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Multi-Dimensional Predictors of HIV PrEP Knowledge, PrEP Acceptability and HIV Testing among Adolescents and Young Adult Men in Ghana

Ikenna Obasi Odii[1], Edson Chipalo[2]

[1]School of Nursing, The University of Alabama at Birmingham, Birmingham, Alabama, USA
[2]Department of Social Work, College of Allied Health Sciences, University of Cincinnati, Cincinnati, Ohio, USA
Email: ioodii@uab.edu

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Abstract

Background: Research on sexuality and HIV prevention among adolescents and young adults (AYA) men are limited despite recent progress in HIV prevention and the low generalized HIV levels in Ghana. **Objectives:** To assess the prevalence of HIV PrEP Knowledge, PrEP Acceptability, HIV Testing, and to identify multi-dimensional factors predicting the knowledge and acceptability of PrEP coupled with HIV testing engagement among adolescents and young adult (AYA) males aged 15 - 24 years in Ghana. **Methods:** The men's dataset of the 2022 Ghana Demographic and Health Survey (n = 2453) were utilized for this study. Descriptive characteristics were summarized using frequencies and proportions. Three sets of multivariate logistic regression models examined the relationship between independent (socio-demographics) and dependent variables (HIV PrEP knowledge, HIV PrEP Acceptability, and HIV testing). **Results:** Among participants aged 15 - 24 years in Ghana, only 15.3% had knowledge of pre-exposure prophylaxis (PrEP), with a low acceptability rate of 32.1%, while merely 8.5% had undergone HIV testing, despite a 49% rate of sexual activity. The logistic regression results suggest significantly lesser odds of HIV PrEP knowledge among participants from the Volta (AOR = 0.21, 95% CI = 0.08 - 0.58, $p = 0.002$), Eastern (AOR = 0.23, 95% CI = 0.10 - 0.57, $p = 0.01$), Western North (AOR = 0.20, 95% CI = 0.08 - 0.49, $p < 0.001$), and Bono East (AOR = 0.29, 95% CI = 0.13 - 0.66, $p = 0.003$) regions. Conversely, there were significantly higher odds of HIV PrEP knowledge among the widowed/separated/divorced (AOR = 3.57, 95% CI = 1.30 - 9.85, $p = .014$), and the participants with a higher education (AOR = 2.60, 95% CI = 1.29 - 5.26, $p = 0.008$). Furthermore, there were significantly lower odds of HIV testing among

participants from the Central region (AOR = 0.37, 95% CI = 0.16 - 0.83, p = 0.016); whereas those aged between 20 - 24 years old (AOR = 2.11, 95% CI = 1.41 - 3.17, $p < 0.001$), had at least a secondary education (AOR = 2.68, 95% CI = 1.23 - 5.85, $p = 0.013$), a higher education (AOR = 7.07, 95% CI = 2.94 - 16.99, $p < 0.001$), and sexually active (AOR = 1.99, 95% CI = 1.37 - 2.90, $p < 0.001$) had significantly higher odds of HIV testing. **Conclusion:** Region, marital status, employment status, religion, and recent sexual activity appear to be relevant predictors of HIV PrEP knowledge, HIV PrEP acceptability, and HIV testing among the AYA population in Ghana; whereas higher education emerged as a sole strongly significant predictor of both HIV PrEP knowledge and HIV testing respectively. Conclusively, safer sex education among young men with no secondary or higher education residing in regions with lower HIV PrEP awareness and HIV testing should be prioritized. Likewise, existing HIV prevention initiatives in Ghana should consider these empirically significant multidimensional predictors as a valuable guide.

Subject Areas

HIV, Infectious Diseases

Keywords

HIV PrEP Knowledge, HIV PrEP Acceptability, HIV Testing, Adolescent and Young Adult Men, Ghana

1. Introduction

Globally, there were 1.3 million new HIV infections worldwide, along with 630,000 AIDS-related deaths in 2022 [1]. These figures suggest that we are falling short of the global target to have less than 370,000 new HIV infections annually by 2025 [1]. Moreover, an estimated 9.2 million people living with HIV did not receive antiretroviral treatment in 2022 [1]. The situation is even more dire for adolescents and young adults (AYA) who account for 37% of the daily new HIV infections worldwide [2].

Compelling evidence suggests that AYAs reach sexual maturity before they develop mental and emotional maturity coupled with the social skills to cope with the consequences of their sexual behaviors [3] [4]. Unfortunately, AYAs typically engage in risky sexual behaviors before they are exposed to comprehensive HIV prevention information, making them one of the key populations with significant behavioral vulnerability to new HIV infection [5]. In spite of the Centers for Disease Control and Prevention recommendation that all persons 13 - 64 years avail themselves of HIV testing at least once during routine healthcare, and more frequently if engaged in activities that heighten the risk of HIV transmission [6], AYAs remain a key vulnerable population to HIV infection. The prevalence data from recent nationally representative studies in Cameroon reveals that 55% of men aged 15 to 24 have never undergone HIV testing, while only a mere 23.7%

had undergone HIV testing in another study involving men in Côte d'Ivoire [7]. Some sexual and behavioral choices made by AYAs increase their vulnerability to HIV transmission risk behaviors, such as inconsistent use of condom, patronage of transactional sex to meet basic needs, older sexual partners who may not afford them condom negotiation opportunity due to unequal power dynamics [8] [9]. Current evidence corroborates the existence of high rate of HIV infection as a result of high prevalence and vulnerability to risky sexual behaviors among AYAs, such as unsafe sexual practices and multiple sexual partnerships coupled with an early sexual debut which in turn pre-disposes them to HIV acquisition [5] [10]. AYAs may also be encumbered by fear of parental consent or simply fear of being judged as being promiscuous if they access PrEP services [11]. Given the higher fluctuations in the structural, behavioral, emotional and biological realities of AYAs, concern abounds regarding the relationship between these factors and their knowledge of HIV pre-exposure prophylaxis (PrEP) and their engagement in HIV testing. HIV PrEP is a bio-medical intervention medication that provides up to 99% protection from HIV infection for those who test HIV negative [12]. Despite its effectiveness with adherence, other concerns persist about PrEP potentially leading to higher levels of risky sexual behavior and reduced use of alternative HIV prevention methods due to the perception of lowered susceptibility to HIV.

Over the years, several laudable efforts have been made in Ghana towards HIV prevention and control as demonstrated by policy directives in the Ghana AIDS commission national HIV and AIDS policy, the consolidated guidelines for HIV care in Ghana, the ABC of HIV PrEP implementation guidelines (second edition 2022) and the 2020-2024 national strategic plan to reduce human rights-related barriers to HIV and TB services [13]. With an estimated HIV prevalence rate of 1.7%, females of reproductive age 15 - 49 years account for 68% of the 345,599 people living with HIV in Ghana [13]. This higher prevalence of HIV among AYA women is consistent with empirical evidence across Sub-Saharan Africa [14] [15]. However, unlike women who have a good chance of their HIV status being identified during antenatal care, AYA males may be a key demographic with undiagnosed HIV infection. Overall, it is estimated that only 72% of people living with HIV actually know their HIV status, leaving 28% who are unaware of their HIV status who might fall in this AYA age group in Ghana [14]. The existence of AYA men who are unaware of their HIV status may be supported by pertinent findings that men account for the greatest gap in HIV prevention and control services throughout Sub-Saharan Africa [16] [17]. Among men in Sub-Saharan Africa, key barriers against male HIV testing have been closely associated with a lack of HIV knowledge, HIV clinic location or practices, confidentiality issues, fear of doing a HIV test and discovering a positive status [18]. Overall, previous research in Ghana indicates that AYA possessing secondary or higher education, or emanating from the richest wealth status had greater odds of engaging in multiple sexual partnerships than those who were poor with primary or no education [19]. Similarly, age and marital status were significantly associated with HIV testing among Ghanian

AYA involved in another study [20]. Within the few recent studies that have examined the knowledge of PrEP in Ghana, a low knowledge of PrEP and morbid fears of harm from PrEP uptake has been reported among sexual and gender minority groups [21] [22]. This is unsurprising given that a recent US based study also found higher PrEP willingness among sexual minority youth in college in spite of concerns over the [23]. Beyond Ghana, findings from east and southern Africa determined that the initiation of PrEP among AYA may lead to unprotected sex, reduced condom usage, having multiple partners, early sexual debut, neglect of alternative prevention methods, relying solely on PrEP or uncertainty about the HIV status of sexual partners [24].

Research Gaps and Purpose of the Study

Previous studies focusing on HIV PrEP in Ghana have focused on sexual and gender minority men [21] [22] [25], female sex workers [26], and sexually-active adults 18 years and above [27]. There are several gaps in the literature regarding HIV PrEP and HIV testing in Ghana. First, there is a lack of recent HIV PrEP research using recent nationally representative data in order to reflect newer investments in PrEP services and the HIV prevention trends showing the emerging low level of generalized HIV in Ghana which have impacted the science in this field. Second, previous HIV PrEP studies in Ghana have used mainly qualitative methods in their studies which curtails the recruitment of very large sample size that facilitate greater generalization of the findings from the accessible population to the general population. Third, the best available evidence has not focused their PrEP research solely on AYA or examined PrEP and HIV testing concurrently in the same study in Ghana. Therefore, to the best of our knowledge, this study is the first to utilize the 2022 Ghana Demographic and Health Survey, a nationally representative sample, in examining the predictors of HIV PrEP knowledge and HIV testing among AYA men aged 15 - 24 years in Ghana. The following research questions will be addressed: 1) What is the prevalence of HIV PrEP knowledge and HIV testing engagement among male AYA aged 15 - 24 years in Ghana? and, 2) what are the significant predictors of HIV PrEP knowledge and HIV testing among AYA men in Ghana aged 15 - 24 years?

2. Methods

2.1. Study Design and Setting

This study is both a population-based nationally representative study and a secondary cross-sectional study based on the 2022 Ghana Demographic and Health Survey (GDHS) which originally adopted a cross-sectional study design, across communities in Ghana [28]. The 2022 Ghana Demographic and Health Survey (GDHS) collected national demographic and health data from a representative sample of 18,540 households across all 16 regions, with a 99% household response rate and a 97% response rate for individual male interviews. This survey aligns with previous GDHS surveys and contributes to the global repository of

population-based data for Ghana and other developing countries.

2.2. Data Source and Study Population

The Ghana Statistical Service (GSS) executed the 2022 Ghana Demographic and Health Survey (GDHS) from October 17, 2022, to January 14, 2023 [28]. This study utilized data from the men's questionnaire of the 2022 GDHS, covering topics such as HIV knowledge, transmission modes, stigma, and testing history, with participants aged 15 to 59 from 17,933 households. Technical assistance for the survey was provided by Inner City Fund (ICF) through The Demographic and Health Survey Program (DHS), and others, while the study focused specifically on adolescents and young adults aged 15 to 24.

2.3. Sample Size and Sampling Procedures

The sampling frame utilized for the 2022 GDHS is the revised framework developed by GSS, relying on data from the 2021 Population and Housing Census [28]. Originally, interviews were conducted with 17,933 households among 7044 men aged 15 to 59 in the GDHS [28]. In the current study, only 2453 adolescents and young adults aged 15 - 24 years in Ghana were selected and included in the analysis. The 2022 GDHS used a stratified two-stage cluster sampling method to ensure nationally representative data across urban and rural areas within each of Ghana's 16 regions. After selecting 618 clusters using probability proportional to size (PPS), a systematic random sampling of households was conducted, with 30 households from each cluster chosen for interviews, supported by GPS technology and digital tools for accurate data collection.

2.4. Inclusion Criteria

Adolescent and young adult men aged 15 to 24 years in Ghana.

2.5. Exclusion Criteria

Men aged below 15 years or 25 years and above, and women in Ghana.

2.6. Data Quality Control

Before data collection, a pretest was conducted by the DHS, followed by questionnaire adjustments and translation into Twi, Ga, and Ewe, with back translations to ensure accuracy. After finalizing the questionnaires, ICF and GSS staff developed manuals and fieldwork control forms to guide interviewers and supervisors, ensuring smooth survey execution and effective training. Further information on the data-collection procedure can be found on https://www.dhsprogram.com/.

2.7. Ethical Considerations

Permission to use the GDHS datasets was granted by the DHS Inner City Fund International (ICF), with approval received on November 27, 2023. The study adhered to ethical standards set by both the Ghana Health Service Ethical Review

Committee and the ICF Institutional Review Board, ensuring informed consent, confidentiality, and compliance with the Declaration of Helsinki.

2.8. Data Analysis

In the present study, we conducted descriptive statistics by computing and tabulating frequencies and proportions of the socio-demographic variables due to the categorical nature of the variables. Three sets of multivariate logistic regression analysis were performed to ascertain the association across various dependent variables (HIV PrEP awareness, PrEP acceptability, and HIV testing), and independent variables (socio-demographic factors) among adolescents and young adults in Ghana. The odds ratios (OR) and 95% confidence interval was used to determine the probability or likelihood. The data analysis utilized the IBM Statistical Package for the Social Sciences (IBM SPSS version 29), and the statistical significance was set at $p < 0.05$.

3. Measures

3.1. Dependent Variables

There are three sets of dependent variables that were assessed in this study: knowledge of HIV PrEP, acceptability of HIV PrEP, and HIV testing status. Given the importance of a HIV negative status as a condition for PrEP initiation and continued use; 1) knowledge of HIV PrEP was assessed by asking participants the following questions: "Have you heard about PrEP used to prevent someone from getting infected with HIV?" 2) Acceptability of HIV PrEP was assessed by asking the participants, "Do you approve of the use of PrEP?" and, HIV testing status was assessed by asking the participants: "I don't want to know the results, but have you ever been tested for HIV?" All the three variables were coded dichotomously as "yes" or "no".

3.2. Independent Variables

Sociodemographic characteristics cross-cutting biographic (age), structural (region and resident), social/behavioral (marital status, employment, and recent sexual activity), educational (level of education), and religious (religion) dimensions were chosen because of their dominance in the literature and their availability in the DHS dataset. Sociodemographic characteristics examined were region, resident type, age, marital status, education, employment, religion, and recent sexual activity in the current study. Region was assessed by asking the participants: "Before you moved here, which province did you live in?" This was categorized as Western, Central, Greater Accra, Volta, Eastern, Ashanti, Western North, Ahafo, Bono, Bono East, Oti, Northern, Savannah, North East, Upper East, and Upper West regions. Resident type was assessed by asking the participants: Before you moved here, did you live in another city, in a town, or in a village? This was binary coded as 1 = urban, and 2 = rural. Age was assessed by asking participants: "How old were you on your last birthday? In the original survey, this was coded as 1 =

15 - 19 years old, 2 = 20 - 24 years old, 3 = 25 - 29 years old, 4 = 30 - 34 years old, 5 = 35 - 39 years old, 6 = 40 - 44 years old, 7 = 45 - 49, 8 = 50 - 54 years old, 9 = 55 - 59 years old." In the current study, age groups were recoded into two categories only as 1 = 15 - 19 years old, and 2 = 20 - 24 years old to reflect the study population (adolescents and young adults).

To determine the marital status, the participants were asked the following question, "What is your marital status?" Initially, responses were coded as follows: 0 = never in union, 1 = married, 2 = living with partner, 3 = widowed, 4 = divorced, 5 = no longer living together/separated. In the current study, marital status was recoded thus, "0 = single, 1 = married, 2 = cohabitation, 3 = widowed, divorced, and separated". Education level was gauged by asking participants, "What is the highest level of school you attended?" The original categories included 0 = no education, 1 = pre-primary, 2 = primary, 3 = middle, 4 = JSS/JHS, 5 = secondary, 6 = SSS/SHS, 7 = Higher, and 8 = Don't know. Educational level was re-coded thus, "0 = no education/don't know/pre-primary, 1 = primary/middle/JSS, 2 = secondary/SSS/SHS and 3 = higher education. Employment status was determined by asking, "Are you currently working?" This was dichotomously coded as 0 = no, and 1 = yes in the present study and was the same in the original code. Religion was assessed through the question, "What is your religion?" Initially, the survey coded responses as 1 = Catholic, 2 = Anglican, 3 = Methodist, 4 = Presbyterian, 5 = Pentecostal/Charismatic, 6 = Other Christian, 7 = Islam, 8 = Traditionalist/Spiritualist, and 95 = No Religion. In this study, religion was re-coded thus, "Traditionalist/Spiritualist/No religion = 1, Christian = 2, Islam = 3. Recent sexual activity was assessed by asking the participants: "I would like to ask you about your recent sexual activity. When was the last time you had sexual intercourse?" This was coded as 0 = No (Never had sex) and 1 = Yes (Active in last four weeks and not active in last four weeks).

4. Results

4.1. Sociodemographic Characteristics of the Study Participant

Table 1. Sociodemographic characteristics of the participants (N = 2453).

Variables	N	%
Region		
Western	144	5.9
Central	180	7.3
Greater Accra	129	5.3
Volta	110	4.5
Eastern	131	5.3
Ashanti	192	7.8
Western North	136	5.5
Ahafo	125	5.1

Continued

Bono	122	5.0
Bono East	161	6.6
OTI	179	7.3
Northern	177	7.2
Savannah	197	8.0
North East	153	6.2
Upper East	172	7.0
Upper West	145	5.9
Resident Type		
Urban	1115	45.5
Rural	1338	54.5
Age Group (Years)		
15 - 19	1430	58.3
20 - 24	1023	41.7
Marital Status		
Never Married	2258	92.1
Married	111	4.5
Cohabitation	62	2.5
Widowed/Separated/Divorced	22	0.9
Education		
No Education/Don't Know/Pre-primary	176	7.2
Primary/Middle/JSS	1406	57.3
Secondary/SSS/SHS	735	30
Higher	136	5.5
Employment		
Not Employed	881	35.9
Employed	1572	64.1
Religion		
Traditionalist/Spiritualist/No religion	186	7.6
Christian	1591	64.9
Islam	676	27.6
Recent Sexual Activity		
Never had sex	1250	51
Sexually Active	1203	49
Knowledge of HIV PrEP		
No Knowledge (haven't heard)	1934	84.7
Yes, had knowledge (heard)	349	15.3

Continued

Acceptability of PrEP		
No (Don't Approve)	237	67.9
Yes (Approve)	112	32.1
HIV Testing		
No (Never tested)	2245	91.5
Yes (Tested)	208	8.5

Table 1 shows that the AYA population (N = 2453) were mostly composed of participants from Savannah (8%), Ashanti (7.8%), Oti (7.3%), Central (7.3%), Northern (7.2%), and Upper East (7%). Most participants were mainly drawn from the rural areas (54.5%), aged 15 - 19 years (58.3%), overwhelmingly never married (92.1%), primary/Middle/JSS educated (57.3%), employed (64.1%), and Christian (64.9%). Nearly an equal number of participants were sexually active (49%), while 51% reported they never had sex. Furthermore, a mere 15.3% had knowledge of the existence of HIV PrEP, out of which only 32.1% approved of PrEP (acceptability). Overall, only 8.5% had tested for HIV among this sample in Ghana, whereas an overwhelming number of participants never tested for HIV (see Table 1).

4.2. The Relationship Between Sociodemographic Predictors, HIV PrEP Knowledge, HIV PrEP Acceptability (Approval) and Ever Tested for HIV

The Results of the logistic regression with three models outlines the relationship between the sociodemographic factors (region, resident type, age group, marital status, educational level, employment status, religion, and recent sexual activity), and HIV PrEP knowledge, HIV PrEP acceptability, and HIV testing among AYA males aged 15-24 years old in Ghana (see Table 2). Firstly, there was a statistically significant relationship between knowledge of HIV PrEP, and originating from Volta ($p = 0.002$), Eastern ($p = 0.001$), Western North ($p < 0.001$), Bono East ($p = 0.003$), being widowed/separated/divorced ($p = 0.014$), having a higher than secondary school education ($p = 0.008$). Likewise, originating from the Central region ($p = 0.016$), being within ages 20-24 years ($p < 0.001$), having a secondary or higher education ($p = 0.013$), being sexually active ($p < 0.001$), showed statistical significance with HIV testing. Conversely, no statistically significant relationship was found between any of the sociodemographic factors and HIV PrEP acceptability.

Regarding the regression analysis for HIV PrEP knowledge (see Table 2), Model 1 shows that participants from Central (AOR = 1.31, 95% CI = 0.74 - 2.30), Northern (AOR = 1.13, 95% CI = 0.59 - 2.15), Savannah (AOR = 1.28, 95% CI = 0.68 - 2.41), North East (AOR = 1.41, 95% CI = 0.73 - 2.70), Upper East (AOR = 1.47, 95% CI = 0.82 - 2.62), and Upper West (AOR = 1.13, 95% CI = 0.59 - 2.15) had higher odds of having PrEP knowledge than residing in the Western region.

Similarly, residing in rural areas (AOR = 1.19, 95% CI = 0.92 - 1.55), aged between 20 - 24 (AOR = 1.13, 95% CI = 0.83 - 1.53), married (AOR = 1.02, 95% CI = 0.58 - 1.8), cohabitation (AOR = 1.06, 95% CI = 0.53 - 2.1), widowed/separated/divorced (AOR = 3.57, 95% CI = 1.30 - 9.85), secondary education (AOR = 1.31, 95% CI = 0.73 - 2.35), higher education (AOR = 2.60, 95% CI = 1.29 - 5.26), employed (AOR = 1.26, 95% CI = 0.96 - 1.67), Christian (AOR = 1.07, 95% CI = 0.66 - 1.72), and sexually active (AOR = 1.26, 95% CI = 0.95 - 1.66) were all associated with higher odds of having knowledge about HIV PrEP.

In model 2, residing in Western North (AOR = 1.30, 95% CI = 0.21 - 8.11), Ahafo (AOR = 2.65, 95% CI = 0.76 - 9.22), Bono (AOR = 1.63, 95% CI = 0.46 - 5.70), and Upper West (AOR = 2.49, 95% CI = 0.74 - 8.3) were associated with higher odds of PrEP acceptability or approval. Furthermore, residing in rural areas (AOR = 1.00, 95% CI = 0.57 - 1.74), married (AOR = 1.24, 95% CI = 0.40 - 3.90), cohabitation (AOR = 1.73, 95% CI = 0.38 - 7.90), widowed/separated/divorced (AOR = 1.36, 95% CI = 0.20 - 9.14), employed (AOR = 1.03, 95% CI = 0.58 - 1.82), Christian (AOR = 3.07, 95% CI = 0.92 - 10.29), Islam (AOR = 2.89, 95% CI = 0.80 - 10.43) and recent sexual activity (AOR = 1.04, 95% CI = 0.59 - 1.85) were associated with higher odds of HIV PrEP approval or acceptability.

Model 3 indicates that there were higher odds of testing for HIV among participants from North East (AOR = 1.03, 95% CI = 0.45 - 2.38), and Upper East (AOR = 1.17, 95% CI = 0.57 - 2.41) compared to participants from Western region. Moreover, AYA between ages 20 - 24 years (AOR = 2.11, 95% CI = 1.41 - 3.17), married (AOR = 1.26, 95% CI = 0.65 - 2.44), cohabitation (AOR = 1.24, 95% CI = 0.55 - 2.77), widowed/separated/divorced (AOR = 2.19, 95% CI = 0.73 - 6.56), secondary education (AOR = 2.68, 95% CI = 1.23 - 5.85), higher education (AOR = 7.07, 95% CI = 2.94 - 16.99), employed (AOR = 1.18, 95% CI = 0.82 - 1.70), Christian (AOR = 1.20, 95% CI = 0.60 - 2.40) and were recently sexually active (AOR = 1.99, 95% CI = 1.37 - 2.90) had higher odds of testing for HIV (see Table 2).

Table 2. Logistic regression results showing the relationship between sociodemographic predictors, HIV PrEP knowledge, HIV PrEP acceptability (approval) and ever tested for HIV.

Variable	PrEP Knowledge, PrEP Acceptability, and HIV Testing		
	Model 1 HIV PrEP Knowledge AOR (95% C.I)	Model 2 HIV PrEP Acceptability AOR (95% C.I)	Model 3 HIV Testing AOR (95% C.I)
Region			
Western	Ref	Ref	Ref
Central	1.31 (0.74 - 2.30)	0.47 (0.15 - 1.49)	0.37 (0.16 - 0.83)*
Greater Accra	0.65 (0.33 - 1.28)	0.78 (0.21 - 2.94)	0.66 (0.31 - 1.42)
Volta	0.21 (0.08 - 0.58)**	0.97 (0.12 - 7.70)	0.63 (0.25 - 1.56)

Continued

Eastern	0.23 (0.10 - 0.57)**	0.34 (0.03 - 3.36)	0.60 (0.26 - 1.41)
Ashanti	0.82 (0.46 - 1.48)	0.38 (0.11 - 1.35)	0.70 (0.34 - 1.40)
Western North	0.20 (0.08 - 0.49)***	1.30 (0.21 - 8.11)	0.73 (0.33 - 1.62)
Ahafo	0.90 (0.46 - 1.69)	2.65 (0.76 - 9.22)	0.38 (0.15 - 0.99)
Bono	0.93 (0.48 - 1.80)	1.63 (0.46 - 5.70)	0.54 (0.22 - 1.30)
Bono East	0.29 (0.13 - 0.66)**	0.81 (0.15 - 4.40)	0.76 (0.35 - 1.68)
Oti	0.55 (0.29 - 1.06)	1.71 (0.18 - 2.84)	0.49 (0.22 - 1.12)
Northern	1.13 (0.59 - 2.15)	0.70 (0.20 - 2.45)	0.62 (0.27 - 1.45)
Savannah	1.28 (0.68 - 2.41)	0.70 (0.20 - 2.41)	0.50 (0.21 - 1.21)
North East	1.41 (0.73 - 2.70)	0.47 (0.13 - 1.76)	1.03 (0.45 - 2.38)
Upper East	1.47 (0.82 - 2.62)	0.97 (0.32 - 2.90)	1.17 (0.57 - 2.41)
Upper West	1.13 (0.59 - 2.15)	2.49 (0.74 - 8.3)	0.42 (0.15 - 1.15)
Resident Type			
Urban	Ref	Ref	Ref
Rural	1.19 (0.92 - 1.55)	1.00 (0.57 - 1.74)	0.90 (0.64 - 1.25)
Age Group			
15 - 19	Ref	Ref	Ref
20 - 24	1.13 (0.83 - 1.53)	0.61 (0.34 - 1.11)	2.11 (1.41 - 3.17)***
Marital Status			
Never	Ref	Ref	Ref
Married	1.02 (0.58 - 1.8)	1.24 (0.40 - 3.90)	1.26 (0.65 - 2.44)
Cohabitation	1.06 (0.53 - 2.1)	1.73 (0.38 - 7.90)	1.24 (0.55 - 2.77)
Widow/Separate/Divorce	3.57 (1.30 - 9.85)*	1.36 (0.20 - 9.14)	2.19 (0.73 - 6.56)
Education			
No Education/Don't Know/Pre-primary	Ref	Ref	Ref
Primary/Middle/JSS	0.97 (0.56 - 1.70)	0.63 (0.19 - 2.10)	0.92 (0.42 - 2.01)
Secondary/SSS/SHS	1.31 (0.73 - 2.35)	0.75 (0.22 - 2.59)	2.68 (1.23 - 5.85)*
Higher	2.60 (1.29 - 5.26)**	0.91 (0.21 - 3.93)	7.07 (2.94 - 16.99)***
Employment			
Not Employed	Ref	Ref	Ref
Employed	1.26 (0.96 - 1.67)	1.03 (0.58 - 1.82)	1.18 (0.82 - 1.70)
Religion			
Traditionalist/Spiritual-ist/No Religion	Ref	Ref	Ref
Christian	1.07 (0.66 - 1.72)	3.07 (0.92 - 10.29)	1.20 (0.60 - 2.40)
Islam	0.74 (0.44 - 1.24)	2.89 (0.80 - 10.43)	0.99 (0.47 - 2.08)

Continued

Recent Sexual Activity			
Never had sex	Ref	Ref	Ref
Sexually active	1.26 (0.95 - 1.66)	1.04 (0.59 - 1.85)	1.99 (1.37 - 2.90)***

*=$p < 0.05$, **=$p < 0.01$, ***=$p < 0.001$. PrEP = Pre-Exposure Prophylaxis, AOR = Adjusted Odd Ratio, CI = Confidence Intervals, Model 1 = HIV PrEP knowledge is analyzed as an outcome variable, Model 2 = HIV PrEP acceptability is analyzed as an outcome, and Model 3 = HIV testing is analyzed as an outcome. Ref = Reference comparison group.

5. Discussion

This nationally-representative study aimed to identify factors predicting PrEP knowledge, acceptability, and HIV testing engagement among adolescent and young adult males (AYA) aged 15 - 24 years in Ghana, using the most recent GDHS data. Our findings are notable, as previous research on PrEP has not specifically focused on this demographic, revealing key insights into their health-seeking behaviors.

Our findings align well with existing studies among men and AYA with similar nationally representative sample in Sub-Saharan African countries of Ghana, Cote d'Ivoire, Cameroon, and South Africa which found lower levels of HIV PrEP knowledge, acceptability and low testing for HIV [7] [25] [29]. Similarly, a South African study found that low PrEP knowledge was the most consequential barrier to PrEP willingness among young people [29]. Other key populations at risk for HIV infection that were recently studied within Sub-Saharan Africa such as female sex workers, sexual and gender minority groups also share a similar trend regarding low HIV PrEP knowledge but high acceptability following PrEP awareness [22] [30]. Given the high rate of sexual activity in these group of male populations amidst poor HIV PrEP knowledge and HIV testing, there is urgent need to launch multifarious HIV prevention manifesto for young men across Ghana and beyond. At present, the African women HIV prevention community accountability board has launched a HIV prevention choice manifesto for women and girls in Africa which focuses on tackling inequalities for girls and women, expanding access to newer PrEP options such as long-acting HIV PrEP and flexible silicone vaginal ring, and enhancing women leadership in HIV prevention [31]. This should be replicated across Africa for AYA men starting with Ghana in order to stem the tide on new HIV infection and transmission in this demographic all through Africa. Carrying AYA men along in specialized new HIV preventive interventions will be a useful transformational step in the overall reduction in HIV prevalence, and AIDS mortality for Sub-Saharan Africa. Given that men account for the greatest gap in HIV prevention and control services throughout Sub-Saharan Africa [16], more specialized interventions for AYA men would be quite strategic. Providing PrEP alongside other prevention strategies within existing adolescent sexual and reproductive health initiatives, coupled with information and support, can mitigate potential health risks associated with PrEP initiation, thereby fostering healthy sexual behavior changes [24] [32].

In relation to knowledge of HIV PrEP, this study found statistically significant relationships for participants originating from Volta, Eastern, Western North, Bono East, being widowed/separated/divorced, and having a higher than secondary school education. Similarly, for HIV testing, originating from the Central region, being within ages 20 - 24 years, having a secondary or higher education and being sexually active, showed statistical significance in the study. These findings are congruent with a previous study in Ghana which found statistical significance between HIV testing, and age and marital status among AYA [20]. Beyond Ghana, existing studies in Cameroon, Congo, Nigeria, Uganda, and Mozambique, also found age and higher education as significant predictors of HIV testing [7] [33] [34]. However, this current study found a noteworthy lack of any statistically significant relationship between the sociodemographic factors, and HIV PrEP acceptability, which appears to be a consequence of the low PrEP knowledge finding among this AYA male population in Ghana. This is slightly different for other key populations such as female sex workers and sexual/gender minority groups where PrEP acceptability is demonstrably higher [22] [30] [35] and stands out as a key difference between this current study and previous recent studies in Ghana. In this current study, the findings regarding low HIV PrEP knowledge, acceptability, and HIV testing highlight the need to be innovative in rolling out PrEP in such a way that it reverses the existing trend and coincides with AYA readiness for sex or important milestones. Guilamo-Ramos *et al.* [36] opines that sexual reproductive health outcomes among youths are improved when parental support is harnessed for AYA, particularly as they navigate important milestones and socio-cognitive emotional maturity. It is a call for the return of family values where parents take a special interest in guiding AYA males through their readiness for sex and condom use behavior in order to ensure a safe sexual reproductive health outcome. Consequently, parents can play a critical role in teaching their AYA about PrEP as a protective mechanism should they become sexually active.

Another notable finding in this study is that the social demographic predictors cross-cuts HIV PrEP knowledge, HIV PrEP acceptability, and HIV testing were the region, marital status, employment status, religion and recent sexual activity. Likewise, having a higher education was a highly unique significant predictor of both HIV PrEP knowledge and HIV testing respectively. Specifically, participants who originated from the Volta, Eastern, Western North, Bono East, were widowed/separated/divorced, and had higher education than secondary education, all had higher odds of HIV PrEP knowledge than participants from the Western region of Ghana. Certain prior studies found correlation between marital status and higher knowledge of HIV prevention similar to the current study suggesting that sexual behavioral health outcomes may be improved within the confines of marital experience [37]-[39]. Moreover, the current findings are also consistent with previous studies among young men that found higher odds of HIV testing among men with a higher education [7] [37]. This suggests that comprehensive PrEP counseling should be re-enforced as a HIV prevention strategy in Ghana so as to appeal to the educated group of AYA men to engage in routine HIV testing, while

health authorities continue focusing on using community level structures in reaching the less educated population. A recent study also found that a highly sexually active population of young men aged 15 - 24 years engaged in multiple sexual relationships without requisite knowledge of their HIV status or PrEP in Cote d'Ivoire [40], which aligns with our current finding that recent sexual activity was a significant predictor of both HIV testing and HIV PrEP knowledge. Therefore, measures should be put in place to translate the predictors of PrEP and HIV testing into building social peer networks of support groups which can champion safe sex practices, make it easier for men to initiate PrEP, drive up phone reminders for peers who are on PrEP or could benefit from them, and advocate for participation in adherence counseling for AYA men. Structural issues such as providing youth friendly PrEP clinics and staff training to increase familiarity with PrEP protocols, should be urgently addressed particularly for regions with lower PrEP knowledge and HIV testing. Shifting cultural narratives from ignorance to empowerment and supporting accurate self-assessment during important milestones of AYAs are essential for effectively addressing their sexual reproductive health outcomes. This involves investing in nationwide media campaigns for clear PrEP dissemination and formal/informal community-based initiatives, guided by targeted messaging to both heterosexual, sexual or gender minorities, and rigorous routine appraisal of these measures.

Proactively, emerging technologies and artificial intelligence such as the NASSS (Non-adoption, Abandonment, Scale-up, Spread and Sustainability) framework and the Human Behavior-Change Project (HBCP), can be adopted and utilized to speed up evidence synthesis in real-time in order to effect health behavioral change among the AYA male population in Ghana [41]. NASSS comprises six domains, encompassing the illness or condition, technology, value proposition, intended adopters, organization (s), and the wider system, supplemented by a seventh domain examining their evolution over time [42]. Evidence exists of their use in the past for smoking cessation [43] and physical activity interventions [44] which indicates that HIV testing behavior and PrEP acceptability can be improved with technology and artificial intelligence. The NASSS framework is being seriously considered in Zimbabwe by generating evidence from key stakeholders' perspectives on the adoption of telehealth in HIV care [45]. Ghana can do the same while strengthening existing interventions such as: i) health staff training about PrEP, broad social marketing campaigns, ii) scaled-up community-based outreaches to Greater Accra, Ashanti, Ahafo, Bono, Oti, Northern, Savannah, North East, Upper East, and Upper West regions with lower odds of HIV PrEP knowledge and HIV testing, and iii) integrating PrEP into school-based curriculum and services targeted at the AYA population so as to improve their overall reproductive health outcomes.

6. Limitations and Strengths of the Study

Given the secondary nature of this research and based on the observational study design adopted during primary data collection, flaws associated with social

desirability bias may impact the current study. Participants may have either underreported information or been subject to recall bias, factors which could potentially impact the outcomes of the current study. Moreover, the study's cross-sectional framework suggests it lacks the capacity to conclusively establish or imply a causal inference between HIV PrEP, acceptability of HIV PrEP, HIV testing, and socio-demographic predictors. Furthermore, considering that the sample utilized for this study were derived from the larger men's dataset (ages 15 - 59), the item pool in the measures may have been too broad or rigorous or not tailored to AYAs particularly the youngest group (ages 15 - 19) which may have impacted their responses.

To comprehensively evaluate sexual reproductive health outcomes among AYAs in Ghana for both genders, future studies should focus on studying both male and female AYAs in Ghana concurrently.

Conversely, this study boasts of several strengths. To the best of our knowledge, this is the first study to examine HIV PrEP knowledge, HIV PrEP acceptability, and HIV testing concurrently among AYA men in Ghana using the newest nationally representative 2022 GDHS, and therefore the best available evidence in the field for Ghana. Secondly, the findings enjoy the advantage of generalizability to the male AYA population in Ghana considering the large nationally representative sample size. Thirdly, the quantitative methods adopted in analyzing the findings contrasts methodologically with existing studies on HIV PrEP in Ghana which mostly utilized qualitative methods. Fourthly, the focus on the general AYA male population without partitioning the sample into behavioral, sexual and gender identities, would give a better overall insight into HIV prevention evidence in Ghana.

7. Conclusion

This study found low knowledge of PrEP, low PrEP acceptability, and low HIV testing among AYA men in Ghana, with higher education being a significant predictor of both PrEP knowledge and HIV testing. Key socio-demographic factors, such as region, marital status, and sexual activity, were identified as predictors for HIV-related outcomes, while no significant associations were found between PrEP acceptability and these factors. The findings highlight the importance of formal and informal HIV prevention interventions tailored to these multi-dimensional predictors to improve sexual health outcomes for AYA men in Ghana.

Consent for Publication

All authors participated in the final revision and were consented prior to final manuscript submission.

Availability of Data and Materials

All data for this study are provided in this document, and the comprehensive dataset is freely available through the https://www.dhsprogram.com/ website.

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Authors' Contributions

I.O.O conceptualized the article and wrote the initial draft of the article. E.C reviewed the article for methodological rigor. Both I.O.O and E.C approved the final version and I.O.O submitted the final version on behalf of the team.

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Authors' Information

Ikenna Obasi Odii, MSN, BSN, is a PhD Candidate & Graduate Teaching Assistant at the School of Nursing, University of Alabama at Birmingham, Alabama, USA.

Edson Chipalo PhD, MSW, is an Assistant Professor at the Department of Social Work, College of Allied Health Sciences, University of Cincinnati Ohio, USA.

Conflicts of Interest

The authors declare that they have no competing interests.

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