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Risks and predictors of HIV infection among adolescents in conflict regions of Nigeria

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Abstract

Objectives: HIV remains highly prevalent in sub-Saharan Africa, home to approximately 66 % of all people living with HIV and 85 % of children and adolescents living with HIV globally. The region also experiences the highest levels of armed conflict, resulting in a dual burden of violence and infectious diseases like HIV. Despite these challenges, few studies have explored the impact of war and armed conflict on HIV transmission among adolescents in sub-Saharan Africa. To address this gap in the literature, our study examines HIV risk behaviors among adolescents in both conflict and non-conflict zones of Nigeria.

Methods: This was a cross-sectional study of adolescents aged 15–19 years, identified through the Nigeria HIV/AIDS Indicator and Impact Survey (NAIIS). We assessed the prevalence of HIV risk behaviors across the entire country, stratified by conflict zone status. Bivariate associations between risk behaviors and conflict status were evaluated using the chi-square test. To identify factors associated with HIV infection among adolescents, we employed survey-weighted logistic regression models, reporting adjusted odds ratios (AOR) and 95 % confidence intervals (CI).

Results: We analyzed 20,518,667 weighted records of adolescents aged 15–19 years, from both conflict (11 %) and non-conflict zones (89 %) of Nigeria. Despite the majority of adolescents residing in non-conflict zones, we found that high-risk behaviors for HIV, such as the non-use of condoms, were more prevalent in conflict zones. However, transactional sex and having two or more sexual partners were significantly higher among adolescents in non-conflict areas. Notably, the risk of HIV infection was over three times higher among adolescents who did not use condoms during sexual intercourse (AOR: 3.22, CI: 1.13, 9.19; p 0.029). Additional risk factors included younger age, educational status, engagement in transactional sex, and having multiple sexual partners.

Conclusions: This study reports the risk behaviors that contribute to HIV infection among adolescents, particularly within conflict settings. Our findings highlight the link between conflict and heightened HIV risk behaviors among Nigerian adolescents. By identifying these factors and understanding the unique challenges faced by adolescents in conflict zones, more effective, youth-friendly reproductive health programs can be developed for regions impacted by war and conflict.

Keywords: HIV AIDS; adolescents; conflict zones; risk behaviors; condom use; sexual health education

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Introduction

HIV/AIDS has been a major concern for public health officials since the pandemic's emergence in the early 1980s [1]. As of 2023, an estimated 39.9 million people were living with HIV globally, of which one million were adolescents (15–19 years). It is also estimated that about 100,000 children and adolescents die annually from AIDS-related causes globally [2, 3].

In Africa, the incidence of HIV had declined from 1.75 per 1,000 among all ages in 2010 to 0.57 per 1,000 (or a 67 % reduction) by the year 2022 [3]. Despite the observed reduction, sub-Saharan Africa (SSA) remains the region most heavily affected by the HIV epidemic in the world. As of 2022, it accounted for approximately 66 percent of people of all ages living with HIV and 85 percent of children and adolescents living with HIV worldwide [4]. Nigeria, one of the sub-Saharan countries, has the world's fourth-highest burden of HIV/AIDS in the world with an estimated about two million people living with HIV (PLHIV) and 149,244 new infections recorded in 2023 [5, 6]. Out of that, adolescents accounted for about one in four new infections and still have the highest risk of acquiring HIV infection [7, 8].

To curb the spread of HIV and end the pandemic by 2030, UNAIDS developed the 95-95-95 targets [9]. Although progress has been made towards these goals, some countries in SSA still lag and are yet to achieve the first target of having 95 % of PLWH aware of their status [9]. While several factors may have contributed to this failure, one major yet often overlooked explanation is the potential impact of armed conflicts. Armed conflicts in a community or country can profoundly affect the health and behaviors of the residents in those settings [1]. It is universally reported that SSA is the region with the most armed conflicts, refugees, and IDPs in the world leading to a double burden of violence and infectious disease proliferation and propagation [1, 10].

Armed conflicts have a significant negative impact on the health of the populations they affect [11]. Conflicts disrupt people's access to healthcare and their quality of life through political instability, the breakdown of social and healthcare systems, underfunding, insecurity, poverty, a large influx of refugees and internally displaced people (IDPs), as well as the deterioration of already weak health systems [10, 12]. In such situations, patients with HIV are, especially vulnerable because the disease requires strict adherence to treatment, regular HIV care, and a continuous supply of drugs, which in conflict zones, can be very difficult to access [13]. Lack of HIV testing, treatment, and adherence services in conflict zones worsened by stigmatization, governments' lack of political will to expand these services as well as a lack of donor commitment to close the funding gap leads to increased HIV incidence, prevalence, and related morbidity and mortality [14–16].

A study from Libya illustrates the impact of armed conflicts on HIV transmission, revealing significant changes in the virus's prevalence. During the conflict, the movement of IDP from the Eastern to the Western region facilitated the spread of new HIV strains, triggering increased HIV cases in the Western and Central areas of the country [11]. Similarly, Mozambique's HIV prevalence was around 1 % following its civil war from 1975 to 1992, but it increased dramatically in the first decade after the war [17]. Another study from Nigeria revealed that conflict and post-conflict activities involving armed bandits increase the risk of contracting HIV among refugees, people living in IDP camps, and other vulnerable groups, such as women and children in Nigeria [18].

Adolescents living with HIV face worse outcomes across the HIV care continuum compared to adults and children, with lower rates of testing, lesser antiretroviral therapy (ART) coverage, and lower viral suppression [19]. In conflict regions, adolescents face unique vulnerabilities that elevate their risk of contracting HIV [20, 21]. Understanding these risks and the predictors is crucial for developing effective and targeted interventions. The intersection of conflict and adolescence creates a perfect storm for increased HIV risk. Given the nature of HIV among adolescents and the significant impact of armed conflict on its incidence and prevalence, it is crucial to assess the effect of armed conflicts on HIV prevalence in Nigeria, a country that is increasingly challenged by spasmodic and chronic armed skirmishes. Accordingly, this study aims to evaluate the impact of armed conflicts on HIV prevalence and identify the factors associated with the risk of HIV infection among adolescents in conflict-affected regions of Nigeria. Few studies on HIV in SSA have disaggregated results in this manner, making this evaluation particularly important.

Methods

Study design

This was a cross-sectional study conducted among adolescents identified through the Nigeria HIV/AIDS Indicator and Impact Survey (NAIIS). NAIIS is so far the largest HIV survey in the world, conducted from July to December 2018 across 36 states and the Federal Capital Territory of Nigeria. The NAIIS study was a comprehensive, nationwide household-based survey that assessed the burden of HIV and related health indicators, including hepatitis B virus (HBV), hepatitis C virus (HCV), Tuberculosis, and other infections. The primary objective of the NAIIS study was to provide accurate estimates of HIV prevalence and viral load suppression in the Nigerian population. Complete survey methods are described in the NAIIS final report [19].

Sampling

Target population and sampling frame

Our dataset include adolescents aged 15–19 years, as participants under 15 years were not captured in the survey. The survey population excluded military bases and institutionalized children and adults. The sampling frame was comprised of 662,855 Enumeration Areas (EAs), a total of 28,900,478 households, and 140,431,798 persons based on the 2006 Census (the last census in Nigeria), with an average number of families and persons per EA of 44 and 212, respectively. The EAs were mutually exclusive (non-overlapping). This ensured that all families and residents had an equal probability of being included in the survey.

Sampling design

The NAIIS utilized a two-stage, stratified cluster sampling technique to ensure that the sample was representative of Nigeria's diverse demographic and geographic composition. The first stage involved the selection of Enumeration Areas (EAs) using a random sampling method from the National Population Commission's sampling frame. This frame was constructed from the 2006 Population and Housing Census, updated to reflect population changes. In the second stage, households within each selected EA were systematically sampled. This stratified approach aimed at a sample size that could provide reliable estimates at both the national and state levels.

Study variables

Outcome variable

The primary outcome of our analysis was HIV status (positive or negative): HIV status was ascertained using screening and confirmatory tests on blood samples. HIV status was coded one for HIV-positive status and 2 for HIV-negative status.

Explanatory variables

Other important variables in our analysis were: sociodemographic and sexual risk behavior variables which included age (15–19 years), gender (male and female), language (Hausa, Yoruba, Igbo, English, and Others), religion (Islam, Christians, and Others), Marital Status (married or unmarried), Education (no education, primary, secondary, and post-secondary), age at first sex (<15, and 15–19 years), Condom use during the last sexual intercourse in the past 12 months (used condom or did not use a condom), Number of sexual partners (zero partner, one sexual partner, and two or more sexual partners), Transactional sex (yes or no), Zones (conflict or non-conflict), Circumcised (yes or no), Pregnant (yes or no).

Data collection and management

The NAIIS involved 1,935 field staff, including 190 team leaders, 380 interviewers, counselors, drivers, community trackers, and 415 laboratorians. The teams were supervised by a director and supported by five zonal technical advisors. The National HIV Linkage to Care Advisor and 14 field coordinators were also involved in data collection, quality checks, and technical support.

The data collection process for the NAIIS study was a collaborative effort involving various stakeholders, including government agencies, international organizations, and local communities. The survey used structured questionnaires to gather detailed demographic and behavioral information. The questionnaires covered a wide range of topics, including socio-economic status, sexual behavior, HIV testing history, and access to healthcare services. These questionnaires were captured electronically and administered by trained staff during face-to-face interviews conducted in participants' homes. Interviews were conducted in the participants' preferred local languages, with staff interpreting from English where necessary, to ensure accuracy in this multilingual context Biomarker testing was a critical component of the survey. Blood samples were collected from consenting participants to test for HIV and other relevant biomarkers, such as Hepatitis B and C. During the household data collection, questionnaires, and laboratory data were transmitted between tablets via Bluetooth connection. This facilitated the synchronization of household rosters and ensured that data collection for each participant followed the correct pathway. All field data collected in the Census and Survey Processing System (CSPro) and the Laboratory Data Management System (LDMS) were transmitted to a central server using File Transfer Protocol Secure (FTPS) over a 4G or 3G telecommunication provider at least once a day. Data was backed up daily to a secured encrypted portable USB drive stored at a different location. For unmarried participants under the age of 16, parental or guardian consent was obtained before blood testing and interviews. Although participants were also screened for hepatitis B and C, these data are not presented here as the current analysis focuses exclusively on HIV outcomes, not HIV co-infections.

Data analysis

The NAIIS database was previously validated and found to be highly accurate [22]. Data were analyzed using R statistical software (version 4.4.1) with a two-tailed type 1 error rate set at 5 %. All results were weighted to account for the complex survey design. The survey package in R was used to manage the data accounting for sampling weights, clustering, and stratification. Specifically, the "svydesign" function from the survey package corrected for differential selection probabilities within each sample location as specified by the sample design, nonresponse, noncoverage, and sampling error related to the four post-stratification variables, and it also accounted for differences in population size across study locations.

The analysis included participants from all 36 states and the Federal Capital Territory (FCT) of Nigeria. Based on the categorization determined by the security subcommittee of the NAIIS study, as described in a previous publication [23], five states Benue, Borno, Plateau, Yobe, and Zamfara were classified as conflict zones. All other states and the FCT were considered non-conflict zones. We performed a descriptive analysis showing frequencies in numbers and proportions, stratified by conflict and non-conflict zones, to give readers a clearer perspective on participant distribution.To examine the bivariate relationships between HIV status and predictor variables, Chi-square test was used for differences in proportion across categorical variables while Wilcoxon rank-sum test was applied to determine differences between continuous variables, which were all non-parametric. Survey logistic models were also employed to compare the likelihood of test positivity for HIV infections between the two zones. The following covariates were included in the models: conflict (yes or no), age, gender, age at first sex, education, condom use, transactional sex, and number of sexual partners. A forest plot was utilized to visualize the odd ratios (OR).

Ethical consideration

This evaluation was supported by the approved protocol for the Nigeria AIDS Indicator and Impact Survey (NAIIS 2018). Informed consent was obtained from all participants, and the protocol received approval from the U.S. Centers for Disease Control and Prevention (CDC) in Atlanta, GA, USA (protocol #7103), the Institutional Review Board of the University of Maryland, Baltimore, and the Nigerian National Health Research Ethics Committee.

Results

We analyzed a total of **104,213,826** weighted records of individuals that were surveyed. Out of these, **20,518,667** individuals **(20 %)** were classified as adolescents aged 15–19 years as defined in the study. About **2,204,368** of the adolescents **(11 %)** resided in conflict zones while the rest **(18,314,299 or 89 %)** were residents in non-conflict zones. The socio-demographic distribution and risk factors of the surveyed adolescents showed some variation between conflict and non-conflict zones.

Table 1 presents a comparison of differences in socio-demographic characteristics among study participants (conflict vs. non-conflict zones). In both conflict and non-conflict zones, there was a similarity in age, with a mean (±SD) age of 17 (±1) years for both groups. The proportion of males vs. females was also comparable in both zones, with a nearly equal split of approximately **50 %** male and **50 %** female participants **(p=0.2)**. There were notable differences in language spoken between the zones with the Hausa language being more predominant in the conflict zones **(37** vs. **43 %)** while the English language was spoken at a similar

Table 1: Socio-demographic characteristics of adolescents (15–19 years) by conflict status.

Characteristics	Non-conflict zone (n=18,314,299)	Conflict zone (n=2,204,368)	p-Value
Age [16–18, 20, 21] years, mean (±SD)	17 (±1)	17 (±1)	**0.083**[†]
Gender, n (%)			**0.2**
Male	9,430,143 (51 %)	1,100,612 (50 %)	
Female	8,884,156 (49 %)	1,103,756 (50 %)	
Language, n (%)			**<0.001**
English	1,625,560 (8.9 %)	192,968 (8.8 %)	
Hausa	6,734,799 (37 %)	940,950 (43 %)	
Yoruba	3,102,511 (17 %)	4,953 (0.2 %)	
Igbo	2,496,768 (14 %)	5,416 (0.2 %)	
Others	4,354,661 (24 %)	1,060,080 (48 %)	
Religion, n (%)			**<0.001**
Islam	9,688,370 (53 %)	1,299,631 (59 %)	
Christian	8,559,761 (47 %)	892,731 (40 %)	
Others	66,168 (0.4 %)	12,006 (0.5 %)	
Marital status, n (%)			**0.078**
Married	1,867,797 (91 %)	321,135 (94 %)	
Unmarried	182,147 (8.9 %)	20,478 (6.0 %)	
Education, n (%)			**<0.001**
Post-secondary	658,166 (3.8 %)	81,974 (3.9 %)	
Secondary	12,791,029 (74 %)	1,251,357 (60 %)	
Primary	2,006,876 (12 %)	310,456 (15 %)	
No education	1,885,485 (11 %)	433,183 (21 %)	

Chi-squared test was used to derive p-values except as indicated below: [†]Wilcoxon rank-sum test. The bold values illustrate the Socio-demographic characteristics of adolescents (15–19 years) by conflict status.

level. The proportion of Muslims was notably higher in conflict compared to non-conflict zones, while the opposite trend was observed for Christianity. Specifically, the Muslim population was approximately **6 %** greater in areas affected by conflict, whereas the Christian population was approximately **7 %** higher in regions without active conflict. Most adolescents were married regardless of zones of residence, and the proportion was modestly higher in conflict zones (**3 % greater**). Areas affected by conflict were characterized by a considerable discrepancy in educational levels when compared to relatively peaceful regions. The percentage of the adolescent population that had received no formal education was higher in conflict zones, exceeding that found in non-conflict zones by **10 %**. Conversely, the level of secondary education was notably lower in regions plagued by conflict (**14 % lower**), although that of post-secondary education was comparable for both groups. In summary, we observed significant socio-demographic differences between adolescent residents in conflict zones with respect to spoken language, religion, and education, but the two zones were comparable relative to age, gender, and marital status.

Further analysis revealed that adolescents in conflict zones who reported their first sexual encounter between the ages of 15 and 19 years were 6 % more likely to have initiated sexual activity within this age range (Table 2). The prevalence of circumcision among males was found to be high and similar in both conflict and non-conflict zones, with 98 % of adolescents in both zones being circumcised (p 0.7). The proportion of individuals with ≥2 sexual partners was higher in non-conflict zones compared to conflict zones (13 vs. 6.4 %)." Most adolescents in both zones did not use condoms, with a higher percentage in conflict (89 %) than in non-conflict zones (79 %). Conversely, the use of condoms during the last sexual intercourse in the past 12 months was about two-fold greater among adolescents in non-conflict (21 %) compared to those in non-conflict (11 %) zones. Adolescents within non-conflict zones exhibited a 25 % higher frequency of transactional sex compared to their counterparts in conflict zones (15 vs. 12 %). The prevalence of HIV infection was 0.2 % in both zones.

In summary, we observed considerable variation in sexual risk behavior among adolescents living in conflict vs. non-conflict zones with respect to age at first sex, number of sexual partners, condom use, and transactional sex. However, these two zones demonstrate homogeneity in circumcision, pregnancy, and HIV status.

The multivariable analysis of HIV risk factors among adolescents aged 15–19 years revealed several important findings (Table 3 and Figure 1). Residing in conflict zones was not significantly associated with increased HIV risk (AOR: 0.48, CI: 0.16, 1.43; p 0.19). Gender, however, emerged as a critical factor, and the result showed that female adolescents were about 90 % percent less likely to acquire HIV compared to males (AOR: 0.10, CI: 0.02, 0.55; p 0.008). Age was also significant, as older adolescents (15–19 years) had a reduced risk (AOR: 0.52, CI: 0.31, 0.90; p 0.019) of HIV infection compared to younger adolescents. Condom use was a significant protective factor, with adolescents who did not use condoms having over three times the adjusted odds of contracting HIV infection compared to those who used condoms (AOR: 3.22, CI: 1.13, 9.19; p 0.029). Other factors, such as age at first sex, education level, transactional sex, and the number of sexual partners did not show statistically significant associations with HIV risk in adjusted models.

In summary, we found the most significant risk factor for HIV infection among adolescents to be non-use of condoms during sexual intercourse. Female adolescents exhibited a markedly reduced risk for HIV infection

Table 2: HIV risk behaviors among adolescents (15–19 years) in conflict and non-conflict zones.

Characteristics	Non-conflict zone, (n=18,314,299)	Conflict zone, (n=2,204,368)	p-Value
Age at first sex, n (%)			**0.013**
First sex [16–18, 20, 21] years	3,494,428 (69 %)	376,699 (75 %)	
First sex <15 years	1,379,377 (27 %)	114,579 (23 %)	
Unknown	154,520 (3.1 %)	10,151 (2.0 %)	
Circumcised (male), n (%)			**0.7**
Yes	9,038,393 (98 %)	1,075,487 (98 %)	
No	177,909 (1.9 %)	19,544 (1.8 %)	
Pregnant (girls), n (%)			**0.7**
Yes	402,169 (23 %)	53,263 (22 %)	
No	1,346,665 (77 %)	188,461 (78 %)	
Number of sexual partners, n (%)			**<0.001**
Two or more sexual partners	649,716 (13 %)	31,845 (6.4 %)	
One sexual partner	3,433,782 (69 %)	386,277 (77 %)	
Zero sexual partners	924,514 (18 %)	82,282 (16 %)	
Condom use, n (%)			**<0.001**
Used condom	833,460 (21 %)	45,494 (11 %)	
Did not use a condom	3,214,070 (79 %)	370,686 (89 %)	
Transactional sex, n (%)			**0.027**
Yes	623,187 (15 %)	49,199 (12 %)	
No	3,403,455 (85 %)	367,603 (88 %)	
HIV status, n (%)			**0.8**
HIV positive	41,877 (0.2 %)	4,508 (0.2 %)	
HIV negative	18,272,422 (99.8 %)	2,199,860 (99.8 %)	

Chi-squared test was used to derive p-values. The bold values illustrate the Socio-demographic characteristics of adolescents (15–19 years) by conflict status.

Table 3: Predictors of HIV among adolescents living in conflict and non-conflict zones of Nigeria.

Characteristics	AOR[1]	95 % CI[2]	p-value
Zones			**0.19**
Non-conflict zone	Reference	Reference	
Conflict zone	0.48	0.16, 1.43	
Gender			**0.008**
Male	Reference	Reference	
Female	0.10	0.02, 0.55	
Age (15–19 years)	0.52	0.31, 0.90	**0.019**
Age at first sex, years			**0.86**
First sex [16–18, 20, 21]	Reference	Reference	
First sex less than 15	0.75	0.26, 2.21	
Unknown	0.79	0.10, 6.20	
Education			**0.77**
Post-secondary	Reference	Reference	
No education	1.36	0.20, 9.36	
Primary	0.61	0.10, 3.61	
Secondary	0.87	0.17, 4.38	
Condom use			**0.029**
Used condom	Reference	Reference	
Did not use a condom	3.22	1.13, 9.19	
Transactional sex			**0.92**
No	Reference	Reference	
Yes	1.06	0.35, 3.17	
Number of sexual partner			**0.083**
One sexual partner	Reference	Reference	
Two or more sexual partners	0.30	0.07, 1.17	

[1]AOR, adjusted odds ratio, [2]CI, confidence interval. The bold values illustrate the Socio-demographic characteristics of adolescents (15–19 years) by conflict status.

acquisition. The result for the association between residence in conflict zones and the risk of HIV among adolescents was not statistically significant.

Discussion

Certain sexual health risk factors occurred in high frequencies within the adolescent population of Nigeria. The most prominent among them was the high rate of non-utilization of condoms among adolescents irrespective of whether they were from conflict or non-conflict zones (89 vs. 79 %, respectively). Although pre-pubertal sex (at age <15 years) was slightly more frequent in conflict zones (27 vs. 23 %), initiation of sex during the adolescent years [16–18, 20, 21] occurred with greater frequency in the non-conflict than in conflict zones (75 vs. 69 %). The greater frequency of condom non-usage among adolescents living in conflict zones might be indicative of either cultural/religious preference or the non-availability of condoms due to armed conflicts. By contrast, circumcision, a protective factor against HIV acquisition, was nearly universal in both zones (98 %). In the adjusted model, we noted a more than three-fold increase in the risk of HIV as a result of the non-use of condoms during sexual encounters in the adolescent population in Nigeria ((AOR 3.22; CI 1.13, 9.19; p 0.029). This result is in tandem with the findings of the 2020 condom accessibility and use in Nigeria poll conducted by the National Agency for

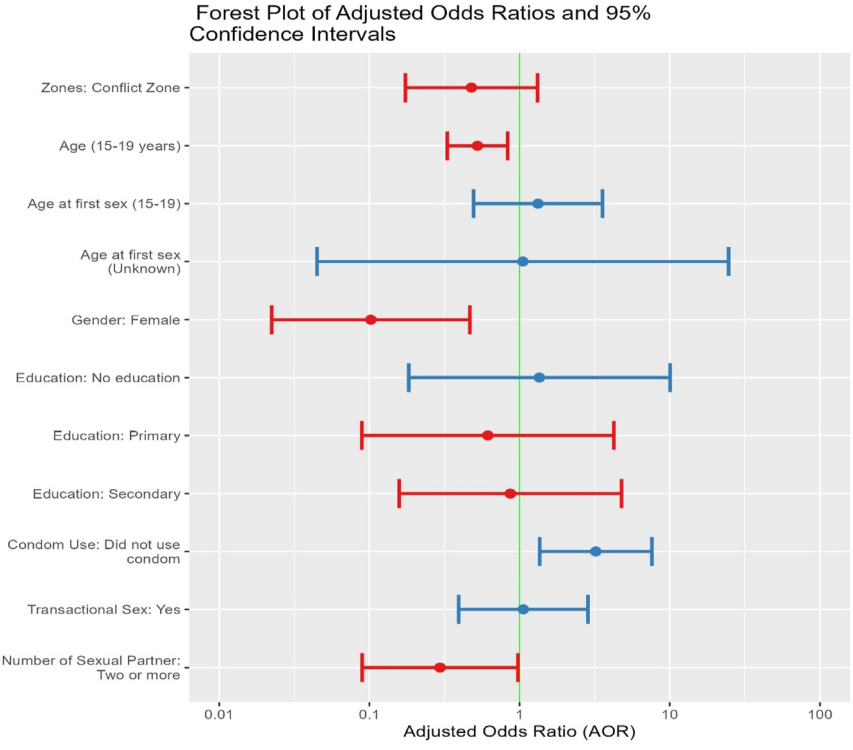

Figure 1: Forest plot of AORs and their 95 % CIs for the logistic regression analysis for the association between conflict zones residence with risk of HIV.

the Control of AIDS and AIDS Healthcare Foundation. The poll reported that only one in four Nigerians used condoms for protection against sexually transmitted diseases [24].

It is apparent from our results that contrary to our expectation, adolescents residing in conflict zones did not portray preponderance of all the considered high-risk sexual behaviors relative to their counterparts living in non-conflict environments. While they exhibited a higher frequency of non-condom use and pre-pubertal sex, they revealed a lower frequency for multiple partners and transactional sex. This could explain the equal risk for HIV among adolescents regardless of the zone of residence in our study. Interestingly, the findings do not agree with other studies linking war and armed conflicts to increased HIV transmission [25]. A plausible explanation could be that the areas designated officially as conflict zones in our report did not manifest features of a warlike situation but were rather areas of relative insecurity to people and properties due to banditry, armed robbery, occasional terrorist attacks, and kidnappings. In many of the zones, armed conflicts with security agencies occurred occasionally but were more likely in remote areas characterized by difficult terrains and other geographical access barriers. Therefore, on the spectrum of conflicts, the insecurity zones in Nigeria most likely depict the milder phenotypes of armed conflicts.

The findings of this study highlight a concerning gap in sexual health awareness among adolescents, which may be responsible for the persistent rise in new HIV infections within this population further blunting the impact of ongoing efforts of HIV epidemic control in the country. An interventional study in Nigeria demonstrated that improved adolescent sexual health knowledge is linked to a reduction in risk behaviors [26]. However, lack of awareness and ignorance remain significant barriers to the utilization of reproductive health services in the country [27]. Therefore, it is crucial to develop culturally and religiously appropriate strategies to enhance sexual health awareness among adolescents in Nigeria, a nation characterized by its rich cultural and religious diversity.

Research has highlighted that early sexual activity among adolescents can lead to significant negative outcomes [28]. Our findings corroborate this by revealing that each additional year of increment in age was associated with a 48 % reduction in the risk of HIV infection during the adolescent years (AOR: 0.52, CI: 0.31–0.90; p 0.019). This is a reflection of the lower vulnerability threshold among younger adolescents who engage in early sexual behavior, placing them at higher risk for HIV infection and the subsequent challenges of accessing optimal HIV care. Adolescents living with HIV experience worse outcomes across the HIV care continuum compared to both adults and children, including lower rates of HIV testing, reduced antiretroviral therapy (ART) coverage and diminished viral suppression rates [29]. Hence, it is imperative that strategies for HIV epidemic control in this population introduce programming during the formative years to discourage engagement in early sexual health risk behaviors. Such strategic interventions need to take into consideration socio-cultural and religious inclinations and taboos that might distinguish conflict vs. non-conflict zones, as demonstrated by differences in social characteristics in our study. We highlight strategies such as strengthening community-based outreach, improving culturally sensitive health education, and integrating sexual and reproductive health services within humanitarian response programs to address the identified cultural and religious barriers.

Limitation

A limitation of this study is the definition of the adolescent population, which was restricted to individuals aged 15–19 years. This constraint limited our ability to determine whether the findings are generalizable to the entire adolescent age spectrum, including younger adolescents. Future studies could consider including younger adolescents, while ensuring ethical safeguards, to provide a more comprehensive understanding of sexual behaviors and HIV risk in this population. Another limitation is that condom use history, and other sexual behaviors were self-reported, introducing the potential for recall and social desirability bias, particularly in stigmatized settings. It is also plausible that participants' knowledge of their HIV status may have influenced their responses. To mitigate these biases, future research could employ triangulated data sources, such as biomarker validation, longitudinal designs, or confidential digital data collection methods, to enhance accuracy. Despite these limitations, our findings align with previous literature, and, to our knowledge, this study remains one of the few to examine the impact of conflict on sexual behaviors and HIV infection among adolescents.

Conclusions

This study demonstrates that adolescents in Nigeria, regardless of residence in conflict or non-conflict zones, face significant sexual health risks, particularly high rates of non-condom use, early sexual initiation, and limited access to sexual and reproductive health services. Contrary to expectations, adolescents in conflict zones did not exhibit uniformly higher risk behaviors, which may reflect the less

intense nature of insecurity in these areas compared to war-affected settings reported in other studies. These findings underscore the urgent need for culturally and religiously appropriate interventions to promote sexual health awareness, delay sexual debut, and increase condom use among adolescents. Future research should explore context-specific strategies to improve access to sexual and reproductive health services in both conflict and non-conflict settings, and evaluate the effectiveness of community-based, youth-friendly, and humanitarian response–integrated approaches to reduce HIV vulnerability in this population.

Data sharing statement

The study data are available upon reasonable request. Deidentified individual participant data, and statistical analysis plans will be made available. Data will be accessible beginning in nine months and ending 36 months following article publication. Access to the data will require a data sharing agreement and will be granted to researchers whose proposed use of the data is approved by an independent ethics committee identified for this purpose. Requests for data sharing can be submitted to the corresponding author (Hamisu.salihu@kirct.com).

Table 1. Socio-demographic characteristics of adolescents (15–19 years) living in conflict and non-conflict zones: This table summarizes participants' key demographic characteristics, including age distribution, sex, education level, marital status, and place of residence, stratified by conflict exposure. Percentages and weighted sample sizes are reported, and chi-square tests were used to assess group differences.

Table 2. HIV risk behaviors among adolescents (15–19 years) in conflict and non-conflict zones: This table presents behavioral risk factors for HIV, such as age at sexual debut, number of sexual partners, condom use, and HIV testing history, with comparisons between zones. Weighted percentages and p-values are included.

Table 3. Predictors of HIV among adolescents living in conflict and non-conflict zones of Nigeria: This table reports adjusted odds ratios (AORs) and 95 % confidence intervals (CIs) from multivariable logistic regression analyses assessing sociodemographic and behavioral predictors of HIV infection.

Figure 1. Forest plot of AORs and their 95 % CIs for the association between residence in conflict zones and HIV risk: This figure visually displays AORs with 95 % CIs for each predictor, allowing for an at-a-glance comparison of HIV risk factors between conflict and non-conflict settings. Notes and abbreviations (AOR, CI, p-values) are clearly defined in each legend for ease of interpretation.

Research ethics: This study was analyzed by the approved protocol for the Nigeria AIDS Indicator and Impact Survey (NAIIS 2018).

Informed consent: Informed consent was obtained from all participants, and the protocol received approval from the U.S. Centers for Disease Control and Prevention (CDC) in Atlanta, GA, USA (protocol #7103), the Institutional Review Board of the University of Maryland, Baltimore, and the Nigerian National Health Research Ethics Committee.

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Data availability: All data files are available from the Nigeria AIDS Indicator and Impact Survey (NAIIS) website, which is obtainable via the Federal Ministry of Health. Contact information for data access is as follows: 1. nada@naiis.ng 2. osajayabs@gmail.com The two email addresses are affiliated with both the Federal Ministry of Health and the Nigeria AIDS Indicator and Impact Survey (NAIIS).

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