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HIV and Current Status Awareness Among Men in the Military in Sub-Saharan Africa: A Comparison with the General Population and Associations with Transmission Knowledge, Stigma and Discrimination, and Testing Sites

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

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Public Health (Epidemiology)

By

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2022

DEDICATION

To my husband, Ryan Anthony Nabors, who has always been a steadfast supporter of all my academic goals. His encouragement has kept me going, his love has kept me confident, and his humor has kept me sane.

EPIGRAPH

“The cosmos is within us. We are made of star-stuff.
We are a way for the universe to know itself.”
Carl Sagan

“The essence of global health equity is the idea that something
so precious as health might be viewed as a right.”
Paul Farmer

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ART	Anti-retroviral therapy
CI	Confidence Interval
DHS	Demographic and Health Survey
ESA	Eastern and Southern Africa
HIV	Human Immunodeficiency Virus
IRB	Institutional Review Board
MICS	Multiple Indicator Cluster Surveys
PEPFAR	President's Emergency Plan for AIDS Relief
PHIA	Population-based HIV Impact Assessment
PLHIV	People Living with HIV
PR	Prevalence Ratio
RDT	Rapid Diagnostic Test
SABERS	Seroprevalence and Behavioral Epidemiology Risk Survey
SSA	Sub-Saharan Africa
STI	Sexually Transmitted Infection
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNGASS	United Nations General Assembly Special Session
WHO	World Health Organization
WCA	Western and Central Africa

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ABSTRACT OF THE DISSERTATION

HIV and Current Status Awareness Among Men in the Military in Sub-Saharan Africa: A Comparison with the General Population and Associations with Transmission Knowledge, Stigma and Discrimination, and Testing Sites

by

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Doctor of Philosophy in Public Health (Epidemiology)

University of California San Diego, 2022
San Diego State University, 2022

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BACKGROUND. The Global AIDS Strategy 2021-2026 called for more focus on the 'missing' men in areas with HIV to address the gender gap in testing and treatment. Men in the militaries of sub-Saharan Africa are a unique sub-population due to their culture and work environment and a priority for increasing HIV status awareness.

METHODS. Data on active-duty men ages 18-49 years were combined from 20 Seroprevalence and Behavioral Epidemiology Risk Surveys conducted among militaries in sub-Saharan Africa from 2013-2020. Meta-analyses with sub-groups were used to compare HIV prevalence, HIV knowledge, condom use, and discriminatory attitudes with the general population. Associations of HIV knowledge, negative attitudes, perceived discrimination, and use of military HIV testing sites with HIV status awareness were determined using meta-regression analyses. Among men at higher-risk of acquiring HIV, imputation-based modeling was used to estimate the effect of changing identified associations on HIV status awareness at the population level.

RESULTS. In Western/Central Africa, HIV prevalence and knowledge were higher in the military compared to the general population (2.7%vs1.3%). HIV status awareness was lower among men without correct HIV transmission knowledge, high perceived discrimination, and who didn't use military testing facilities. Among high-risk men, the estimated difference in status awareness was +6.3% if 100% had correct HIV transmission knowledge, +3.8% if 100% had low perceived discrimination, and +2.7% if 100% used military testing. In Eastern/Southern Africa, HIV knowledge was higher in the military compared to the general population. Among high-risk men, only use of military testing was associated with status awareness with an estimated difference in awareness of +6.3% if 100% used military testing.

CONCLUSIONS. The exposures related to military services may be putting men in the military in Western/Central Africa at increased risk of HIV. Identifying men living with HIV and getting them connected to treatment is vital for prevention of morbidity/mortality and transmission. Increasing HIV knowledge and use of military testing sites as well as

decreasing perceived discrimination could increase overall status awareness among men at high-risk of acquiring HIV. Current military HIV programs should focus on proven interventions in these areas for HIV prevention and to increase status awareness.

CHAPTER 1: INTRODUCTION

The AIDS epidemic has claimed the lives of an estimated 36 million people worldwide.[1] Through advances in prevention and treatment and an incredible global public health effort, incident HIV infections and AIDS-related deaths have been on the decline since peaking over 20 years ago.[2] Yet, HIV remains a priority health issue with an estimated 38 million people living with HIV (PLHIV) and 690,000 AIDS-related deaths in 2020 globally.[3]

In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) announced an ambitious plan to globally scale-up a series of testing and treatment targets to effectively end the AIDS epidemic by 2030.[4] The '95-95-95' by 2030 targets aim for 95% of PLHIV being aware of their HIV status, 95% of PLHIV aware of their status on anti-retroviral therapy (ART), and 95% of PLHIV on ART being virally suppressed. Substantial gains have been made since 2014 but the midterm '90-90-90 by 2020' targets fell short at 84%-87%-90%.[5] The first target, PLHIV are aware of their status, is the entry point to the care continuum, effects the entire cascade, and the was lowest of the testing and treatment targets in 2020. Persistent gender gaps in the continuum have contributed to the shortfall in reaching the midterm '90-90-90' by 2020 goals with men consistently behind women at each step.[6] Among adults living with HIV in 2020, 82% of men were aware of their status compared to 88% of women, 68% were on ART compared to 79% of women, and 62% were virally suppressed compared to 72% of women. Globally, most incident HIV infections occurred among key populations in 2020 (sex workers, men who have sex with men, people who inject drugs, and transgender people), however, this is inverted in sub-Saharan Africa (SSA) where HIV is a generalized epidemic with transmission self-sustained through heterosexual sex.[5,7] Due

to the gender gap in the testing and treatment targets, men in regions with generalized epidemics, including SSA, have been identified as a priority population for HIV programs in the Global AIDS Strategy 2021-2026 with a focus on increasing status awareness.[8]

Achieving '95-95-95' by 2030 to effectively end AIDS means reaching these targets among all sub-populations.[8] Men in the militaries of SSA represent a unique sub-population of men due to the exposures related to service and culture of the military.[9] Military personnel often experience high levels of stress related to potential or actual combat experience and long periods away from home and regular partners during deployment. Military culture in SSA has been found to encourage risk-taking and to promote concepts of masculinity as part of being a 'good soldier'.[10] However, in the context of HIV, these exposures and attitudes may put personnel at increased risk of acquiring or transmitting HIV infection. The primary mode of HIV transmission in SSA is sexual and cultural ideals around risk-taking behavior and masculinity in the military have been associated with higher-risk sexual behavior.[11,12] Higher-risk sexual behavior during deployment could also make military personnel a bridge between geographic regions. Sexual mixing with civilians can result in acquisition or transmission of HIV among personnel and expose regular partners after returning home.[13] Previous studies have indicated the prevalence of HIV is higher among personnel in the military compared to the general population in SSA with odds ratios ranging widely from 2.81 to 8.12, however these data are outdated or limited.[14,15] Further, concepts of masculinity among men in SSA have been associated with HIV testing uptake and therefore HIV status awareness, the first step in the care continuum and treatment as prevention.[16]

But, there are no known studies on HIV status awareness among military personnel in SSA. Preventing infection and achieving epidemic control among men in the military requires understanding HIV among this unique population.

HIV has been recognized as an important issue among militaries. HIV among personnel poses a potential security threat due to the detrimental impact of high rates on force readiness to address conflict and maintain peace.[13] With support from the United States Department of Defense HIV/AIDS Prevention program funded through the Defense Health Program and the President's Emergency Plan for AIDS Relief (PEPFAR), numerous militaries in Africa have developed HIV-programs which provide comprehensive prevention, care, and treatment as well as education and condom access to military personnel.[17] In addition to the testing and treatment targets, UNAIDS developed a series of HIV-related knowledge, attitude, and behavior indicators to monitor progress on global commitments on HIV/AIDS.[18] These indicators include HIV transmission knowledge, discriminatory attitudes towards PLHIV, and condom use during higher-risk sex. Data is limited on these indicators among military populations in SSA, however available studies suggest sub-optimal levels. Among military personnel in Nigeria, 17.6% did not know that condoms prevent HIV transmission and 9.1% believed HIV could be acquired from a mosquito bite.[19] In the Botswana Defense Force, among a group of predominately non-married (99%) men, only half reported always using a condom during recent sex.[20] Among the Sudan People's Liberation Army, 91% of personnel indicated at least one discriminatory attitude toward PLHIV.[21] While previous data suggest the prevalence of HIV is higher among the military compared to the general population, no studies have made comparisons on HIV-related indicators.

Identifying differences between the military and general population can help inform military-sponsored programs to effectively direct limited funding towards key gaps.

Increasing status awareness among men in SSA has been identified as a programmatic priority.[8] HIV status awareness among PLHIV is the first step not only to reducing morbidity and mortality through ART and viral suppression but also to preventing transmission.[22] Understanding factors associated with HIV status awareness among men in the military can help inform interventions to reach epidemic control in this unique sub-population. There are no known studies on HIV status awareness among military personnel in SSA. Studies among men in SSA have identified common themes around HIV testing uptake, and thereby status awareness, and perceptions of masculinity (promoted in military culture), HIV knowledge, HIV stigma and discrimination concerns, and clinical settings/locations.[23] In Lesotho and Uganda, men with poor HIV transmission knowledge were 35% less likely to have ever been tested for HIV and 22% less likely to be aware of their HIV status, respectively.[24,25] Based on a review of studies in high HIV prevalence countries in SSA, reluctance to seek testing was commonly cited in relation to concerns over shame, judgement, abandonment, and employment discrimination among men.[26] Inconvenient hours, long wait times, and travel distances that are not conducive with work schedules have also been cited among men as barriers to attending HIV testing clinics.[27]

This dissertation aimed to meet the call of the Global AIDS Strategy 2021-2026 to prioritize men in SSA by addressing the paucity of data among a unique sub-population, men in the military, to better inform programmatic efforts and interventions to increase HIV status awareness. Data for this dissertation were combined from cross-

sectional population-based studies conducted among militaries in 20 countries in SSA between 2013-2020 representing 25,934 active-duty men between the ages of 18-49 years.

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CHAPTER 2: Comparisons of HIV Prevalence and Attitudes, Behavior, and Knowledge Between Men in the Military and the General Population in Sub-Saharan Africa

ABSTRACT

Background. Men in the militaries of sub-Saharan Africa are an HIV special population due to the unique exposures of military service. Previous data indicate HIV-infection is higher in the military compared to the general population in sub-Saharan Africa. Comparisons of knowledge, attitudes, and behaviors related to HIV-infection have not been made.

Methods. The prevalence of HIV-infection, condom-use with non-regular sex partners, discriminatory attitudes towards people living with HIV, and HIV transmission knowledge among men ages 15-49 years were compared between the military and general population from 20 countries in SSA. Population differences were assessed using mixed-effects meta-analyses with subgroups (military vs general population) for the Western/Central Africa and Eastern/Southern Africa regions.

Results. The prevalence of HIV-infection was higher among men in the military versus the general population in Western/Central Africa (2.7% vs 1.3%; $p<0.01$) but not in Eastern/Southern Africa (10.6% vs 9.0%; $p=0.73$). Correct HIV transmission knowledge was higher among men in the military versus the general population in both Western/Central Africa (51.1% vs 29.1%; $p<0.01$) and Eastern/Southern Africa (56.2% vs 39.2%; $p=0.01$). Yet, discriminatory attitudes and condom-use did not differ.

Conclusions. These data support that HIV prevalence is higher among men in military in Western/Central Africa. While greater HIV transmission knowledge among the military suggests military-sponsored HIV programs have been effective at education, higher condom-use and lower discriminatory attitudes was not observed. Addressing HIV in the

military is important to the health and capacity of their personnel as well as to preventing acquisition and transmission of HIV with civilians.

INTRODUCTION

HIV continues to represent a major global public health issue with an estimated 38 million people living with HIV (PLHIV) and 690,000 related deaths in 2020 worldwide.[1] Sub-Saharan Africans carry the disproportionate burden of HIV with 67% of all PLHIV residing in sub-Saharan Africa (SSA) while only representing 14% of the global population.[2,3] In general, key populations (sex workers, men who have sex with men, people who inject drugs, and transgender people) represent the majority of incident HIV infections, however, this is inverted in SSA, where HIV is a generalized epidemic with transmission self-sustained through heterosexual sex.[2,4] Men in areas with generalized epidemics have been identified as a priority population in the effort to end the AIDS-epidemic.[5,6] They represent a persistent gap in HIV testing and treatment targets hindering global goals. In 2020 in Eastern and Southern Africa, an estimated 87% of adult men living with HIV were aware of their status compared to 92% of adult women, 71% were on anti-retroviral therapy (ART) compared to 83% of women, and 65% were virally suppressed compared to 76% of women. These gender gaps are even more notable in Western and Central Africa where 73% of adult men living with HIV were aware of their status compared to 85% of women, 66% were on ART compared to 83% of women, and 53% were virally suppressed compared to 67% of women in 2020. Men are also more likely to be diagnosed with advanced HIV and less likely to adhere to care resulting in more co-morbidities and higher risk of AIDS-related death.[7]

Military populations in SSA are composed predominately, if not exclusively, of men. They also represent a special population due to the work environment and cultural norms that may put personnel at increased risk of acquiring HIV.[8] The military work environment is unique as personnel experience high levels of stress related to combat and deployment, as well as long periods away from home and regular sexual partners. Military culture in SSA has been found to condone or even encourage risky behaviors as a 'good soldier' should accept and be willing to take risks.[9] In the military context, encouragement of risk-taking behavior and promotion of concepts of masculinity have been associated with higher-risk sexual behavior.[10] These exposures and behaviors may result in a higher HIV prevalence among the military leading to concerns about the detrimental effect of HIV on militaries in SSA and their capacity to maintain peace and address conflict.[11] Further, personnel on deployment who engage in higher-risk sexual behaviors with civilians may act as a bridge acquiring or transmitting HIV between geographical areas. They could also bring back new infections and transmit to their regular sexual partners. Previous meta-analyses comparing the military and general population in SSA found increased odds of HIV among the military; however, these studies used older data or relied on data from a limited number of countries.[12,13]

While previous studies suggest the prevalence of HIV is higher among the military compared to the general population in SSA, there are no known studies on differences in behaviors, attitudes, or knowledge that may be driving these observations. The Joint United Nations Programme on HIV/AIDS (UNAIDS) developed a series of indicators intended to measure factors associated with HIV transmission, testing, and treatment among populations.[14] These include, but are not limited to,

condom use during higher-risk sex, discriminatory attitudes towards PLHIV, and HIV transmission knowledge. These HIV-related indicators are commonly measured in population-based studies enabling comparisons across groups and over time.

Condom use is a highly effective method in the prevention of sexual transmission of HIV, the primary mode of transmission in SSA.[15,16] In SSA, the rate of condom use during higher-risk sex (sex with a non-marital, non-regular partner as defined by UNAIDS) ranged from ~20% in Ethiopia to ~90% in Botswana.[2] Condom use has previously been reported to be low among SSA militaries. Among a group of predominately non-married (99%) men serving in the Botswana Defence Force, only 51% reported always using a condom during sex in the past three months.[17]

Stigma and discrimination has a pervasive impact on HIV transmission and the entire continuum of care.[2] While in many countries in SSA, HIV-related discriminatory attitudes have declined over the past 20 years, in some they remain constant or have even increased. Between 2014-2019, 32% of residents of Eastern and Southern Africa and 52% of residents of Western and Central Africa indicated they would not buy fresh vegetables from a shopkeeper or vendor if you knew this person had HIV/AIDS. HIV-related stigma and discrimination has been associated with HIV transmission risk behavior including higher-risk sexual behavior and poor treatment adherence.[18-21] Concerning levels of HIV-related discriminatory attitudes have been previously reported among military personnel in SSA. In a study among the Sudan People's Liberation Army personnel, 91% indicated at least one discriminatory attitude toward PLHIV.[22]

HIV transmission knowledge is essential for preventing infection and understanding risk.[23,24] HIV transmission knowledge is defined by UNAIDS as the ability

to correctly identify common HIV sexual transmission prevention methods and reject major misconceptions.[25] Knowledge of HIV transmission among young men (ages 15-24 years) has generally increased in SSA over the past 10 years but remains far short of the UNAIDS goal of 90% of young adults having correct HIV transmission knowledge by 2020. In 2020 in Eastern and Southern Africa and Western and Central Africa, only 46% and 31% of young men demonstrated correct HIV transmission knowledge, respectively.[26] Poor HIV transmission knowledge has also been reported among military personnel in SSA. In a study among soldiers in Nigeria, 17.6% of personnel did not know that condoms prevent HIV transmission and 9.1% believed HIV could be acquired from a mosquito bite.[27]

Data on HIV among military populations in SSA is limited. HIV prevalence and related indicators are frequently measured at the national level by large population-based surveys, but these do not target or differentiate military populations. Previous studies have indicated the prevalence of HIV may be higher among the military. Available data on condom-use during higher-risk sex, discriminatory attitudes towards PLHIV, and HIV transmission knowledge among militaries in SSA indicate intervention is needed to prevent personnel from acquiring and/or transmitting HIV. However, potential differences in HIV-related indicators between the military and general population have not been evaluated and comparisons of HIV prevalence are limited. Understanding HIV among the militaries of SSA in comparison to the general population can help inform military-sponsored programs to tailor their efforts for this unique population. Effective HIV prevention and treatment programs in the military are important not only to the health of personnel but to preventing acquisition and

transmission of HIV with civilians. This was the first known study to evaluate combined data on HIV prevalence and related indicators from standardized representative population-based studies among military personnel implemented across SSA. The objectives of this study were to compare the prevalence of HIV infection, condom use, discriminatory attitudes, and HIV transmission knowledge between men in the military and the general population. This study aimed to expand our knowledge of a unique sub-population of men in SSA, military personnel, and to provide insight on potential differences with the general population to better inform targeted public health efforts.

METHODS

Study Population

Data on military personnel used for this study was derived from Seroprevalence and Behavioral Epidemiology Risk Survey (SABERS) conducted in SSA between 2013-2020 with support from the US Department of Defense HIV/AIDS Prevention Program (**Table 2.1**). The SABERS is a cross-sectional study designed to be representative of the military for a respective country with the primary objective of estimating the prevalence of HIV infection among active-duty military personnel, methods previously published.[28] Military personnel enrolled in the SABERS provided a blood sample for HIV rapid diagnostic testing (RDT) and completed a self-administered or interviewer-led questionnaire. The SABERS methods and questionnaire are generally standardized across countries; however, protocols and materials are adapted to the military's needs and cultural context. Data collection for a SABERS is typically completed between three to six weeks. This study included data from SABERS conducted in 20 countries in SSA

that included 25,934 men who were active-duty military personnel between the ages of 18 and 49 years. The protocol for the SABERS was approved by institutional review boards (IRBs) in-country for the respective military and by the IRB for the Naval Health Research Center (San Diego, CA, USA) or the Defense Health Agency (dependent on year of study). All military personnel provided informed consent.

General population data for comparison to the military of a respective country was extracted from the nationally representative population-based studies the Demographic and Health Survey (DHS), Multiple Indicator Cluster Survey (MICS), or Population-based HIV Impact Assessment (PHIA) completed between 2010-2020 and from the UNAIDS AIDSinfo database.[29-31] Studies for comparison were selected based on indicator availability and the year that was closest in time to the implementation of the SABERS. The average time between implementation of population-based comparison studies and the SABERS was 1.6 years and ranged from zero to eight years. Similar to the SABERS, the DHS, MICS, and PHIA have been conducted in multiple countries and include standardized modules on HIV related knowledge, attitudes, and behaviors. Data used for this study from the general population included men ages 15-49 years.

Comparison between the military and general population was grouped by SSA region in concordance with the UNAIDS regions. HIV is a generalized epidemic in SSA but Eastern and Southern Africa bare the highest burden of HIV infections and is closer to epidemic control based on testing and treatment targets.[32] The Eastern and Southern region for this study included: Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho. The Western and Central region included: Burundi, Cameroon, Chad,

Democratic Republic of Congo (DRC), Gabon, Republic of Congo (ROC), Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea Conakry, Liberia, Togo, and Sierra Leone.

HIV Prevalence

Individual HIV status for military personnel was determined based on either a two or three RDT algorithm that followed national standards at the time of the SABERS for a respective country. HIV prevalence among military personnel was determined based on percentage positive according to the HIV RDT algorithm for each military. HIV prevalence for the general population was extracted from AIDSinfo from UNAIDS for the same year the SABERS was implemented for a respective country (accessed 2021).[33] UNAIDS provides modelled estimates of HIV prevalence for a country on an annual basis based on the best available epidemiological and programmatic data.[34]

HIV-Related Indicators

Condom use with non-regular sex partners ('higher-risk sex') was used to describe behavior related to prevention of sexual transmission of HIV. Condom use during higher-risk sex is one of the core indicators defined for the implementation of the Declaration of Commitment on HIV/AIDS by the United Nations General Assembly Special Session (UNGASS) on HIV/AIDS.[35] UNAIDS further defines higher-risk sex as sex with a non-regular, non-marital partner.[36] Prevalence of condom use with non-regular sex partners was defined in the SABERS and comparison general population studies as among those who had a non-marital, non-cohabitating sexual partner (described as a casual partner or sex worker partner in the SABERS) in the past 12 months, the percentage who reported using a condom at last sexual intercourse with that partner.

Discriminatory attitudes towards PLHIV in the SABERS was defined as the percentage who responded they 'agree' or 'strongly' agree to the statement 'most people would not buy vegetables from a shopkeeper or food seller that they knew had AIDS.' In the comparison general population studies, discriminatory attitudes towards PLHIV was defined as a 'no' response to the question 'would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV?'.

HIV transmission knowledge was defined in the SABERS and comparison general population studies based on ability to correctly identify ways to prevent sexual transmission of HIV and reject major misconceptions about HIV transmission based on the following questions defined by the UNAIDS Guidelines on Construction of Core Indicators.[35]

- Can having sex with only one faithful, uninfected partner reduce the risk of HIV transmission?
- Can using condoms reduce the risk of HIV transmission?
- Can a healthy-looking person have HIV?
- Can a person get HIV from mosquito bites?
- Can a person get HIV by sharing a meal with someone who is infected?

Correct HIV transmission knowledge in the SABERS, PHIA, DHS, and MICS was defined as 'yes' for those who answered all questions correctly and 'no' if one or more questions was answered incorrectly among those who answered all questions. Correct HIV transmission knowledge was examined among young men aged 15-24 years, the target population for the indicator as defined by UNAIDS, and among all men aged 15-49 years.

Analysis

Comparisons of the prevalence of HIV infection, condom use with non-regular partners, discriminatory attitudes towards PLHIV, and correct HIV transmission knowledge between men in the military and the general population were conducted using mixed-effects meta-analyses with subgroups (military vs general population) for the Central and Western Africa and Eastern and Southern Africa regions. First, a random-effects meta-regression based on the inverse-variance method[37] with logit transformation[38] of the prevalence estimates for the military and general population was used to determine summary prevalence estimates for HIV prevalence, condom use with non-regular partners, discriminatory attitudes towards PLHIV, and correct HIV transmission knowledge by region for each population. The 95% confidence intervals for the estimated HIV prevalence for militaries and the UNAIDS reported confidence limits for the general population were used to approximate the standard errors for the models for HIV prevalence. The prevalence estimate standard errors for the models for the HIV-related indicators were calculated using the total sample size and observed events for each population. Cochran's Q was used for the test of heterogeneity of HIV prevalence and related indicators by region for each population with an alpha of 0.10. To further quantify the heterogeneity of HIV prevalence and related indicators within each population, the I^2 statistic and tau were reported. The test for subgroup differences (military vs general population) was conducted using the random-effects meta-regression for the prevalence estimates and fixed-effects for the population. The correlation of percent who used a condom at last sex with a non-regular partner, percent with discriminatory attitudes towards PLHIV, and percent with correct HIV

transmission knowledge between the military and the general population was assessed among all included countries using Pearson's correlation. Alpha for all tests was set at 0.05.

As a sensitivity analysis to evaluate if time differences between comparison studies for HIV-related indicators were driving observed differences, correlations of indicators were re-assessed with countries with four or more years between comparison studies removed.

All analyses were conducted in RStudio version 1.3.1093 for Mac (R Foundation) with the meta (general package for meta-analysis) version 5.1-0 and stats (the R stats package) version 4.0.3 packages.

RESULTS

HIV Prevalence

Within the Western and Central Africa region, HIV prevalence among men in the general population was lower (1.3%) than that among men the military population (2.7%; $p<0.01$) (**Figure 2.1**). In the Eastern and Southern Africa region, HIV prevalence did not differ between men in the general population (9.0%) and men in the military population (10.6%; $p=0.73$).

HIV-Related Indicators

In the Western and Central Africa region, approximately half of men in the general population (45.0%) and the military (57.3%) reported using a condom during last sex with a non-regular partner in the past 12 months (**Figure 2.2**). In Southern and Eastern Africa, most men in the general population (65.4%) and in the military (72.5%)

reported using a condom during last sex with a non-regular partner in the past 12 months. Condom use with a non-regular partner was not found to differ between men in the general population and the military in the Western/Central ($p=0.29$) or in the Eastern/Southern Africa region ($p=0.43$).

Just under half of men in the general population and in the military in the Western and Central Africa region indicated they would not buy vegetables from a shopkeeper/vendor that they knew had HIV (48.9% and 39.7%, respectively; $p=0.52$). In the Eastern and Southern Africa region, approximately one in five indicated the same discriminatory attitudes towards PLHIV among the general population (19.3%) and the military (13.7%; $p=0.42$).

In the Western and Central Africa region, the proportion with correct HIV transmission knowledge was higher in the military (51.1%) compared to the general population among young men ages 15-25 years (51.1% vs 29.1%; $p<0.01$) and among all men (58.9% vs 31.7%; $p<0.01$). In the Eastern and Southern Africa region, the proportion with correct HIV transmission knowledge was higher among all men (56.2% vs 39.2%; $p=0.01$) but not among young men (36.6% vs 48.3%, $p=0.12$).

Discriminatory attitudes towards PLHIV were positively correlated between the military and the general population ($R=0.74$, $p<0.01$; **Figure 2.3**). Correct HIV transmission knowledge among all men in the military and general population was moderately correlated with borderline significance ($R=0.42$, $p=0.07$). Correct HIV transmission knowledge among young men ages 15-25 years and condom use with non-regular partners were not found to be correlated between the general population and the military ($R=0.04$, $p=0.88$ and $R=0.38$, $p=0.28$, respectively).

Sensitivity analyses where countries with four or more years difference between comparison studies were removed from the data did not show notable changes in correlations of HIV-related indicators (discriminatory attitudes R=0.78; HIV transmission knowledge, all men R=0.42; HIV transmission, young men R=0.22; condom use with non-regular partners R=0.39).

DISCUSSION

This study explored potential differences in HIV prevalence and related indicators between men in the military and in the general population across the regions of SSA. HIV prevalence was significantly higher among men in the military in the Western and Central Africa region (2.7% vs 1.3%, $p<0.01$) but not in the Eastern and Southern Africa region (10.6% vs 9.0%, $p=0.73$). This was the first known study to compare HIV-related indicators among militaries and the general population in SSA. There were no significant differences observed in condom use with non-regular partners and discriminatory attitudes towards PLHIV between men in the military and general population; however, the military trended towards higher condom use and lower discriminatory attitudes in both the Western and Central Africa region and in the Eastern and Southern Africa region. Men in the military showed higher levels of correct HIV transmission knowledge in both the Western and Central Africa region (58.9% vs 31.7%, $p<0.01$) and in the Eastern and Southern Africa region (56.2% vs 39.7%, $p=0.01$). Only discriminatory attitudes towards PLHIV were found to be correlated between the military and general population.

The regional HIV prevalence estimate for the general population from this study was similar to UNAIDS estimates for the Western and Central Africa region but higher for the Eastern and Southern Africa region. The UNAIDS estimate for HIV prevalence among men aged 15-49 years in the general population in 2017 was 1.0% for the Western and Central Africa region and 5.1% for the Eastern and Southern Africa region.[33] The estimated HIV prevalence for the general population in the Western and Central Africa region from the current study, based on 14 countries using data between 2013-2019, was slightly higher at 1.3%. The current study's estimated overall HIV prevalence for the general population in the Eastern and Southern Africa region, based on six countries using data from 2015-2020, was markedly higher at 9.0%. The higher estimate for HIV prevalence in the general population for the Eastern and Southern Africa region in this study may be driven by mostly Southern African countries from this region being included in this study. Southern Africa has the highest HIV prevalence in the world[32] and may have skewed our findings from the true average for the overall Eastern and Southern Africa region. These data suggest the estimated overall HIV prevalence for men in the military for the Eastern/Southern African region may also be inflated compared to the true prevalence for the region.

A previous meta-analysis comparing HIV prevalence in the military versus young men in the general population in 21 SSA countries using data up to 2006 also found a higher odds of HIV among the armed forces.[12] However, the odds were strikingly high (OR 8.12) compared to the current study which found a prevalence approximately twice as high (prevalence ratio 2.08) among the military in the Western and Central Africa region only. This study varied from our study in several noteworthy ways. Our study

conducted comparisons within the regions of Africa, an important consideration as HIV transmission patterns are not consistent across Africa. Further, the comparison group from the general population was young men ages 15-25 years. Militaries are predominately male; however, they do include women who generally have a higher prevalence in SSA in the general population. Additionally, the armed forces include an age distribution beyond 25 years old. Age and sex are major risk factors for HIV and comparing HIV prevalence across groups will likely be strongly confounded. A more recent meta-analysis from 2014 also found increased odds of HIV among militaries in SSA compared to men in the general population (OR 2.81).[13] This estimate was more comparable to the findings from the current study on the Western and Central Africa region. Further, the 2014 study is more appropriate for comparison as three out of the four included countries were in Western Africa and the comparison group included men aged 15-49 years in the general population. The current study found that HIV prevalence was not consistently higher among military personnel across the regions of SSA. This could be related to differences in the profile of HIV transmission in Western and Central Africa and Eastern and Southern Africa. In 2019, an estimated 27% of incident HIV infections in Western and Central Africa occurred among clients of sex workers and sex partners of key populations, almost as high as among the non-key population (31%).[2] In contrast, in Eastern and Southern Africa an estimated 72% of incident HIV infections occurred among the non-key population. Concerning rates of behaviors related to HIV transmission risk have been reported in multiple militaries in SSA. In Angola, 60% of men in the military reported more than one sexual partner in the past 12 months and 9.0% reported a sex worker partner while only half of personnel

reported using a condom with their last casual and/or sex worker partner.[39] In Botswana, approximately 70% of non-married personnel reported multiple sexual partners in the past three months. Alcohol abuse, an issue also more prevalent among military personnel[40], has been positively associated with risky sexual behaviors including unintended sex, multiple sexual partners, and sex with sex workers in multiple armed forces.[17,39,41-43] Military bases are also known locations that attract sex workers due to the presence of large groups of men with absent families.[44] Engagement in sex with multiple partners and sex workers while having sub-optimal condom use may be driving the higher prevalence among the military in Western and Central Africa where transmission is commonly occurring among key populations and their sexual partners. However, these behaviors in the Eastern and Southern African region may not put military personnel at elevated HIV risk compared to the general population where HIV transmission primarily occurs among the non-key population.

Deployment to conflict-settings may also put military personnel at increased risk compared to the general population. Areas of conflict destabilize communities putting them at potentially increased risk of HIV due to breakdowns in access to care and prevention methods as well as increased poverty which can lead more women to rely on sex work to survive and to become susceptible to sexual predation.[45] Military personnel deployed to these areas could be at increased risk of acquiring HIV with sexual mixing with civilians, especially with longer engagements. HIV-risk related to deployment to conflict-settings may also be higher in Western and Central Africa where more countries are experiencing state-based conflicts or boarder countries with conflicts compared to Eastern and Southern Africa.[46]

Previous data along with the current study suggest exposures and the culture related to military service may be putting personnel at increased risk of HIV. Understanding key gaps in behaviors, attitudes, and knowledge among the military can help inform programs among military personnel and target interventions that aim to reduce HIV transmission. HIV among military personnel is considered a security threat as high rates of HIV among personnel can comprise combat readiness potentially destabilizing the political and social environment of a country and region.[11] In recognition of the impact of HIV on the armed forces, comprehensive prevention, care, and treatment, military-focused programs in SSA have been developed with support from the US Department of Defense HIV/AIDS Prevention Program funded through the Defense Health Program and the President's Emergency Plan for AIDS Relief (PEPFAR).[47] These programs include a focus on education and condom access. The higher rates of correct HIV transmission knowledge among men in the military observed in the current study may be the result of the on-going education and outreach efforts of these military-focused programs. Education rates among the military and general population could also differ as some militaries have minimum education requirements for entry. While HIV transmission knowledge was higher among the military, there is still need for increasing knowledge as almost over 40% of personnel were not able to correctly identify the major ways to prevent sexual transmission and reject common misconceptions. Educational interventions on HIV-related knowledge have generally been found to be effective based on a meta-analysis of studies in SSA, though impact on increasing condom use and reducing HIV incidence were inconsistent.[48] In a study among the Botswana Defense Force, 91% of personnel agreed condoms were an

effective HIV prevention method yet, ~70% reported multiple sexual partners while only half used condoms during the last three months.[17] The data from the current study suggest that educational programs in the military may be effective as transmission knowledge is higher among the military, but their impact is not being reflected in reduced sexual risk behavior based on condom-use with non-regular partners being the same as the general population. Programmatic activities that focus on increasing condom use should ensure intervention methods demonstrate awareness translating to practice. Effective intervention is also needed on HIV-related discrimination among the military, especially in Western and Central Africa. The Global AIDS Strategy 2021-2026 aims for less than 10% of PLHIV to experience stigma and discrimination by 2025.[36] Meeting this goal will require addressing discriminatory attitudes among all populations. While discriminatory attitudes among the military were correlated with the general population, efforts to combat stigma and discrimination have been shown to work in other settings suggesting discriminatory attitudes can be reduced among the military. In a scoping review of stigma reduction interventions in healthcare settings in low- and middle-income countries, 20 out of 21 studies found a significant improvement.[49]

Strengths and Limitations

Data on military personnel and the general population used for this study were derived from representative population-based studies. The SABERS was designed specifically to estimate the prevalence of HIV among a country's armed forces. These data represent almost half of the countries of SSA. While other studies, such as the DHS, MICS, and PHIA, capture similar data in the general population, they do not capture if participants were members of the military. This means the SABERS is unique

in its military focus. However, military personnel may be included in DHS, MICS, and PHIA studies potentially diluting observed differences between the populations. Conversely, many military personnel reside on the base/unit at which they serve and are therefore unlikely to be captured in household-based surveys meaning overlap is likely minimal. Comparison of HIV prevalence with the general population was derived from the best available models provided by UNAIDS for the same year as the SABERS among the military. HIV incidence has been declining for over 20 years. It is therefore important to include comparisons based on the same year for HIV as time would be expected to confound differences. Established HIV-related indicators were used in this study to compare knowledge, attitudes, and behaviors. Comparison of HIV transmission knowledge, discriminatory attitudes towards PLHIV, and condom-use with non-regular partners were assessed in all included studies using very similar if not the same language. This strengthens the ability to compare this data using meta-analysis methods which can be limited by study design differences. The current study also used individual level data from military population studies enabling the inclusion of only men in specified age bands making the data more comparable to the general population estimates for the same group.

This study did have some limitations. Though data from 20 militaries was included it does not represent all of SSA, limiting generalizability. Further, there was less representation from Eastern and Southern Africa compared to Western and Central Africa in this study. Due to the large variability in estimates between countries within regions, power was limited without a larger number of studies especially for variables that were not available for all countries. HIV-related stigma and discrimination concerns

may have resulted in volunteer bias where those who knew they are living with HIV refused to participate in the SABERS. While all SABERS make every effort to ensure results and responses are confidential, volunteer bias was recognized as a likely issue in one country; however, this country was kept in study for HIV-related indicators (excluded for HIV prevalence). Available information on HIV-related indicators is particularly important in settings with such barriers and by combining the data sets this minimizes the impact of biases from any individual country. Comparisons of HIV-related indicators were made across multiple years based on the closest available data. Changes in prevalence of indicators related to time could therefore potentially bias identified differences. However, population levels of attitudes and knowledge have been found to remain relatively stable over multiple years in SSA so time would not be expected to strongly effect the prevalence of indicators for comparisons made within several years.[2,50-52] Further, sensitivity analyses that removed countries with comparison studies more than four years apart did not find notable changes to correlations of indicators. HIV prevalence was estimated in the SABERS using national standard rapid diagnostic testing algorithms, but algorithms were not consistent across all studies in terms of number of tests (two or three) or specific tests used which may have led to some variability in sensitivity/specificity between countries. However, the algorithms used were based on national standards and World Health Organization guidelines, therefore performance differences should be minimal. To assess sexual activity with greater risk of HIV transmission, condom use at last sex with a non-regular partner was used, a core indicator from the Declaration of Commitment on HIV/AIDS by

UNGASS. This variable provides an indication of higher-risk sex in the population but does not fully capture risk related to sexual behavior such as multiple regular partners.

CONCLUSION

HIV is an important component of military health programs.[2,47] Men in the militaries of SSA are a priority population, as men in regions with generalized epidemics, as well as a special population due to their unique culture and exposures.[5,8] Understanding HIV prevalence and related indicators among men in the military as they compare to the general population is needed to better inform and target programmatic efforts for this unique population. The results of this study suggest that HIV prevalence is higher among men in the military in Western and Central Africa where HIV incidence is as common among clients of sex workers and partners of key populations as it is in non-key populations. Yet, no difference was observed in HIV prevalence between men in the military and general population in Eastern and Southern Africa where HIV incidence is most common in non-key populations. Preventing sexual acquisition of HIV with sex workers and while on deployment among military men in Western and Central Africa is likely key to reducing the burden of HIV among their armed forces. Additionally, HIV transmission knowledge is higher among men in the military compared to the general population potentially related to effective educational campaigns that are a key component of military HIV programs. Yet, translation of transmission knowledge to less risky sexual behavior was not observed. No differences were observed in HIV discriminatory attitudes; however, stigma reduction interventions have been shown to be effective in other populations in similar settings and therefore should be advocated

for among the military.[49] Addressing HIV among the military is not only important because data suggest personnel are at increased risk, but also for preventing transmission to the general population and to regular sexual partners, especially during and after deployment.

Table 2.1: Military and General Population Data Sources

	Military Population Source, Year	**General Population Source, Year**			
Region/ Country	HIV Prevalence & Related Indicators	HIV Preval-ence	Condom Use [a]	Discriminatory attitudes towards PLHIV [b]	HIV prevention knowledge [c]
EASTERN AND SOUTHERN					
Angola	SABERS, 2015	UNAIDS Estimate for respective SABERS year	DHS, 2015/16	*	DHS, 2015/16
Ethiopia	SABERS, 2018		DHS, 2016	DHS, 2016	DHS, 2016
Malawi	SABERS, 2018		DHS, 2015/16	DHS, 2015/16	DHS, 2015/16
Mozambique	SABERS, 2016		^	*	AIS, 2015 (DHS)
Eswatini	SABERS, 2020		PHIA, 2016	MICS, 2014	MICS, 2014
Lesotho	SABERS, 2017		PHIA, 2016/17	DHS, 2014	PHIA, 2016/17
WESTERN AND CENTAL					
Burundi	SABERS, 2017	UNAIDS Estimate for respective SABERS year	DHS, 2016/17	DHS, 2016/17	DHS, 2016/17
Cameroon	SABERS, 2018		DHS, 2018	DHS, 2018	DHS, 2018
Chad	SABERS, 2014		^	*	DHS, 2014/15
Democratic Republic of Congo	SABERS, 2014		^	*	DHS, 2013/14
Gabon	SABERS, 2018		^	DHS, 2012	DHS, 2012
Republic of Congo	SABERS, 2014		^	*	DHS, 2011/12
Benin	SABERS, 2017		DHS, 2017/18	DHS, 2017/18	DHS, 2017/18
Burkina Faso	SABERS, 2018		^	DHS, 2010	DHS, 2010
Cote d'Ivoire	SABERS, 2014		^	*	DHS, 2011/12
Ghana~	SABERS, 2016		^	DHS, 2014	DHS, 2014
Guinea Conakry	SABERS, 2019		DHS, 2018	DHS, 2018	DHS, 2018
Liberia	SABERS, 2017		DHS, 2019/20	DHS, 2019/20	DHS, 2019/20
Togo	SABERS, 2014		^	*	DHS, 2013/14
Sierra Leone	SABERS, 2013		^	*	DHS, 2013

[a] Condom use at last sex with non-marital, non-cohabitating partner in past 12 months among those who reported a non-marital, non-cohabitating partner

[b] Responded 'No' or 'Agree/Strongly' to the question: Would you buy (or 'Most people would not buy') fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV?

[c] Among those who have heard of HIV/AIDS, percentage who correctly identify both ways of preventing the sexual transmission of HIV and reject major misconceptions about HIV transmission (ages 15-24 years)

Abbreviations: SABERS, Seroprevalence and Epidemiology Risk Survey; DHS, Demographic and Health Survey; PHIA, Population Based HIV Impact Assessment; AIS, AIDS Indicator Survey (DHS); MICS, Multiple Indicator Cluster Survey

~ Excluded from HIV prevalence estimate

^ General population data not available

* Military population data not available

Figure 2.1: Summary HIV prevalence of men in the military (ages 18-49 years) and general population (ages 15-49 years) by region (Central and Western Africa and Eastern and Southern Africa)

Abbreviations: k, number of studies; I^2, I^2 statistic; t, tau

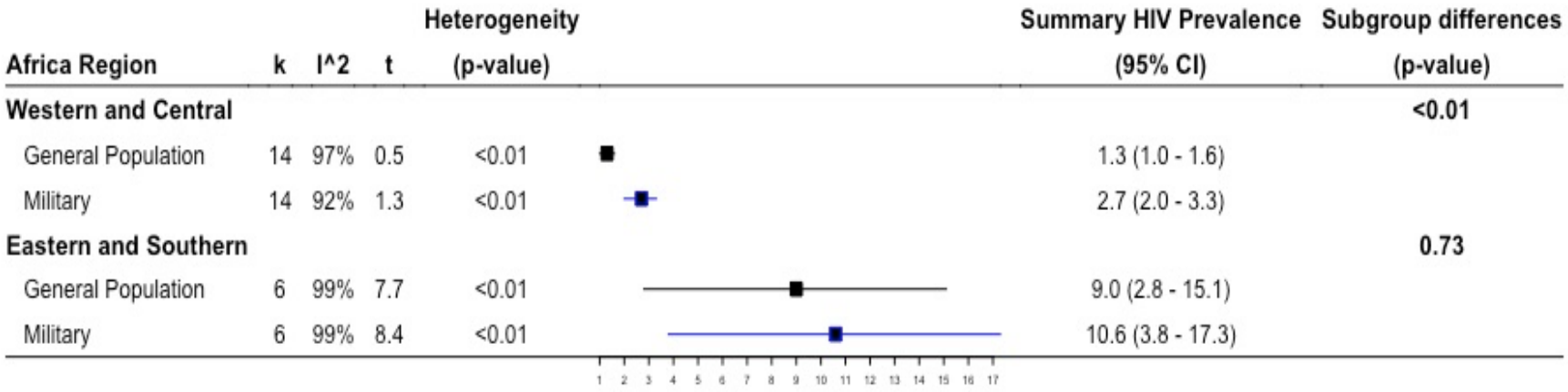
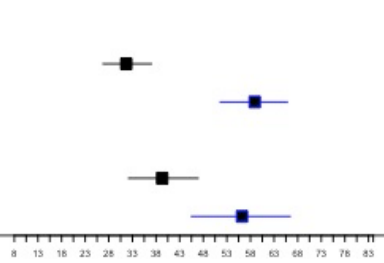

Heterogeneity
Summary HIV Prevalence
Subgroup differences
Africa Region
k
I^2
t
(p-value)
(95% CI)
(p-value)
Western and Central
<0.01
General Population
14
97%
0.5
<0.01
1.3 (1.0 - 1.6)
Military
14
92%
1.3
<0.01
2.7 (2.0 - 3.3)
Eastern and Southern
0.73
General Population
6
99%
7.7
<0.01
9.0 (2.8 - 15.1)
Military
6
99%
8.4
<0.01
10.6 (3.8 - 17.3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Figure 2.2: Summary prevalence of HIV-related indicators of men in the military (ages 18-49 years) and general population (ages 15-49 years) by region (Central and Western and Eastern and Southern Africa)

Abbreviations: k, number of studies; o, observations; I^2, I^2 statistic; t, tau; PLHIV, people living with HIV

HIV Indicator	k	o	I^2	t	Heterogeneity (p-value)	Summary Proportion (yes) (95% CI)	Subgroup differences (p-value)
Condom use with non-regular sex partners							
West and Central Africa Region							0.29
General Population	5	2,834	99%	57.0	<0.01	45.0 (33.1 - 57.4)	
Military	5	7,540	99%	87.0	<0.01	57.3 (38.4 - 74.3)	
Eastern and Southern Africa Region							0.43
General Population	5	8,753	99%	57.0	<0.01	65.4 (53.4 - 75.8)	
Military	5	3,552	99%	74.3	<0.01	72.5 (57.7 - 83.6)	
Discriminatory Attitudes towards PLHIV							
West and Central Africa Region							0.52
General Population	8	40,964	99%	92.5	<0.01	48.9 (33.5 - 64.5)	
Military	8	9,176	99%	132.8	<0.01	39.7 (20.7 - 62.4)	
Eastern and Southern Africa Region							0.42
General Population	4	22,322	99%	94.5	<0.01	19.3 (8.7 - 37.7)	
Military	4	4,697	93%	38.0	<0.01	13.7 (9.7 - 18.9)	
Correct HIV Transmission Knowledge							
Young men (ages 15-25 years)							
West and Central Africa Region							<0.01
General Population	14	29,516	99%	45.0	<0.01	29.1 (24.4 - 34.2)	
Military	14	1,283	76%	43.4	<0.01	51.1 (44.2 - 58.0)	
Eastern and Southern Africa Region							0.12
General Population	6	14,015	98%	40.3	<0.01	36.6 (29.5 - 44.4)	
Military	6	2,109	92%	57.0	<0.01	48.3 (36.0 - 60.8)	
All men (ages 15-49 years)							
West and Central Africa Region							<0.01
General Population	14	74,879	99%	44.9	<0.01	31.7 (26.8 - 37.0)	
Military	14	18,176	99%	56.2	<0.01	58.9 (51.6 - 65.8)	
Eastern and Southern Africa Region							0.01
General Population	6	32,864	99%	38.5	<0.01	39.3 (32.2 - 46.9)	
Military	6	7,369	98%	53.5	<0.01	56.2 (45.5 - 66.4)	



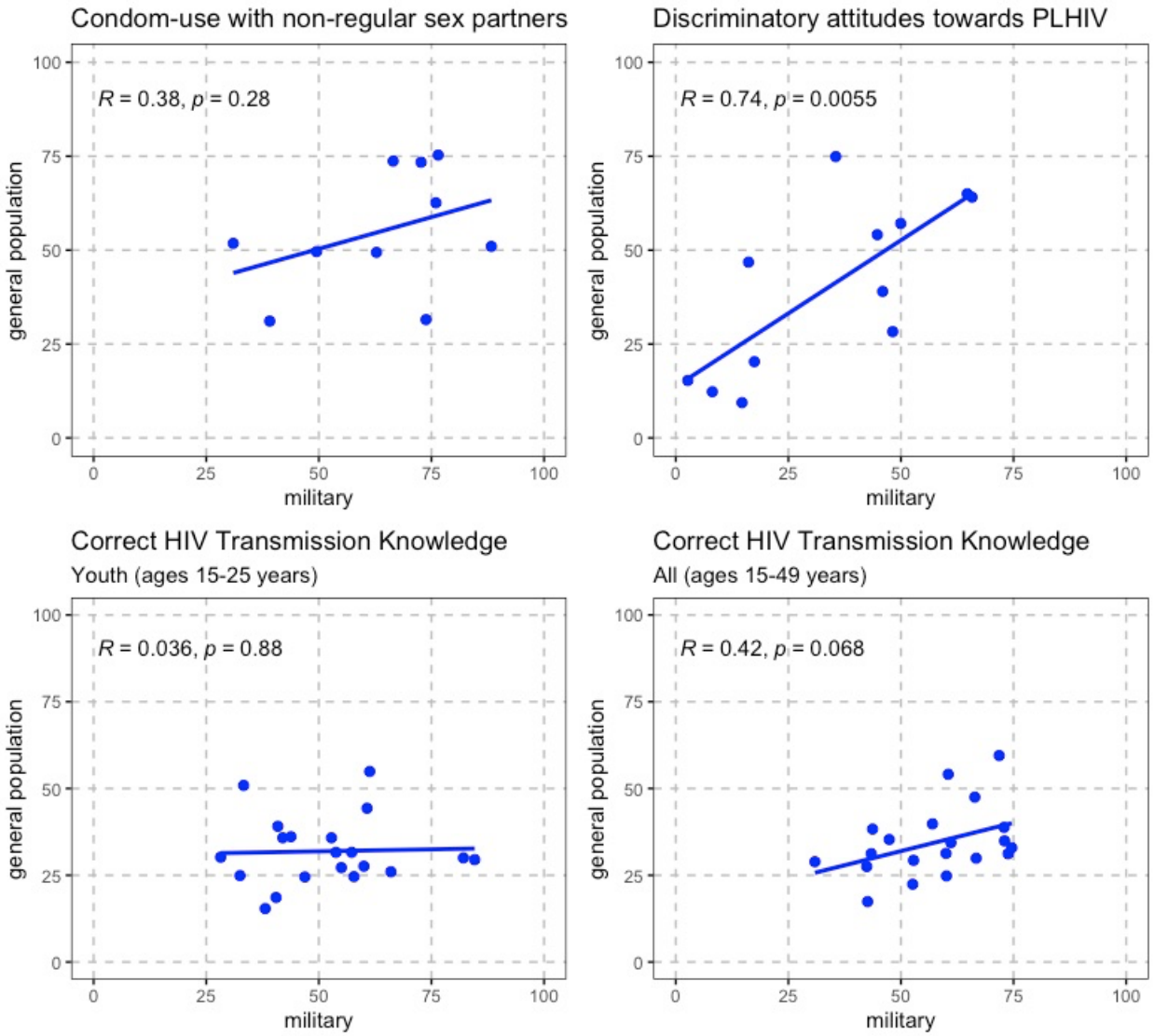


Figure 2.3: Correlation of HIV-related indicators among men in the military (ages 18-49 years) and general population (ages 15-49 years) in sub-Saharan Africa

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CHAPTER 3: The Association of HIV Status Awareness and Key Indicators Among Men in the Militaries of sub-Saharan Africa

ABSTRACT

Background. Increasing HIV status awareness among men living with HIV in sub-Saharan Africa is a priority in the strategy to end AIDS by 2030. Military personnel are a special population due to the culture and exposures related to service which may negatively impact status awareness. However, there are no known studies on HIV status awareness among this unique sub-population.

Methods. Data from 16 Seroprevalence and Behavioral Epidemiology Risk Surveys completed in sub-Saharan Africa between 2013-2020 representing 19,190 active-duty men ages 18-49 years with information on HIV status awareness were used for this study. Two stage individual participant data meta-regression analyses were used to evaluate the association of HIV status awareness among all men with HIV knowledge, negative attitudes against people living with HIV (PLHIV), perceived discrimination against PLHIV, and HIV testing facility type (military vs non-military) by Africa region.

Results. In Western/Central Africa, the prevalence of HIV status awareness was lower among men without correct HIV transmission knowledge (aPR 0.87, 95%CI 0.82-0.93), high perceived discrimination against PLHIV (aPR 0.90, 95%CI 0.83-0.96), and who did not use military facilities for HIV testing (PR 0.86, 95%CI 0.76-0.98). No factors were identified in association with HIV status awareness in Eastern/Southern Africa.

Conclusions. Multiple potential targets for intervention to increase HIV status awareness among men in the military in Western/Central Africa were identified. These data can be used to inform and direct current military sponsored HIV programs to efficiently use limited resources and maximize treatment as prevention by identifying personnel living with HIV.

INTRODUCTION

HIV incidence and AIDS-related deaths have been declining internationally since the peak over 20 years ago due to substantial public health efforts and advancements in prevention and treatment.[1] In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) announced the goal to end the AIDS epidemic by 2030 through a global scale-up of HIV testing and treatment targets.[2] The 95-95-95 by 2030 goals aim to have 95% of people living with HIV (PLHIV) aware of their status, 95% of diagnosed PLHIV on sustained antiretroviral therapy (ART), and 95% of PLHIV on ART virally suppressed to effectively end AIDS. The midterm 90-90-90 by 2020 targets fell short at 84% - 87% - 90%, respectively, resulting in an estimated 66% of all PLHIV virally suppressed globally, 2.7 million PLHIV below the target of 73% by 2020.[3] Missing these targets resulted in a projected 3.5 million additional infections and 820,000 AIDS-related deaths that would have been prevented had 90-90-90 by 2020 been achieved.[4]

Most of the global burden of HIV is in sub-Saharan Africa (SSA) where 67% of all PLHIV reside and HIV is a generalized epidemic, transmission is self-sustained through heterosexual sex.[1,5] Men in regions with generalized epidemics have been identified as an HIV priority population due to persistent gaps in the testing and treatment targets, compared to women, which have in part hindered reaching global goals.[6-8] The Global AIDS Strategy 2021-2026 calls for a focus on these men to increase status awareness and linkage-to-care. The first target, PLHIV are aware of their status, is the entry point to care, impacts the entire clinical cascade, and was the lowest in the 90-90-90 by 2020 targets.[9] Early diagnosis and ART initiation reduces HIV-related morbidity and mortality and prevents transmission to others through viral suppression making status awareness

key to both HIV treatment and prevention.[10] There are multiple potential drivers of the gender gap in awareness of HIV status. A scoping review of literature published between 1990-2018 on HIV-testing uptake among men in SSA found consistent themes around stigma, fear of testing positive, trust of health care providers, HIV transmission knowledge, risky sexual behaviors, clinic settings/location, and concepts of masculinity.[11]

Militaries are primarily composed of men, a priority population in SSA. Further, militaries are considered an HIV special population due to their unique work environment and exposures compared to the general population as well as the security threat that HIV among the armed forces poses on their capacity to address conflict and maintain peace.[12,13] In SSA, military cultural norms have been found to condone or even promote risk-taking behavior and concepts of masculinity that may put personnel at increased risk of HIV and negatively influence HIV status awareness.[14,15] A scoping review on masculine norms and HIV testing among men in SSA found that fear of losing status with sexual partners, having to change sexual behaviors or negatively impacting 'sexual prowess', being blamed for spreading HIV by engaging in risky sex, losing dignity and respect, impact on sense of strength and self-reliance, clinics being 'women's places', and the impact on a man's ability to be the 'provider' were associated with testing uptake.[16] Previous studies have indicated the prevalence of HIV is higher among the militaries of SSA compared to the general population,[17,18] however, there are no known studies on HIV status awareness or testing among military personnel. The same military related exposures that may be putting personnel at increased risk of HIV compared to the general population could also negatively impact HIV status awareness.

It is therefore important to identify modifiable factors associated with HIV status awareness among men in the military in SSA to better target interventions and focus resources on methods which get PLHIV in the military tested.

HIV transmission knowledge is key to understanding personal risk and translation to test seeking.[19,20] In a population-based study in Lesotho, men who lacked comprehensive HIV transmission knowledge were 35% less likely to have ever been tested for HIV.[21] A cross-sectional study in Uganda found adults with poor HIV transmission knowledge were 22% less likely to have been aware of their status.[22] Stigma and discrimination against PLHIV negatively effects the entire HIV clinical cascade and by consequence the effort to end AIDS.[6] A review of studies in high HIV prevalence countries in SSA found that perceived/anticipated stigma and personal discriminatory attitudes frequently functioned as barriers to uptake of HIV testing and in multiple studies was the strongest barrier.[23] Stigma related concerns over shame, confidentiality, social ramifications, such as judgement and abandonment, loss of sexual partners, and employment discrimination were frequently cited as reasons for not getting tested. Further, national level discriminatory attitudes have been associated with lower HIV status awareness.[24] The legal and policy environment of a country can also impact individual HIV status awareness. Punitive laws against PLHIV and key populations, forms of structural stigma such as criminalization of same-sex sex and sex work, have been previously identified as barriers to HIV testing and care.[25,26] However, laws and policies can also act as facilitators by protecting PLHIV against discrimination and providing an avenue of recourse.

Many military sites in SSA have HIV services available for their personnel on location, a form of differentiated service delivery which provides access to HIV testing with the client population in mind.[27] The UNAIDS 2021-2026 Global Strategy emphasizes the importance of increasing differentiated care and focusing programs to meet population specific needs.[6] A focus group on accessing STI/HIV health services among adult men in South Africa found men saw public clinics as 'women's place' and felt judged by female health care workers.[28] The structure of public clinics often reinforces this concept with women being targeted for HIV testing services during reproductive and child health services.[29] In a study among men in Malawi, a health facility was the least desired option for accessing HIV testing services while men preferred options like employment sites, social places, and outreach programs.[30] Military HIV services may therefore provide a more acceptable location and environment for personnel to seek testing compared to using a public health facility.

There are currently no known studies on HIV status awareness or testing among military personnel in SSA. To our knowledge, this was the first study to explore the associations of HIV status awareness with HIV knowledge, stigma and discrimination, and HIV testing facility type (military vs non-military) among active-duty men in the military in SSA. The objectives of this study were to identify possible barriers and facilitators to awareness of current HIV status among a unique sub-population of men in SSA, military personnel, by region.

METHODS

Study Design and Population

This study combined data collected on active-duty military personnel from Seroprevalence and Behavioral Epidemiology Risk Surveys (SABERS) conducted in 16 countries in SSA between 2013-2020 (**Table 3.1**). The SABERS is a cross-sectional study designed to estimate the prevalence of HIV among a country's armed forces, methods previously published.[31] SABERS are implemented by a military with support from the United States Department of Defense HIV/AIDS Prevention Program using generally standardized methods that are adapted as needed to a country's context. All participants complete an interviewer-administered or self-administered questionnaire, which collects information on demographics and HIV-related knowledge, attitudes, and behaviors. The protocol for the SABERS was approved by institutional review boards (IRBs) in-country for the respective military and by the IRB for the Naval Health Research Center (San Diego, CA, USA) or the Defense Health Agency (dependent on year of study). All military personnel provided informed consent. This study included all men ages 18-49 years who participated in an included SABERS representing 19,824 individuals. Individuals were excluded from all analyses if they were missing any data for variables used to define current HIV status awareness, the primary outcome. Separate models were fit for the independent variables: HIV transmission knowledge, negative attitudes, perceived discrimination, and HIV testing facility type (described below). Individuals were additionally excluded if they were missing any data on variables/items used to define the independent variable in analyses with that respective variable.

Additional data was abstracted from the general population nationally representative surveys Demographic and Health Survey (DHS), Multiple Indicator

Cluster Surveys (MICS), or Population-based HIV Impact Assessment (PHIA) and the UNAIDS laws and policies analytics data portal for each country, where available, to evaluate potential interaction of country context with associations with HIV status awareness.

Countries were grouped for analyses for this study by UNAIDS region. The Western and Central Africa (WCA) region included: Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone (k=10). The Eastern and Southern Africa (ESA) region included SABERS conducted in: Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho (k=6).

From the WCA region, data were available from 12,104 active-duty men ages 18-49 years (**Figure 3.1**). A total of 12,033 (99.4%) provided information on current HIV status awareness (n=1 excluded for missing data on ever being tested for HIV and n=70 excluded for no time since last HIV test and did not self-report as HIV positive). The final analytic sample for HIV knowledge included n=12,032 (99.4%) with one additional exclusion for incomplete knowledge questions. The final analytic sample for negative attitudes included n=6,622 (96.3% from available countries) from six countries (data not available for Cameroon, Burundi, Chad, and Sierra Leone) with n=180 excluded for incomplete responses on the negative attitudes scale. The final analytic sample for perceived discrimination was 8,860 (94.6% from available countries) from eight countries (data not available for Chad and Sierra Leone) with n=429 excluded for incomplete responses on the perceived discrimination scale). The final analytic sample for HIV testing site type was 10,363 (86.1%) with n=1,633 excluded for never being tested for HIV and n=37 with missing data.

From the ESA region, data was available on 7,720 active-duty men ages 18-49 years. A total of 7,157 (97.7%) provided information on current HIV status awareness (n=94 excluded for missing data on ever being tested for HIV and n=469 excluded for no time since last HIV test and did not self-report as HIV positive). The final analytic sample for HIV knowledge included n=6,913 (89.5%) with n=244 excluded for incomplete knowledge questions. The final analytic sample for negative attitudes and perceived discrimination included n=4,697 (89.3% from available countries) from four countries (data not available for Mozambique and Angola). The final analytic sample for HIV testing facility type was 6,198 (80.3%) with n=831 excluded for never being tested for HIV and n=128 with missing data.

HIV Status Awareness

The outcome for this study, HIV status awareness, was defined based on self-reported previous HIV testing (yes, no, don't know), time since last HIV test (<6 months, ≥6 months), and current HIV status (positive, negative, don't know). Individuals were defined as aware of their current HIV status if they had been tested for HIV in the past six months or self-reported they were HIV-positive. Those who had never been tested for HIV or didn't know if they had been tested, had their last HIV test greater than 6 months ago, and reported their HIV-status as negative, don't know, or prefer not to answer were defined as not-aware of their current HIV status.

HIV Transmission Knowledge

The UNAIDS Guidelines on Construction of Core Indicators was used to assess HIV transmission knowledge based on the defined knowledge questions: 1) Can having sex with only one faithful, uninfected partner reduce the risk of HIV transmission? 2)

Can using condoms reduce the risk of HIV transmission? 3) Can a healthy-looking person have HIV? 4) Can a person get HIV from mosquito bites? 5) Can a person get HIV by sharing a meal with someone who is infected?[32] Among those who answered all five questions, correct HIV transmission knowledge was defined as 'yes' for those who answered all questions correctly and 'no' for those who missed one or more questions. All countries for this study were included.

Stigma and Discrimination

Among military personnel, negative attitudes towards PLHIV and perceived discrimination against PLHIV were assessed based on the series of statements from the HIV stigma and discrimination scale published by Genberg et al. and validated among communities in SSA.[33] The negative attitudes and perceived discrimination constructs were based on 8-item and 7-item scales, respectively (**Appendix A**). Participants are asked to 'strongly agree', 'agree', 'disagree', or strongly 'disagree' to each statement which were then scored as 1-4, with higher scores indicating a stronger stigmatizing or discriminatory attitude. Scores were then averaged across the items for each construct among those who responded to all statements and dichotomized into low (average score <2.5) and high (average score ≥2.5). Data on negative attitudes was available from Guinea Conakry, Gabon, Burkina Faso, Benin, Liberia, Ghana, Eswatini, Malawi, Ethiopia, and Lesotho. Data on perceived discrimination was available from Guinea Conakry, Gabon, Burkina Faso, Cameroon, Benin, Burundi, Liberia, Ghana, Eswatini, Malawi, Ethiopia, and Lesotho.

HIV Testing Facility Type

HIV testing facility type was defined based on whether an individual reported they had ever previously used only military facilities, only non-military (government or private) facilities, or both military and non-military facilities for HIV testing among those who had reported ever being tested. Use of HIV testing location was dichotomized into military facilities (military only or both military and non-military) or only non-military facilities. All countries for this study were included.

HIV Prevalence

HIV status for military personnel was determined based on either a two or three rapid diagnostic test (RDT) algorithm that followed national standards at the time of the SABERS for a respective country. HIV prevalence for each military was determined based on percentage positive according to the HIV RDT algorithm for each country.

Covariates

Additional variables included demographics, perception of HIV risk, and sexual history. Demographics included age, highest education (less than primary, primary, secondary, and tertiary), and marital status (single not-living with a partner, single living with a partner, married, and divorced/separated/widowed). Perception of HIV risk was measured among those who did not report an HIV-positive status and was described as not at all likely, somewhat likely, highly likely, and don't know. Sexual history included lifetime sexual partners categorized based on none and quartile cut points (0, 1-3, 4-5, 6-11, 12+; does not include Ghana) and regular, casual, and sex worker (does not include Sierra Leone) partners in the past 12 months (except Angola, last 6 months) among those who reported lifetime sexual activity. Regular partner was defined as 'your spouse, boyfriend/girlfriend, or any person with whom you have a committed

relationship' and was categorized into 0, 1, and 2+ in the past 12 months. Casual partner was defined as 'any person with whom you have had sex with but not a committed relationship (does not include your spouse, boyfriend/girlfriend, regular partners or sex workers)' and was categorized into 0 and 1+ in the past 12 months. Sex workers were defined as 'any person with whom you have sex in exchange for money or gifts' and was categorized into 0 and 1+ in the past 12 months.

Country Factors

For each country, the presence of a restrictive military HIV policy was determined based on whether official policy restricted all personnel living with HIV from certain activities, such as foreign or combat deployment (data unpublished). Discriminatory attitudes against PLHIV among general population adults, punitive and harmful laws based on arrest/prosecution for sex work within the past three years in country, and the social equity environment based on a national level social protection strategy/policy/framework that recognizes key population as beneficiaries were used to describe the HIV-related country context (**Table 3.1**). Country level discriminatory attitudes against PLHIV was defined based on the percentage of general population adults ages 15-49 years who responded 'no' to the question, 'would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV?'. Discriminatory attitudes among the general population was dichotomized into low and high based on the median percentage who responded 'no' (low <42%, high >42%). Data on discriminatory attitudes among the general population was extracted from the nationally representative population-based studies the Demographic and Health Survey (DHS), Multiple Indicator Cluster Surveys (MICS), or Population-based HIV Impact

Assessment (PHIA). Arrest/prosecution of sex workers in the country and the presence of a national social protection strategy/policy/framework for key populations was abstracted from the UNAIDS laws and policies analytics data portal.[34] Data was selected for use based on availability closest in time the SABERS.

Statistical Analyses

Descriptive statistics for all independent variables and covariates by current HIV status awareness weighted by the size of the military (unpublished) were calculated. Prevalence ratios and their 95% confidence intervals were determined for all variables by HIV status awareness using generalized linear models with a binomial family and log link weighted by size of the military and with country specified as clusters.

Two stage individual participant data meta-regression analyses were used to assess whether HIV status awareness was associated with HIV transmission knowledge, negative attitudes towards PLHIV, perceived discrimination against PLHIV, and HIV testing facility type for the WCA and ESA regions.[35] Stage one: for each factor with HIV status awareness, generalized linear models with a binomial family and log link were performed for each country to determine the prevalence ratio and standard error. The models for HIV transmission knowledge, negative attitudes towards PLHIV, and perceived discrimination against PLHIV were adjusted for age and education based on *a priori* identification as likely confounders of each exposure-outcome relationship of interest. Use of military testing sites was assumed to be based on availability of testing services at the military locations personnel were serving and had no *a priori* identified likely confounders. Stage two: a random-effects meta-regression using the inverse-variance method with the prevalence ratio and associated standard error from each

country was used to obtain the summary prevalence ratio and 95% confidence interval for each factor with HIV status awareness for each region. Two stage individual participant meta-regression analysis was additionally used to determine the summary HIV prevalence for each region. To describe the heterogeneity of each factor within the regions, the I^2 statistic, tau, and the p-value for Cochran's Q were reported.

To assess possible effect modification in associations with HIV status awareness by the country context, sub-group analyses by the presence of a military policy restricting activities of personnel living with HIV, arrest/prosecution for sex work in the country, national level social protections of key populations, and discriminatory attitudes among the general population were conducted with each meta-regression model.

All analyses were conducted in RStudio version 1.3.1093 for Mac (R Foundation) with the survey (analysis of complex survey samples) version 4.1-1, meta (general package for meta-analysis) version 5.1-0, and stats (the R stats package) version 4.0.3 packages. All tests were performed with alpha set at 0.05.

RESULTS

In the WCA region, most participants had a secondary education (61.3%), were married (52.4%), and had an average age of 33.3 years (SE 0.9) (**Table 3.2**). Almost all participants reported ever having sex (99.3%). Approximately a third of participants had 1-3 lifetime sexual partners (32.2%) while over one in four had 12 or more (24.8%). Among those who were sexually active, 90.1% reported one or more regular partners, 44.7% one or more casual partners, and 9.2% one or more sex worker partners in the past 12 months. 21.8% thought they were 'highly likely' to acquire HIV. A third were

aware of their current HIV status (35.3%). The prevalence of HIV was 2.7% (**Figure 3.2**).

In the ESA region, the majority of participants had a secondary education (74.8%), were single and not living with a partner (49.9%) and had an average age of 29.7 years (SE 2.0) (**Table 3.2**). Nearly all (94.5%) reported ever having sex, of whom 37.2% had 1-3 lifetime sexual partners. Among those with lifetime sexual activity, 61.8% reported one or more regular partners, 37.9% one or more casual partners, and 31.8% one or more sex worker partners in the past 12 months. One in four believed they were 'highly likely' to acquire HIV (22.4%). 40.8% were aware of their current HIV status. The prevalence of HIV was 10.6% (**Figure 3.2**).

In the WCA region, the prevalence of HIV status awareness was lower among those with less than 100% HIV knowledge (adjusted PR 0.87, 95% CI 0.82-0.93), with high perceived discrimination against PLHIV (adjusted PR 0.90, 95% CI 0.83-0.96), and who used only non-military facilities for testing (PR 0.86, 95% CI 0.76-0.98) (**Figure 3.3**). In ESA, HIV status awareness was not associated with HIV transmission knowledge, negative attitudes against PLHIV, perceived discrimination against PLHIV, or HIV testing facility type.

The associations of HIV status awareness with HIV knowledge, negative attitudes towards PLHIV, perceived discrimination against PLHIV among the military, and HIV testing facility type did not differ by restrictive military policies, discriminatory attitudes among the general population, arrest/prosecution of sex workers in country, or national social protections for key populations (**Figure 3.4**).

DISCUSSION

The Global AIDS Strategy 2021-2026 calls for a focus on increasing HIV status awareness among men in regions with generalized epidemics. This study identified several modifiable factors associated with HIV status awareness among men in the militaries of SSA. In the WCA region, HIV status awareness was lower among those without correct HIV transmission knowledge, with high levels of perceived discrimination against PLHIV, and who did not use military facilities for HIV testing. No factors were associated with HIV status awareness among men in the military in the ESA region. These data suggest that these factors may have a stronger association with HIV status awareness among militaries in regions where less PLHIV know their status in the general population, i.e. WCA where 68% of PLHIV were aware of their status in 2019 compared to 87% in ESA.[1] Identified associations with HIV status awareness were not found to differ based on the country context.

To our knowledge, this was the first study to combine data from militaries across SSA to assess factors associated with HIV status awareness among military personnel. Multiple studies conducted in the general population in SSA found similar associations between HIV knowledge and testing with the current study. In studies among men in Ethiopia, South Africa, and Lesotho, men who were more knowledgeable reported higher rates of ever being tested for HIV.[21,36,37] Studies among university students in SSA also support these findings. In Ghana, university students with higher HIV transmission knowledge were more likely to have ever been tested for HIV.[38] In two separate studies in Nigeria, students with higher HIV knowledge also expressed higher willingness to receive an HIV test.[39,40] While these studies provide further support on the

importance of HIV knowledge in test seeking behavior, they differ in their use of ever testing. Recent testing within the past 6 months was used in part to define status awareness in this study, making it a more sensitive proxy for whether an individual was aware of their current HIV status. Low perception of risk has been found as a barrier to HIV testing uptake and based on the knowledge theory of risk perception, knowledge is necessary to perceive risk.[19,20] However, a systematic review of the association between HIV knowledge and HIV risk perception found inconsistent results.[41] These inconsistencies may be explained by differences in individual context such as a person may be knowledgeable but does not engage in risky behaviors, so they perceive low personal risk. Interventions to increase HIV transmission knowledge among military personnel in WCA may improve HIV status awareness. To deliver the greatest potential impact, they should focus on high-risk personnel and on translating knowledge to appropriate perception of risk and subsequent need for testing.

Multiple studies in SSA on the association of stigma and discrimination with HIV testing were also consistent with this study's findings. In a review of studies conducted in the highest prevalence countries in SSA, stigma was found to be associated with HIV status awareness in South Africa, Nigeria, Mozambique, Kenya, Tanzania, Uganda, Zimbabwe, Zambia, and Malawi.[23] However, these studies did not all differentiate between men and women. Among men in Ethiopia, the lowest rates of ever being tested for HIV were found among those with the highest levels of stigma in both urban and rural areas.[37] These studies along with the current study used a variety of measures for stigma and discrimination and HIV testing among different populations but nonetheless support the pervasive association of stigma and discrimination on HIV status

awareness. The current study found general population discriminatory attitudes did not interact with associations with HIV status awareness. In a study among men in rural South Africa, community-level stigma was not found to be associated with HIV testing.[42] Structural stigma has been found to be associated with lower HIV status awareness among men who have sex with men in Europe.[24] However, associations with HIV status awareness among military personnel was not found to interact with punitive laws or social protections related to HIV transmission in this study. The effects of structural stigma may have less impact on populations with a low prevalence of sexual minorities. Qualitative research on HIV test seeking among men in SSA informs us on potential reasons for how concerns around stigma lead to reluctance to test. In studies among men in South Africa, Kenya, and Malawi, men discussed a fear of testing positive and subsequent negative reactions from intimate partners, family, and peers, being blamed and judged as sexually risky, others learning their status then being shamed and rejected by their community, and losing work opportunities.[43-45] Previous research indicates addressing concerns around stigma is essential to increase HIV status awareness and the current study supports this holds true for men in the military in SSA. Intervention studies among men in SSA to increase status awareness support combining HIV testing services with other health interventions,[46] increasing access to self-testing,[47] and promoting male peer support[48] and community groups to overcome stigma-related barriers.[49] Additionally, interventions targeted towards stigma reduction in populations in low and middle-income have been found to increase HIV testing uptake.[50]

Military populations work in a unique environment regarding access to HIV testing in that many sites also include health facilities that provide HIV testing services on location. In a cluster randomized trial in Zimbabwe, the rate of voluntary HIV testing was 2.8 times higher among employees of businesses that offered on-site HIV testing compared to those that offered vouchers for off-site testing.[51] This supports the current study's findings that military personnel who used on-site testing had higher rates of HIV status awareness. Structural barriers related to accessing testing facilities have been cited in multiple studies among men in SSA such as unsuitable hours for work schedules, long wait times, and inconvenient locations.[11] Health facilities were also often seen as 'women's places'. While there is a paucity of data on providing HIV testing services at men's workplaces, qualitative studies support that workplace-based self-testing may overcome multiple barriers to men getting tested. In a study among high-risk men in Uganda, most men considered workplace-based self-testing as convenient since it did not require travel or accessing testing outside of work hours and that they would experience positive peer influence from observing other's being tested.[52] Though, there were still concerns expressed around stigma related to being seen getting tested and fear of discrimination if positive. However, workplace-based testing may overcome some other potential sources of stigma associated with public HIV testing sites being 'women's places' and places for higher-risk populations such as sex workers and men who have sex with men. The convenience of military HIV testing services should be emphasized to potentially increase HIV status awareness. Militaries should also consider improving acceptability by providing male-tailored services and using peer to peer influence.

Strengths and Limitations

Data used for this study were from the SABERS, which is conducted exclusively among military personnel and designed to estimate the prevalence of HIV and measure related behaviors, attitudes, and knowledge. The SABERS provides information on a special population, military personnel, who are not effectively or intentionally captured in other population-based studies. The inclusion of a large sample of military personnel from 16 different countries from all regions of SSA increases power to identify associations that may not be detected in individual studies and allows more generalizability of the findings across Africa. Further, data collection instruments and methods are generally standardized across SABERS locations allowing the combination of data from multiple countries with less limitations on conclusions derived from meta-analysis methods due to differences in data collection. Additionally, HIV transmission knowledge, negative attitudes towards PLHIV, and perceived discrimination against PLHIV were based on published and validated measures. This study also used individual participant data meta-analysis allowing for the use of consistent inclusion/exclusion criteria, creation of variables, and model adjustment for each included country.

This study had several limitations. The cross-sectional design only allows for assessing associations and therefore cannot infer causation. While causation cannot be determined, plausible causal pathways were identified *a priori* based on published evidence in the development of study models. Additionally, HIV-related knowledge and attitudes have been shown to remain relatively stable across multiple years at the population level in SSA therefore these exposures are likely to come before status

awareness based on recent testing.[1,53-55] This study included many countries across SSA but is not representative of all militaries . However, multiple militaries from each region were included therefore results should still be generalizable across Africa. HIV status awareness used self-reported HIV status and testing which are potentially sensitive questions especially among militaries that restrict activities for personnel living with HIV and may introduce self-report bias. However, differences in associations with status awareness were not detected when military restrictions were included as a subgroup analysis. Additionally, HIV status awareness was based in part on testing within the last six months as this was the timeframe available across the SABERS. Other studies commonly used testing within the past year limiting direct comparisons. However, six months would be a more sensitive proxy for current status awareness and a closer outcome measure to the time of data collection. HIV testing facility type was limited to ever use of military and non-military facilities therefore it could not be determined for this study where last testing occurred. Volunteer bias may have occurred during data collection for the SABERS as PLHIV and those who consider themselves high risk may have refused to participate, especially in countries without robust protections for PLHIV. Volunteer bias was a recognized issue in one of the countries where a SABERS was conducted; however, this country was retained in the combined dataset. Available information on testing for HIV is particularly important in settings with such barriers and by combining the data sets this minimizes the impact of biases from any individual country. The response rate across the remaining studies was high, ranging from 93.1% to 100% of invited participants consenting to the study.

CONCLUSION

Men living with HIV in SSA fall behind on status awareness, ART initiation, and viral suppression hindering epidemic control goals.[6] These men have therefore been identified as a priority population in efforts to increase status awareness and linkage to care, key steps in preventing morbidity and mortality as well as transmission of HIV. Men in the militaries of SSA are also a special population due to their unique exposures and work environment. The Global AIDS Strategy 2021-2026 calls for moving finite resources from less-effective HIV prevention efforts to high-impact methods that focus on the potential of treatment as prevention.[6] Studies such as the current one can help inform military health programs about their unique population to better advise health strategies and improve effectiveness in finding PLHIV and getting them on treatment. The results of this study suggest that increasing HIV transmission knowledge, decreasing perceived discrimination against PLHIV, and increasing use of military testing facilities could increase HIV status awareness among men in the military in Western and Central Africa. Targeted interventions, especially among high-risk personnel, are needed to close the testing and treatment gap.

Table 3.1: Data sources for militaries and country factors

	Military Population		Country Factors		
Region/Country	SABERS (Year)	n[a]	Discriminatory attitudes towards PLHIV among general population (source and year)[b]	Arrest/Prosecution of sex workers in relation to selling sex in past 3 years (year) [c]	Social protection strategy/policy /framework that recognizes key populations as key beneficiaries (year) [c]
WEST AND CENTAL					
Burundi	2017	1,118	DHS 2016/17	*Not available*	No (2017)
Cameroon	2018	1,379	DHS 2018	No (2019)	No (2017)
Chad	2014	1,816	DHS 2014/15	*Not available*	No (2017)
Gabon	2018	742	DHS 2012	Yes (2019)	No (2018)
Benin	2017	1,343	DHS 2017/18	No (2017)	No (2017)
Burkina Faso	2018	1,273	DHS 2010	No (2019)	Yes (2018)
Ghana	2016	899	DHS 2014	Yes (2017)	No (2017)
Guinea Conakry	2019	1,182	DHS 2018	No (2019)	Yes (2019)
Liberia	2017	1,410	DHS 2019/20	Yes (2017)	No (2017)
Sierra Leone	2013	942	DHS 2013	Yes (2017)	No (2017)
EAST AND SOUTHERN					
Angola	2015	2,519	DHS 2015	Yes (2019)	Yes (2020)
Ethiopia	2018	2,704	DHS 2016	No (2021)	No (2017)
Malawi	2018	1,035	DHS 2015/16	No (2021)	No (2018)
Mozambique	2016	504	AIS 2015	Yes (2017)	No (2017)
Eswatini	2020	408	MICS 2014	Yes (2021)	Yes (2020)
Lesotho	2017	550	DHS 2014	No (2017)	No (2017)

[a] Active-duty men ages 18-49 years

[b] Responded 'No' to the question: Would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV?

[c] Source: UNAIDS laws and policies analytics data portal 2017-2021

Abbreviations: MICS, Multiple Indicator Cluster Surveys (UNICEF); DHS, Demographic and Health Survey; AIS, AIDS Indicator Survey (DHS); Seroprevalence and Behavioral Epidemiology Risk Survey (SABERS)

Figure 3.1: Strobe diagram for assessing associations between HIV status awareness with HIV transmission knowledge, negative attitudes towards people living with HIV (PLHIV), perceived discrimination against PLHIV, and HIV testing site type among active-duty military men between the ages of 18-49 years in sub-Saharan Africa (SSA), Seroprevalence and Behavioral Epidemiology Risk Survey (SABERS) 2013-2020

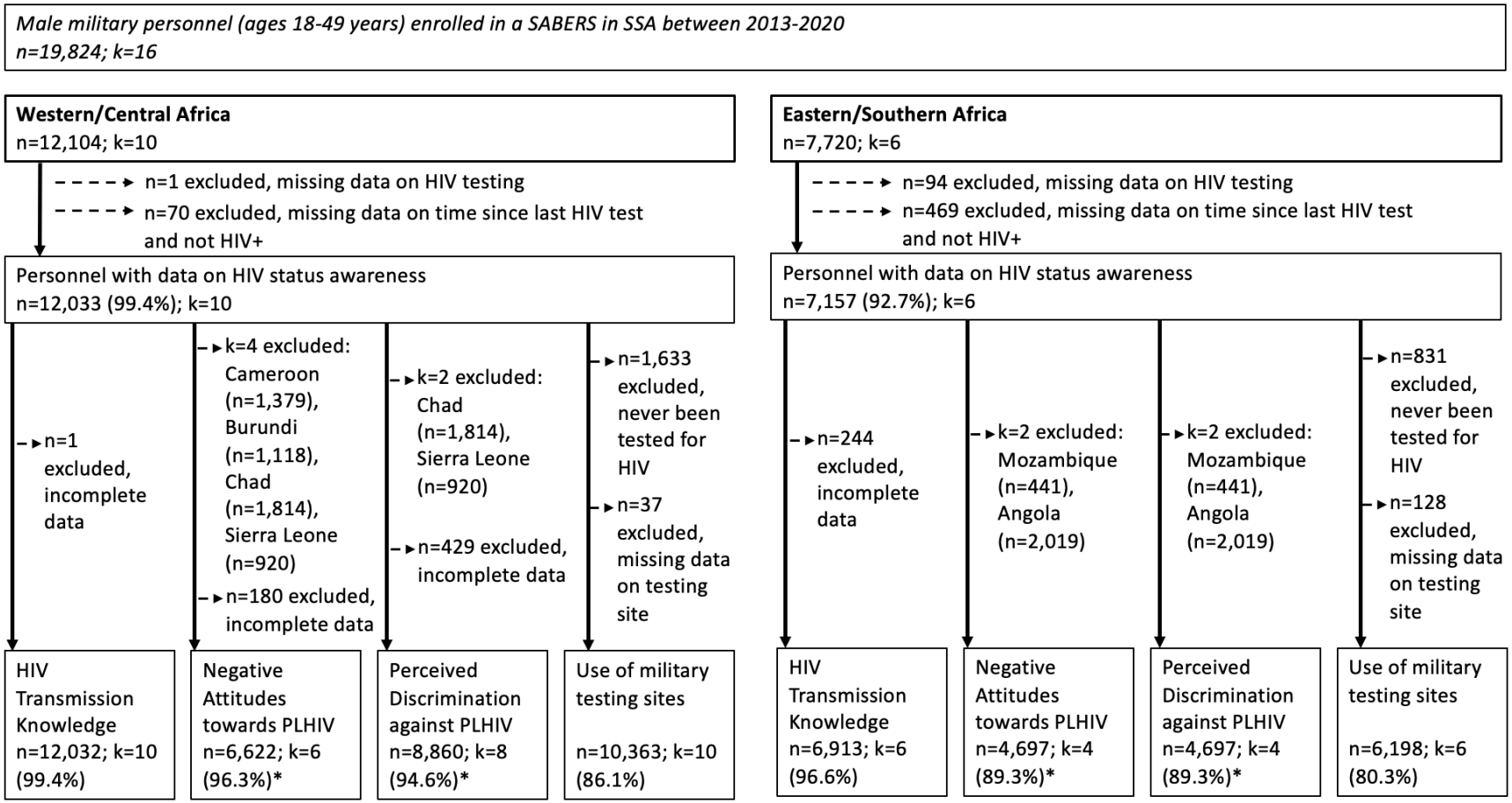

Male military personnel (ages 18-49 years) enrolled in a SABERS in SSA between 2013-2020
n=19,824; k=16
Western/Central Africa
n=12,104; k=10
n=1 excluded, missing data on HIV testing
n=70 excluded, missing data on time since last HIV test and not HIV+
Personnel with data on HIV status awareness
n=12,033 (99.4%); k=10
n=1 excluded, incomplete data
k=4 excluded: Cameroon (n=1,379), Burundi (n=1,118), Chad (n=1,814), Sierra Leone (n=920)
n=180 excluded, incomplete data
k=2 excluded: Chad (n=1,814), Sierra Leone (n=920)
n=429 excluded, incomplete data
n=1,633 excluded, never been tested for HIV
n=37 excluded, missing data on testing site
HIV Transmission Knowledge n=12,032; k=10 (99.4%)
Negative Attitudes towards PLHIV n=6,622; k=6 (96.3%)*
Perceived Discrimination against PLHIV n=8,860; k=8 (94.6%)*
Use of military testing sites n=10,363; k=10 (86.1%)
Eastern/Southern Africa
n=7,720; k=6
n=94 excluded, missing data on HIV testing
n=469 excluded, missing data on time since last HIV test and not HIV+
Personnel with data on HIV status awareness
n=7,157 (92.7%); k=6
n=244 excluded, incomplete data
k=2 excluded: Mozambique (n=441), Angola (n=2,019)
k=2 excluded: Mozambique (n=441), Angola (n=2,019)
n=831 excluded, never been tested for HIV
n=128 excluded, missing data on testing site
HIV Transmission Knowledge n=6,913; k=6 (96.6%)
Negative Attitudes towards PLHIV n=4,697; k=4 (89.3%)*
Perceived Discrimination against PLHIV n=4,697; k=4 (89.3%)*
Use of military testing sites n=6,198; k=6 (80.3%)
* Of data from countries with available data

Table 3.2: Participant characteristics by HIV status awareness among active-duty military men between the ages of 18-49 years, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020 (weighted by military size)

		HIV Status Awareness			
	Total n^ (%)	Yes n^ (%)	No n^ (%)	Prevalence Ratio (95% CI)	p-value
Western/Central Africa [a]	(n^=12270)	(n^=4333)	(n^=7937)		
HIV knowledge					<0.01
100%	7174 (61.6)	2781 (64.2)	4393 (57.0)	1.00 (ref)	
<100%	4463 (38.4)	1550 (35.8)	3313 (43.0)	0.82 (0.75-0.90)	
Negative Attitudes towards PLHIV					0.03
Low (score <2.5)	5347 (97.8)	1531 (98.6)	3816 (97.5)	1.00 (ref)	
High (score ≥2.5)	118 (2.2)	21 (1.4)	97 (2.5)	0.62 (0.41-0.93)	
Perceived Discrimination towards PLHIV					0.43
Low (score <2.5)	7401 (80.0)	2761 (80.6)	4640 (79.0)	1.00 (ref)	
High (score ≥2.5)	1893 (20.0)	663 (19.4)	1230 (21.0)	0.94 (0.81-1.09)	
HIV Testing Facility Type					<0.01
Military facilities	8521 (81.7)	3633 (83.9)	4888 (79.2)	1.00 (ref)	
Non-military facilities only	1913 (18.3)	626 (16.1)	1287 (20.8)	0.83 (0.75-0.91)	
Age, mean (SE), years	33.3 (0.9)	33.5 (0.9)	33.1 (0.8)	1.00 (1.00-1.01)	0.10
Education					0.34
Less than primary	506 (4.2)	126 (2.9)	380 (4.9)	1.00 (ref)	
Primary	1853 (15.4)	674 (15.6)	1179 (15.3)	0.85 (0.76-0.95)	
Secondary	7378 (61.3)	2720 (62.8)	4658 (60.4)	0.84 (0.72-0.99)	
Tertiary	2301 (19.1)	812 (18.7)	1489 (19.3)	0.86 (0.75-0.99)	
Marital Status, no. (%)					
Single, not living with a partner	2191 (18.2)	812 (18.7)	1379 (17.9)	1.00 (ref)	0.78
Single, living with partner	3414 (28.4)	1195 (27.6)	2219 (28.8)	0.94 (0.81-1.11)	
Married	6312 (52.4)	2289 (52.8)	4023 (52.2)	0.98 (0.81-1.18)	
Widowed/Divorced/ Separated	122 (1.0)	37 (0.8)	85 (1.1)	0.81 (0.53-1.25)	
Perception of HIV Risk					0.31
Not at all likely	3560 (30.1)	1267 (30.2)	2293 (30.1)	1.00 (ref)	
Somewhat likely	3251 (27.5)	1201 (28.6)	2050 (26.9)	1.04 (0.86-1.26)	
Highly Likely	2578 (21.8)	992 (23.6)	1586 (20.8)	1.08 (0.88-1.33)	
Don't know	2427 (20.5)	739 (17.6)	1688 (22.2)	0.86 (0.70-1.04)	
Lifetime sexual partners[c]					0.40
0	78 (0.7)	29 (0.8)	49 (0.7)	1.00 (ref)	
1-3	3442 (32.2)	1155 (30.1)	2287 (33.4)	0.90 (0.63-1.30)	
4-5	1911 (17.9)	706 (18.4)	1205 (17.6)	0.99 (0.78-1.27)	
6-11	2594 (24.3)	900 (23.5)	1694 (24.8)	0.93 (0.73-1.19)	
12+	2650 (24.8)	1042 (27.2)	1608 (23.5)	1.06 (0.83-1.34)	

Table 3.2: Participant characteristics by HIV status awareness among active-duty military men between the ages of 18-49 years, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020 (weighted by military size), Continued

		HIV Status Awareness		Prevalence	
	Total	Yes	No	Ratio	
	n^ (%)	n^ (%)	n^ (%)	(95% CI)	p-value
Regular sexual partners in the past year [d]					0.14
0	962 (9.9)	280 (6.6)	682 (9.1)	1.00 (ref)	
1	4407 (45.6)	2340 (55.1)	4173 (55.4)	1.23 (1.03-1.48)	
2+	4305 (44.5)	1630 (38.3)	2675 (35.5)	1.30 (1.05-1.61)	
Casual sexual partners in the past year [d]					0.23
0	6504 (55.3)	2250 (53.1)	4254 (56.6)	1.00 (ref)	
1+	5257 (44.7)	1989 (46.9)	3268 (43.4)	1.09 (0.95-1.26)	
Sex worker partners in the past year [d, e]					0.29
0	10141 (90.8)	3600 (91.4)	6541 (90.4)	1.00 (ref)	
1+	1031 (9.2)	339 (8.6)	692 (9.6)	0.93 (0.82-1.05)	
Eastern/Southern Africa [b]	(n^=7115)	(n^=2902)	(n^=4213)		
HIV knowledge					0.70
100%	3243 (46.4)	1309 (46.1)	1934 (46.6)	1.00 (ref)	
<100%	3743 (53.6)	1530 (53.9)	2213 (53.4)	1.01 (0.95-1.08)	
Negative Attitudes towards PLHIV					0.03
Low (score <2.5)	4403 (98.3)	1883 (98.1)	2520 (98.4)	1.00 (ref)	
High (score ≥2.5)	78 (1.7)	36 (1.9)	42 (1.6)	1.08 (1.03-1.13)	
Perceived Discrimination towards PLHIV					0.06
Low (score <2.5)	3841 (85.7)	1655 (86.3)	2186 (85.3)	1.00 (ref)	
High (score ≥2.5)	639 (14.3)	263 (13.7)	376 (14.7)	0.96 (0.92-0.99)	
HIV Testing Facility Type					<0.01
Military facilities	4996 (83.7)	2562 (88.6)	2434 (79.1)	1.00 (ref)	
Non-military facilities only	973 (16.3)	330 (11.4)	643 (20.9)	0.66 (0.54-0.80)	
Age, mean (SE), years	29.7 (2.0)	30.0 (2.0)	29.6 (2.0)	1.00 (1.00-1.01)	0.28
Education					0.08
Less than primary	324 (4.6)	119 (4.1)	205 (4.9)	1.00 (ref)	
Primary	656 (9.3)	233 (8.1)	423 (10.1)	0.96 (0.92-1.01)	
Secondary	5298 (74.8)	2268 (78.6)	3030 (72.2)	1.16 (1.10-1.23)	
Tertiary	803 (11.3)	266 (9.2)	537 (12.8)	0.90 (0.70-1.16)	
Marital Status, no. (%)					
Single, not living with a partner	3537 (49.9)	1392 (48.1)	2145 (51.2)	1.00 (ref)	0.46
Single, living with partner	1684 (23.8)	689 (23.8)	995 (23.7)	1.04 (0.88-1.23)	
Married	1683 (23.7)	735 (25.4)	948 (22.6)	1.11 (0.99-1.24)	
Widowed/Divorced/ Separated	185 (2.6)	79 (2.7)	106 (2.5)	1.08 (0.91-1.29)	

Table 3.2: Participant characteristics by HIV status awareness among active-duty military men between the ages of 18-49 years, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020 (weighted by military size), Continued

		HIV Status Awareness		Prevalence	
	Total	Yes	No	Ratio	
	n^ (%)	n^ (%)	n^ (%)	(95% CI)	p-value
Perception of HIV Risk					0.02
Not at all likely	1018 (39.8)	356 (39.4)	662 (40.0)	1.00 (ref)	
Somewhat likely	801 (31.3)	267 (29.5)	534 (32.3)	0.95 (0.88-1.03)	
Highly Likely	573 (22.4)	210 (23.3)	363 (22.0)	1.05 (0.95-1.16)	
Don't know	165 (6.5)	70 (7.8)	95 (5.7)	1.22 (1.09-1.36)	
Lifetime sexual partners					
0	378 (5.5)	97 (3.5)	281 (7.0)	1.00 (ref)	0.04
1-3	2537 (37.2)	1039 (37.3)	1498 (37.2)	1.59 (1.35-1.87)	
4-5	1146 (16.8)	472 (17.0)	674 (16.7)	1.60 (1.22-2.11)	
6-11	1439 (21.1)	562 (20.2)	877 (21.8)	1.52 (1.31-1.75)	
12+	1314 (19.3)	614 (22.0)	700 (17.4)	1.82 (1.34-2.45)	
Regular sexual partners in the past year [d]					0.39
0	2508 (38.2)	990 (36.2)	1518 (39.7)	1.00 (ref)	
1	2502 (38.1)	1055 (38.6)	1447 (37.8)	1.07 (1.00-1.14)	
2+	1549 (23.6)	688 (25.2)	861 (22.5)	1.13 (0.90-1.41)	
Casual sexual partners in the past year [d]					0.06
0	4046 (62.1)	1626 (59.9)	2420 (63.7)	1.00 (ref)	
1+	2469 (37.9)	1088 (40.1)	1381 (36.3)	1.10 (1.02-1.17)	
Sex worker partners in the past year [d]					0.11
0	4413 (68.2)	1800 (66.8)	2613 (69.1)	1.00 (ref)	
1+	2061 (31.8)	895 (33.2)	1166 (30.9)	1.06 (1.00-1.14)	

^ Weighted based on military size

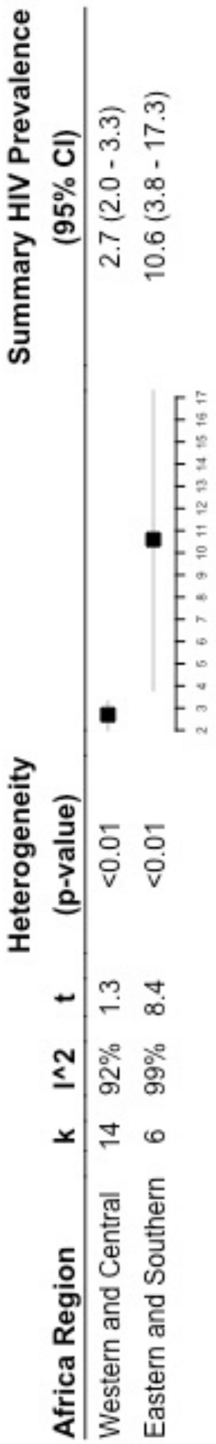
[a] Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone

[b] Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho

[c] Excludes Ghana (data not available)

[d] Only includes those who reported lifetime sexually activity, data from Angola was partners in last 6 months

[e] Excludes Sierra Leone (data not available)



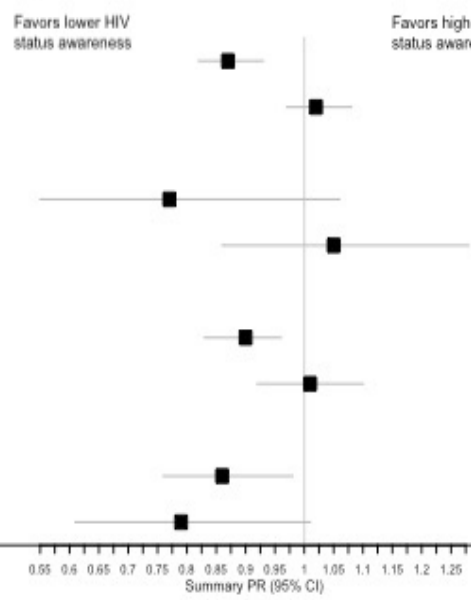
Abbreviations: k, number of studies; o, observations; I^2, I^2 statistic; t, tau; PLHIV, people living with HIV

Figure 3.2: Summary HIV prevalence of men in the military (ages 18-49 years) in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020

Figure 3.3: Two stage individual participant data meta logistic-regression models for HIV status awareness among men in the military (ages 18-49 years) in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020

West/Central: Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone
East/Southern: Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho
[a] Excludes: Cameroon, Burundi, Chad, Sierra Leone, Mozambique, and Angola (data not available)
[b] Excludes: Chad, Sierra Leone, Mozambique, and Angola (data not available)
[c] Only includes those that reported ever being tested for HIV

Factor	k	I^2	tau	Heterogeneity (p-value)	Summary Prevalence Ratio (95% CI)
HIV Transmission Knowledge, <100%					
West/Central	10	30%	0.1	0.17	0.87 (0.82-0.93)
East/South	6	0%	<0.1	0.51	1.02 (0.97-1.08)
Negative Attitudes towards PLHIV, high [a]					
West/Central	6	0%	<0.1	0.97	0.77 (0.55-1.06)
East/South	4	0%	<0.1	0.96	1.05 (0.86-1.28)
Perceived Discrimination against PLHIV, high [b]					
West/Central	8	0%	<0.1	0.90	0.90 (0.83-0.96)
East/South	4	5%	<0.1	0.37	1.01 (0.92-1.10)
HIV Testing Facility Type, non-military only [c]					
West/Central	10	86%	0.2	<0.01	0.86 (0.76-0.98)
East/South	6	91%	0.3	<0.01	0.79 (0.61-1.01)



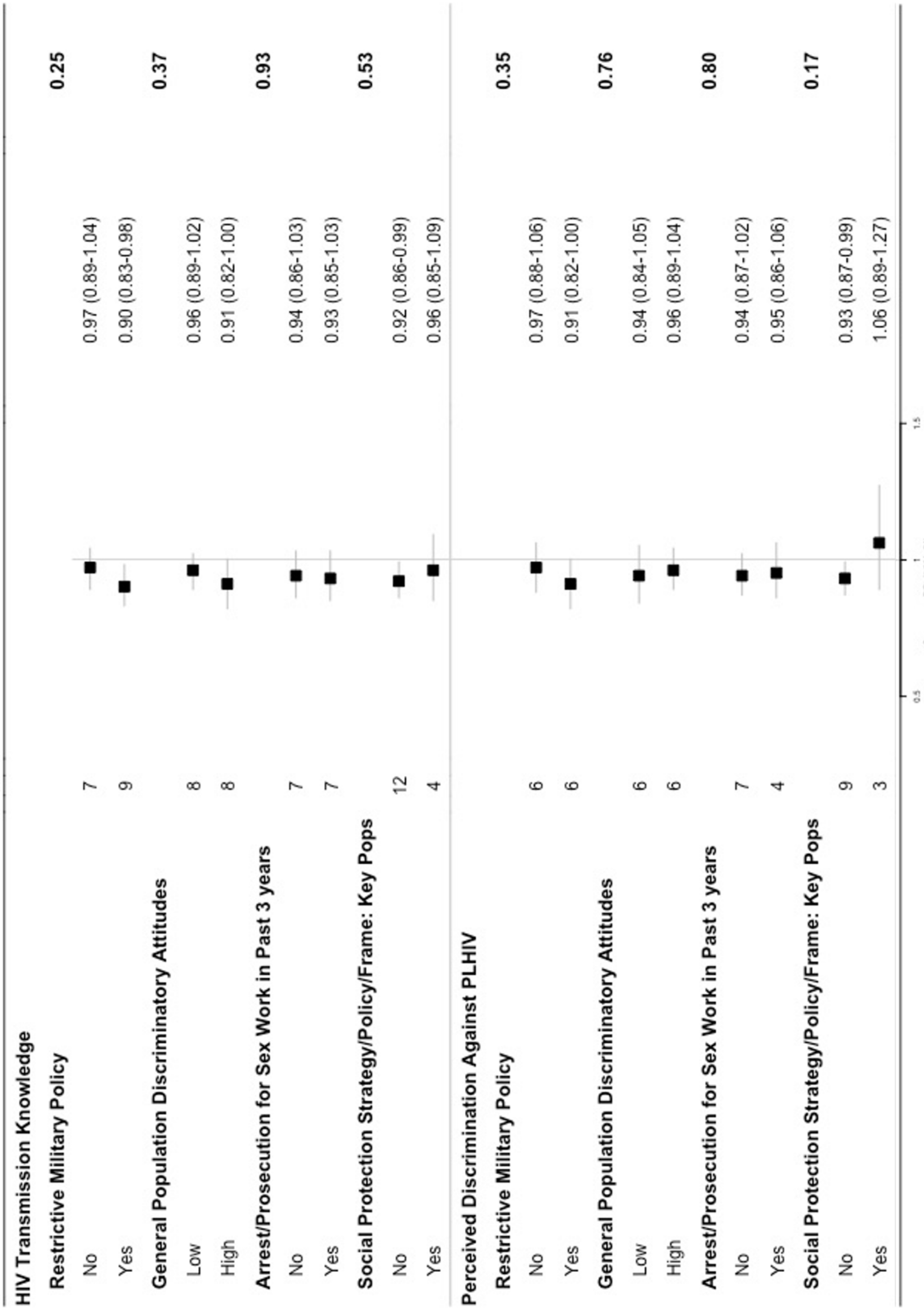


Figure 3.4: Stratified models of associations of HIV status awareness by country factors, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020.

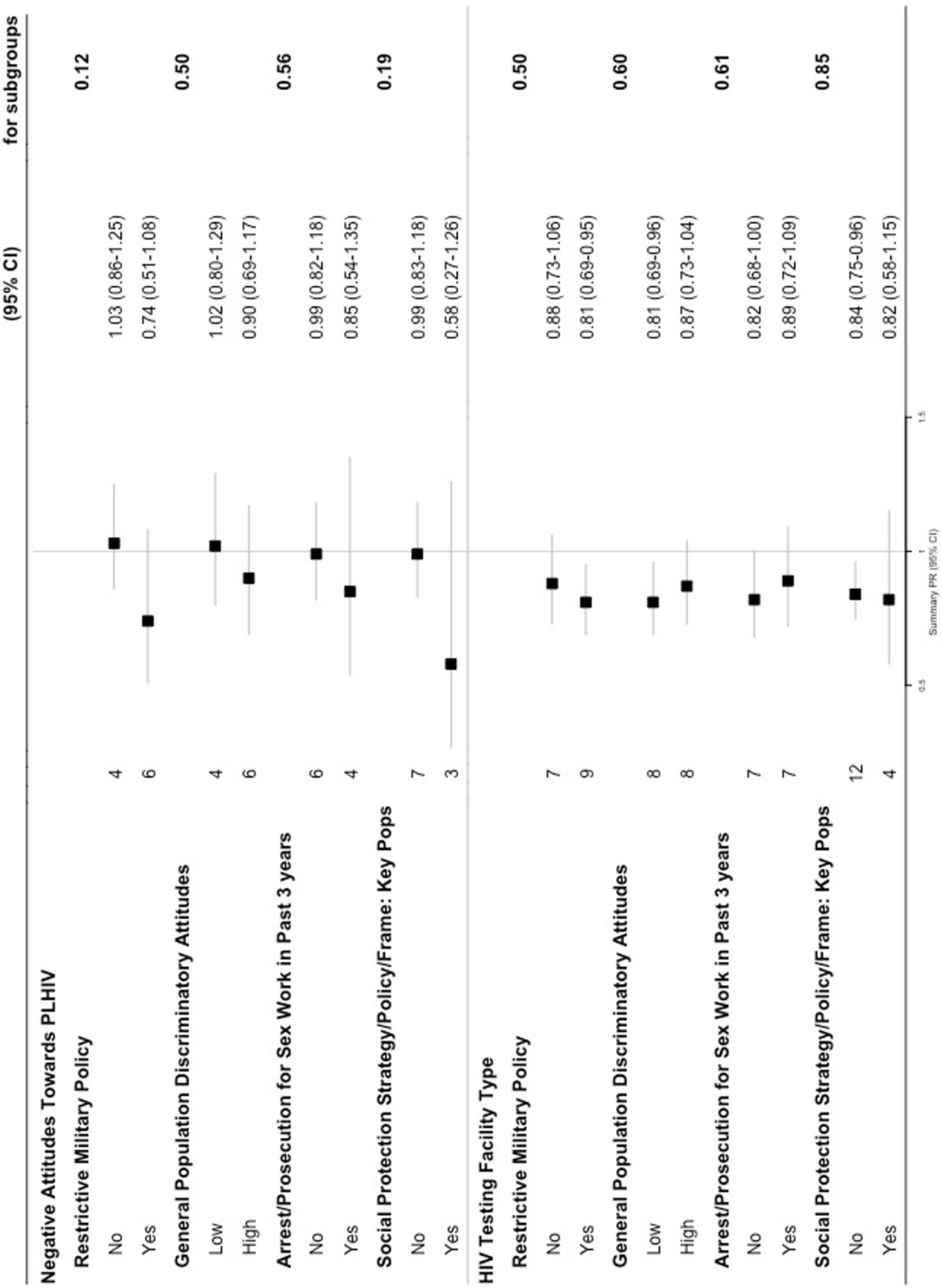


Figure 3.4: Stratified models of associations of HIV status awareness by country factors, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020, Continued

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CHAPTER 4: The Estimated Impact of Interventions on Key Indicators Associated with Current HIV Status Awareness Among High-Risk Men in the Militaries of Sub-Saharan Africa

ABSTRACT

Background. Men in sub-Saharan Africa (SSA) are a priority for increasing HIV status awareness to end AIDS by 2030. HIV testing uptake has been previously associated with HIV knowledge, stigmatizing and discriminatory attitudes, and testing facility location among men in SSA. Military personnel are a unique HIV sub-population due to the culture and exposures related to active-duty service. How interventions on these factors among men in the military could potentially impact current HIV status awareness is unknown.

Methods. Data on high-HIV risk active-duty men were combined from Seroprevalence and Behavioral Epidemiology Risky Surveys conducted in 16 countries in SSA from 2013-2020 (n=12,031). Estimator substitution methods were applied to one-stage individual participant data meta-regression analyses to estimate to potential effects of interventions on HIV transmission knowledge, negative attitudes towards PLHIV, perceived discrimination against PLHIV, and HIV testing facility type on current HIV status awareness.

Results. In Western/Central Africa, the estimated difference in current HIV status awareness was 6.0% (95%CI 0.7-12.3%) if all had 100% HIV transmission knowledge, 3.8% (95%CI 0.8-2.2%) if all had low perceived discrimination, and 2.7% (95% CI 0.5-5.8%) if all used military facilities for testing. In Eastern/Southern Africa, the estimated difference in HIV status awareness was 6.3% (95% CI 0.1-12.2%) if all used military facilities for testing.

Conclusions. Multiple potential points of intervention were identified to increase current HIV status awareness among high-HIV risk men in the military in SSA. While

associations were significant, estimated differences were small indicating programs should consider multiple strategies and explore additional possible barriers.

INTRODUCTION

Treatment as prevention is key to ending the AIDS epidemic which has claimed the lives of an estimated 36.3 million people.[1,2] Anti-retroviral therapy (ART) adherence for people living with HIV (PLHIV) can reduce AIDS-related morbidity/mortality and prevent transmission to others through viral suppression, especially with early detection.[3] The first step in treatment as prevention is getting PLHIV tested and aware of their status. In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) announced the '95-95-95' targets, a series of HIV testing and treatment targets that aspire to effectively end the AIDS epidemic by 2030.[4] These targets aim for 95% of PLHIV to be aware of their status, 95% of PLHIV aware of their status on ART, and 95% of PLHIV on ART to be virally suppressed by 2030. However, the midterm '90-90-90' by 2020 targets fell short of global goals with status awareness among PLHIV being the lowest of the targets at 84% at the end of 2020 equating to an estimated 2.3 million PLHIV who remain to be identified to reach 90%.[5]

Challenges in reaching targets have been driven in part by persistent gender gaps with men falling consistently behind women.[6] Among adult men living with HIV in 2020, 82% were aware of their status compared to 88% of adult women, 68% of men were on ART compared to 79% of women, and 62% were virally suppressed compared to 72% of women.[7] Men are also more likely to be diagnosed with advanced HIV and less likely to adhere to care resulting in higher rates of AIDS-related death.[8] Further,

lower status awareness among men living with HIV in regions with generalized epidemics (self-sustaining through heterosexual transmission) also contributes to higher incidence rates among women, as men are not getting virally suppressed through ART and transmitting to their sexual partners.[9,10] The Global AIDS Strategy 2021-2026 identified men living in regions with generalized HIV epidemics as a priority population to increase HIV status awareness and linkage to care.[1]

Sub-Saharan Africa (SSA) bares the disproportionate burden of HIV with 67% of PLHIV globally in SSA while only representing 14% of the world population.[5,11] HIV is a generalized epidemic in SSA with 61% of infections among non-key populations (i.e. sex workers, people who inject drugs, men who have sex with men, transgender women, and their sexual partners) compared to the rest of the world where only 7% of infections were among non-key populations in 2020.[7] Men in SSA are therefore a priority population for increasing status awareness. As we approach the first 90 of the testing and treatment cascade, identifying remaining individuals who are living with HIV and unaware of their status is becoming more challenging and costly.[12] Men at high-risk of acquiring HIV are therefore an important group for increasing testing uptake as they likely have a higher HIV positivity rate.[13] Furthermore, previous studies among men in SSA have found that men with high-risk sexual behaviors are not necessarily more likely to get tested. In a study in Uganda, men with multiple risky-sexual behaviors tested at a similar frequency to lower risk men.[14] Results from a study in Zambia also supported this, men who did not use a condom at last sex were more likely to have never been tested for HIV.[15]

The gender gap in HIV status awareness is driven by multiple potential barriers to test seeking among men. A review of literature on HIV testing among men in SSA found HIV knowledge, concerns around stigma and discrimination, clinical setting/locations, and perceptions of masculinity were frequently cited in association with testing uptake.[16] Lack of HIV knowledge has been negatively associated with ever being tested among men in multiple countries in SSA.[17-19] In support of achieving the 95-95-95 targets, the 2016 UN Political Declaration on Ending AIDS developed a series of 'fast-track' commitments which included 90% of young people having comprehensive HIV transmission knowledge by 2020.[10] However, current estimated levels fall well short of this goal with 46% of young men in Western and Central Africa (WCA) and 51% of young men in Eastern and Southern Africa (ESA) demonstrating comprehensive HIV transmission knowledge.[20] HIV stigma and discrimination has been recognized as one of the strongest barriers to testing uptake.[21] In studies among men in SSA, HIV testing reluctance was connected to fear of testing positive and stigma related concerns around losing sexual partners, being judged/shamed by their family and community, and employment discrimination.[22-24] Due to the ubiquitous effect of stigma and discrimination on the entire testing and treatment cascade, zero discrimination by 2020 was also included as part of the UNAIDS 'fast-track' commitments.[10] Yet, discrimination remains common among adults in SSA with 52% of Western/Central Africans and 32% of Eastern/Southern Africans unwilling to buy vegetables from a vendor if they knew they had HIV. Location and setting of HIV testing services can also act as barriers to testing uptake among men in SSA. Clinics are often seen as 'women's places' and physical access can present a challenge to working men due to inconvenient hours, long wait

times, and distance.[16] The UNAIDS 2021-2026 Global Strategy includes a call to increase providing testing that meets population specific needs which includes focusing on men.[1]

Men in the militaries of SSA may be at increased risk of acquiring and transmitting HIV compared to their non-military peers in the general population due to their unique cultural and work environment. Military personnel are often away from their homes and regular sexual partners and experience high levels of work-related stress due to combat and deployment. Concepts of masculinity such as embracing risk and valuing strength have been found to be condoned or even promoted by militaries as these values prepare men to be 'good soldiers'.[25] However, these concepts of masculinity have also been connected to increased HIV risk and lower testing uptake among men in SSA.[26] Many militaries have recognized HIV as a health priority among their personnel and have developed HIV programs which provide prevention, testing, and treatment among their forces.[27] While the aforementioned studies indicate potential points of intervention among men in SSA, no known studies have focused on status awareness among military personnel. Further, the potential impact of interventions among military personnel is unknown as they are a function of relationships with status awareness and the prevalence among the population. As we approach epidemic control, there is a need for directing finite resources to high-impact methods that focus on the potential of treatment as prevention.[1] The first step of which is increasing HIV status awareness among men.

More information is needed on modifiable factors associated with current status awareness among men in the militaries of SSA, an HIV special population, to help close

the gender gap. The current study comes from the first combination of individual participant data from militaries across all regions of SSA to our knowledge. This study aimed to estimate the effect of changing HIV knowledge, negative attitudes towards PLHIV, perceived discrimination against PLHIV, and use of military HIV testing sites on current HIV status awareness among men at high-risk of HIV serving in the militaries of SSA. These findings can be used to help inform existing programs on interventions with the largest theoretical impact on current HIV status awareness.

METHODS

Study Design and Population

Data from 16 Seroprevalence and Behavioral Epidemiology Risk Surveys (SABERS) conducted in SSA from 2013-2020 were used for this study. SABERS is a cross-sectional study conducted among active-duty military personnel with the primary objective of estimating HIV prevalence and related behaviors, attitudes, and knowledge among a country's armed forces. The SABERS uses a standardized questionnaire and methods that are adapted as needed to the country context and implemented by the military with support from the United States Department of Defense HIV/AIDS Prevention Program, methods previously published.[28] The protocols for SABERS were approved by institutional review boards (IRBs) in-country for the respective military and by the IRB for the Naval Health Research Center (San Diego, CA, USA) or the Defense Health Agency (dependent on year of study). All military personnel provided informed consent.

This study included men ages 18-49 years who were high-risk for acquiring or transmitting HIV infection based on self-reported sexual behavior in the past year and who participated in the Sierra Leone 2013, Chad 2014, Angola 2015, Ghana 2016, Mozambique 2016, Burundi 2017, Benin 2017, Liberia 2017, Lesotho 2017, Ethiopia 2018, Malawi 2018, Cameroon 2018, Gabon 2018, Burkina Faso 2018, Guinea Conakry 2019, or Eswatini 2020 SABERS (n=12,031). Risk-based screening questions recommended to optimize HIV testing services and available in the SABERS were used to define 'high HIV risk'.[29] Men were included in this study if they reported in the past 12 months more than one sexual partner, one or more sex worker partners, not always using condoms with casual partners, or experiencing an incident where alcohol use led to unintended sex or failure to use a condom properly. Participants were excluded if they did not provide information on variables used to determine HIV status awareness (defined below). For analyses with HIV knowledge, negative attitudes, perceived discrimination, and HIV testing facility type, participants were additionally excluded if they were missing any data for the variables used to define the respective exposure. Analyses for this study were also conducted by UNAIDS region. WCA included: Benin, Burkina Faso, Burundi, Cameroon, Chad, Gabon, Ghana, Guinea Conakry, Liberia, and Sierra Leone (n=7,336; k=10). ESA included: Angola, Ethiopia, Eswatini, Lesotho, Malawi, and Mozambique, (n=4,695; k=6).

In WCA, 7,308 high-HIV risk male military personnel with available data on current HIV status awareness were included in this study (n=28 excluded for missing data on time since last HIV test; **Figure 4.1**). The final analytic sample for HIV transmission knowledge included 7,308 personnel (99.6%), negative attitudes towards

PLHIV included 4,297 personnel (97.6% of data from countries with variable, n=76 excluded for incomplete data), perceived discrimination against PLHIV included 5,598 personnel (95.8% of data from countries with variable, n=217 excluded for incomplete data), and use of military sites for HIV testing included 6,410 (87.4%, n=875 excluded for never being testing and n=23 for missing data on test site).

In ESA, 4,695 high-HIV risk male military personnel with available data on current HIV status awareness were included in this study (n=29 excluded for missing data on HIV testing and n=302 excluded for missing data on time since last HIV test). The final analytic sample for HIV transmission knowledge included 4,208 personnel (89.6%, n=156 excluded for incomplete data), negative attitudes towards PLHIV and perceived discrimination against PLHIV included 2,749 personnel (89.3% of data from countries with variable), and use of military sites for HIV testing included 3,800 (80.9%, n=505 excluded for never being testing and n=59 for missing data on test site).

Current HIV Status Awareness

Previous HIV testing (yes, no, don't know), time since last HIV test among those who reported previous testing (<6 months, ≥6 months), and current HIV status among those who reported ever being tested for HIV (positive, negative, don't know) were used to determine current HIV status awareness. Individuals were defined as currently aware of their HIV status if they self-reported taking an HIV test in the past 6 months or were already aware of being HIV-positive. If an individual had never been tested for HIV or had not been tested within the past 6 months and did not report they were HIV-positive, they were defined as not currently aware of their HIV status.

HIV Transmission Knowledge

HIV transmission knowledge was defined based on identifying methods to reduce sexual transmission of HIV and rejecting major misconceptions about HIV according to the five knowledge questions outlined in Monitoring the Declaration of Commitment on HIV/AIDS: Guidelines on Construction of Core Indicators from UNAIDS.[30] 1) Can having sex with only one faithful, uninfected partner reduce the risk of HIV transmission? 2) Can using condoms reduce the risk of HIV transmission? 3) Can a healthy-looking person have HIV? 4) Can a person get HIV from mosquito bites? 5) Can a person get HIV by sharing a meal with someone who is infected? Among those who answered all five questions, individuals who answered all correctly were defined as having 100% HIV transmission knowledge and anyone who missed one or more questions was defined as having <100% HIV knowledge. Data on HIV transmission knowledge were available from all countries included in this study.

Stigma and Discrimination

The constructs 'negative attitudes towards PLHIV' and 'perceived discrimination against PLHIV' were measured using the 8-item and 7-item scales, respectively, published by Genberg et al. on assessing HIV stigma and discrimination in developing countries (**Appendix A**).[31] The Genberg et al. scales were previously validated among adults in SSA. Individual items are scored from 1-4 based on a response of 'strongly agree', 'agree', 'disagree', or 'strongly disagree' to a given statement, with higher scores indicating higher stigmatizing or discriminatory attitudes. The overall score for the construct was then determined based on the average from all items. For this study, negative attitudes towards PLHIV and perceived discrimination against PLHIV were

defined as high and low based on a cutoff of 2.5 using the average score of the construct. High (average score ≥2.5) indicates the individual generally agreed with statements describing negative attitudes or perceived discrimination and low (average score <2.5) signifies they generally disagreed. Data on stigma and discrimination were available from SABERS conducted in Benin, Burkina Faso, Burundi, Cameroon, Ethiopia, Eswatini, Gabon, Ghana, Guinea Conakry, Lesotho, Liberia, and Malawi.

HIV Testing Facility Type

HIV testing facility type was based on self-reported location of any previous HIV test (military health facility, government health facility, and/or private health facility) among those who reported ever being tested. If an individual reported using only government and/or private health facilities for HIV testing they were defined as using 'non-military sites only' for testing. If an individual reported using a military health facility (exclusively or non-exclusively) there were defined as having ever used military sites for HIV testing. Data on location of HIV testing was available from all countries included in this study.

Covariates

HIV prevalence, demographics, perception of HIV risk, and sexual history were additionally included to describe the population and for model adjustment. HIV prevalence was based on the result of rapid diagnostic testing (RDT) conducted at the time of the study. Each participant was tested for HIV using either a two or three test RDT algorithm based on the national standard at the time of implementation. Demographics included age, highest education (less than primary, primary, secondary, and tertiary), and marital status (single not-living with a partner, single living with a

partner, married, and divorced/separated/widowed). Perception of risk was based on the question ‘how likely are you to acquire HIV?’ among those who did not report they were HIV positive with the options ‘not at all likely’, ‘somewhat likely’, ‘highly likely’, and ‘don’t know’. Number of sexual partners in the past 12 months (except Angola, last 6 months) was categorized into 0, 1, or 2+ for regular partners and 0 or 1+ for casual and sex worker partners (data on sex workers not available for Sierra Leone). Regular partner was described as ‘your spouse, boyfriend/girlfriend, or any person with whom you have a committed relationship.’ Casual partner was described as ‘any person with whom you have had sex with but not a committed relationship (does not include your spouse, boyfriend/girlfriend, regular partners, or sex workers).’ Sex worker was described as ‘any person with whom you have sex in exchange for money or gifts.’ Condom use with a casual partner was based on the reported frequency of condom use in the past 12 months and was defined for this study as ‘all the time’ or ‘less than all the time’. Alcohol and sex related factors included ‘in the past X months, did drinking alcohol prevent you from using condoms or using condoms correctly?’ (yes, no) and ‘in the past X months did you have unintended sex as a result of drinking alcohol?’ (yes, no). The timeframe for questions related to alcohol use varied between 3 months and 12 months across the SABERS.

Statistical Analyses

Descriptive statistics were calculated for all variables weighted by the size of the military (unpublished). Generalized linear models (GLM) with a binomial family and log link weighted by size of the military and with country specified as clusters were used to determine prevalence ratios and their 95% confidence intervals for all covariates by

current HIV status awareness. Significance tests for covariates were conducted using Pearson's chi-square with Rao & Scott adjustment.[32]

The associations of current HIV status awareness with HIV transmission knowledge, negative attitudes towards PLHIV, perceived discrimination against PLHIV, and HIV testing facility type were determined with one-stage individual participant data meta-regression analyses. One-stage individual participant data meta-analysis allows for the inclusion of all studies in one step by using a random effects model to address clustering by study and avoid issues that can emerge with simple pooling such as Simpson's paradox.[33,34] Prevalence ratios and 95% confidence intervals for current HIV status awareness by each factor were calculated using generalized linear mixed effect models (GLMM) with a binomial family and log link weighted by size of the military with country specified as a random effect. Models were adjusted based on *a priori* identified likely confounders in the causal path. The models for HIV transmission knowledge, negative attitudes towards PLHIV, and perceived discrimination against PLHIV were adjusted for age and education, set as fixed effects. Use of military testing sites was assumed to be based on availability of testing services at the military locations personnel were serving and had no *a priori* identified likely confounders.

For factors that were significantly associated with current HIV status awareness for a region, estimator substitution, an imputation-based modeling method, was used to calculate the estimated effect of changes in exposure level from baseline on current HIV status awareness among high-HIV risk male military personnel as a population, method originally published by Ahern et al.[35] For example, given the modelled population, if 100% of the population had correct HIV transmission knowledge, what would be the

estimated proportion with current HIV status awareness. Using the same GLMM models described for the one-stage individual participant data meta-analyses, estimated population proportion with current HIV status awareness was modelled given a 20%, 40%, 60%, 80%, and 100% change in exposure from baseline. The estimated proportions were determined by first) fitting the model to obtain fitted values for each individual, second) imputing the defined percent change in exposure in the 'unexposed', and third) applying the fitted values from the model to predict individual current HIV status awareness with the imputed dataset and averaging across the population to predict proportion with current HIV status awareness. The 95% confidence interval for the estimated proportion was obtained by bootstrapping with 500 iterations. Estimated effects were calculated as percent difference in proportion with current HIV status awareness given percent change in exposure from baseline level.

All analyses were conducted in RStudio version 1.3.1093 for Mac (R Foundation) with survey (analysis of complex survey samples) version 4.1-1 and lme4 (linear mixed-effect models using 'Eigen' and S4) version 1.1-26. All tests were performed with alpha set at 0.05.

RESULTS

Western and Central Africa

The prevalence of HIV among participants was 2.3% (**Table 4.1**). Most participants had a secondary education (65.6%), were single, living with partner (35.3%) or married (42.3%), and had an average age of 32.5 years. In the past year, most had two or more regular sexual partners (58.4%), one or more casual sexual partners

(70.9%), and no sex worker partners (85.3%). Half of personnel with a casual sexual partner did not always use condoms with that partner (49.9%). Over one in ten reported that alcohol use had resulted in incorrect condom use (14.5%) or unintended sex (12.9%). 18.5% thought they were 'highly likely' to acquire HIV. Two-fifths had less than 100% HIV knowledge (40%). Only 1.8% had high negative attitudes towards PLHIV while 23.7% had high perceived discrimination against PLHIV. 58% had ever used a military site for HIV testing. Overall, 37.3% were currently aware of their HIV status. None of the included covariates were associated with HIV status awareness (**Table 4.2**).

After adjusting for age and education, the proportion of current HIV status awareness was 18% higher among personnel with correct HIV transmission knowledge (aPR 1.18, 95% CI 1.11-1.26, p<0.01; **Table 4.3**). The estimated difference in the proportion of current HIV status awareness if all personnel had comprehensive HIV transmission knowledge was 6.0% (95% CI 0.7-12.3%; **Figure 4.2**). At a 20% change in HIV transmission knowledge, the estimated difference in status awareness was 1.2% (95% CI 0.6% - 3.2%).

The proportion of current HIV status awareness was 17% higher among those with low perceived discrimination against PLHIV (aPR 1.17, 95% CI 1.08-1.27, p<0.01; **Table 4.3**), after adjusting for age and education. The estimated difference in proportion with current HIV status awareness was 0.8% (95% CI 0.7-2.2%) with a 20% change from high to low perceived discrimination against PLHIV and 3.8% (95% CI 0.8-2.2%) if all personnel had low perceived discrimination against PLHIV (**Figure 4.2**).

Those who used military sites for HIV testing had a proportion of current status awareness 1.17 times higher (95% CI 1.08-1.26, p<0.01; **Table 4.3**) than those who used exclusively non-military sites. The estimated difference in proportion with current HIV status awareness with a 20% increase in use of military sites for HIV testing was 0.5% (95% CI 0.5-1.6%) and 2.7% (95% CI 0.5-5.8%) if all personnel used military sites (**Figure 4.2**).

Eastern and Southern Africa

The prevalence of HIV among participants was 3.1% (**Table 4.1**). The average age among participants in ESA was 29.5 years and most had a secondary education (76.9%) and were single and not living with a partner (55.9%). 38.1% had two or more regular sexual partners, 57.9% had one or more casual sexual partners, and 51.6% had one or more sex worker partners in the past 12 months. Over half did not always use condoms with their casual partner (53.7%) and one in five reported alcohol use resulted in incorrect condom use (20.9%) or unintended sex (19.3%). 22.4% of personnel thought they were highly likely to acquire HIV. Over half did not demonstrate correct HIV transmission knowledge (54.1%). 3.1% had high negative attitudes towards PLHIV and 13.4% had high perceived discrimination against PLHIV. One in six did not use military sites for HIV testing (16.3%). Among all participants, 42.8% were currently aware of their HIV status. Current HIV status awareness was higher among those that did not know their HIV risk (PR 1.31, 95% CI 1.06-1.62) or thought they were highly likely to acquire HIV (PR 1.05 95% CI 0.99-1.11) compared to those that believed they were not at all likely to acquire HIV (p<0.01; **Table 4.2**). Those that did not always use condoms

with their casual partner had a lower rate of current HIV status awareness compared to those who always used condoms (PR 0.86, 95% CI 0.81-0.92, p<0.01).

The proportion of current HIV status awareness was 58% higher among personnel who used military sites for HIV testing compared to those who used exclusively non-military sites (PR 1.58, 95% CI 1.39-1.80, p<0.01; **Table 4.3**). The estimated difference in the proportion with current HIV status awareness was 0.8% (95% CI 0.7-2.2%) with a 20% change in use of military sites for HIV testing and 6.3% (95% CI 0.1-12.2%) if all personnel used military sites (**Figure 4.3**).

DISCUSSION

Current HIV status awareness among high HIV risk men in the military was low at 37% in WCA and 43% in ESA. Given the established programs and resources for HIV prevention, testing, and treatment among the included militaries in SSA, increasing current HIV status awareness among these men is important to maximize their benefit. This study identified multiple potential points of intervention to increase HIV status awareness. In WCA, HIV status awareness was higher among men with correct HIV transmission knowledge, low perceived discrimination, and who used military sites for testing. Increasing the percentage of men with correct HIV transmission knowledge to 100% resulted in the greatest estimated difference in HIV status awareness (6% difference) followed by increasing low perceived discrimination to 100% (4% difference) and use of military testing sites to 100% (3% difference). In ESA, only use of military sites for testing was associated with status awareness with men who used military sites

having a larger proportion with status awareness and an estimated 6% difference in status awareness if all men used military sites for testing.

Consistent with the current study's findings for WCA, a study which combined data from Demographic and Health Surveys (DHS) conducted in 29 SSA countries between 2010-2019, showed men without correct HIV knowledge were 41% less likely to have ever been tested for HIV.[36] These findings were stronger than the current study potentially due to the use of ever testing over recent testing. Similar to the current study, these results were based on data from multiple countries across SSA however associations were not assessed by regions. HIV transmission knowledge may reflect effective health education programs in the military which also connect personnel to HIV testing services resulting in increased HIV status awareness.[27] While HIV knowledge was associated with current status awareness in WCA there was no association observed in ESA. The study population had a similar HIV prevalence between WCA (2.3%) and ESA (3.1%), however, ESA has the highest HIV prevalence in the world among the general population at 6.5% compared to 1.3% in WCA. Personnel may therefore receive more exposure to HIV educational campaigns outside of the military resulting in knowledge that does not necessarily translate to perception of risk and increased testing uptake. In a systematic review, multiple studies were found with positive, negative, and no association between HIV knowledge and risk perceptions indicating an inconsistent direction. Further, a study among men in South Africa with multiple sexual partners found that while men with risky-sexual behaviors perceived higher risk, this did not translate to getting tested.[37]

Concerns around HIV-related stigma and discrimination and reluctance to test are multi-faceted. Lack of confidentiality by health care providers, fear of abandonment, being blamed and/or judged by their community, and concerns of employment discrimination have been frequently identified as barriers to testing across SSA.[21] In a study in rural South Africa, men with no anticipated stigma (similar to perceived discrimination used in the current study) were 40% more likely to have been tested in the past year.[38] In Mozambique, similar findings were reported where men with any anticipated stigma were 35% less likely to have been tested in the past year.[39] This was further supported in a study in rural Tanzania where men with no anticipated stigma were more likely to have ever been tested for HIV.[40] These support our findings on perceived discrimination though the association was stronger potentially due to an exclusively rural population in the South African study and the use of a lower threshold for stigmatizing attitudes being 'any stigma'. In contrast to the current study which found no associations with negative attitudes, men in a study in rural Ethiopia were less likely to seek HIV testing with any level of stigmatizing attitudes compared to no stigma.[41] Again, this may be related to demographic differences in rural communities compared to the military. Differences in the association of perceived discrimination with HIV status awareness between WCA and ESA may again be driven by differences in HIV prevalence between the regions with ESA having the highest regional prevalence in the world.[5] Military personnel in ESA may therefore have more peers living with HIV which could overcome stigma-related concerns through social-network influence.[42]

The convenience of military testing sites for military personnel may overcome barriers to testing uptake reported by men with other testing facilities. From a qualitative

study in Kenya, men cited facility location and inconvenient clinic times as barriers to testing.[23] These barriers may be especially significant for working men who find it difficult to access clinics during normal hours as evidenced by employed men in Cote d'Ivoire having lower odds of recent testing compared to unemployed men.[43] In a study on workplace based self-testing among Ugandan men, convenience of accessing testing at work and the involvement of employers were reported as drivers to testing uptake.[44] For active-duty personnel, availability of testing on military sites provides a convenient location that requires minimal travel and is easier to access during working hours. Encouragement by military leadership to use military testing facilities may also be a facilitator in testing uptake.

Previous studies in other populations provide support that increasing HIV knowledge, decreasing stigma, and worksite-based testing can increase HIV testing. Results from a meta-analysis of intervention studies conducted in SSA on HIV-related knowledge showed significantly higher levels of knowledge among those who received an education intervention.[45] Further, a pilot randomized control trial in Rwanda showed men who received an HIV focused health education program demonstrated a greater increase in HIV knowledge and HIV test seeking compared to routine education.[46] It is important to note that while men who received routine education also showed increased HIV knowledge, the larger uptake in testing was observed in the intervention arm which included education on HIV transmission, diagnosis, benefits of status disclosure, and care and treatment. This study suggests that interventions on HIV knowledge will be more effective if they also include information on getting tested and living with HIV. Additionally, in a review of interventions to increase testing among men in SSA,

educational campaigns were found to be most successful when driven by other men.[47] A review of interventions on HIV-related stigma and HIV testing uptake in developing countries found a number of successful strategies that reduced stigma and increased testing including: increasing knowledge, reducing fear of unwanted disclosure and discrimination, reducing shame, reducing blame, reducing discriminatory practices among health care workers, and increasing interactions with PLHIV.[48] Further, the impact of stigma on testing uptake is multi-layered therefore interventions to address stigma should focus on multiple potential sources to meaningfully overcome barriers. A randomized control trial conducted in Zambia that allocated all employees of businesses to receive either vouchers for off-site voluntary testing or at an on-site rapid testing clinic found that testing-uptake was 2.8 times higher among employees with on-site testing.

Strengths and Limitations

This study combined data from SABERS conducted in 16 countries in SSA since 2013 and represents the largest known dataset on HIV and related knowledge, attitudes, and behaviors among active-duty military personnel in Africa. The SABERS were designed and powered to estimate HIV prevalence meaning individual studies are likely underpowered to detect associations. By combining across multiple studies, this substantially increased our ability to test for potential facilitators and barriers to status awareness to inform HIV programs among the armed forces. Individual participant data meta-analyses were used allowing for standardized inclusion/exclusion criteria and model adjustment reducing design differences between countries that could limit conclusions. Additionally, the scales used for HIV knowledge, negative attitudes, and perceived discrimination were based on previously published or validated measures.

The SABERS use a cross-sectional study design which is ideal for estimating prevalence but cannot estimate risk and limits conclusions of causality. Concerns over stigma and discrimination related to testing positive for HIV may have resulted in volunteer bias even though individual participant results for SABERS are confidential, especially in countries without robust protections for PLHIV. This was a recognized issue in one of the countries where a SABERS was conducted; however, this country was retained in the combined dataset. Available information on testing for HIV is particularly important in settings with such barriers and by combining the data sets this minimizes the impact of biases from any individual country. Estimator substitution is a causal inference method which allows for the use of cross-sectional data to estimate effects but relies on strong assumptions like temporality. The primary outcome, HIV status awareness, includes a specified timeframe of 6 months, so while all data was collected at a single time point, we can assess that the outcome for those that did not self-report as HIV-positive was recent. Other studies commonly used testing within the past year, limiting direct comparisons. Testing within the past 6 months was used for this study as it was the timeframe available across the SABERS. However, six months would be a more sensitive proxy for current status awareness and a closer outcome measure to the time of data collection. Further, attitudes and knowledge included in this study have been found to generally remain stable at the population level over time.[10,49-51] Additional assumptions include no unmeasured confounders, independence of the exposures and outcome between one individual and another, and no individual in the population has a zero probability of exposure. In a study on stigma in South Africa, community level stigma was not found to be associated with testing among men.[38] Men

who had never been tested for HIV were excluded from analyses on use of military testing sites as their probability of exposure would be zero.

CONCLUSION

Men in SSA are a priority population for increasing HIV status awareness and linkage to care in order achieve epidemic control and end AIDS by 2030.[1] This study identified several potential points of intervention included in the UNAIDS core commitments to increase HIV status awareness among men at high-risk of acquiring or transmitting HIV serving in the militaries of SSA. These included increasing HIV transmission knowledge, decreasing perceived discrimination, and increasing use of military sites for testing. The associations identified in this study, while significant, indicated relatively small estimated effects even with substantial changes in exposure level. This suggests that making meaningful impacts on HIV status awareness among men at high-risk of HIV will likely require addressing multiple factors. Identifying potential barriers and facilitators among men specifically at high-risk of acquiring or transmitting HIV is important as they likely have higher positivity rates but have not been found to seek testing more often compared to those at lower risk.[13-15] Military personnel represent a unique sub-population of men due to their work environment and culture as well as potentially being at increased risk of exposure. Understanding how UNAIDS core commitments are associated with HIV status awareness among the military and estimating the impact of interventions provides valuable information to stakeholders to assist in directing limited funding and programmatic policy.

Figure 4.1: Strobe diagram for assessing associations between current HIV status awareness with HIV transmission knowledge, negative attitudes towards PLHIV, perceived discrimination against PLHIV, and HIV testing facility type among high HIV risk active-duty military men between the ages of 18-49 years in sub-Saharan Africa, Seroprevalence and Epidemiology Risk Survey 2013-2020 (Burundi 2017, Cameroon 2018, Chad 2014, Gabon 2018, Benin 2017, Burkina Faso 2018, Ghana 2016, Guinea Conakry 2019, Liberia 2017, Sierra Leone 2013, Angola 2015, Ethiopia 2018, Malawi 2018, Mozambique 2016, Eswatini 2020, and Lesotho 2017)

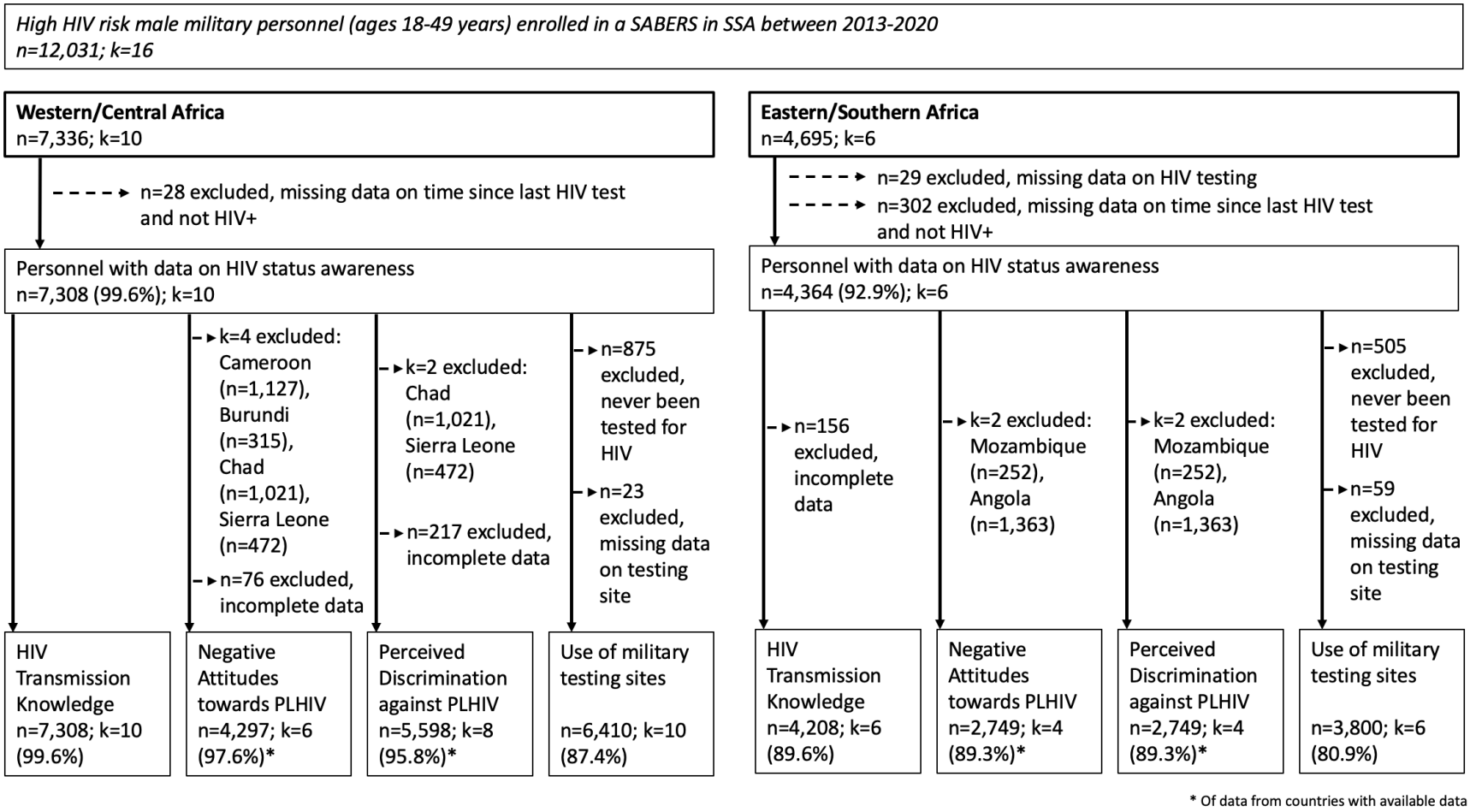

High HIV risk male military personnel (ages 18-49 years) enrolled in a SABERS in SSA between 2013-2020
n=12,031; k=16
Western/Central Africa
n=7,336; k=10
n=28 excluded, missing data on time since last HIV test and not HIV+
Personnel with data on HIV status awareness
n=7,308 (99.6%); k=10
k=4 excluded: Cameroon (n=1,127), Burundi (n=315), Chad (n=1,021), Sierra Leone (n=472)
n=76 excluded, incomplete data
k=2 excluded: Chad (n=1,021), Sierra Leone (n=472)
n=217 excluded, incomplete data
n=875 excluded, never been tested for HIV
n=23 excluded, missing data on testing site
HIV Transmission Knowledge n=7,308; k=10 (99.6%)
Negative Attitudes towards PLHIV n=4,297; k=6 (97.6%)*
Perceived Discrimination against PLHIV n=5,598; k=8 (95.8%)*
Use of military testing sites n=6,410; k=10 (87.4%)
Eastern/Southern Africa
n=4,695; k=6
n=29 excluded, missing data on HIV testing
n=302 excluded, missing data on time since last HIV test and not HIV+
Personnel with data on HIV status awareness
n=4,364 (92.9%); k=6
n=156 excluded, incomplete data
k=2 excluded: Mozambique (n=252), Angola (n=1,363)
k=2 excluded: Mozambique (n=252), Angola (n=1,363)
n=505 excluded, never been tested for HIV
n=59 excluded, missing data on testing site
HIV Transmission Knowledge n=4,208; k=6 (89.6%)
Negative Attitudes towards PLHIV n=2,749; k=4 (89.3%)*
Perceived Discrimination against PLHIV n=2,749; k=4 (89.3%)*
Use of military testing sites n=3,800; k=6 (80.9%)
* Of data from countries with available data

Table 4.1: Description of high HIV risk active-duty military men in sub-Saharan Africa, Seroprevalence of Behavioral Epidemiology Risk Survey 2013-2020

Characteristic	**Total (Sub-Saharan Africa)[a]** (n=11,672) n^ (%)	**Western/Central Africa [b]** (n=7,308) n^ (%)	**Eastern/Southern Africa [c]** (n=4,364) n^ (%)
HIV Result, no. (%)			
Positive	297 (2.6)	170 (2.3)	127 (3.1)
Negative	11218 (97.4)	7224 (97.7)	3994 (96.9)
Age, mean (SE), years	31.5 (1.1)	32.5 (0.7)	29.5 (2.5)
Education			
Less than primary	441 (3.8)	231 (3.1)	210 (5.1)
Primary	1234 (10.7)	842 (11.4)	392 (9.6)
Secondary	8004 (69.6)	4847 (65.6)	3156 (76.9)
Tertiary	1817 (15.8)	1474 (19.9)	344 (8.4)
Marital Status, no. (%)			
Single, not living with a partner	3877 (33.7)	1580 (21.4)	2296 (55.9)
Single, living with partner	3637 (31.6)	2612 (35.3)	1025 (25.0)
Married	3785 (32.9)	3128 (42.3)	655 (16.0)
Widowed/Divorced/ Separated	201 (1.7)	72 (1.0)	129 (3.1)
Perception of HIV Risk			
Not at all likely	2804 (31.1)	2170 (29.7)	635 (37.2)
Somewhat likely	2713 (30.1)	2123 (29.1)	590 (34.5)
Highly Likely	1654 (18.4)	1272 (17.4)	382 (22.4)
Don't know	1834 (20.4)	1734 (23.8)	101 (5.9)
Regular sexual partners in the past year [d]			
0	1860 (16.3)	300 (4.1)	1559 (38.4)
1	3717 (32.5)	2764 (37.5)	953 (23.5)
2+	5854 (51.2)	4305 (58.4)	1549 (38.1)
Casual sexual partners in the past year [d]			
0	3843 (33.7)	2140 (29.1)	1703 (42.1)
1+	7557 (66.3)	5215 (70.9)	2341 (57.9)
Condom use with casual partners last 12 months			
All the time	3670 (48.9)	2602 (50.1)	1067 (46.3)
Less than all the time	3832 (51.1)	2591 (49.9)	1240 (53.7)
Sex worker partners in the past year [d, e]			
0	7940 (72.0)	6005 (85.3)	1934 (48.4)
1+	3092 (28.0)	1031 (14.7)	2061 (51.6)
Incorrect condom use as a result of drinking last 12 months			
Yes	1629 (16.9)	866 (14.5)	763 (20.9)
No	7986 (83.1)	5098 (85.5)	2888 (79.1)

Table 4.1: Description of high HIV risk active-duty military men in sub-Saharan Africa, Seroprevalence of Behavioral Epidemiology Risk Survey 2013-2020, Continued

Characteristic	Total (Sub-Saharan Africa)[a] (n=11,672)	Western/Central Africa [b] (n=7,308)	Eastern/Southern Africa [c] (n=4,364)
	n^ (%)	n^ (%)	n^ (%)
Unintended sex as a result of drinking last 12 months			
Yes	1479 (15.4)	771 (12.9)	707 (19.3)
No	8149 (84.6)	5194 (87.1)	2955 (80.7)
Current HIV Status Awareness			
Yes	4518 (39.2)	2755 (37.3)	1763 (42.8)
No	6997 (60.1)	4639 (62.7)	2358 (57.2)
Negative Attitudes towards PLHIV [f]			
Low (score <2.5)	5841 (98.2)	3490 (98.2)	1297 (96.9)
High (score ≥2.5)	107 (1.8)	65 (1.8)	42 (3.1)
Perceived Discrimination towards PLHIV [g]			
Low (score <2.5)	6576 (79.2)	4504 (76.3)	2072 (86.6)
High (score ≥2.5)	1722 (20.8)	1402 (23.7)	320 (13.4)
HIV Transmission knowledge			
100%	6298 (55.0)	4435 (60.0)	1864 (45.9)
<100%	5154 (45.0)	2960 (40.0)	2195 (54.1)
HIV Testing Facility Type			
Military facilities	6704 (66.9)	3805 (58.0)	2899 (83.7)
Non-military facilities only	3320 (33.1)	2756 (42.0)	564 (16.3)

^ Weighted based on military size

[a] Burundi 2017, Cameroon 2018, Chad 2014, Gabon 2018, Benin 2017, Burkina Faso 2018, Ghana 2016, Guinea Conakry 2019, Liberia 2017, Sierra Leone 2013, Angola 2015, Ethiopia 2018, Malawi 2018, Mozambique 2016, Eswatini 2020, and Lesotho 2017

[b] Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone

[c] Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho

[d] Only includes those who reported lifetime sexually activity, data from Angola was partners in last 6 months

[e] Data not available for Sierra Leone

[f] Data not available for: (Western/Central) Cameroon, Burundi, Chad, and Sierra Leone; (Eastern/Southern) Mozambique and Angola

[g] Data not available for: (Western/Central) Chad and Sierra Leone; (Eastern/Southern) Mozambique and Angola

Table 4.2: Bivariate associations with current HIV status awareness among high HIV risk military personnel in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020

	Current HIV Status Awareness			
	Yes n^ (%)	No n^ (%)	Prevalence Ratio (95% CI)	p-value
Total (sub-Saharan Africa) [a]				
Age, mean (SE), years	31.5 (1.2)	31.4 (1.1)	1.00 (1.00-1.01)	0.58
Education				0.24
Less than primary	139 (3.1)	302 (4.3)	1.00 (ref)	
Primary	465 (10.3)	769 (11.0)	1.19 (0.96-1.48)	
Secondary	3212 (71.3)	4792 (68.6)	1.27 (0.94-1.72)	
Tertiary	692 (15.4)	1125 (16.1)	1.21 (0.92-1.59)	
Marital Status, no. (%)				0.54
Single, not living with a partner	1596 (35.4)	2281 (32.6)	1.00 (ref)	
Single, living with partner	1360 (30.1)	2277 (32.6)	0.91 (0.81-1.02)	
Married	1483 (32.9)	2302 (32.9)	0.95 (0.78-1.16)	
Widowed/Divorced/Separated	74 (1.6)	127 (1.8)	0.89 (0.71-1.12)	
Perception of HIV Risk				0.38
Not at all likely	1073 (32.5)	1731 (30.4)	1.00 (ref)	
Somewhat likely	1002 (30.3)	1711 (30.0)	0.97 (0.83-1.13)	
Highly Likely	632 (19.1)	1022 (17.9)	1.00 (0.85-1.17)	
Don't know	596 (18.0)	1238 (21.7)	0.85 (0.69-1.04)	
Regular sexual partners in the past year [d]				0.51
0	756 (16.9)	1104 (15.9)	1.00 (ref)	
1	1404 (31.4)	2313 (33.3)	0.93 (0.79-1.09)	
2+	2318 (51.8)	3536 (50.9)	0.97 (0.85-1.12)	
Casual sexual partners in the past year [d]				0.15
0	1454 (32.6)	2389 (34.4)	1.00 (ref)	
1+	3007 (67.4)	4550 (65.6)	1.05 (0.98-1.12)	
Condom use with casual partners last 12 months				0.07
100% of the time	1527 (51.2)	2143 (47.4)	1.00 (ref)	
Less than 100% of the time	1456 (48.8)	2376 (52.6)	0.91 (0.83-1.00)	
Sex worker partners in the past year [d, e]				0.69
0	3055 (71.2)	4885 (72.4)	1.00 (ref)	
1+	1234 (28.8)	1858 (27.6)	1.04 (0.87-1.24)	
Incorrect condom use as a result of drinking last 12 months				0.86
Yes	638 (16.8)	991 (17)	1.00 (ref)	
No	3150 (83.2)	4836 (83)	1.01 (0.92-1.10)	
Unintended sex as a result of drinking last 12 months				0.72
Yes	577 (15.2)	902 (15.5)	1.00 (ref)	
No	3217 (84.8)	4932 (84.5)	1.01 (0.95-1.08)	

Table 4.2: Bivariate associations with current HIV status awareness among high HIV risk military personnel in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020, Continued

	Current HIV Status Awareness			
	Yes n^ (%)	No n^ (%)	Prevalence Ratio (95% CI)	p-value
Western/Central Africa [b]				
Age, mean (SE), years	32.7 (0.73)	32.4 (0.73)	1.00 (1.00-1.01)	0.16
Education				0.32
Less than primary	59 (2.1)	172 (3.7)	1.00 (ref)	
Primary	311 (11.3)	531 (11.4)	1.45 (1.13-1.86)	
Secondary	1832 (66.5)	3015 (65.0)	1.48 (0.93-2.35)	
Tertiary	553 (20.1)	921 (19.9)	1.47 (0.98-2.19)	
Marital Status, no. (%)				0.40
Single, not living with a partner	615 (22.3)	965 (20.8)	1.00 (ref)	
Single, living with partner	931 (33.8)	1681 (36.2)	0.92 (0.80-1.05)	
Married	1192 (43.3)	1936 (41.7)	0.98 (0.82-1.17)	
Widowed/Divorced/Separated	16 (0.6)	56 (1.2)	0.58 (0.38-0.88)	
Perception of HIV Risk				0.28
Not at all likely	843 (31.4)	1327 (28.8)	1.00 (ref)	
Somewhat likely	810 (30.1)	1313 (28.5)	0.98 (0.82-1.18)	
Highly Likely	487 (18.1)	785 (17.0)	0.99 (0.81-1.21)	
Don't know	548 (20.4)	1186 (25.7)	0.81 (0.67-0.99)	
Regular sexual partners in the past year [d]				0.44
0	95 (3.5)	205 (4.4)	1.00 (ref)	
1	1019 (37.1)	1745 (37.7)	1.17 (0.91-1.50)	
2+	1630 (59.4)	2675 (57.8)	1.20 (0.92-1.56)	
Casual sexual partners in the past year [d]				0.33
0	763 (27.9)	1377 (29.8)	1.00 (ref)	
1+	1973 (72.1)	3242 (70.2)	1.06 (0.94-1.19)	
Condom use with casual partners last 12 months				0.29
100% of the time	1019 (51.8)	1583 (49.1)	1.00 (ref)	
Less than 100% of the time	947 (48.2)	1644 (50.9)	0.93 (0.83-1.05)	
Sex worker partners in the past year [d, e]				0.04
0	2245 (86.9)	3760 (84.5)	1.00 (ref)	
1+	339 (13.1)	692 (15.5)	0.88 (0.80-0.97)	
Incorrect condom use as a result of drinking last 12 months				0.42
Yes	308 (13.8)	558 (15.0)	1.00 (ref)	
No	1929 (86.2)	3169 (85.0)	1.06 (0.92-1.23)	
Unintended sex as a result of drinking last 12 months				0.88
Yes	291 (13.0)	480 (12.9)	1.00 (ref)	
No	1946 (87.0)	3248 (87.1)	0.99 (0.89-1.10)	

Table 4.2: Bivariate associations with current HIV status awareness among high HIV risk military personnel in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020, Continued

	Current HIV Status Awareness			
	Yes n^ (%)	No n^ (%)	Prevalence Ratio (95% CI)	p-value
Eastern/Southern Africa [c]				
Age, mean (SE), years	29.7 (2.4)	29.3 (2.5)	1.00 (1.00-1.01)	0.33
Education				0.05
Less than primary	80 (4.6)	130 (5.5)	1.00 (ref)	
Primary	154 (8.8)	238 (10.1)	1.03 (0.97-1.09)	
Secondary	1380 (78.7)	1776 (75.6)	1.15 (1.04-1.26)	
Tertiary	139 (7.9)	205 (8.7)	1.06 (0.92-1.23)	
Marital Status, no. (%)				0.84
Single, not living with a partner	980 (55.8)	1316 (56)	1.00 (ref)	
Single, living with partner	429 (24.4)	596 (25.4)	0.98 (0.86-1.12)	
Married	290 (16.5)	365 (15.5)	1.04 (0.87-1.24)	
Widowed/Divorced/Separated	58 (3.3)	71 (3.0)	1.05 (0.87-1.26)	
Perception of HIV Risk				<0.01
Not at all likely	230 (37.4)	405 (37.1)	1.00 (ref)	
Somewhat likely	192 (31.2)	398 (36.4)	0.90 (0.83-0.98)	
Highly Likely	145 (23.6)	237 (21.7)	1.05 (0.99-1.11)	
Don't know	48 (7.8)	53 (4.8)	1.31 (1.06-1.62)	
Regular sexual partners in the past year [d]				0.59
0	661 (38.1)	898 (38.6)	1.00 (ref)	
1	385 (22.2)	568 (24.4)	0.95 (0.83-1.09)	
2+	688 (39.7)	861 (37.0)	1.05 (0.80-1.37)	
Casual sexual partners in the past year [d]				0.05
0	691 (40.1)	1012 (43.6)	1.00 (ref)	
1+	1033 (59.9)	1308 (56.4)	1.09 (1.03-1.15)	
Condom use with casual partners last 12 months				<0.01
100% of the time	507 (49.9)	560 (43.4)	1.00 (ref)	
Less than 100% of the time	509 (50.1)	731 (56.6)	0.86 (0.81-0.92)	
Sex worker partners in the past year [d, e]				0.54
0	809 (47.5)	1125 (49.1)	1.00 (ref)	
1+	895 (52.5)	1166 (50.9)	1.04 (0.93-1.16)	
Incorrect condom use as a result of drinking last 12 months				0.19
Yes	330 (21.3)	433 (20.6)	1.00 (ref)	
No	1221 (78.7)	1667 (79.4)	0.98 (0.95-1.00)	

Table 4.2: Bivariate associations with current HIV status awareness among high HIV risk military personnel in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020, Continued

	Current HIV Status Awareness			
	Yes n^ (%)	No n^ (%)	Prevalence Ratio (95% CI)	p-value
Eastern/Southern Africa [c]				
Unintended sex as a result of drinking last 12 months				0.03
Yes	285 (18.3)	422 (20.0)	1.00 (ref)	
No	1271 (81.7)	1684 (80.0)	1.07 (1.02-1.12)	

^ Weighted based on military size

[a] Burundi 2017, Cameroon 2018, Chad 2014, Gabon 2018, Benin 2017, Burkina Faso 2018, Ghana 2016, Guinea Conakry 2019, Liberia 2017, Sierra Leone 2013, Angola 2015, Ethiopia 2018, Malawi 2018, Mozambique 2016, Eswatini 2020, and Lesotho 2017

[b] Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone

[c] Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho

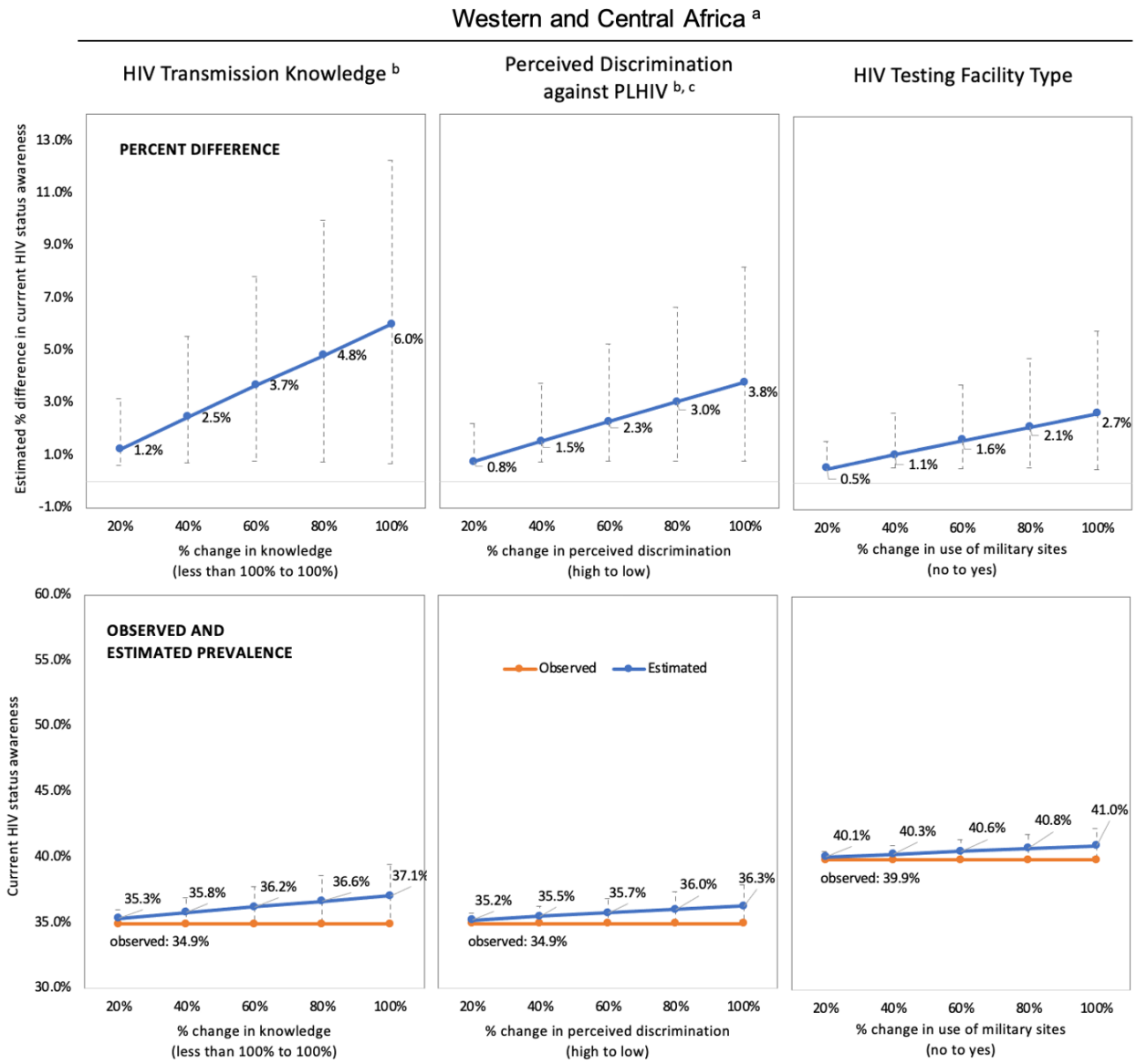
[d] Only includes those who reported lifetime sexually activity, data from Angola was partners in last 6 months

[e] Data not available for Sierra Leone

Table 4.3: Prevalence ratios for HIV status awareness among high HIV risk military personnel in sub-Saharan Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020

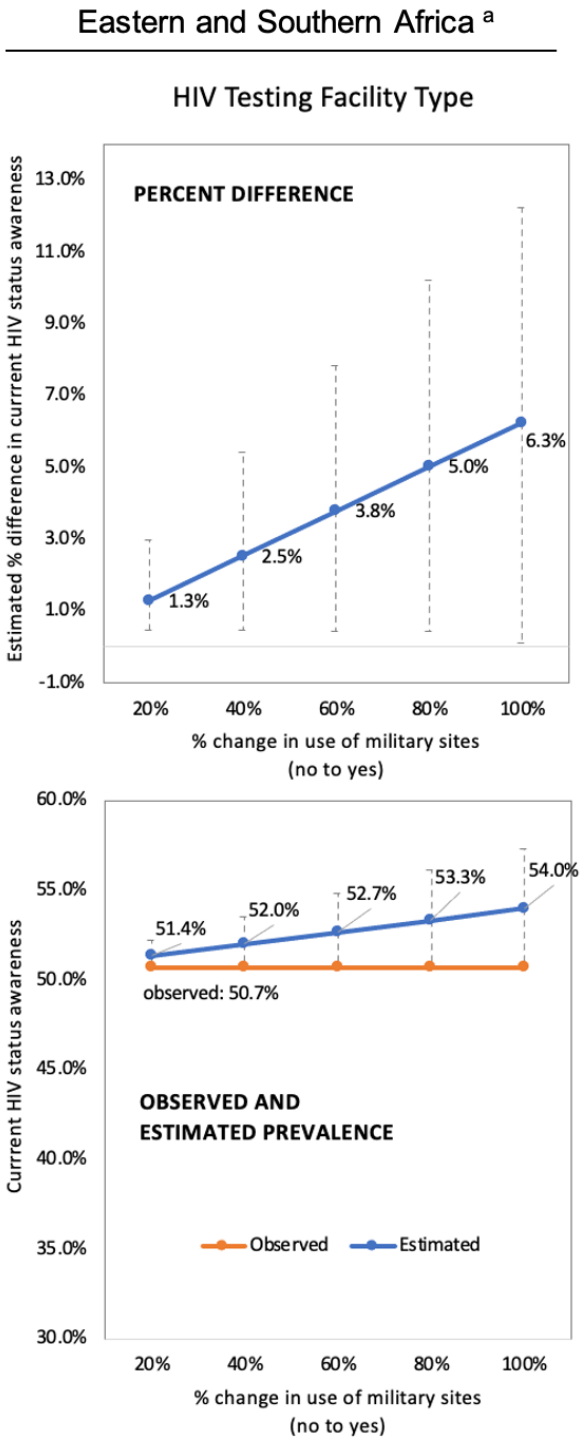
		Current HIV Status Awareness (yes)		
Region	Factor	Prevalence Ratio	95% CI	p-value
Sub-Saharan Africa	Correct HIV transmission knowledge [a]	1.09	1.04-1.15	<0.01
	Low negative attitudes towards PLHIV [a, b]	0.99	0.74-1.32	0.93
	Low perceived discrimination against PLHIV [a, c]	1.11	1.04-1.19	<0.01
	Use military sites for HIV testing	1.29	1.21-1.38	<0.01
Western/Central Africa	Correct HIV transmission knowledge [a]	1.18	1.11-1.26	<0.01
	Low negative attitudes towards PLHIV [a, b]	1.13	0.71-1.80	0.60
	Low perceived discrimination against PLHIV [a, c]	1.17	1.08-1.27	<0.01
	Use military sites for HIV testing	1.17	1.08-1.26	<0.01
East/Southern Africa	Correct HIV transmission knowledge [a]	0.98	0.91-1.06	0.70
	Low negative attitudes towards PLHIV [a, b]	0.90	0.63-1.27	0.54
	Low perceived discrimination against PLHIV [a, c]	0.94	0.83-1.07	0.36
	Use military sites for HIV testing	1.58	1.39-1.80	<0.01

[a] adjusted for age and education
[b] Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone
[c] Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho



[a] Burundi, Cameroon, Chad, Gabon, Benin, Burkina Faso, Ghana, Guinea Conakry, Liberia, and Sierra Leone
[b] adjusted for age and education
[c] Data not available for Chad and Sierra Leone

Figure 4.2: Estimated percent difference and observed and estimated prevalence in current HIV status awareness with percent change in HIV transmission knowledge, perceived discrimination against PLHIV, and HIV testing facility type among high HIV risk male military personnel in Western and Central Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020



[a] Angola, Ethiopia, Malawi, Mozambique, Eswatini, and Lesotho

Figure 4.3: Estimated percent difference and observed and estimated prevalence in current HIV status awareness with percent change in HIV testing facility type among high HIV risk male military personnel in Eastern and Southern Africa, Seroprevalence and Behavioral Epidemiology Risk Survey 2013-2020

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CHAPTER 5: DISCUSSION AND CONCLUSION

Overview

Men in sub-Saharan Africa (SSA) are a priority population in the current strategy to end AIDS.[1] Increasing HIV status awareness among men in SSA is the critical first step in the continuum of care and to realizing the full impact of treatment as prevention. Achieving the global goal to end AIDS by 2030 requires meeting the '95-95-95' testing and targets among all populations. This dissertation aimed to improve knowledge on HIV and evaluate potential impacts of interventions among a unique sub-population of men in SSA, military personnel. First, comparisons of HIV prevalence and related indicators were made between men in the military and general population to identify gaps in knowledge, attitudes, and behaviors. Second, associations of HIV status awareness and related indicators among men in the military were assessed to identify potential points of intervention for military-sponsored HIV programs. Last, the estimated impact of interventions to increase HIV status awareness among men at high-risk of acquiring HIV in the military were modelled to inform the highest probable impact methods and help direct finite resources.

The primary data source for this dissertation was the SABERS. The SABERS is uniquely positioned to study HIV among military personnel as it is the only population-based study on military personnel conducted across multiple countries. While the SABERS focuses on HIV and related knowledge, attitudes, and behaviors, they are only powered to estimate HIV prevalence, potentially limiting the ability to detect other associations within individual studies. Combining SABERS increased study power as well as generalizability of results across larger regions. As the SABERS uses standardized methods and data collection tools, the limitations and potential biases

related to combining across studies often cited with meta-analyses are reduced. However, combining across studies did remove the ability to observe and discuss potential differences between countries within regions. Substantial time and effort were required to combine the twenty SABERS included in this dissertation. Data dictionaries from each study, originally implemented in several different languages, had to be reviewed, organized, compared, and standardized to determine availability of data across all the studies. After variables for use in this dissertation were determined, each dataset had to be recoded and checked against original data to combine for use in analyses. The organization and combination of the SABERS datasets represented approximately a third of the time required to complete this work.

Comparisons to the General Population

The current study found the prevalence of HIV was over twice as high among men in the military compared to the general population in the Western and Central Africa region (2.7% vs 1.3%, $p<0.01$). These results support findings from previous studies on HIV being higher among the military versus the general population.[2,3] This study further found no difference in HIV prevalence was observed between men in the military and general population for the Eastern and Southern Africa region (10.6% vs 9.0%, $p=0.73$). While HIV is a generalized epidemic in SSA, in Western and Central Africa the rates of incident HIV infections were similar between clients of sex workers/partners of key populations and in non-key populations in 2019.[4] In contrast, in Eastern and Southern Africa most incident HIV infections were among non-key populations. Higher risk-sexual behaviors, such as sex with sex workers who are commonly present around military bases,[5] may be elevating the risk of HIV infection

among personnel in Western and Central Africa compared to the general population but not in Eastern and Southern Africa. Additionally, state-based conflicts, where military personnel are commonly deployed, can destabilize HIV care and treatment among local populations increasing transmission rates potentially impacting military personnel with sexual mixing.[6] These conflicts have been more frequent in Western and Central Africa compared to Eastern and Southern Africa in the recent past.[6,7] This dissertation's findings demonstrate the importance of potential regional differences in the HIV epidemic and transmission patterns when considering programmatic strategies among the military. While regional differences were observed, findings should be generalizable among countries within these regions as HIV and related behaviors are not bound within borders and adjoining countries would be expected to share similar epidemics.

HIV transmission knowledge was greater among men in the military compared to the general population in both the Western and Central Africa region (58.9% vs 31.7%, $p<0.01$) and the Eastern and Southern Africa region (56.2% vs 39.7%, $p=0.01$). However, there was no difference in condom-use with non-regular partners and discriminatory attitudes towards people living with HIV (PLHIV) between men in the military and the general population. Militaries across SSA have established HIV-programs providing testing, treatment, and care as well as education for their personnel with support from the United States Department of Defense HIV/AIDS Prevention Program.[8] The higher level of HIV transmission knowledge may reflect successful education campaigns implemented by these programs. Yet, greater use of condoms with non-regular sex partners and lower discriminatory attitudes towards PLHIV were not observed among the military. These data suggest that current HIV programs have

not been effective at translating knowledge to behavior and attitude change. This is supported by a study among the Botswana Defense Force where 91% of personnel agreed condoms were effect at preventing HIV infection but 70% had multiple sexual partners and only half used condoms.[9]

Military education campaigns should consider adapting proven interventions to increase condom use and decrease discrimination among their personnel. Programmatic efforts aimed at primary prevention of HIV infection are important to help HIV-negative personnel maintain their negative serostatus, especially at key points of potential exposure such as during deployment. HIV prevention is important to the health of military personnel and force readiness as well as to the general population among whom the military is deployed.

Associations with HIV Status Awareness

Prevention of HIV infection through treatment of PLHIV is a key tool in the strategy to end AIDS.[1] Sustained anti-retroviral therapy (ART) substantially reduces AIDS-related morbidity and mortality, allowing personnel to continue serving, and prevents onward transmission through viral suppresion.[10] HIV status awareness among military personnel is the first step to getting PLHIV on treatment.

HIV status awareness among men in the military in Western and Central Africa was lower among those with low HIV transmission knowledge (PR 0.87), high perceived discrimination (PR 0.90), and who did not use military facilities for HIV testing (PR 0.86). While there were no other known studies on HIV status awareness among military personnel in SSA, multiple studies among the general population support these findings. In studies among men in Ethiopia, South Africa, and Lesotho, greater HIV

knowledge was associated with ever being tested for HIV.[11-13] A systematic review on HIV testing in SSA found stigma was reported in association with HIV testing uptake in multiple studies and was frequently reported as the strongest barrier.[14] Facility accessibility has been reported as a barrier to HIV testing among men in multiple studies in SSA due to work schedules conflicting with hours of availability, long wait times, and travel distance.[15] A qualitative study among men in Uganda found these commonly reported barriers were overcome by providing workplace based self-testing.[16]

None of the indicators (HIV knowledge, negative attitudes, perceived discrimination, or testing facility location) were associated with HIV status awareness among men in the military in Eastern and Southern Africa. These observed regional variations may be driven by differences in current level of HIV status awareness and testing uptake between Western/Central Africa and Eastern/Southern Africa. HIV status awareness among PLHIV in Western and Central Africa in the general population was only 68% compared to 87% in Eastern and Southern Africa in 2019.[4] Known indicators may be significant in countries with less general population status awareness among PLHIV but are not strong enough in countries with higher levels of status awareness. As we approach the '95-95-95' testing and treatment targets, identifying these remaining individuals in need of testing is anticipated to become more costly and challenging.[17]

To increase HIV status awareness among men, militaries in Western and Central Africa should consider implementing interventions targeting HIV transmission knowledge, perceived discrimination against PLHIV, and use of provided military facilities for testing. Additional study is needed among militaries in Eastern and Southern Africa to identify potential facilitators and barriers to status awareness.

Estimated effects of interventions to increase HIV status awareness

Identifying the remaining men living with HIV will become more challenging and costly as we approach epidemic control.[17] Men at higher risk of HIV infection, based on behavior, are likely to have a higher HIV positivity rate.[18] Targeting military personnel at higher risk of HIV infection for increasing status awareness should therefore more efficiently use finite resources to achieve '95-95-95' by 2030.

In Western and Central Africa among men in the military at higher-risk of acquiring HIV, current HIV status awareness was associated with HIV transmission knowledge, perceived discrimination, and use of military facilities for testing. Counter-factual models estimating the population difference in status awareness showed improving HIV transmission knowledge would have the greatest estimated effect, with a 6.0% increase in status awareness if all personnel had correct knowledge. The estimated population difference in HIV status awareness was 3.8% higher if all personnel had low perceived discrimination and 2.7% higher if all personnel used military testing facilities. In Eastern and Southern Africa, only use of military facilities was associated with status awareness. The estimated population difference in HIV status awareness among high-risk men in the military in Eastern and Southern Africa was 6.5% higher if all personnel used military facilities for testing. Again, regional differences in significant factors associated with HIV status awareness may be related to the proportion of individuals in need of increased testing which is larger in Western and Central Africa compared to Eastern and Southern Africa based on general population progress towards the '95-95-95' testing and treatment targets.[19]

Interventions on HIV knowledge, stigma reduction, and providing workplace-based HIV testing have demonstrated success in increasing HIV testing uptake (and thereby HIV status awareness) among other populations in Africa. A pilot randomized trial among men in Rwanda showed an HIV health education program improved HIV knowledge and testing uptake.[20] The education program included components on getting tested and living with HIV and should also be considered an important part of an effective intervention on HIV knowledge to increase testing. Additionally, other interventions implemented to increase HIV knowledge among men were found to be most effective when driven by other men.[21] Multiple studies on reducing stigma have also been shown to increase testing uptake.[22] Programmatic efforts to address stigma and discrimination should understand the many potential stigma-related barriers to testing among their personnel to develop a successful strategy. The potential impact on HIV testing uptake with workplace-based options was demonstrated in a randomized control trial in Zimbabwe where testing uptake was 2.8 times higher among men with on-site workplace testing compared to those that were provided a voucher to go off-site.[23]

CONCLUSIONS

This dissertation provided important data to military health programs across SSA with the first regional summaries of HIV related knowledge, attitudes, and behaviors as well as current HIV status awareness. The availability of these data mean militaries can better identify their programmatic successes and points for strengthening. Several overall recommended priorities for military-sponsored HIV programs for primary

prevention of HIV and HIV status awareness among active-duty men were identified. HIV knowledge was higher among men in the military compared to the general population suggesting education programs have been effective but improvements in condom-use and reduction in discriminatory attitudes are needed as part of primary prevention efforts. These considerations are particularly important in Western and Central Africa where the HIV prevalence was over twice that of the general population. HIV status awareness is essential to maintaining health and force readiness, preventing transmission of HIV by men in the military, and achieving epidemic control. HIV transmission knowledge, perceived discrimination, and use of military facilities for testing were identified in association with HIV status awareness. However, estimated effects of interventions on these factors to increase HIV status awareness among men at higher risk of HIV infection, while significant, showed minimal impact indicating additional intervention is needed beyond those identified in this dissertation. Informing HIV programs that serve men in the militaries of SSA is important to the health and well-being of this unique sub-population, achieving HIV epidemic control in Africa, and reaching the global goal to end AIDS.

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APPENDIX A: STIGMA AND DISCRIMINATION SCALES

Negative Attitudes

People living with HIV should be ashamed

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People who have HIV are cursed

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People living with HIV deserve to be punished

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

Families of people living with HIV should be ashamed

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

It is reasonable for your military to discharge people who have HIV

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People who have HIV are disgusting

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People with HIV should be isolated from other people

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People living with HIV should not have the same freedoms as other people

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

Perceived Discrimination

People living with HIV in this military face neglect from their family

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People living with HIV in this military face physical abuse

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People living with HIV in this military face ejection from their homes by their families

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

Most people would not buy vegetables from a shopkeeper or food seller that they knew had HIV

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People who are suspected of having HIV lose respect in the military

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People living with HIV in this military face rejection (not socially accepted) from their peers

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)

People living with HIV in this military face verbal abuse or teasing

Strongly agree (1)

Agree (2)

Disagree (3)

Strongly disagree (4)