analysis of the Association between Selected Risk Factors and HIV Status in Cameroon, Cote d'Ivoire and Senegal

In Cameroon, after adjusting for all the other variables, only 5 out of 12 risk factors including gender, age, current marital status, number of injections in the last 12 months, and total

lifetime numbers of sex partners remained significantly associated with increased odds of HIV infection (Table 5). On the other hand, after controlling for the other risk factors, 'age at first sex' emerged as a protective factor against HIV infection (OR=0.71; 95% CI= 0.56, 0.89; p=.003).

In Cote d'Ivoire, after controlling for all the other variables, 7 out of 9 risk factors including gender, age, current marital status, wealth index, number of injections in the last 12 months, total lifetime number of sexual partners, and know a place to get AIDS test were still demonstrated significant association with increased likelihood of HIV infection (Table 4.3.2) . One factor, 'educational level' appeared as a protective factor against HIV infection with the greatest reduction in the odds of HIV being among men and women with higher education background (OR=0.30; 95% CI= 0.12, 0.78; p=.014).

In Senegal, after adjusting for all the other variables, only 3 out of 7 risk factors, gender, age, number of injections in the last 12 months, and total lifetime number of sexual partners stayed significantly associated with increased odds of HIV infection (Table 4.3.2). After adjusting for all the other variables, only women (OR=2.69; 95% CI= 1.25, 5.80; p=.012), or those who had received 5 and more injections in the last 12 months (OR=3.14; 95% CI= 1.27, 7.75; p=.013), or who had one or more lifetime sexual partners beside their wife/husband (OR=2.89; 95% CI= 1.33, 6.28; p=.007) were significantly associated with increased odds of HIV infection.

Table 5 Multivariate analysis of the association between selected risk factors and HIV status in Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

Variable	Cameroon			Cote d'Ivoire			Senegal		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Male	1.00			1.00			1.00		
Female	2.14	1.71-2.68	<.001*	2.35	1.67-3.32	<.001*	2.69	1.25-5.80	=.012*
Age									
15-19	1.00			1.00			1.00		
20-29	1.72	1.08-2.73	=.022*	2.67	1.12-6.36	=.027*	1.05	0.29-3.81	=.945
30-39	2.18	1.35-3.54	=.002*	4.84	1.98-11.86	=.001*	1.53	0.41-5.65	=.526
40-49	2.13	1.28-3.53	=.004*	7.00	2.80-17.49	<.001*	1.88	0.49-7.23	=.358
Educational level									
No education	1.00			1.00			1.00		
Primary	1.31	0.90-1.91	=.164	0.81	0.58-1.13	=.217	0.66	0.32-1.38	=.270
Secondary	1.14	0.76-1.72	=.521	0.63	0.42-0.95	=.027*	0.28	0.08-1.01	=.052
Higher	0.96	0.54-1.71	=.894	0.30	0.12-0.78	=.014*	0.00	0.00-	=.997
Current marital status									
Never in union	1.00			1.00			1.00		
Married/Living with a partner	1.71	1.18-2.48	=.005*	1.42	0.79-2.54	=.243	0.86	0.20-3.76	=.839
Widowed/ Divorced	3.68	2.21-6.13	<.001*	3.10	1.40-6.88	=.005*	1.68	0.37-7.54	=.498
Separated/No longer living together	2.70	1.73-4.22	<.001*	0.89	0.38-2.09	=.783	0.00	0.00-..	=.999
Wealth index									
Poor	1.00			1.00			1.00		
Middle	0.93	71-1.22	=.597	1.05	0.70-1.58	=.813	0.58	0.28-1.21	=.144
Rich	1.03	0.80-1.32	=.840	1.51	1.09-2.07	=.012	0.63	0.30-1.31	=.214
Age at first sex									
Never had sex	..	…	…	1.00			1.00		
Before 15	1			1.37	0.32-5.96	=.671	1.15	0.24-5.46	=.864
15+	0.71	0.56-0.89	=.003*	1.40	0.33-5.94	=.645	0.77	0.17-3.46	=.729
STI in last 12 months									
No	1.00			1.00			1.00		
Yes	1.41	0.99-1.99	=.056	1.09	0.65-1.84	=.741	2.84	0.79-10.27	=.111
Number of injections in last 12 months									
None	1.00			1.00			1.00		
1-4	1.18	0.95-1.47	=.133	1.09	0.81-1.45	=.583	1.01	0.55-1.85	=.979
5+	1.57	1.21-2.04	=.001*	1.81	1.13-2.92	=.014*	3.14	1.27-7.75	=.013*

Variable	Cameroon			Cote d'Ivoire			Senegal		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Multiple sex partners in last 12 months									
0	1.00			1.00			1.00		
1	1.21	0.92-1.59	=.184	1.40	0.87-2.25	=.162	1.11	0.30-4.12	=.878
2+	0.90	0.60-1.35	=.606	0.78	0.36-1.69	=.532	1.39	0.22-8.85	=.726
Total lifetime numbers of sex partners									
1	1.00			1.00			1.00		
2	1.41	0.93-2.14	=.108	1.59	0.99-2.54	=.053	3.20	1.59-6.44	=.001*
3+	2.86	2.03-4.04	<.001*	2.54	1.66-3.89	<.001*	5.43	2.37-12.42	<.001*
Know a place to get HIV test									
No	1.00			1.00			1.00		
Yes	1.26	0.81-1.96	=.308	1.84	1.23-2.76	=.003	1.29	0.67-2.47	=.453
Ever been tested for HIV									
No	1.00			1.00			1.00		
Yes	1.14	0.90-1.44	=.286	1.32	0.96-1.82	=.093	0.96	0.49-1.89	=.908
Condom used last time had sex with most recent partner									
No	1.00			1.00			1.00		
Yes	0.97	0.75-1.26	=.838	1.03	0.68-1.57	=.883	1.24	0.42-3.60	=.698

--This category was reduced *p <.05

4.3.3. Multivariate Analysis of the Association between Selected Risk Factors and HIV Status between Cameroon, Cote d'Ivoire and Senegal

Table 6 presents the results of the multivariate analysis of the association between selected factors and HIV status among the three countries. After adjusting for the country indicators and all the 13 other variables, 8 risk factors appeared significantly associated with increases in the likelihood of HIV infection in both Cameroon and Cote d'Ivoire in reference to Senegal. However, only 'education level' came out as a protective factor against HIV infection. The greatest reduction in the likelihood of HIV infection (OR=0.53; 95% CI= 0.35, 0.83;

p=.005) was among men and women with higher education background in both Cameroon and Cote d'Ivoire in reference to Senegal. The results of the adjusted analysis showed Cameroon at significantly greater increased odds (OR= 2.97; 2.18-4.03; p<.001) of HIV infection than Cote d'Ivoire (OR=2.57; 1.89-3.50; p<.001) in reference to Senegal.

Also, the results of the adjusted analysis indicated that women were 2.18 times more likely to have HIV infection compared to men in both Cameroon and Cote d'Ivoire in reference to Senegal. Adults in their twenties and over also showed significant increases in the odds of HIV prevalence with the highest increase (OR=2.81; 95% CI= 1.85, 4.26; p<.001) being among men and women aged 40-49 in both Cameroon and Cote d'Ivoire in reference to Senegal. Adults who were widowed or divorced also had 234% higher odds (OR=3.34; 95% CI= 2.22, 5.02; p<.001) of being HIV positive compared to those who were never married in both Cameroon and Cote d'Ivoire in reference to Senegal.

Further, adults who reported having had STI in the last 12 months (OR=1.33; 95% CI= 1.01, 1.77; p=.044) or received 5 and more injections in the last 12 months (OR=1.64; 95% CI= 1.32, 2.05; p<.001) were significantly associated with increased odds of HIV infection compared to those who had not in both Cameroon and Cote d'Ivoire in reference to Senegal. Men and women who had more than one lifetime sexual partner or one additional lifetime sexual partner beside their wife or husband were significantly associated with increased likelihood of HIV infection with the highest increase odds (OR=3.09; 95% CI= 2.40, 3.98; p<.001) being among those who had two and more lifetime sexual partners in both Cameroon and Cote d'Ivoire in reference to Senegal. Those who knew a place to get AIDS test were also significantly associated with an increase in the likelihood of HIV infection (OR=1.52; 95% CI= 1.17, 1.99; p=.002) compared to those who did not in both Cameroon and Cote d'Ivoire in reference to Senegal.

Table 6 Multivariate analysis of the association between selected risk factors and HIV status between Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

Variable	OR	95% CI	p-value
Country			
Senegal	1.00		
Cote d'Ivoire	2.57	1.89-3.50	<.001*
Cameroon	2.97	2.18-4.03	<.001*
Gender			
Male	1.00		
Female	2.18	1.82-2.61	<.001*
Age			
15-19	1.00		
20-29	1.78	1.21-2.63	=.003*
30-39	2.50	1.67-3.74	<.001*
40-49	2.81	1.85-4.26	<.001*
Educational level			
No education	1.00		
Primary	0.88	0.71-1.10	=.269
Secondary	0.73	0.57-0.94	=.015*
Higher	0.53	0.35-0.83	=.005*
Current marital status			
Never in union	1.00		
Married/Living with a partner	1.60	1.19-2.17	=.002*
Widowed/Divorced	3.34	2.22-5.02	<.001*
Separated/No longer living together	2.02	1.38-2.96	<.001*
Wealth index			
Poor	1.00		
Middle	0.93	0.75-1.15	=.487
Rich	1.14	0.95-1.38	=.170
Age at first sex			
Never had sex	1.00		
Before 15	1.32	0.47-3.68	=.597
15+	1.03	0.37-2.84	=.957
STI in last 12 months			
No	1.00		
Yes	1.33	1.01-1.77	=0.044*
Number of injections in last 12 months			
None	1.00		
1-4	1.14	0.96-1.35	=.126
5+	1.64	1.32-2.05	<.001*
Multiple sexual partners in last 12 months			
0	1.00		
1	1.26	1.00[a]-1.59	=.054
2+	0.89	0.62-1.26	=.499

Variable	OR	95% CI	p-value
Total lifetime numbers of sexual partners			
1	1.00		
2	1.72	1.29-2.19	<.001*
3+	3.09	2.40-3.98	<.001*
Know a place to get HIV test			
No	1.00		
Yes	1.52	1.17-1.99	=.002*
Ever been tested for HIV			
No	1.00		
Yes	1.20	1.00[a]-1.44	=.053
Condom used last time had sex with most recent partner			
No	1.00		
Yes	1.01	0.82-1.26	=.902

a-rounded up to the nearest tenth *p <.05

4.4. Best Predictive Risk Factors of HIV Infection and their Contribution to Variations in HIV Prevalence in Cameroon, Cote d'Ivoire, and Senegal

This section presents the results of the forward stepwise likelihood ratio (Forward LR) analysis in an attempt to answer the study question #4. Forward LR was performed to identify which of the following nine HIV risk factors resulting from the multivariate analysis of each country, gender, age, educational level, current marital status, wealth index, age at first sex, number of injections, total lifetime numbers of sex partners, and know a place to get AIDS test, are best in predicting the acquisition of HIV infection in Cameroon, Cote d'Ivoire and Senegal.

The resulting model suggested seven best predictors of HIV infection in Cameroon. They were gender, age, current marital status, age at first sex, number of injections, total lifetime numbers of sex partners, and know a place to get AIDS test (Table 7). The model summary shows that the overall model was a good fit (-2Log Likelihood= 3973.103; Hosmer and Lemeshow goodness-of-fit test statistic p=.069). Also, the model was statistically significant

(χ^2= 332.79, df= 13, p<.001) and all the predictors together accounted for 9.3% of the variations (Nagelkerke R^2= .093) in HIV prevalence in Cameroon. The model was accurate in correctly classifying 94.8% of all cases (Table 8).

In Cote d'Ivoire, the results of Forward LR logistic regression pointed to 5 risk factors as the best predictors of HIV infection including gender, age, current marital status, lifetime numbers of sex partners, and know a place to get AIDS test (Table 7). Table 8 shows that the overall model of five predictors was a good fit (-2Log Likelihood= 2096.534; Hosmer and Lemeshow goodness-of-fit test statistic p=.094). Also, the overall model was statistically significant (χ^2= 174.97, df= 10, p<.001) and all the five predictors contributed to 8.9% of the variations (Nagelkerke R^2= .097) in HIV prevalence of Cote d'Ivoire. The model was accurate in correctly classifying 96.1% of all cases.

In Senegal, the results of the forward stepwise LR analysis presented 4 risk factors as best predictive risk factors of HIV prevalence. This included gender, age, wealth index, and total lifetime numbers of sex partners (Table 7). The overall model of four predictors was a good fit (-2Log Likelihood= 734.576; Hosmer and Lemeshow goodness-of-fit test statistic p=.860). Also, the model was statistically significant (χ^2= 54.21, df= 8, p<.001), and all the predictors together could explain 7.3% of the variations (Nagelkerke R^2= .073) in HIV prevalence. The model was accurate in correctly classifying 98.8% of all cases (Table 8).

As shown in Table 7, three best predictors were common to all three countries in spite of their differences. They were gender, age, and total lifetime numbers of sex partners. Further, current marital status and knowledge of place for HIV testing were found to best predict HIV prevalence in both Cameroon and Cote d'Ivoire. Finally, the results indicated that Cameroon had more HIV predictors than Cote d'Ivoire or Senegal.

Table 7 Best predictive risk factors of HIV prevalence in Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011) – Results of Forward Stepwise Likelihood Ratio

Variable	Cameroon			Cote d'Ivoire			Senegal		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Gender									
Male	1.00			1.00			1.00		
Female	2.13	1.75-2.60	<.001*	2.39	1.79-3.20	<.001*	3.81	2.04-7.13	<.001*
Age									
15-19	1.00			1.00			1.00		
20-29	1.95	1.25-3.04	=.003*	2.70	1.22-5.99	=.014*	1.28	0.37-4.41	=.694
30-39	2.80	1.77-4.44	<.001*	5.04	2.23-11.43	<.001*	2.02	0.60-6.81	=.255
40-49	2.33	1.44-3.78	=.001*	7.24	3.15-16.65	<.001*	3.40	1.02-11.35	=.047*
Current marital status									
Never in union	1.00			1.00			1.00		
Married/Living with a partner	1.49	1.12-1.98	=.006*	1.25	0.85-1.82	=.255			
Widowed/ Divorced	3.94	2.61-5.94	<.001*	3.04	1.66-5.56	<.001*			
Separated/No longer living together	2.68	1.82-3.95	<.001*	1.08	0.55-2.15	=.817			
Wealth index									
Poor							1.00		
Middle							0.52	0.28-0.96	=.038*
Rich							0.47	0.26-0.85	=.014*
Age at first sex									
Never had sex	…	…	…						
Before 15	1.00								
15+	0.71	0.58-0.88	<.001*						
Number of injections in last 12 months									
None	1.00								
1..4	1.24	1.01-1.51	=.036*						
5+	1.69	1.33-2.14	<.001*						
Total lifetime numbers of sex partners									
0	1.00			1.00			1.00		
1	1.45	1.00-2.11	=.049*	1.77	1.12-2.61	=.012*	2.79	1.54-5.06	=.001*
2+	2.88	2.14-3.87	<.001*	2.56	1.75-3.73	<.001*	5.45	2.80-10.60	<.001*
Know a place to get HIV test									
No	1.00			1.00					
Yes	1.59	1.08-2.33	.020*	2.09	1.54-2.84	<.001*			

*p<.05

Table 8 Model summary of best predictive risk factors of HIV prevalence in Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011) – Results of Forward Stepwise Likelihood Ratio

	Cameroon			Cote d'Ivoire			Senegal		
Number of variables in model	7			5			4		
-2Log Likelihood (LL)	3973.103			2096.534			734.576		
Hosmer and Lemeshow (H-L) goodness-of-fit test statistic	p =.069			p =.094			p =.860		
x^2/ df /p-value	332.79/	13	/<.001*	174.97/	10	/<.001*	54.21/	8	/<.001*
Nagelkerke R^2	0.093			0.089			0.073		
Classification accuracy	94.8%			96.10%			98.80%		

*p<.05

CHAPTER V

DISCUSSION AND CONCLUSION

5.1. Discussion

The purpose of the study was to explore differences in HIV risk factors that help explain variations in HIV prevalence between Cameroon, Cote d'Ivoire, and Senegal. The study achieved its goal by 1) identifying and comparing risk factors between the three African countries 2) identifying and comparing the prevalence of HIV infection between the three countries, and assessing its distribution by socio-demographics; 3) determining risk factors that are associated with the prevalence of HIV infection in each country; and 4) identifying best predictors of HIV prevalence and their contribution to variations in HIV prevalence within each country. Finding best predictive risk factors and their degree of contribution might assist in shaping effective prevention interventions, and therefore advancing preventive efforts in each country to help eliminate the gap in HIV prevalence between the three countries.

5.1.1. Differences in Risk Factors between Cameroon, Cote d'Ivoire, and Senegal

The study found significant ($p<.001$) differences in the characteristics of the three countries in regards to all 13 risk factors. Women were more represented in all three countries compared to men. However, Senegal has more women representation than does Cameroon or Cote d'Ivoire. Young adults aged 20-29 were represented in majority in all three countries than all the other age groups. However, there were more young adults aged 20-29 in Cote d'Ivoire than in Cameroon and Senegal. The majority of men and women in all three countries were married or living together; however, a high proportion of this group resided in Cote d'Ivoire than in Cameroon or Senegal. Further, more rich people were in Cameroon than in Senegal or Cote d'Ivoire. Thus,

these findings provided clear evidence of the differences between the socio-demographic characteristics of the three countries.

Further, the practice of polygyny was the same in all three countries. However, there were significant ($p<.001$) differences in the characteristics of sexual behaviors among men and women of the three countries. More women and men reported they were sexually active before the age of 15, had multiple sexual partners, and one additional lifetime sexual partner besides wife or husband in Cote d'Ivoire than in Senegal or Cameroon. These findings were consistent with the 2013 Global report (UNAIDS, 2013) that highlighted an increase in the number of sexual partners in Cote d'Ivoire. However, more men and women embraced polygynous lifestyle in Cameroon compared to those in Cote d'Ivoire or Senegal.

More adults reported they had had STI in the last 12 months in Cote d'Ivoire compared to Cameroon or Senegal. Also, a higher proportion of men and women indicated they had received 5 and more injections in the last 12 months, knew a place to get HIV test, had ever been tested for HIV, and used condom last time had sex with most recent partner in Cameroon than in Cote d'Ivoire or Senegal. These differences in risky behaviors between the three countries are another clear indication of the differences in characteristics of the three countries.

Interestingly, men and women in all three countries were struggling in changing their behavior. Even though the majority of adults in all three countries indicated they knew a place to get HIV test, only less than a half indicated they had ever been tested for HIV. More, only quarter or less of those people stated they used condom last time they had sex with their most recent partner. These findings are consistent with the 2013 Global Report (UNAIDS, 2013) which indicated that several countries had noticed a reduction in the use of condoms among men and women.

5.1.2. Distribution of HIV Infection among Men and Women within and between Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011): Gender Inequality

The findings pointed out the unevenly distribution of HIV prevalence among males and females in all three countries. In Cameroon, women were almost twice affected by HIV infection than men, and had the highest HIV prevalence age-wise than men. Women with primary or secondary were the most infected with HIV compared to their fellow men. Those who were widowed or divorced were 8 times more vulnerable to HIV infection compared to women who never got married, and 2.5 times more than their men counterparts. Further, women who had their first sex before the age of 15, had STI in the last 12 months, got 5 and more injections in the last 12 months, had one or more sexual partner(s) in addiction to husband, or 3 and over as lifetime number of sexual partners, know a place to get HIV test, and had ever been tested for HIV were the most affected by HIV infection compared to other women and compared to their male counterparts.

The reasons of these gender inequalities are multiple including biological, medical, and aesthetic factors, age of partner, poverty that left women financially powerless, status of subordination that constrains them to polygamous life and weakens their ability to negotiate safer sex, and cultural rules and discriminatory laws that undermine woman' values. These findings are consistent with previous studies and reports (Buve et al., 2012, Gay et al., 2012; Njikam-Savage, 2005; Rwenge, 2013; UNAIDS, 2013). Accordingly, in its Global Report, UNAIDS (2013) exhorted all countries to address the issue of gender disparities, abuse and violence, and enable them to take control of their lives to reduce their vulnerability to HIV infection.

In Cote d'Ivoire, women were one and a half times likely to have HIV infection than men. Like in Cameroon, women in Cote d'Ivoire had the highest HIV prevalence age-wise compared to men. Women who were widowed or divorced were almost 6 times more vulnerable

to HIV infection compared to women who never got married, and 2.3 times more exposed to HIV than their counterpart men. Further, women who had 3 and more lifetime number of sexual partners, knew a place to get HIV test, and had ever been tested for HIV were the most significantly infected with HIV compared to other women and compared to their male counterparts. Even though those who had their first sex before 15 were not the most highly affected among women, they were comparing to their male counterparts. These findings are supported by previous studies (Hertog, 2008). In her study on gender differences between Tanzania and Cote d'Ivoire, Hertog (2008) found also that polygamous marriage was protective against HIV for men but not for women in Cote d'Ivoire. Her study showed that Muslim and Protestant women living in polygamous marriage in Cote d'Ivoire were ten times more likely to be HIV positive than their male counterparts. Thus, like in most African countries, women' status of subordination, polygamous life, financial dependency, and other country-specific contexts can also help explain gender disparities in Cote d'Ivoire.

In Senegal, the findings indicated that HIV prevalence was significantly unevenly distributed among men and women on five risk factors. Women were 0.8 times more likely to have HIV compared to their fellow men. Those in their forties and over and who were widowed or divorced were the most affected by HIV infection compared to their male counterparts. Women who had their first sex before 15 and had 3 and more lifetime partners were the most HIV positive. Despite its lowest HIV prevalence in the region Senegal is still faced with some challenges including gender differences, HIV epidemic with older people, girls' early debut at sex (15 years), multiple lifetime sexual partnership or polygyny. These findings are consistent with those of previous studies and reports (ANSD, 2012; UNAIDS, 2013). As indicated above, Hertog (2008) found in her study that men in polygamous marriage benefit more than women do.

For men, polygamy union is protective while for women it is harmful. Our study found that women who were in polygamous marriages (3 and more lifetime sexual partners) were 6.6 times more likely to have HIV infection compared to other women who were in a single marriage and 3.3 times more likely to be HIV positive compared to their male counterparts. Senegal needs to address these issues to avoid averting its privileged low HIV prevalence.

5.1.3. Association between Selected Risk Factors and HIV Prevalence in Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

In Cameroon, the adjusted analysis found five risk factors including gender, age, current marital status, number of injections in the last 12 months, and total lifetime numbers of sex partners that remained significantly associated with increased odds of HIV infection. However, delayed in sexual debut was found to be a protective factor against HIV infection. These results are consistent with findings of previous studies and reports (Auvert et al., 2001; Buvé et al., 2002; Gay et al., 2012; Njikam-Savage, 2005; Weiss et al., 2001; UNAIDS, 2013). The results of the multivariate analysis highlighted the greater increased odds of HIV infection among adults 30 and over. Because a high number of older people are associated with HIV infection, it would be interesting to extend our research scope beyond the age of 49 to understand and help capture those undetected cases of HIV infection in the population. Often, studies focused on younger adults and overlooked older population. These findings are also supported by previous research (Gay et al., 2012). Therefore, further research is needed to shed light on older people's cases for effective prevention design.

In Cote d'Ivoire, the findings of the adjusted analysis showed seven risk factors, gender, age, current marital status, wealth index, number of injections in the last 12 months, total lifetime numbers of sex partners that remained strongly and significantly associated with increased odds of HIV infection. On the other hand, having secondary or higher education background

continued to associated with reduced odds of HIV infection. These results were consistent with findings of previous studies and reports (Auvert et al., 2001; Gay et al., 2012; Hertog, 2008, UNAIDS, 2013). The 2013 Global Report (UNAIDS, 2013) pointed out that there is evidence of increase in risky behaviors including a rise in the number of sexual partners in Cote d'Ivoire. However, there is limited research in these areas in Cote d'Ivoire.

In Senegal, the results of the multivariate analysis indicated only three risk factors as strongly and significantly associated with increased odds of HIV infection. Based on the extensive history of Senegal in having control of HIV infection and keeping its prevalence low at all times, it is not surprising that it had fewer risk factors than the other two countries. These findings are consistent with previous studies and reports (Foley & Nguer, 2010; Willems, 2009; UNAIDS, 2013)

Having received 5 and more injections in the last 12 months was strongly associated with increased odds of HIV infection in all three countries. It has been extensively documented that contaminated syringes and needles are major sources of HIV acquisition among those who shared injection equipment (Gay et al., 2012; Growing et al., 2013; Reid, 2009). Reid (2009) in his review reported that medical injections with used syringes and needles during invasive medical and dental care constituted a risk factor for the acquisition of HIV infection. Also, it has been documented that injection drug use is no more unusual phenomenon in the sub-Saharan African region. Accordingly, prevention interventions need to seriously take into consideration this risk factor to help control HIV transmission in Cameroon, Cote d'Ivoire and Senegal.

Further, total lifetime number of sexual partners was strongly and significantly associated with being HIV positive in all three countries with the highest odds of HIV infection being observed among those with two and more lifetime sexual partners. The results shed light onto the

polygamous nature of African society that is deeply rooted in political power and social forces (UNAIDS, 2010; Buve et al, 2002; Mah & Shelton, 2011). Only through structural changes and at the national scale that individual behavior change will occur.

The results of unadjusted analysis highlighted condom use with most recent partner as a protective factor against HIV infection. Nevertheless, many men and women in both Cameroon and Cote d'Ivoire still avoid using it or use it sporadically. According to Njikam-Savage (2005), the lack of condom use among university students were due to many reasons including promotion of active sexual engagement and infidelity, commercial profits, repulsion towards condoms, and inability to negotiate condom use with older partners. In their review, Gay et al., (2012) found women powerless regarding the use of condoms since men have the ultimate decision. The Global report (UNAIDS) stressed the lack of condom use in Cote d'Ivoire and other countries in the Sub-Saharan African region. Accordingly, it is preponderant that prevention programs adopt strategies that make condom use socially acceptable.

Thus, the adjusted analysis in each country showed that Cameroon has less independent risk factors compared to Cote d'Ivoire that are associated with having HIV infection. This let us to the challenge of how to best establish the relationship between differences in risk factors and variations in HIV prevalence with Cameroon having the highest HIV prevalence (4.3%) compared to Cote d'Ivoire (3.7%)? The remaining lines will help us shed light on the relationship.

5.1.4. Association between Selected Risk Factors and HIV Prevalence between Cameroon (2011), Cote d'Ivoire (2011-2012), and Senegal (2010-2011)

The results of the adjusted logistic regression among countries demonstrated that each country as whole was strongly, significantly, and independently associated with increased odds of HIV prevalence in comparison to Senegal. This implies that there were factors above and

beyond differences in risk factors that also can help explain variations in the prevalence of HIV. In their paper, international response to the HIV/AIDS epidemic: planning for success, Piot and Seck (2001) argued that the society in which successful responses to the HIV epidemic has been achieved and HIV prevalence and incidence have been maintained low is the nation where political leaders, and national and local communities have identified effective priorities for action, initiated deeper social structure changes, and expanded availability of relevant resources. They state "…it is precisely when the response to the epidemic is based on a broad social mobilization, accompanied by clear deliverables, that success has been achieved" (p. 1108).

These claims are consistent with the 2013 Global Report (UNAIDS, 2013) that highlighted many countries' lack in the thorough and rigorous approach that will assist them in moving forward. The report also indicated that the prevention strategies should not be implementing in isolation but taking into account the local need of the population or the local context. The 2013 Global Report stipulates "It is clear that only when a comprehensive set of HIV prevention initiatives is rolled out at a national scale with sufficient access to, and frequent use of, qualities services, will countries realize the optimal prevention returns" (p.14). Therefore, UNAIDS (2013) suggested that new prevention efforts combine behavioral, biomedical, and structural programming approaches to help speed up the progress. This recommendation is consistent with the study. Prevention priorities should take into consideration country-specific context to help speed the progress in the fight for HIV.

As expected and in comparison to Senegal, all the risk factors that were significantly associated with HIV infection were all at increased odds except one, 'education level.' In its introduction and literature review, the study has highlighted the historical advantage and the many initiatives including political and local involvement, social and economic contexts, cultural

strongholds, scientific research which Senegal has undertaken to help its society sustain the low HIV prevalence and incidence. On the other hand, Cameroon and Cote d'Ivoire have seen some of these critical elements missing in their prevention efforts. Particularly, the decade of civil war and political instability that had torn Cote d'Ivoire and the presence of virulent HIV strains (Buvé, 2002; Nsagha et al., 2012) and the lack of rigorous oversight of HIV (Yakam & Gruénais, 2009) prevention programs in Cameroon could be serious limitations to the reduction in HIV prevalence and incidence comparable to the level of Senegal. Therefore, these findings brought into light the importance of taking into consideration many of the factors that are beyond HIV prevention scope if effective prevention efforts will be achieved. Further, the results of educational level demonstrated that a reduced number of adults with secondary and higher education background were associated with HIV infection compared to Senegal. Even though more people are educated in Cameroon than in Cote d'Ivoire, the examination of the results of univariate and multivariate of 'educational level' indicated that more men and women in Cote d'Ivoire are aligning their knowledge to their actions than people in Cameroon do.

5.1.5. Best Predictors of HIV Infection in Cameroon, Cote d'Ivoire, and Senegal

The results of Forward LR substantiated that there were differences in risk factors among the three countries and some of those risk factors were strongly and significantly associated with being infected with HIV. The fact that Cameroon has the highest HIV prevalence (4.3%) and showed more best predictive risk factors (7) that are strongly and significantly associated with HIV infection while Cote d'Ivoire has 3.7% as HIV prevalence and presents less best predictors (5) with some significant tied to the disease might help explain both countries' differences in risk factors and their association to variations in the prevalence of HIV. As also evidenced by the Nagelkerke R squared, all the identified best predictors together accounted for 9.3% of variations

in HIV prevalence in Cameroon whereas in Cote d'Ivoire, all the identified best predictive risk factors together could explain 8.9% of variations in HIV prevalence (Table 4.4.2). Not surprising, Senegal with its lowest HIV prevalence (0.7%) had the lowest identified best predictors (4) compared to those of Cameroon or Senegal. These few identified best predictive risk factors were not all strongly associated with HIV infection.

Thus, the major findings of the study are that differences in risk factors can help explain variations in HIV prevalence. However, these differences accounted only for a portion of the variation in HIV prevalence. Accordingly, country indicators' strong association with HIV prevalence suggests there are other factors above and beyond risk factors that can capture the unexplained variations of HIV prevalence.

5.2. Strengths and Study Limitations

Because DHS surveys phase 6 were population-based surveys, collected datasets were nationally representative samples of the three countries, Cameroon, Cote d'Ivoire, and Senegal. Also, HIV sample weights were applied to both women and men datasets for all three countries when assessing frequency counts and percentages, or distributions. Accordingly, the study results could be generalized to the entire population of each country. Also, the study shed light onto the countries' strong and significant indication that not all the difference in HIV prevalence is captured by risk factors but only some of it is.

This study has some limitations. First, because of the nature of the study design and DHS data collection which were cross-sectional, no causality of identified risk factors could be considered. Second, the study used secondary data which limited flexibility and required research questions to fit data. Third, the timeframe of data collection for each Cameroon and Senegal overlapped while that of Cote d'Ivoire slightly differed. This slight gap in data

collection might limit the interpretation of results. Fourth, DHS survey relies on respondents' self-report; accordingly, data could be prone to normative and recall bias, and therefore should be interpreted be caution. Indeed, because of the sensitiveness of many questions, respondents particularly women might misreport or underreport information deemed private or critical to the survival of their marriage, their dignity, or safety in African society. Also, participants may not recall sexual partners they had had in the past particularly in regard to the question related to total lifetime partnerships. Fifth, some variables had limited or missing data, which might reflect on the analysis of results.

5.3 Implications for HIV Prevention Programs and Public Health Policy

Prevention measures should embrace structural changes at a national or societal scale. The country indicators revealed that there are variations in HIV prevalence that are not explained by differences in risk factors. Accordingly, prevention efforts need to take into consideration country-specific context in order to scale up progress in the fight against the disease.

Also, prevention interventions should direct their attention on older adults. Most of the prevention programs have been toward young adults overlooking this group of people. Further, prevention efforts should address the issue of gender disparities and poverty in the sub-Saharan African region. Many women widowed or divorced engaged in sex exchanges in order to support their children. Unless we direct our focus on sources of gender inequality in the region, the prevalence of HIV among women will remain high and prevention efforts will be vain.

Prevention programs should ensure that condoms are free and available to young adults to allow them to view condom use as true preventive measures instead of profit-making. Female condom should be promoted to allow women to take control of their body and counter their inability to negotiate safer sexual intercourses.

Because drug injection users (DIU) are rapidly increasing in number in the Sub-Saharan region, it is necessary that public health decision-makers work in collaboration with law makers to help eradicate punitive measures that prevent DIUs from seeking health and social services. Public health policies should ensure all medical and dental care abide by the rules and laws and use only unopened and clean syringes and needles for each patient particularly in rural and remote areas.

5.4 Conclusion

There are considerable differences in risk factors among the three countries. These risk factors are strongly and significantly associated with having HIV infection. Also, the comparison of the association between risk factors and HIV infection among countries showed a strong and significant association between country indicators and the acquisition of HIV infection. This led us to conclude that differences in risk factors can help explain variations in HIV prevalence. However, only part of the variation is captured by the risk factors. These findings have implications for intervention design and public health policy. More research is needed to shed light on variations in HIV prevalence that are above and beyond the contribution of differences in risk factors.

References

Agence Nationale de la Statistique et de la Démographie (ANSD) [Senegal], and ICF International. 2012. *Senegal demographic and health and multiple indicator cluster survey (EDS-MICS) 2010-2011*. Rockville, Maryland, USA: ANSD and ICF International.

AIDS.Gov. (2009). Overview of HIV treatment. Retrieved from http://aids.gov/hiv-aids-basics/just-diagnosed-with-hiv-aids/treatment-options/overview-of-hiv-treatments.

AIDS.Gov. (2013a). Stages of HIV infection. Retrieved from http://aids.gov/hiv-aids-basics/just-diagnosed-with-hiv-aids/hiv-in-your-body/stages-of-hiv

AIDS.gov. (2013b). Pre-exposure prophylaxis (PrEP). Retrieved from http://aids.gov/hiv-aids-basics/prevention/reduce-your-risk/pre-exposure-prophylaxis.

AIDSTAR-One. Biomedical interventions: Post-exposure prophylaxis (PEP). Retrieved from http://www.aidstar-one.com/focus_areas/prevention/pkb/biomedical_interventions/post_exposure_prophylaxis_pep

Ainsworth, M., & Teokul, W. (2000). Breaking the silence: Setting realistic priorities for AIDS control in less-developed countries. *Lancet, 356,* 55-60.

Anglaret, X., Minga, A., Gabillard, D., Ouassa, T., Messou, E., Morris, B., Traore, M., et al. (2012). AIDS and non-AIDS morbidity and mortality across the spectrum of CD4 cell counts in HIV-infected adults before starting antiretroviral therapy in Cote d'Ivoire. *HIV/AIDS Clinical Infectious Diseases, 54 (1),* 714-723.

Ansari D. A., & Gaestel, A. (2010). Senegalese religious leaders' perceptions of HIV/AIDS and implications for challenges stigma and discrimination. *Culture, Health & Sexuality, 12(6),* 633-648.

Auvert, B., Buvé, A., Ferry, B., Caraël, M., Morison, L., Lagarde, E., et al. (2001). Ecological and individual level analysis of risk factors for HIV infection in four urban populations in sub-Aharan Africa with different levels of HIV infection. *AIDS, 15 (S4)*: S15-S30.

AVERT (2014). Universal access to HIV treatment. *AVERTing HIV and AIDS.* Retrieved from http://www.avert.org/universal-access-hiv-treatment.htm.

Bailey, R., Moses, S., Parker, C., Agot, K., Maclean, I., Krieger, J., et al. (2007). Male circumcision for HIV prevention in young men in Kisumu, Kenya: A randomised controlled trial." *Lancet* 369 (9562): 643-656. doi:10.1016/S0140-6736(07)60312-2.

Bankole, A., Singh, S. , Woog, V., Wulf, D. (2004). Risk and protection: Youth and HIV/AIDS in Sub-Saharan Africa. New York: Guttmacher Institute.

Boily, M.-C., Mâsse, B., Alsallaq, R., Padian, N. S., Eaton, J. W., Vesga, J. F., & Hallett, T. B. (2012). HIV treatment as prevention: considerations in the design, conduct, and analysis of cluster randomized controlled trials of combination HIV prevention. *PLoS Medicine*, *9*(7), e1001250. doi:10.1371/journal.pmed.1001250.

Buchbinder, S. P. (2012). Antiretroviral use for prevention and other factors affecting the course of the HIV-1 epidemic. *Topics in Antiviral Medicine*, *20*(2), 32–40.

Buvé, A. (2002). HIV epidemics in Africa: What explains the variations in HIV prevalence? *IUBMB Life*, *53*, 193-195. DOI: 10.1080/15216540290098891.

Buvé, A., Bishikwabo-Nsarhaza, K., & Mutangadura, G. 2002. AIDS in Africa 1: The spread and effect of HIV-1 infection in sub-Saharan Africa. *The Lancet, 359*, 2011- 2017.

Buvé, A., Caraël, M., Hayes, R. J., Auvert, B., Ferry, B., Robinson, N. J., Anagonou, S., et al. (2001). Multicentre study on factors determining differences in the rate of spread of HIV in sub-Saharan African: Methods and prevalence of HIV infection. *AIDS, 15(4)*, S5-S14.

Centers for Disease Control and Prevention (CDC). (2014). HIV/AIDS basics. Retrieved from http://www.cdc.gov/hiv/basics/whatishiv.html

Cohen, M. S., Smith, M. K., Muessig, K. E., Hallett, T. B., Powers, K. A., & Kashuba, A. D. (2013). Antiretroviral treatment of HIV-1 prevents transmission of HIV-1: where do we go from here? *Lancet*, *382*(9903), 1515–1524. doi:10.1016/S0140-6736(13)61998-4.

Darbes, L., N. Crepaz, C; Lyles, Kennedy, G., Rutherford, G. (2008). "The efficacy of behavioral interventions in reducing HIV risk behaviors and incident sexually transmitted diseases in heterosexual African Americans." AIDS 22(10): 1177-1194.

Desclaux, A. Equity in access to AIDS Treatment in Africa: Pitfalls among achievement. In Castro, A. & Singer, M. (eds). *Unhealthy Health Policy: A Critical Anthropological Examination*. Walnut Creek, California, AltaMira Press.

Demographic Health Survey Program. (2014a). Who we are. Retrieved from http://dhsprogram.com/Who-We-Are/About-Us.cfm.

Demographic Health Survey Program. (2014b). Model questionnaires. Retrieved from http://dhsprogram.com/What-We-Do/Survey-Types/DHS-Questionnaires.cfm.

Dimbuene, Z. T., & Defo, B. K. (2011). Forstering accurate HIV/AIDS knowledge among unmarried youths in Cameroon: Do family environment and peers matter? BMC *Public Health*, *11*, 348-359. Htpp://www.biomedcentral.com/1471-2458/11/348.

Drezin, J., Torres, M., & Daly, K. (2007). Barriers to condom access: Setting an agenda. *ICASO Advocacy Briefing*. Toronto, Ontario: International Council of AIDS Service Organization

Dunkle, k., Stephenson, R., Karita, E. Chomba, E., & Kayitenkore, K. (2008). New heterosexually transmitted HIV infections in married or cohabitating couples in urban Zambia and Rwanda: An analysis of survey and clinical data. Lancet, 371, 2183-2191.

Ellis, J. C., Ahmad, S., & Molyneux, E. M. (2005). Introduction of HIV post-exposure prophylaxis for sexually abused children in Malawi. *Archives of Disease in Childhood, 90(12)*, 1297–1299.

Fishel, J., Ortiz, L., Barrere, B., & United States Agency for International Development (USAID). 2012. Measuring concurrent sexual partnerships: Experience of the Measure DHS project to date. *DHS Methodological Reports 7*. Retrieved from http://dhsprogram.com/pubs/pdf/MR7/MR7.pdf

Fokam, J., Billog, S. C., Bissek, A. C. ZK., Kembou, E., Milenge, P., Abessouguie, I., et al. (2013). Declining trends in early warning indicators for HIV drug resistance in Cameroon from 2008-2010: Lesson and challenges for low-resource settings. *BMC Public Health, 13*, 308-317. http//www.biomedcentral.com/1471-2458/13/308.

Foley, E. E., Nguer, R. (2010). Courting success in HIV/AIDS prevention: The challenges of addressing a concentrated epidemic in Senegal. *African Journal of AIDS Research (AJAR), 9(4)*, 325-336.

Gay, J., Croce-Galis, M., Hardee, K. (2012). What works for women and girls: Evidence for HIV/AIDS interventions. 2nd edition. Washington DC: Futures Group, Health Policy Project. www.whatworksforwomen.org.

Gilbert, P. B., McKeague, I. W., Eisen, G., Mullins, C., Guéye-Ndiaye, A., Mboup, S., & Kanki, P. J. (2003). Comparison of HIV-1 and HIV-2 infectivity from a prospective cohort study in Senegal. *Statistics in Medicine, 22*, 573-593. Doi: 10.1002/sim.1342.

Gilbert, S. S. (2008). The influence of Islam on AIDS prevention among Senegalese university students. *AIDS Education and Prevention, 20 (5),* 399-407.

Granish, R. M., Gilks, C. F., Dye, C., De Cock, K. M., Williams, B.G. (2009). Universal voluntary HIV testing with immediate antiretroviral therapy as a strategy for elimination of HIV transmission: a mathematical model. *The Lancet, 373(9657),* 48-57. doi: 10.1016/S0140-6736(08)61697-9.

Gray, R., Kogozi, G., Serwadda, D., Maumbi, F., Watya, S., Nalugoda, F., et al.(2007). Male circumcision for HIV prevention in men in Rakai, Uganda: A randomised trial." *Lancet* 369: 657-666. doi:10.1016/S0140-6736(07)60313-4.

Gowing, L. R., Hickman, M., & Degenhardt, L. (2009). Mitigating the risk of HIV infection with opioid substitution treatment. *Bull World Health Organ, 91*, 148-149. Doi:10.2471/BLT.12.109553.

Gupta, R. K., Van de Vijver, D. A. M. C., Manicklal, S., & Wainberg, M. A. (2013). Evolving uses of oral reverse transcriptase inhibitors in the HIV-1 epidemic: from treatment to prevention. *Retrovirology*, *10*, 82. doi:10.1186/1742-4690-10-82.

Hearst, N., & Chen, S. (2004). Condom promotion for AIDS prevention in the developing world: is it working? *Studies in family planning, 35(1),* 39-47.

Hertog, S. (2008). *Explaining gender differences in the risk of prevalent HIV infection: Analyses of the Tanzania and Côte d'Ivoire AIS*. Paper prepared for the 2008 Meetings of the Population Association of America, New Orleans, USA. http://paa2008.princeton.edu/papers/80476.

Institut National de la Statistique (INS) et Ministere de la Lutte contre le Sida (Cote d'Ivoire) et ORC Macro. (2006). *Enquête sur les indicateurs du Sida, Côte d'Ivoire 2005*. Calverton, Maryland, USA: INS et ORC Macro.

Institut National de la Statistique (INS) et ICF. International. (2012a). *Enquête Démographique et de Santé et à Indicateurs Multiples du Cameroun 2011*. Calverton, Maryland, USA : INS et ICF International.

Institut National de la Statistique (INS) et ICF International. (2012b). *Enquête Démographique et de Santé et à Indicateurs Multiples de Côte d'Ivoire 2011-2012*. Calverton, Maryland, USA: INS et ICF International.

Jean, K., Anglaret, X., Moh, R., Lert, F., Dray-Spira, R. (2012). Barriers to HIV testing in Cote d'Ivoire: The role of individual characteristics and testing modalities. PLoS ONE, e41353.

Jean, K., Gabillard, D., Moh, R., Danel, C., Fassassi, R., Desgrees-du-Lou, A., Eholie, S., et al. (2014). Effect of early antiretroviral therapy on sexual behaviors and HIV-1 transmission risk among adults with diverse heterosexual partnership statuses in Cote d'Ivoire. *The Journal of Infectious Diseases, 209*, 431-440.

Joint United Nations Programme on HIV/AIDS (UNAIDS). (2004a). Epidemiological fact sheets on HIV/AIDS/STIs: Cameroon HIV/AIDS estimates. Retrieved from http://data.unaids.org/publications/fact-sheets01/cameroon_en.pdf

Joint United Nations Programme on HIV/AIDS (UNAIDS). (2004b). Epidemiological fact sheets on HIV/AIDS/STIs: Cote d'Ivoire HIV/AIDS estimates. Retrieved from http://data.unaids.org/publications/fact-sheets01/cotedivoire_en.pdf

Joint United Nations Programme on HIV/AIDS (UNAIDS). (2006). Fact sheet last updated: Sub Saharan Africa. Retrieved from http://data.unaids.org/pub/EpiReport/2006/20061121_epi_fs_ssa_en.pdf

Joint United Nations Programme on HIV/AIDS (UNAIDS). (2009). Fact sheet: Sub Saharan Africa: Latest epidemiological trends. Retrieved from http://data.unaids.org/pub/FactSheet/2009/20091124_fs_ssa_en.pdf

Joint United Nations Programme on HIV/AIDS (UNAIDS). (2010). Reference Group on estimates modelling and projections: Working group on measuring concurrent sexual partnerships: HIV: Consensus indicators are needed for concurrency. *The Lancet, 375*, 621-622.

Joint United Nations Programme on HIV/AIDS (UNAIDS). 2013. HIV/AIDS fact sheet. Retrieved from http://www.unaids.org/en/resources/campaigns/globalreport2013/factsheet

Lagarde, E., Auvert, B., Carael, M., Laourou, M., Ferry, B., Akam, E. (2001). Concurrent sexual partnerships and HIV prevalence in five urban communities of sub-Saharan Africa. *AIDS, 15*, 877-884.

Leonard, L., Ndiaye, I., Kapadia, A., Eisen, G., Diop, O., Mboup, S., & Kanki P. (2000). HIV prevention among male clients of female sex workers in Kaolack, Senegal: Results of peer education program. *AIDS Education and Prevention, 12(1)*, 21-37.

Koffi, A., K., & Kawahara, K. (2008). Sexual abstinence behavior among never-married youths in a generalized HIV epidemic country: Evidence from the 2005 Cote d'Ivoire AIDS indicator survey. *BMC Public Health, 8*, 408-422. Doi: 10.1186/1471-2458-8-408.

Mah, T. L., & Shelton, J. D. 2011. Concurrency revisited: Increasing and compelling epidemiological evidence. *Journal of the International AIDS Society,* 14, 33. doi:10.1186/1758-2652-14-33

Matovu, J., Ssempijja, V., Makumbi, F., Gray, R., Kigozi, G., Nalugoda, F., et al. (2007). Sexually transmitted infection management, safer sex promotion and voluntary HIV counseling and testing in the male circumcision trial, Rakai, Uganda. Reproductive Health Matters, 15(29), 68-74.

Matovu, J. K. B. (2010). Preventing HIV transmission in married and cohabiting HIV-discordant couples in Sub-Saharan Africa through combination prevention. *Current HIV Research, 8,* 430-440.

Misha, V., Assche, S. B., & United States Agency for Internatio nal Development (USAID). 2009. Concurrent sexual partnerships and HIV infection: Evidence from national population-based surveys. *The DHS Working Papers, 62*. Retrieved from http://pdf.usaid.gov/pdf_docs/PNADO191.pdf

Montaner, J. S. G. (2013). Treatment as prevention: toward an AIDS-free generation. *Topics in Antiviral Medicine, 21*(3), 110–114.

Morris M. 2001. Concurrent partnerships and syphilis persistence: New thoughts on an old puzzle. *Sexually Transmitted Diseases, 28,* 504-507.

Ndondoki, C., Brou, H., Timite-Konan, M., Oga, M., Amani-Bosse, C., Menan, H., et al. (2013). Universal HIV screening at postnatal points of care: Which public health approach for early infant diagnosis in Cote d'Ivoire. PLoS ONE, 8(8), e67996.

Negin, J., Wariero, J., Mutuo, P., Jan, S., & Pronyk, P. (2009). Feasibility, acceptability, and cost of home-based HIV testing in rural Kenya. *Tropical Medicine and International Health, 14(8):* 849-855.

Njikam-Savage, O. M. (2005). Risky sexual behavior, sexually transmitted infections, HIV/AIDS and health promotion among students in the University of Douala. (2005). *African Population Studies, 20(1),* 53-67.

Nkuo-Akenji, T., Nkwesheu, A., Nyasa, R., Tallah, E., Ndip, R., & Angwafo III, F. (2007). Knowledge of HIV/AIDS, sexual behavior and prevalence of sexually transmitted infections among female students of the University of Buea, Cameroon. *African Journal of AIDS Research, 6(2),* 157-163.

Nsagha, D. S., Njunda, A. L., Kamga, H. L. F., Assob, J. C. N., Bongken, E. A. (2012). HIV-1/HIV-2 co-infection among voluntary counseling and testing subjects at a regional hospital in Cameroon. *African Health Sciences, 12(3),* 276-281.

Ojieabu, W. A., Femi-Oyewo, M., Ojieabu, C. I. (2012). Impact of educational status on HIV/AIDS Knowledge, attitude and misconceptions among pregnant women. Inertnational *Journal of Biological and Chemical Sciences, 6(4),* 1582-1592.

Peltzer, K. (2010). Early sexual debut and associated factors among in-school adolescents in eight African countries. *Acta Paediatrica, 99,* 1242-1247.

Pettifor, A., O'Brien, K., Macphail, C., Miller, W.C., & Rees, H. (2009). Early coital debut and associated HIV risk factors among young women and men in South Africa. *International Perspectives on Sexual and Reproductive Health, 35*(2), 82-90. doi:10.1363/ifpp.35.082.09

Piot, P., & Coll-Seck, A.M. (2001). Policy and Practice: International response to the HIV/AIDS epidemic: Planning for success. *Bulletin of the World Health Organization, 79(12),* 1106-1112.

Putzel, J. (2006). A history of state action: The politics of AIDS in Uganda and Senegal. In P. Denis & C. Becker (Eds), *The HIV/AIDS Epidemic in Sub-Saharan Africa in a Historical Perspective*. Senegal: Senegalese Network.

Reid, S. R. (2009). Injection drug use, unsafe medical injections, and HIV in Africa: A systematic review. *Harm Reduction Journal, 6*, 24-35.

Reniers, G., & Watkins, S. (2010). Polygyny and the spray of HIV in Sub-Saharan Africa: A case of benign concurrency. *AIDS, 242(2),* 299-307.

Reniers, G., Watkins, S., & Tfaily, R. (2010). Benign concurrency in context and practice: A response to Epstein and Stanton. *AIDS, 24(11),* 1792-1795.

Rwenge, J.B.M. (2013). Comportements sexuels parmi les adolescents et jeunes en Afrique subsahararienne francophone et facteurs associes. *African Journal of Reproductive Health, 17(1),* 49-67.

Siegfried, N., Muller, M., Deeks, J., & Volmink, J. (2009). Male circumcision for prevention of heterosexual acquisition of HIV in men (Review).” *Cochrane Database Systematic Review* (2): CD003362. doi: 10.1002/14651858.CD003362.pub2.

Siika, A., Nyandiko, W., Mwangi, A., Waxman, M., Sidle, J., Kimaiyo, S., & Wools-Kaloustian, K. (2009). The structure and outcomes of a HIV postexposure prophylaxis program in a high HIV prevalence setup in Western Kenya.” *Journal of Acquired Immune Deficiency Syndromes* 51 (1): 47-53.

Smith, M. K., Powers, K. A., Muessig, K. E., Miller, W. C., & Cohen, M. S. (2012). HIV treatment as prevention: the utility and limitations of ecological observation. *PLoS Medicine*, *9*(7), e1001260. doi:10.1371/journal.pmed.1001260.

Supervie, V. (2013). [Antiretroviral drugs-based HIV prevention methods: what impact on the HIV epidemic?]. *Médecine sciences: M/S*, *29*(4), 373–382. doi:10.1051/medsci/2013294010

Stöckl, H., Kalra, N., Jacobi, J., & Watts, C. (2013). Is early sexual debut a risk factor for HIV infection among women in Sub-Saharan Africa? A systematic review." *American Journal of Reproductive Immunology*, 69, 27–40. doi:10.1111/aji.12043.

United Nations Children's Fund (UNICEF). 2012. Multiple indicator cluster survey. *Statistics and Monitoring*. Retrieved from http://www.unicef.org/statistics/index_24302.html

Vuylsteke, B., Semde, G., Sika, L., Crucitti, T., Traore, V. E., Buve, A., Laga, M. (2012). HIV and STI prevalence among female sex workers in Cote d'Ivoire: Why targeted prevention programs should be continued and strengthened. PLoS ONE, 7(3), e32627.

Vuylsteke, B., Semde, G., Sika, L., Crucitti, T., Traore, V. E., Buve, A., Laga, M. (2012b). High prevalence of HIV and sexually transmitted infections among male sex workers in Abidjan, Cote d'Ivoire: Need for services tailored to their needs. *Sexually Transmitted Infections, 88*, 288-293.

Wand, H., & Ramjee, G. 2012. The Relationship between age of coital debut and HIV seroprevalence among women in Durban, South Africa: A cohort study. *BMJ Open*, 2, 1-8.

Weber, J., Tatoud, R., & Fidler, S. (2010). Post-exposure prophylaxis, pre-exposure prophylaxis or universal test and treat: The strategic use of antiretroviral drugs to prevent HIV acquisition and transmission. *AIDS 24 (S4)*: S27-S39.

Weinhardt, L. S., Carey, M. P., Johnson, B. T., & Bickham, N. L. (1999). Effects of HIV counseling and testing on sexual risk behavior: a meta-analytic review of published research, 1985-1997. *American Journal of Public Health, 89(9),* 1397-1405.

Weir, S. S., Pailman, C., Mahlalela, X., Coetzee, N., Meidany, F., Boerma, J. T. (2003). From people to places: Focusing AIDS prevention Efforts where it matters most. *AIDS, 17*, 895-903.

Willems, R. (2009). The importance of interdisciplinary collaborative research in responding to HIV/AIDS vulnerability in rural Senegal. *African Journal of AIDS Research (AJAR), 8(4)*, 433-442.

Wilson, D. P. (2012). HIV treatment as prevention: natural experiments highlight limits of antiretroviral treatment as HIV prevention. *PLoS Medicine*, *9*(7), e1001231. doi:10.1371/journal.pmed.1001231

World Health Organization. (2013). HIV/AIDS. Retrieved from http://www.who.int/mediacentre/factsheets/fs360/en/

Yakam, J. C. T., & Gruenais, M. E. (2009). Role conflict and quest of legitimacy in a Cameroonian HIV/AIDS oriented institution. *Sudanese Journal of Public Health, 4(1),* 229-233.