CHARACTERIZING THE SAUTI vAGYW HIV RISK ASSESSMENT TOOL TO MEASURE VULNERABILITY OF ADOLESCENT GIRLS AND YOUNG WOMEN IN TANZANIA

by
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Abstract

**Background:** Improved strategies to address the disproportionate burden of HIV in adolescent girls and young women (AGYW) remains as a crucial component of an effective HIV response. To best serve AGYW with personalized, evidence-based HIV intervention packages, validated risk stratification tools are needed. The aim of this study was to characterize the reliability and validity of the Sauti vAGYW HIV risk assessment tool using exploratory factor analysis.

**Methods:** A 20-item scale was developed and administered to 6,526 out-of-school AGYW aged 15-24 in five regions of Tanzania August 2015 to June 2016. Exploratory factor analysis was used to assess the underlying construct of HIV vulnerability among AGYW. Factors were extracted based on Kaiser’s criterion, eigenvalues, scree plots, Horn’s test, and interpretability. Items were included if the factor loadings were within the range of 0.3 and 0.9 with no cross-loadings. Cronbach’s alpha, item-rest and item-test correlations were used to test reliability of the scale. Construct validity was assessed using point-biserial correlations and multivariate logistic regression between the scale and HIV-related health outcomes.

**Results:** Twelve items were retained in the final scale, representing three factors. Cronbach’s alpha of the overall scale and Factor 1 were 0.76 and 0.72, respectively, suggesting high internal consistency. Factor 2 (α=0.47) and Factor 3 (α=0.65) had relatively lower Cronbach’s alpha, potentially influenced by the small number of items loaded onto these factors. The item-test correlations of the twelve items ranged from 0.40 to 0.63, whereas the item-rest correlations ranged from 0.26 to 0.52. Risk scores were
significantly associated with history of HIV test, history of childbirth, and the use of alcohol during sex in the past 30 days. The odds of having ever taken an HIV test (OR: 2.04; 95% CI: 1.40, 2.98), given birth to a child (OR: 1.50; 95% CI: 1.01, 2.22), and use of alcohol when having sex in the past 30 days (OR: 2.57; 95% CI: 1.13, 5.85) were significantly higher comparing the very high risk group to the low risk group. However, the associations with other risk levels did not reach the level of statistical significance.

**Conclusions:** The Sauti vAGYW HIV risk assessment tool reliably stratifies out-of-school AGYW in Tanzania based on individual and structural HIV risks. Scaling implementation of this risk stratification tool may support better HIV prevention specification ranging from enhanced counseling and education to HIV pre-exposure prophylaxis.

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Chapter 1: Introduction

1.1 Background of HIV/AIDS:

Human immunodeficiency virus (HIV) is a single-stranded RNA virus that is transmitted through blood and other bodily fluids, such as semen, vaginal discharge, and breast milk. It belongs to the retrovirus family that uses a unique type of enzyme, called reverse transcriptase, to reverse transcribe their proviral RNA to DNA. This DNA is then transported to the nucleus and integrated into the host genome for viral replication. The main target of HIV is the CD4 T-helper cell that plays a critical role in activating the adaptive immune response against foreign pathogens. The rapid decline in the CD4 count caused by HIV infection induces acquired immune deficiency syndrome, also known as AIDS, which makes the infected individuals highly susceptible to other bacterial or viral infections.

Since the first outbreak in the 1980s, more than 35 million people have died from HIV-related diseases, such as Pneumocystis carinii pneumonia (PCP) and other invasive cancers, including Kaposi’s Sarcoma (KS) (1–4). In 1985, one of the first line anti-retroviral drugs, called zidovudine (AZT), was discovered (5). It blocks the function of reverse transcriptase by using the modified nucleosides that have greater affinity than the human nucleosides. Because these modified nucleosides lack a hydroxyl group on the 3’ end, it prevents further DNA elongation. Zidovudine is particularly important in preventing mother-to-child transmission, as it is used as a primary anti-retroviral drug given to the HIV-exposed, uninfected infant during childbirth (6). There are six classes of anti-retroviral drugs that are currently available, which include NRTIs, non-nucleoside
reverse transcriptase inhibitors (nNRTIs), protease inhibitors (PIs), integrase strand transfer inhibitors (INSTIs), fusion inhibitors, and entry inhibitors (CCR5s). Once diagnosed with HIV, people receive anti-retroviral therapy (ART) that combines two or more classes of drugs. While, these HIV regimens do not cure people living with HIV, they can effectively slow down the progression of HIV infection and improve the longevity of HIV-infected individuals (5).

With the global movement to address the HIV epidemic around the world, anti-retroviral therapy has been successfully implemented in various settings. In 2015, over 17 million HIV-infected individuals were on treatment, which is a 14% increase from 2014 (7). Increased availability of ART has reduced AIDS-related deaths by 43% since the first global treatment target was made in 2003. It has also decreased various co-morbidities among individuals who are living with HIV around the world (8).

Despite the success in the scale-up of ART, challenges still remain. Reverse transcriptase lacks the proofreading mechanism (5,9). This error-prone virus proliferation allows rapid mutations in the genetic materials of HIV, which leads to drug resistance (9). A study published in 1998 estimated that all possible single point mutations, and even double mutations, could be observed on a daily basis if 100 million cells were newly infected daily (10).

Latent HIV infection provides another layer of challenges for eradication of the virus. Many studies have shown that a small quantity of HIV particles become dormant inside the resting memory CD4+ T cells soon after the infection, establishing a latent reservoir (8,11,12). The latently infected cells do not express viral proteins on the cell
surface, which allows them to escape from the host’s immune system. The HIV reservoirs are often so stable that viral particles can persist inside these cells for an extended period time without going through viral replication (9,11,12). Although there are a few drugs that target free floating viruses, a majority of existing drugs target HIV when it is actively proliferating (8,11,12). Therefore, the presence of latent reservoirs hinders our ability to effectively remove all viral particles from the body (8,9). To better target these HIV reservoirs, many researchers have focused on developing strategies to either reactivate the HIV particles hidden in latent reservoirs or permanently suppress them from reactivating in the future (13,14). In recent years, the “Shock and Kill” approach has received much attention from the science community for its potential to eradicate HIV reservoirs in the host (15,16). This new therapeutic approach aims to “awaken” the dormant HIV particles in the latent reservoirs and induce viral transcription so that our immune system can recognize and kill the infected cells. However, more research is needed to understand its exact mechanism, as well as its efficacy and safety (15,17–19).

1.2 HIV/AIDS in Adolescent Girls and Young Women

Despite the ongoing effort to reduce the global burden of HIV, adolescent girls and young women aged 15-24 years continue to face disproportionately high incidence and prevalence of HIV. In 2015, they accounted for 20% of all new infections globally, which was 6% greater than the number of infections occurred in their male counterparts (7). The difference is more prominent in HIV endemic areas. In sub-Saharan Africa, for instance, adolescent girls and young women experience over two-fold higher incidence of HIV compared to their male peers across all regions (7).
Almost 80% of HIV-infected young women aged-15-24 years live in sub-Saharan Africa, where they, on average, acquire HIV 5-7 years earlier than men (20). This sex-disparate burden of HIV is attributable to a variety of gender-specific factors. Several studies have suggested that, physiologically, women might be more susceptible to sexually transmitted diseases than men. This is due to the relatively large surface area of the vaginal wall made up of thin mucous membrane, which allows the easy passing of viruses and bacteria (21–24). The ulcers and inflammation caused by sexually transmitted infections (STIs) significantly increase the efficiency of HIV transmission among women (25,26).

Despite the potential link between the biological characteristics and increased susceptibility to HIV, the sex-disparate incidence and prevalence are mainly driven by other individual-level factors that enhance young women’s vulnerability to HIV acquisition. Data have consistently shown that women’s age at coital debut and duration of sexual experience could be indicative of other sexual risks for HIV infection (27–29). In resource-limited communities, women who initiated sex at an early age were more likely to engage in various sexual risk-taking behaviors, such as condomless vaginal or anal sex, concurrent partnerships, and having multiple sexual partners (27,30–35). These behavioral factors were also found to be highly associated with increased incidence of HIV and other STIs, such as herpes simplex virus and human papillomavirus (29,36).

Until recently, primary HIV prevention programs supporting adolescent girls and young women have mainly focused on the individual-level interventions that promote increased knowledge in sexual reproductive health, delayed coital debut, and frequent condom use (35,37). However, these behavioral change programs often failed to take into
consideration the broader social and economic contexts of young women’s lives that influence their decision to engage in various high-risk sexual activities. Several studies have suggested that there is an underlying causal pathway link between individual behaviors and structural factors that strongly influences one’s risk and vulnerability to HIV (37–39). In many countries, poverty is a big challenge in HIV prevention. Especially in high HIV burden areas, a higher proportion of children may lose either one or both of their parents to HIV-related diseases (40). AIDS orphans experience increased financial burden and food insecurities, which lead them to engage in HIV-related risk behaviors, such as alcohol or substance abuse, condomless sex, and early marriage (30,35,40–46).

The poverty-driven HIV risks are not unique to orphaned children. It has been observed in multiple studies that adolescents living in poor households experience a high rate of school dropout due to the need to support their family financially or materially (30,40,47,48). Their low levels of education, however, place them at a disadvantage in terms of employment. Often, they have to take on low-paying jobs that are rather labor intensive (40). Due to the limited employment opportunities, many young women, including non-orphaned adolescent girls, begin seeking out transactional sexual relationships with older men who can provide them financial support or increased social status (40,43).

Negative health implications of transactional sex have been well documented in the literature. Studies conducted in South Africa showed that transactional sex was highly associated with HIV infection after adjusting for lifetime number of sexual partners and age at coital debut (49,50). This is mainly due to women’s financial dependence on men,
which hinders their ability to negotiate for monogamy or condom use in both casual and committed relationships. Gender inequalities that exist in this type of sexual relationships further exacerbate girls’ vulnerability to HIV infection. Studies have found that women who engaged in transactional sex were more likely to have experienced sexual violence, gender-based violence, and substance abuse (41,42,49,51).

The HIV epidemic among adolescent girls and young women is complex and often compounded by multifaceted vulnerabilities across individual, social, and structural levels. To better address the urgent needs of adolescent girls and young women outside the healthcare settings, the United States President’s Emergency Plan for AIDS Relief (PEPFAR) launched the Determined, Resilient, Empowered, AIDS-free Mentored, and Safe Women (DREAMS) initiatives in 2014, in collaboration with the Bill & Melinda Gates Foundation, Girl Effect, Johnson & Johnson, ViiV Healthcare, Gilead Sciences (52). The DREAMS core intervention packages include both social and biomedical protection programs that promote gender equality and women’s empowerment. These packages aim to address root causes of HIV epidemic in this population by delivering comprehensive intervention services, including increased access to HIV testing and counseling, family planning and gender-based violence services, and social asset building (53).

One of the services that the DREAMS initiatives began providing recently is pre-exposure prophylaxis (PrEP). PrEP is an antiretroviral medication that is developed to prevent HIV infection among sero-negative individuals. In many countries in sub-Saharan Africa, women often do not have control over engaging safer sex activities due
to the power imbalance in their relationships shaped by gender inequalities and gendered social norms (30,35,40–43,46,48). Several studies have found that young girls are particularly more vulnerable to coerced sex and intimate partner violence (47,48,54). To better address this issue, implementation of PrEP is critical as it allows women to initiate HIV prevention without depending on their male partners (34,55).

In 2015, the World Health Organization published a new guideline that recommends daily dose of PrEP, containing tenofovir disoproxil fumarate (TDF), to all high-risk populations (56,57). The Food and Drug Administration (FDA) also approved a daily dose of Truvada consists of 300 mg of TDF co-formulated with 200 mg emtricitabine (FTC), which has shown high efficacy in heterosexually active adults, men who have sex with men, and transwomen (58)(59–61). Currently, a variety of PrEP formulations, such as topical microbicides and vaginal rings, are being tested for their efficacy and safety (34,55). Of those, self-inserted vaginal ring containing dapivirine has shown promising results, reducing HIV incidence in the intervention arm by 31% (62–64).

The cash transfer program is another service that is provided by the DREAMS initiatives. They aim to reduce the number of new HIV infections in young girls by reverting their social and economic vulnerabilities. Although the program impact has shown to vary in their robustness due to the differences in multilevel vulnerabilities reflected in a localized group of risk factors, many studies have found promising results in mitigating HIV-related health outcomes in different settings. For instance, a cluster randomized controlled trial conducted in Kenya showed that cash incentive programs
significantly decreased the rate of teen pregnancy by five percentage points (65). Another study also found that cash/cash-in-kind programs effectively reduced adolescent girls’ overall HIV risk by mitigating the effect of social and psychosocial factors on their HIV risk behaviors (66).

Given the complex nature of young women’s vulnerability to HIV risk, combination prevention that incorporates biomedical, behavioral, and structural-level interventions is highly needed (37,39). Additionally, HIV prevention models must be structured and implemented in a way that is sensitive to the context of each setting. Strategic planning and implementations of various services provided by the DREAMS initiatives in high burden areas would allow us to effectively reduce HIV transmission among adolescent girls and young women.

1.3 Instruments to Identify Most Vulnerable Young Women

To better tailor existing prevention interventions, a number of vulnerability indices have been developed. In 2013, the UNICEF created the Adolescent Girls Multilevel Vulnerability Index (AGI) to measure HIV vulnerability among girls aged 10-19 years in Uganda (67). By using a range of individual, community, and structural-level indicators, they aimed to directly estimate the proportion of vulnerable girls across the country and help guide the implementation of region-specific interventions (67). The Vulnerable Girls Index (VGI) and Supportive Community Index (SCI), on the other hand, aimed to assess structural vulnerability attributes of adolescent girls aged 10-17 years in Eastern and Southern Africa by analyzing their orphan-hood and household composition (68). Several other scales are also available to measure both empiric and perceived
vulnerability to HIV infection among women of reproductive age in different settings (69,95).

Despite the growing body of risk assessment literature, data on how various layers of HIV risk interrelate with one another are scarce. There is a gap in the literature on whether there are distinct patterns of determinants across individual, community, and structural level that expose young women to different levels of HIV vulnerability. In order to create personalized, evidence-based intervention packages, we need to develop vulnerability profiles of young women using psychometric methodologies. This would then allow us to identify girls who are at highest risk of HIV acquisition and guide them to appropriate intervention services to mitigate their risk of HIV acquisition.

1.4 Study Objectives

Tanzania is one of the ten sub-Saharan countries that are implementing the DREAMS initiatives. Approximately 1.4 million people are currently living with HIV, with HIV prevalence ranges from 1.5% to 14.8% across the country (71). In February 2015, the USAID awarded Jhpiego a five-year funding to implement the Sauti Program in Tanzania. The program’s main objective is to improve the overall well-being of adolescent girls and young women by reducing HIV transmission through comprehensive, evidence-based HIV prevention and treatment packages. To maximize the programmatic impact in the country, the Sauti-TZ program adapted the existing indices and developed a new HIV risk assessment tool that is specific to adolescent girls and young women aged 15-24 years.
The aim of this study is two-fold:

**AIM 1:** To characterize the reliability and validity of the Sauti vAGYW HIV risk assessment tool using exploratory factor analysis.

**AIM 2:** To assess the predictive value of the Sauti vAGYW HIV risk assessment tool for HIV infection and other secondary parameters of HIV risk to help guide age-appropriate, population specific program implementation.
Chapter 2: Methods

2.1 Psychometric Methods for Scale Development

Scales are one of the most widely used instruments for data collection in psychosocial studies. They are often used to assess underlying constructs, such as attitudes, perceptions, and other psychological characteristics, that are generally not directly observable. In scales, we include a set of observed items that, in the aggregate, presumably reflect these latent variables. By assessing common covariation among these items, we can indirectly infer the relationship and magnitude of these underlying latent phenomena (72).

In scale development, a series of validity assessments could be conducted to ensure that the scale is measuring what is designed to measure. First, face validity evaluates how valid the observed indicators, also known as items, seem to appear on the surface. It requires a logical reasoning to examine if indicators in the scale seem to belong in the domain of interest (73). Content validity, on the other hand, measures how well the selected indicators in the scale represent all possible variables of a specified content domain. It is often assessed through the conceptual definition of constructs, literature reviews, and interviews with the experts in the field (72). After completing the assessments of face validity and content validity, researchers could further evaluate the validity of a scale through construct validity. Construct validity involves assessing the fit of empirical correlations between observed indicators in the nomological network or theory one has established (72).
Factor analysis is a common psychometric method that is used in scale development, which allows us to assess a scale’s dimensionality that is reflected in a set of items based on inter-item correlations (74). A scale can be either unidimensional or multidimensional. In a unidimensional scale, all items may be correlated with each other to reflect a single common latent variable. In a multidimensional scale, on the other hand, items group into two or more factors that reflect multiple latent variables. Unlike unidimensional scales, multidimensional scales allow us to further assess the correlations between these latent variables and see whether they reflect a deeper common underlying construct. Factor analysis is also useful when identifying items that have a similar magnitude of associations with latent variables. It allows us to remove any redundancy in the correlated variables (72).

There are two types of factor analysis: exploratory factor analysis and confirmatory factor analysis. Since our primary objective was to explore the data to characterize underlying latent variables that are associated with vulnerability to HIV risk among adolescent girls and young women, exploratory factor analyses was the primary method used in this study.

2.2 Definition of Vulnerability

For the purpose of this study, vulnerability is defined as a multilevel conceptual framework that includes a range of individual, cultural, structural, and economic factors, which influences the level of susceptibility to HIV infection among adolescent girls and young women aged 15-24 years (75,76).
2.3 Item generation

Indicators related to vulnerability to HIV risk were selected based on several factors. First, a literature search was conducted to extract indicators for teen pregnancy and incidence of HIV and STIs among adolescent girls and young women aged 15-24 years. In conjunction, existing vulnerability scales, such as Vulnerable Girls Index (GI) indicators, Supportive Community Index (SCI) indicators, and Adolescent Girls Index (AGI), were reviewed to select indicators that are relevant to the Tanzanian context. Following the literature review, a multidisciplinary team, representing the Tanzanian government, the Centers for Disease Control and Prevention (CDC), the Joint United Nations Programme on HIV/AIDS (UNAIDS), the United Nations International Children’s Emergency Fund (UNICEF), and both local and international non-profit organizations, were assembled at a stakeholder consultation in May 2015 in Tanzania. As experts in HIV research on key populations, adolescent health, gender studies, and economic development, they reviewed evidence for each indicator in the context of Tanzanian culture. Throughout this process, items were dropped or reworded for clarity. After finalizing the instrument, it was translated into Kiswahili and pilot-tested with 600 adolescent girls and young women in local clinics in Dar es Salaam.

The vAGYW HIV risk assessment tool consisted of 20 items across five domains (Table 1). Each item was assigned with a score ranging from 0 to 3, with 3 representing the highest level of vulnerability for that specific item. After completing the tool, a cumulative risk score was calculated manually to determine the level of vulnerability of each participant. Based on the score, participants were categorized into four different risk
groups: low, middle, high, and very-high. The tool also contained three maximum risk questions at the end. If a participant answered yes to any of these three questions, she was automatically assigned to the very-high risk group. These questions were: “Did you have three or more concurrent partners in the past 12 months?” “Did you exchange sex for goods in the past 12 months?” and “Did you exchange sex for cash in the past 12 months?” For the purpose of this study, these three maximum risk questions were excluded in the analysis.

2.4. Study Populations

Our analysis utilized two different datasets that were collected by Jhpiego’s Sauti-TZ program: index data and routine health program screening data. Index data were used to characterize psychometric properties of our instrument. To assess its predictive validity, index data were merged with routine health program screening data.

INDEX DATA

Data were collected between August 2015 and June 2016 in Dar es Salaam, Iringa, Mbeya, Njombe, and Shinyanga, Tanzania. Adolescent girls and young women aged 15-24 years were screened and enrolled into the study from different study sites. These included routine mobile community-based HTC+ service centers, drop-in centers, venue-based (i.e. bars, guest houses, salons, market places) community mobilization activities, and behavior change and communication (BCC) activity centers. Index data were also collected from other Sauti health-related services, including women’s empowerment programs (WORTH+). In order to better assess the vulnerability profile of
adolescent girls and young women, only those who were not enrolled in school at the time of recruitment were enrolled into the study. The selection criteria for out-of-school was borrowed from the DHS survey, which defined it by attending less than 10 days of school in the past three months (71). Once recruited into the study, trained peer educators, community health promoters, and empowerment workers administered the risk index to determine participants’ HIV vulnerability levels.

**HEALTH SCREENING DATA**

Data were collected using a health screening survey, which was completed by all clients who received Sauti’s services. The questionnaire covered a wide range of topics that included socio-demographic indicators, nutritional status, Body Mass Index (BMI), sexual behaviors, alcohol/drug consumptions, sex work, gender-based violence, TB screening, STI/HIV screening and testing, and family planning use.

2.5. Statistical Analyses

First, duplicate entries and records with missing data in more than four items were excluded from our analysis (Figure 1). For exploratory data analyses, frequency distributions of study participant’s baseline socio-demographic and sexual behavioral characteristics were described using summary statistics. Then, a Kaiser-Meyer-Olkin index was performed to test the sampling adequacy of the model for factor analysis (77).

For exploratory factor analysis, iterative principal factor analysis with promax oblique rotation was employed to describe the underlying latent construct (78). As items were coded as categorical variables, polychoric correlation matrices were used to
estimate the degrees of associations between observed variables \( (79) \). The number of factors retained in the final scale was selected based on Kaiser’s criterion \( (77) \), eigenvalues, scree plots, Horn’s test, and interpretability \( (80, 81) \).

After rotation, factor loadings of all items were compared. Items were included in the final scale if they had factor loadings within the range of 0.3 and 0.9 \( (81) \) with no or few cross loadings \( (82) \). Uniqueness of each item was also assessed to estimate the strength of inter-item correlations. Internal consistency of the scale was examined using item-test correlations, item-rest correlations, and Cronbach’s alpha for the entire scale and within each factor \( (83) \).

Convergent validity of the Sauti vAGYW HIV risk assessment tool was assessed through correlations between the risk scores for each factor, the overall scale, and secondary parameters of HIV risk. The secondary parameters of HIV risk that were included in the analysis were history of HIV test, current usage of barrier contraceptive, ever giving birth to a child, and using alcohol during sex in the past 30 days. In the analysis, history of childbearing was used as a surrogate indicator for currently living and financially supporting a child. Index data were merged with Sauti’s routine health program screening data in a 1:1 ratio by survey completion date, date of birth, and participant’s unique program ID number. To ensure representativeness of this sub-sample, the baseline characteristics between the merged and unmerged groups were compared by using Wilcoxon rank sum tests for continuous variables and Pearson’s chi-square tests for categorical variables. Correlations between the risk scores and dichotomous HIV-related health outcomes were assessed using point-biserial correlation
(84). The predictive value of the risk levels (low, middle, high, and very-high) with these outcomes was assessed using multivariate logistic regression. To account for age and regional variations in HIV risk, participant’s age and region of current residence were adjusted in the models. Due to the last three maximum risk questions that automatically put participants in the very-high risk group if answered yes to any of them, the risk group distribution was skewed (Table 7). For this analysis, participants were redistributed across four different risk levels based on their cumulative risk scores obtained from the final scale.

All statistical analyses were conducted using Stata 14.2 (85).

2.4 ETHICS STATEMENT

The National Institute for Medical Research (NMRI) and the Ministry of Health and Social Welfare of the United Republic of Tanzania provided the ethical clearance for the primary data collection of both index and health program screening data. The secondary data analysis for this study was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.
Chapter 3: Results

3.1 Study Population of Index Data

Frequency distributions of baseline socio-demographic and sexual behavior characteristics of 6,526 adolescent girls and young women are presented in Table 2. The median age of participants was 20 years, and 39.3% (n = 2,565/6,526) girls completed primary school. Almost 70% (n = 4,436/6,526) of participants in our study were not married or living with a man as if married, and more than half of participants reported to have ever gone to bed hungry because there was not enough food available at home. In terms of sexual behaviors, the majority of girls (n= 5,264/6,526) had experience of vaginal intercourse, while the other 10.5% (n = 685/6,526) reported to have had both vaginal and anal intercourse in the past. Although the most common age range for coital debut was between 16 and 18 years (n = 3,297/6,097), other 31.4% (n = 1,916/6,097) reported that they had their first intercourse when they were 15 years old or younger. Condom and other modern contraceptive use were quite low in this population. Almost half (n = 2,988/6,175) of participants reported that they did not use condoms in the past three times they had vaginal sex. The other 56.0% (n = 3,647/6,526) reported that they were not currently using any modern contraceptive methods. In addition, over half (n = 3,472/6,201) of participants had at least one pregnancy in their life.

3.2 Exploratory Factor Analysis of Sauti’s vAGYW HIV Risk Assessment Tool

The overall Kaiser-Meyer-Olkin index was 0.85 (range: 0.62 - 0.92), which suggested that index data had good sampling adequacy for factor analysis (77). From
exploratory factor analysis, three factors were identified, which explained 45% of the total variance in the index data.

Of the 20 items, 12 items were retained in the final scale. Eight items that were excluded from the final scale included education level, marital status, history of physical violence, social group participation, condom use during the last three time they had anal sex, modern contraceptive use, and age of the head of household. These were omitted because they had either too high (>0.9) or too low factor loadings (<0.3), cross-loaded on to more than one factor with the similar strength, or had low item-test correlations. Some items, such as modern contraception use, were also excluded from the final scale because they failed to converge during the iterative process.

Exploratory factor loadings and reliability coefficients of the twelve items that were retained in the final scale are presented in Table 3. More than half of the items loaded onto the sexual behavior factor with factor loadings ranged from 0.40 to 0.77. The socioeconomic vulnerability and transactional sex factors included three and two items, respectively. Factor loadings ranged from 0.47 to 0.79 on the socioeconomic vulnerability factor, and from 0.55 to 0.84 on the transactional sex factor.

The item-test correlations of the twelve items were within the acceptable range (0.40-0.63). The item-rest correlations ranged from 0.26 to 0.52, with the lowest in the food insecurity item. Assessments of Cronbach’s alpha found that the overall scale (α = 0. 7622) and sexual behavior factor (α = 0. 7182) had high internal consistency (83). The socioeconomic vulnerability and transactional sex factors, however, had lower Cronbach’s alpha, which were 0.4727 and 0.6514, respectively.
3.3 Assessing the Relationships Between Risk Scores and HIV-related Health Outcomes

A total of 288,142 records in the health screening dataset were observed, as can be seen in Figure 2. Of these, 1,096 (0.4%) were excluded because they were either duplicate entries of the same participant or had missing or incorrect program IDs. Of the remaining 287,076, 153,532 (53.5%) were men and removed from the analysis. Among the remaining 133,514 records that were merged with the index data, only 1,130 participants were successfully linked between the two datasets. Of this, 1,071 (95%) participants provided consent for data use and included in our analysis.

Frequency distributions of several HIV-related health outcomes were explored among those who could be linked with health screening data (Table 4). Among 1,068, 20 (1.9%) girls tested HIV positive and over half of them have taken an HIV test in the past. Among girls, 3.8% (n = 29/768) have received drugs in the past in exchange for sex, while 15.1% (n = 117/776) have received money or goods in exchange for sex. In addition, only 6.1% (n = 50/814) of participants reported that they have used alcohol when they had sex in the past 30 days. In addition, 97.8% (n = 348/356) has not had any symptoms of Vaginal Discharge Syndrome (VDS). In terms of reproductive health, more than 30% (n = 335/1071) of participants have ever given birth to a child. Furthermore, 69.1% (n= 503/728) participants have never used any type of family planning methods, and only 21.9% (n = 140/638) were currently using them. Lastly, 5.3% (n = 34/639) participants reported that they were currently using either female or male condoms.
To assess convergent validity, correlations between the risk scores for each factor and the overall scale and other HIV-related health outcomes, such as history of HIV test, current usage of barrier contraceptive, history of live birth, and using alcohol during sex in the past 30 days, were assessed (Table 6). As expected, positive and significant associations were observed between the risk scores from the total scale and history of HIV test (0.1005), history of childbirth (0.088), and use of alcohol during sex in the past 30 days (0.067). The sexual behavior factor showed the similar trend as the total scale with history of HIV test (0.1027) and childbirth (0.087). The risk score for the transactional sex factor showed positive correlation with history of HIV test (0.1155), childbirth (0.0624), and using alcohol during sex in the past 30 days (0.0962), whereas, the risk score for the socioeconomic vulnerability was not correlated with any of these outcomes.

The preliminary comparisons of the associations between the risk levels assigned by the HIV risk assessment tool and the aforementioned secondary parameters of HIV risk are presented in Table 8. According to the data that was collected using the DHS survey in 2011-2012 (71), there were variations in the socio-demographic status, as well as the prevalence of both HIV infection and risky behaviors, across different age groups (15-19 vs. 20-24) and by region (71). Thus, we adjusted for participant’s age and region of residence in our analyses to obtain valid correlation estimates.

Overall, the odds of having ever taken an HIV test (OR: 2.04; 95% CI: 1.40, 2.98), given birth to a child (OR: 1.50; 95% CI: 1.01, 2.22), and use of alcohol when having sex in the past 30 days (OR: 2.57; 95% CI: 1.13, 5.85) were significantly higher
comparing the very high risk group to the low risk group. However, the associations with other risk levels did not reach the level of statistical significance.

Chapter 4: Discussion

The main objective of this study was to characterize the psychometric properties of the Sauti vAGYW HIV risk assessment tool using exploratory factor analysis. Our study findings showed that the overall construct of vulnerability to HIV risk among out-of-school adolescent girls and young women in Tanzania may be best represented by three factors: sexual behavior, transactional sex, and socioeconomic vulnerability. The first factor, “sexual behavior,” explored diverse individual-level sexual risk indicators related to HIV vulnerability in young women. These included sexual history, age at coital debut, pregnancy history, and age-disparate sexual relationships, which have shown to increase incidence of HIV and other STIs in different populations (27,28,30,86). Not surprisingly, the item that measured partner’s HIV status loaded onto the sexual behavior factor, as partner’s high plasma viral load is highly associated with increased risk of HIV transmission among the serodiscordant couples (87). Consistent with previous findings, partner’s HIV status item also loaded onto this factor (47,51,88). This highlights HIV-related stigma and gender imbalance, especially in intergenerational relationships, where girls may not be able to openly discuss partner’s HIV status or negotiate for condom use.

Several studies have shown that early coital debut is highly associated with high risk sexual behaviors in HIV endemic areas, such as having multiple sex partners, inconsistent condom use, compensated sex, and teen pregnancy (86). A study conducted in Tanzania also showed that girls who did not know partner’s HIV sero-status were more
likely to engage in multiple sexual partnerships (89). In our analysis, however, the items that measured multiple sexual partners and compensated sex loaded together in a single factor, rather than with other sexual risk behavioral indicators. This combination of items suggests that our tool might be picking up and effectively identifying those whose HIV risk is elevated specifically due to traditionally defined transactional sex. This theory is supported by several studies conducted in Tanzania. In many parts of the country, poverty is a big concern. Due to family’s economic deprivation, adolescent girls are often expected to contribute financially or materially to support their family from a young age (48,54). The limited economic options that are available to these girls strongly influence their decisions to engage in transactional sex with multiple partners or enter sex work at an early age (47,48,54).

This study finding suggests that girls who engage in transactional sex might be exposed to HIV risk through a different vulnerability pathway from those whose risk is increased by other sexual behaviors, highlighting the need for adaptive, individualized HIV prevention approaches. To our knowledge, this is the first risk assessment tool that has captured women’s increased vulnerability to HIV risk specifically due to their engagement in commercial sex. In the past, not many vulnerability indices have included transactional sex in their instruments. Of the few that looked at transactional sex, they used proxy measures in their metrics, which often failed to discriminate women who engaged in sex work from those who did not (69). In this sense, our tool improves the previous indices as it was leveraged to comprehensively characterize adolescent girl and young women’s vulnerabilities to HIV risk across different cultural and social circumstances. This tool is also relevant from the programmatic perspective as it will help
distinguish girls who engage in various types of transactional sex and guide them to appropriate interventions, such as HIV pre-exposure prophylaxis and social protection services, to mitigate their vulnerabilities to HIV risk.

The Sauti vAGYW HIV risk assessment tool also effectively distinguished structural determinants of HIV vulnerability in this population in a meaningful way. Consistent with findings from previous studies, our analyses showed that not having adult support, whether it was emotional or financial support, was highly correlated with increased food insecurity and history of sexual violence. In many parts of sub-Saharan Africa where HIV is endemic, a higher proportion of children and adolescents are orphaned by one or both parents due to HIV-related diseases (40). AIDS orphans often experience a multiple emotional and economic stressors as a result of bereavement, changing in caregivers, and frequent moves (90), which may lead to lower perceived social support, higher level of depressive symptoms, and low self-esteem (91). Poor psychological status and family dysfunction are particularly threatening to young girls’ safety and well-being, which increases their overall vulnerability to HIV infection. This is further supported by other studies that showed that the absence of either parent was highly associated with history sexual violence and social isolation among adolescent girls (92–94).

Consistent with studies conducted elsewhere, girls who were categorized into the very high risk group were more likely to have given birth to a child, tested for HIV, and used alcohol when having sex in the past 30 days (32,33,66,95,96), illustrating that our instrument has good predictive validity. However, other risk groups (Low, Middle, and
High) failed to show statistically significant associations with these outcomes potentially due to the low number of girls who could be linked with the routine health program screening dataset. Nonetheless, it is worth noting the trends in odds ratios across different risk groups, which indicate that the risk scores may indeed predict HIV-related health outcomes in adolescent girls and young women. However, further evaluation with a larger sample size is needed to capture statistically significant relationships across risk levels and strengthen convergent validity of our scale.

Overall, the items and factors identified in our analyses were well correlated with each other as hypothesized based on the conceptual framework and findings from the previous literature. The Sauti vAGYW HIV risk assessment tool showed promising construct validity and predictive validity, as the risk scores were highly associated with the aforementioned known HIV-related health outcomes. Although, the overall scale showed high internal consistency, two sub-scales had low internal reliability. This was expected because they only loaded two or three items. As Cronbach’s alpha is sensitive to the number of items loaded onto each factor, internal consistency of these two sub-scales was compromised (97). This finding suggests that the three sub-scales that were identified in this analysis should be used together as part of the Sauti HIV risk assessment tool, rather than independently, to better assess vulnerability to HIV risk in this population.

In recognition of the importance of delivering comprehensive, evidence-based interventions, a number of indices were developed to predict the risk and vulnerability to HIV transmission in different populations. Despite the growing body of literature on risk
assessment tools, not many studies have used psychometric statistical methods to characterize the relationships between the observed items and latent variables in their scales. Using exploratory factor analysis, our study showed high validity and reliability of the Sauti vAYGW risk assessment tool and identified three factors that are associated with the underlying construct of vulnerability in adolescent girls and young women. Our instrument is also unique in that it specifically targets young women who are out of school due to either school dropout or lack of access to education. As data have consistently shown, girls with low levels of education are more vulnerable to HIV risk due to the increased social and economic vulnerabilities (96)(90,98,99). Although a few indices have included education as one of the indicators, none of them specifically analyzed the levels of HIV vulnerability among those who were not currently enrolled in school. Thus, our tool sheds light on key HIV vulnerability indicators that are unique to out-of-school girls in Tanzania.

The Sauti vAGYW HIV risk assessment tool has several implications on public health practice. Adolescence is an important turning point in life when many people begin experiencing significant physical and psychological changes (100). As many adolescents start exploring their sexuality, it becomes crucial to deliver appropriate reproductive health information and services in a timely manner. However, due to their young age and low socioeconomic status, it becomes challenging for them to access necessary services to reduce early, unintended pregnancy, as well as STI and HIV transmission (100). Although several school-based intervention programs that include sexuality education have shown a reduction in early pregnancy and incidence of STIs in adolescents, they often fail to reach those who either do not have access to education or
dropped out of school (44,95). Sauti’s vAGYW HIV risk assessment tool addresses this gap as it is designed specifically for out-of-school adolescent girls and young women aged 15-24 years. Using a minimum set of key HIV vulnerability indicators, it allows us to rapidly identify those who are at high risk of HIV acquisition and channel them to appropriate high-impact intervention programs, effectively reducing their advance in HIV risk as they mature from adolescence to adulthood.

Due to the evolving nature of their vulnerabilities along the HIV risk pathway, it becomes particularly important to understand the effectiveness of various HIV prevention and treatment packages among adolescents and young adults. To better assess the program impact, the Sauti HIV risk assessment tool could also be utilized to measure the change in the level of vulnerability among adolescent girls and young women before and after receiving the Sauti services. The data collected could then be used for program implementation, as well as to inform policy and decision-making both at the regional and national levels.

Our study also found a lower frequency of condom use in our study population, suggesting heightened risk of HIV among out-of-school girls in Tanzania. In HIV prevention, barrier methods are essential in the absence of additional preventive measures, such as PrEP or ART treatment, as they block the direct contact of the virus with the mucous membrane of the penis, vagina, or anus during sexual intercourse. Tanzania has been conducting a mass media campaign to raise awareness of condom use in HIV prevention for more than a decade. As a result, in 2011, three-quarters of girls aged 15-24 reported that they knew using condoms could lower the risk of HIV
transmission, and approximately 40% of those who had more than one sexual partner in
the past 12 months reported that they used a condom during the last sexual intercourse
(71). However, in our study, we found that a significantly lower number of participants
were currently using either female or male condoms. Although it is possible that this
discrepancy could be due to the low linkage rate between the two datasets in our study, it
might also be suggesting a potential gap in Sauti’s programmatic approach that the
services are not reaching those who are at highest risk of HIV acquisition. The low
prevalence of using barrier methods in young populations in Tanzania underscores the
need to improve the programmatic strategies to reach those who are at highest risk of
HIV acquisition.

This study has a number of limitations. First, the Sauti vAGYW risk assessment
tool was developed primary on the basis of research and programmatic interests of the
Sauti Program in Tanzania that focused on addressing health needs of hard-to-reach
vulnerable girls who might have been missed by school-based interventions. Therefore,
our study findings may not be generalizable to all African adolescent girls and young
women. Second, all responses on the Sauti vAGYW HIV risk assessment tool were self-
reported, which raise concerns for social desirability bias and recall bias. Third, when
assessing the merged data, we observed a low linkage rate between the index and routine
health screening datasets. The inherent challenges in the development of client’s unique
program ID, as well as the poor data quality and management system of the Sauti
program, created a barrier to crosscheck participant IDs to improve our linkage. The
inadequate sample size in the merged dataset may have contributed to the lack of
statistical significance between some of the risk groups and HIV-related health outcomes.
in our analysis. Furthermore, the lack of data on some of the key secondary parameters of HIV risk also limited our ability to adequately evaluate the predictive ability of the Sauti vAGYW HIV risk assessment tool. For instance, the routine health screening data, many of STIs and gender-based violence indicators had a large volume of missing data. In addition, although 31.3% of the participants reported having given birth to a child in our study population, we did not have further information on whether or not these children were currently living with our study participants. As having a child very likely increase the financial burden on women, it would be important to assess how well risk scores can identify these women from those who do not have a dependent.

Our methodological approach also has several limitations. Although the quantitative approach using exploratory factor analysis allowed us to assess item correlations with the underlying construct, it should not undermine the importance of theoretically informed judgments in developing a viable scale. In our analysis, some of the items that were excluded in the final scale included well-known determinants of HIV risk in this population, such as anal sex and contraception use. Thus, further evaluation of the metrics’ structure is needed in different populations. The overall procedure of exploratory factor analysis required subjective decision-making about the estimation method, as well as the inclusion and exclusion of items in the final scale. Currently, information on the strengths and weaknesses of the existing factor extraction methods is scarce, impeding the process of identifying and extracting relevant factors. It has been argued that maximum likelihood is most ideal in many cases when the data are normally distributed, as it provides a statistical method to test the goodness of fit of the model and correlations between factors (81). However, since we could not assume the continuous
scale underlying many of the categorical items in our instruments to be normally distributed, the maximum likelihood estimation could not be used in our analysis, hindering our ability to formally assess statistical significance of each factor loading.

Despite these limitations, the psychometric properties have indicated the validity, reliability, and accuracy of the Sauti HIV risk assessment tool. A further important direction for future research is to validate the scoring system of our tool using biological outcomes, such as HIV and other STIs, and other vulnerability determinants of HIV risk, including gender-based violence, orphanhood, and poverty. In addition, future research on vulnerability to HIV risk among out-of-school girls would greatly benefit from confirmatory factor analysis. It would allow us to test our hypothesized theory established using exploratory factor analysis and assess how applicable our scale’s structure is in different samples of adolescent girls and young women. The use of additional psychometric approaches, such as latent class analysis, would also enhance our understanding of empirically derived patterns of vulnerability determinants of HIV risk and strengthen our overall analytic results.

Chapter 5: Conclusions

Despite the ongoing effort to reduce the global burden of HIV, adolescent girls and young women aged 15-24 years continue to face disproportionately high burden and incidence of HIV compared to age-matched men. To best serve this population, comprehensive and age-appropriate HIV interventions are highly needed. Our study proved that the Sauti vAGYW HIV risk assessment tool can effectively risk-stratify girls based on their level of vulnerability to HIV risk, suggesting the need for of this tool may
better specify HIV intervention research and programmatic needs for adolescent girls and young women. Furthermore, the briefness and easy-administration of this tool would allow rapid identification of girls who are at highest risk of HIV, and guide them to appropriate high-impact services to mitigate their vulnerability to HIV acquisition.
Appendices

Table 1. Items in the original vAGYW HIV risk index

<table>
<thead>
<tr>
<th><strong>DOMAIN 1: SEXUAL BEHAVIOR</strong></th>
<th><strong>Variables</strong></th>
<th><strong>Question</strong></th>
<th><strong>Response</strong></th>
</tr>
</thead>
</table>
|                               | Sexual history| Have you ever had sex? If yes, have you had only vaginal sex, anal sex or both? | 1. Yes, vaginal and anal sex (3 points)  
2. Yes, anal sex only (3 points)  
3. Yes, vaginal sex only (2 points)  
4. Never had vaginal or anal sex (0 points) |
|                               | Age at coital debut | How old were you when you first had sex? | 1. ≤15 years old (3 points)  
2. 16-18 years old (2 points)  
3. >18 years old (0 points) |
|                               | Recent sex | Have you had sex in the past 12 months? | 1. Yes (3 points)  
2. No (0 points) |
|                               | Condom use last three vaginal sex | Thinking about the last three times you had vaginal sex, how many of those times did you use a condom? | 1. None (3 points)  
2. Once (3 points)  
3. Twice (2 points)  
4. All three times (0 points)  
5. I don’t know (3 points) |
|                               | Condom use last three anal sex | Thinking about the last three times you had anal sex, how many of those times did you use a condom? | 1. None (3 points)  
2. Once (3 points)  
3. Twice (2 points)  
4. All three times (0 points)  
5. I don’t know (3 points)  
6. Never had anal sex (0 points) |
|                               | Multiple sexual partners | In the last 12 months, have you had more than one sexual partner within the 30-day period | 1. Yes, over 3 sexual partners (3 points)  
2. Yes, 2 sexual partners (2 points)  
3. Yes, but don’t know how many (3 points)  
4. No (0 points)  
5. Don’t know (3 points) |
|                               | Compensated sex | Have you ever had sex with anyone because he provided you or you expected that he would | 1. Yes (3 points)  
2. No (0 points) |
<table>
<thead>
<tr>
<th>Variables</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
</table>
| Pregnancy history         | Have you ever been pregnant? If yes, what age were you when you were first pregnant? | 1. Yes, <15 years old (3 points)  
2. Yes, 15-17 years old (2 points)  
3. Yes, 18-20 years old (1 point)  
4. Yes, >20 years old (0 points)  
5. Yes, but don’t know age when first pregnant (1 point)  
6. Never been pregnant (0 point) |
| Modern contraception use  | Are you currently using any form of modern contraception?                  | 1. Yes (2 points)  
2. No (3 points) |
| Condom use                | If you are using modern contraception, do you also use a condom?          | 1. Uses contraception but never a condom (2 points)  
2. Uses contraception but only sometimes a condom (2 points)  
3. Uses contraception and always uses a condom (0 points) |
| Age-disparate sexual relationships | What was the biggest age difference between you and a sexual partner? | 1. >10 years (3 points)  
2. 6-10 years (2 points)  
3. 3-5 years (1 point)  
4. Less than 3 years (0 point)  
5. Don’t know (3 points) |
| Partner’s HIV status       | Do you know the HIV status of your current sexual partner(s)?             | 1. At least one HIV+ partner (3 points)  
2. All HIV- (0 points)  
3. Don’t know (3 points) |

**DOMAIN 2: SEXUAL AND GENDER VIOLENCE**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
</table>
| Sexual violence           | At any time in your life, as a child or as an adult, have you ever experienced sexual violence? If yes, how often have you experienced this kind of sexual violence? | 1. Yes, >3 times (3 points)  
2. Yes, 1-2 times (2 points)  
3. Yes, once (1 point)  
4. Never experienced sexual violence |
| Physical violence         | Has anyone ever used their hands or an object to hurt you physically?     | 1. Yes (3 points)  
2. No (0 points)  
3. Don’t know (2 points) |

**DOMAIN 3: IMPOVERISHMENT**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
</table>
| Food insecurity           | In the past 30 days, have you gone to sleep at                           | 1. Yes, often (3 points)  
2. Sometimes (2 points)  
3. Never (0 points)  
4. Don’t know (2 points) |
### Child-headed household

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>How old is the head of your household?</td>
<td>1.  15-18 years old (2 points)</td>
</tr>
<tr>
<td></td>
<td>2.  19-24 years old (1 point)</td>
</tr>
<tr>
<td></td>
<td>3.  24-69 years old (0 point)</td>
</tr>
<tr>
<td></td>
<td>4.  &lt;15 or &gt;70 years old (3 points)</td>
</tr>
<tr>
<td></td>
<td>5.  Never experienced (0 point)</td>
</tr>
</tbody>
</table>

### Marital status

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you currently married or living together with a man as if married?</td>
<td>1.  No (0 point)</td>
</tr>
<tr>
<td></td>
<td>2.  Yes, &lt;18 years old (3 points)</td>
</tr>
<tr>
<td></td>
<td>3.  Yes, 18 old and older (1 point)</td>
</tr>
</tbody>
</table>

### DOMAIN 4: ISOLATION

<table>
<thead>
<tr>
<th>Variables</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult support</td>
<td>Is there an adult in your household or community to whom you can go for emotional and/or financial support?</td>
<td>1.  No (3 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.  Yes, but only emotional support (2 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.  Yes, but financial support (2 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.  Yes, both emotional and financial support (0 point)</td>
</tr>
<tr>
<td>Community participation</td>
<td>Are you a member of any social group which meets at least two times per month?</td>
<td>1.  No (3 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.  Yes (0 point)</td>
</tr>
</tbody>
</table>

### DOMAIN 5: SCHOOLING AND LITERACY

<table>
<thead>
<tr>
<th>Variables</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>Have you ever attended school? If yes, what is the highest grade/form/year that you have completed</td>
<td>1.  Never attended school (3 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.  Yes, but did not complete primary school (3 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.  Yes, completed primary school (2 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.  Yes, but did not complete secondary school (1 point)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.  Yes, completed secondary school (0 point)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.  Yes, but don’t know highest grade completed (1 point)</td>
</tr>
</tbody>
</table>
Figure 1. Flow diagram of exclusion criteria of the study sample in index data
### Table 2. Baseline socio-demographic and behavioral characteristics of adolescent girls and young women aged 15-24 years within index data

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of participants (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age (n=6,526)</td>
<td>20</td>
</tr>
<tr>
<td><strong>Venue (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>Routine mobile CBHTC+ services</td>
<td>556 (8.5)</td>
</tr>
<tr>
<td>Venue-based &amp; BCC activities</td>
<td>1,891 (29.0)</td>
</tr>
<tr>
<td>Drop-in centers</td>
<td>437 (6.7)</td>
</tr>
<tr>
<td>Others</td>
<td>3,642 (55.8)</td>
</tr>
<tr>
<td><strong>Region (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>Dar es Salaam</td>
<td>903 (13.8)</td>
</tr>
<tr>
<td>Iringa</td>
<td>664 (10.2)</td>
</tr>
<tr>
<td>Mbeya</td>
<td>2,246 (34.4)</td>
</tr>
<tr>
<td>Njombe</td>
<td>1,084 (16.6)</td>
</tr>
<tr>
<td>Shinyanga</td>
<td>1,629 (25.0)</td>
</tr>
<tr>
<td><strong>Education (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>Never attended school</td>
<td>577 (8.8)</td>
</tr>
<tr>
<td>Incomplete primary school</td>
<td>1,179 (18.1)</td>
</tr>
<tr>
<td>Completed primary school</td>
<td>2,565 (39.3)</td>
</tr>
<tr>
<td>Incomplete secondary school</td>
<td>961 (14.7)</td>
</tr>
<tr>
<td>Completed secondary school</td>
<td>1,135 (17.4)</td>
</tr>
<tr>
<td>Don’t know highest grade completed</td>
<td>109 (1.7)</td>
</tr>
<tr>
<td><strong>Marital status (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>4,436 (68.0)</td>
</tr>
<tr>
<td>Married</td>
<td>2,090 (32.0)</td>
</tr>
<tr>
<td><strong>Have gone to bed hungry because no food (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>3,630 (55.6)</td>
</tr>
<tr>
<td>Rarely</td>
<td>1417 (21.7)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>588 (9.0)</td>
</tr>
<tr>
<td>Often</td>
<td>890 (13.6)</td>
</tr>
<tr>
<td><strong>Sexual history (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>Never had sex</td>
<td>411 (6.3)</td>
</tr>
<tr>
<td>Only had vaginal sex</td>
<td>5,264 (80.7)</td>
</tr>
<tr>
<td>Only had anal sex</td>
<td>166 (2.5)</td>
</tr>
<tr>
<td>Had both vaginal and anal sex</td>
<td>685 (10.5)</td>
</tr>
<tr>
<td><strong>Age at coital debut (n=6,097)</strong></td>
<td></td>
</tr>
<tr>
<td>≤15 years old</td>
<td>1,916 (31.4)</td>
</tr>
<tr>
<td>16-18 years old</td>
<td>3,297 (54.1)</td>
</tr>
<tr>
<td>&gt; 18 years old</td>
<td>884 (14.5)</td>
</tr>
</tbody>
</table>
Table 2. Baseline socio-demographic and behavioral characteristics of adolescent girls and young women aged 15-24 years within index data, cont.

<table>
<thead>
<tr>
<th></th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pregnancy history (n=6,201)</strong></td>
<td></td>
</tr>
<tr>
<td>Never been pregnant</td>
<td>2,729 (44.0)</td>
</tr>
<tr>
<td>Have been pregnant</td>
<td>3,472 (66.0)</td>
</tr>
<tr>
<td><strong>Age at pregnancy (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;15 years old</td>
<td>260 (4.2)</td>
</tr>
<tr>
<td>15-18 years old</td>
<td>1,104 (17.8)</td>
</tr>
<tr>
<td>&gt; 18 years old</td>
<td>1,502 (24.2)</td>
</tr>
<tr>
<td>Don't know when</td>
<td>99 (1.6)</td>
</tr>
<tr>
<td><strong>Current modern contraceptive usage (n=6,526)</strong></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3,657 (56.0)</td>
</tr>
<tr>
<td>Yes</td>
<td>2,869 (44.0)</td>
</tr>
<tr>
<td><strong>Condom use last 3 vaginal sex (n=6,175)</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2,988 (48.4)</td>
</tr>
<tr>
<td>Once</td>
<td>1,119 (18.1)</td>
</tr>
<tr>
<td>Twice</td>
<td>669 (10.83)</td>
</tr>
<tr>
<td>Three times</td>
<td>1,053 (17.1)</td>
</tr>
<tr>
<td>Don’t know</td>
<td>346 (5.6)</td>
</tr>
<tr>
<td><strong>Maximum number of concurrent sexual partners (n=6,158)</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2,546 (41.3)</td>
</tr>
<tr>
<td>≥3 sexual partners</td>
<td>1,128 (18.3)</td>
</tr>
<tr>
<td>2 sexual partners</td>
<td>1,723 (28.0)</td>
</tr>
<tr>
<td>Don’t remember number</td>
<td>370 (6.0)</td>
</tr>
<tr>
<td>Don’t know</td>
<td>391 (6.4)</td>
</tr>
</tbody>
</table>
### Table 3. Exploratory factor loadings and reliability coefficients of the twelve items retained in the final scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor loadings</th>
<th>Reliability coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1: Sexual behavior</td>
<td>Factor 2: Socioeconomic vulnerability</td>
</tr>
<tr>
<td>Sexual history</td>
<td>0.4626</td>
<td>0.1260</td>
</tr>
<tr>
<td>Age at coital debut</td>
<td>0.5045</td>
<td>0.1091</td>
</tr>
<tr>
<td>Recent sex</td>
<td>0.6772</td>
<td>-0.2379</td>
</tr>
<tr>
<td>Condom use last three vaginal sex</td>
<td>0.7707</td>
<td>-0.1566</td>
</tr>
<tr>
<td>Multiple sexual partners</td>
<td>-0.0214</td>
<td>-0.1146</td>
</tr>
<tr>
<td>Compensated sex</td>
<td>0.3034</td>
<td>-0.0418</td>
</tr>
<tr>
<td>Pregnancy history</td>
<td>0.4029</td>
<td>0.2460</td>
</tr>
<tr>
<td>Age-disparate sexual relationships</td>
<td>0.5008</td>
<td>0.1522</td>
</tr>
<tr>
<td>Partner’s HIV status</td>
<td>0.4195</td>
<td>0.0628</td>
</tr>
<tr>
<td>Sexual violence</td>
<td>-0.0687</td>
<td>0.5202</td>
</tr>
<tr>
<td>Food insecurity</td>
<td>-0.1701</td>
<td>0.7934</td>
</tr>
<tr>
<td>Adult support</td>
<td>0.0210</td>
<td>0.4748</td>
</tr>
<tr>
<td>Factor-specific Cronbachs alpha</td>
<td>0.7182</td>
<td>0.4727</td>
</tr>
<tr>
<td>Overall scale</td>
<td>0.7622</td>
<td></td>
</tr>
</tbody>
</table>

**Not applicable**

### Table 4. Correlation matrix of the promax rotated common factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Factor 2</td>
<td>0.5754</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Factor 3</td>
<td>0.4662</td>
<td>0.4368</td>
<td>1</td>
</tr>
</tbody>
</table>

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Figure 2. Flow diagram of exclusion criteria of the study sample in health screening data and merging with index data

- 1,096 records excluded (0.4%)
  - Missing ID
  - Incorrectly assigned ID
  - Duplicate entries
- Records with correct ID (n=287,046)
- 153,552 records excluded (53.5%)
  - Male
  - Men who have sex with men (MSM)
  - MSM sex worker
- Records from index data (n=6,526)
- Records of FSW, AGYW, Population with high risk (n=133,514)
- Merged records for analysis (n=1,130)
Table 5. Frequency distributions of HIV-related health outcomes among linked adolescent girls and young women aged 15-24

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Linked participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever taken HIV test in the past (n=992)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>528 (53.2)</td>
</tr>
<tr>
<td>Yes</td>
<td>464 (46.8)</td>
</tr>
<tr>
<td>HIV test results (n=1,018)</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>1,048 (98.1)</td>
</tr>
<tr>
<td>Positive</td>
<td>20 (1.9)</td>
</tr>
<tr>
<td>Have symptoms of Vaginal Discharge Syndrome (VDS)</td>
<td></td>
</tr>
<tr>
<td>(n=356)</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>348 (97.8)</td>
</tr>
<tr>
<td>Positive</td>
<td>8 (2.3)</td>
</tr>
<tr>
<td>Received drugs in exchange for sex in the past 30 days (n=768)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>739 (96.2)</td>
</tr>
<tr>
<td>Yes</td>
<td>29 (3.8)</td>
</tr>
<tr>
<td>Received money or goods in exchange for sex (n=776)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>659 (84.9)</td>
</tr>
<tr>
<td>Yes</td>
<td>117 (15.1)</td>
</tr>
<tr>
<td>Under the influence of alcohol when had sex in the past 30 days (n=814)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>764 (93.9)</td>
</tr>
<tr>
<td>Yes</td>
<td>50 (6.1)</td>
</tr>
<tr>
<td>Have ever used any family planning method (n=728)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>503 (69.1)</td>
</tr>
<tr>
<td>Yes</td>
<td>226 (30.9)</td>
</tr>
<tr>
<td>Have given births to a child (n=1071)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>736 (68.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>335 (31.3)</td>
</tr>
</tbody>
</table>
Table 5. Frequency distributions of HIV-related health outcomes among linked adolescent girls and young women aged 15-24, cont.

<table>
<thead>
<tr>
<th>Currently using any family planning method (n=639)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>499 (78.1)</td>
</tr>
<tr>
<td>Yes</td>
<td>140 (21.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currently using barrier contraceptive method$^c$ (n=639)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>605 (94.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>34 (5.3)</td>
</tr>
</tbody>
</table>

$^a$ VDS was analyzed as a proxy for STI infection
$^b$ Modern contraception methods included in the analysis are POP/COP pills, injectable, standard days, cycle beads, male condom, female condom, vasectomy, tubal ligation, IUD, and Jadelle/Implanon implant
$^c$ Barrier contraceptive methods indicate using either female and male condoms
Sample size for each HIV-related health outcome varies due to missing data
Table 6. Point-biserial correlations between cumulative risk scores and HIV-related health outcomes

<table>
<thead>
<tr>
<th>Ever taken HIV test in the past</th>
<th>Total scale</th>
<th>Factor 1: Sexual behavior</th>
<th>Factor 2: Socioeconomic vulnerability</th>
<th>Factor 3: Transactional sex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1005**</td>
<td>0.1027**</td>
<td>0.0097</td>
<td>0.1155**</td>
</tr>
<tr>
<td>Currently using barrier contraceptives</td>
<td>0.0234</td>
<td>0.0075</td>
<td>0.0594</td>
<td>0.0040</td>
</tr>
<tr>
<td>Have given birth to a child</td>
<td>0.0884**</td>
<td>0.0866**</td>
<td>0.0381</td>
<td>0.0624*</td>
</tr>
<tr>
<td>Used alcohol when had sex in the past 30 days</td>
<td>0.0674*</td>
<td>0.0576</td>
<td>0.0094</td>
<td>0.0962**</td>
</tr>
</tbody>
</table>

** Statistically significant at p=0.05 level
*Statistically significant at p=0.10 level

Table 7. Distribution of participants in each risk level before and after linking with health screening data

<table>
<thead>
<tr>
<th>Risk levels</th>
<th>Number of participants before redistribution N=1071 (%)</th>
<th>Number of participants after redistribution N=1071 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>55 (5.1)</td>
<td>295 (27.5)</td>
</tr>
<tr>
<td>Middle</td>
<td>287 (26.8)</td>
<td>303 (28.3)</td>
</tr>
<tr>
<td>High</td>
<td>148 (13.8)</td>
<td>225 (21.0)</td>
</tr>
<tr>
<td>Very High</td>
<td>581 (54.3)</td>
<td>248 (23.2)</td>
</tr>
</tbody>
</table>
Table 8. Odds ratios of HIV-related health outcomes across risk levels after adjusting for age (15-19 vs. 20-24) and region

<table>
<thead>
<tr>
<th>HIV-related health outcome variables</th>
<th>Odds Ratio (95% CI)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ever taken HIV test in the past</td>
<td>Currently using barrier contraceptives</td>
<td>Have given birth to a child</td>
<td>Used alcohol when had sex in the past 30 days</td>
</tr>
<tr>
<td><strong>Risk level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Medium</td>
<td>1.34 (0.94, 1.90)</td>
<td>0.88 (0.35, 2.19)</td>
<td>0.97 (0.69, 1.42)</td>
<td>0.70 (0.27, 1.80)</td>
</tr>
<tr>
<td>High</td>
<td>1.37 (0.94, 2.01)</td>
<td>1.15 (0.44, 3.02)</td>
<td>0.98 (0.65, 1.47)</td>
<td>1.44 (0.61, 3.40)</td>
</tr>
<tr>
<td>Very High</td>
<td>2.04** (1.40, 2.98)</td>
<td>0.59 (0.19, 1.83)</td>
<td>1.50** (1.01, 2.22)</td>
<td>2.57** (1.13, 5.85)</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-19</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>20-24</td>
<td>2.09** (1.60, 2.68)</td>
<td>1.42 (0.66, 3.06)</td>
<td>3.49** (2.55, 4.78)</td>
<td>1.37 (0.71, 2.65)</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dar es Salaam</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Iringa</td>
<td>1.61* (0.97, 2.68)</td>
<td>2.86 (0.74, 11.04)</td>
<td>1.52 (0.88, 2.62)</td>
<td>1.15 (0.43, 3.05)</td>
</tr>
<tr>
<td>Mbeya</td>
<td>0.52** (0.35, 0.79)</td>
<td>1.59 (0.42, 5.98)</td>
<td>1.35 (0.85, 2.13)</td>
<td>0.52 (0.21, 1.27)</td>
</tr>
<tr>
<td>Njombe</td>
<td>1.34 (0.84, 2.15)</td>
<td>1.20 (0.28, 5.07)</td>
<td>2.36** (1.42, 3.93)</td>
<td>1.24 (0.50, 3.12)</td>
</tr>
<tr>
<td>Shinyanga</td>
<td>0.42** (0.27, 0.65)</td>
<td>0.92 (0.12, 4.00)</td>
<td>0.89 (0.54, 1.45)</td>
<td>0.27** (0.08, 0.91)</td>
</tr>
</tbody>
</table>

** Statistically significant at p=0.05 level
*Statistically significant at p=0.10 level
References


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Curriculum Vitae

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Research Program Assistant, Mar 2017 – May 2017
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Pediatric TB prevention project in South Africa

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Key Populations Program, Johns Hopkins University (Baltimore, MD)
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Jhpiego (Dar es Salaam, Tanzania)
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**PUBLICATIONS, PRESENTATIONS**

