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Seroprevalence of the Human Papillomavirus IgG Antibodies and the Associated Factors Among Female Adolescents in Gombe, North-Eastern Nigeria: A Pre-Vaccine Roll-Out Survey

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Abstract

Background: Human papillomavirus (HPV) vaccination before sexual debut offers the best protection against cervical cancer. Baseline seroprevalence data are needed to guide the timing of vaccination programmes.

Objectives: To determine the HPV IgG antibody seroprevalence and identify associated factors among Nigerian female secondary school adolescents.

Methods: In this cross-sectional study, 384 female adolescents aged 10–19 years were recruited by multistage sampling from secondary schools in Gombe Local Government Area between January and June 2022. A structured questionnaire was used to capture socio-demographic and risk factor data. Serum samples were tested for HPV IgG antibodies using an enzyme-linked immunosorbent assay.

Results: The overall HPV IgG antibody seroprevalence was 9.4% (36/384). No seropositive participant was found in the 10–13 years old group (0/72) compared to 22.3% (23/103) among 17–19 years olds ($p < 0.001$). On multivariate analysis, age 17–19 years ([AOR] = 2.66; 95% CI: 1.18–6.01) and history of sexual activity (AOR = 19.05; 95% CI: 5.22–69.54) were independent predictors of seropositivity.

Conclusion: HPV IgG seronegativity was universal in the early adolescence group, while seropositivity increased markedly in late adolescence. These findings support the rationale for prioritising girls younger than 14 years in Nigeria's national HPV vaccination programme, as vaccination before natural HPV exposure offers the greatest preventive effectiveness.

Keywords: Cervical cancer, ELISA, Immunoglobulin G, Sexual debut, Sexually Transmitted Infections, Vaccination.

Introduction

Human papillomavirus (HPV) infection is the most common sexually transmitted infection globally, and persistent infection with high-risk genotypes is the necessary cause of cervical cancer. [1, 2] In Nigeria, cervical cancer is the second most common malignancy in women.[3] Adolescents carry a large burden of new HPV

infections, with 60–80% caused by the high-risk types of the virus.[4]

A study from Jos, Northcentral Nigeria, documented a genital HPV-DNA prevalence of 13% among girls aged 9–20, with the earliest detection at 10 years and peak prevalence at 16–17 years.[5] DNA-based detection, however, may underestimate cumulative exposure because the immune system clears most infections within two years. [6] Despite the virologic clearance, HPV IgG antibodies may persist for over a decade after infection, making serology a more reliable marker of lifetime exposure.[7, 8]

Pre-vaccination seroprevalence surveys have been used to guide the selection of target age groups for HPV vaccination. This has shown that most girls, aged 9–14 years, are HPV-naïve and that vaccine effectiveness is greatest before initial exposure.[9-13] However, such data remain sparse in sub-Saharan Africa, even though the region bears the highest burden of HPV-related disease.[14] Given regional differences in sexual behaviour, HIV prevalence, and circulating HPV genotypes, locally generated seroprevalence data are important for informing the national HPV vaccination programme and for monitoring population-level immunity following vaccine introduction [15] Nigeria launched its national HPV vaccination programme in 2024, but there are currently no local seroprevalence data to support the optimal age window for vaccination of female adolescents in Nigeria. Therefore, this study aimed to determine the HPV IgG seroprevalence and identify associated socio-demographic and risk factors among female secondary school adolescents in Gombe, North-Eastern Nigeria.

Methods

Study design and setting

This cross-sectional study was conducted between January and June 2022 in Gombe Local Government Area (LGA) of Gombe, Northeastern Nigeria. Gombe LGA is predominantly urban, with a cosmopolitan population drawn from over 20 ethnic groups. The LGA has 11 administrative wards and hosts both public and private secondary schools.

Study population

The study was conducted among female secondary school students (1st to 6th grade). Female students aged 10–19 years residing and attending secondary schools in Gombe LGA were included in the study, while students whose parents refused consent were excluded.

Ethical consideration

Ethical approval for the study was obtained from the Health Research and Ethics Committee of the Federal Teaching Hospital, Gombe (with certificate number NHREC/25/10/2013). Permission was also obtained from the Gombe State Ministry of Education and the management of selected schools. Written informed consent was obtained from parents/guardians, while assent was taken from the participants. Confidentiality was strictly maintained.

Sample size determination

The minimum sample size of 351 was calculated using Fisher's formula, [16] for cross-sectional studies at 95% confidence level and a p-value set at 0.05. Out of the 440 students initially included, 49 declined consents, while seven were absent on the days of blood sample collection, leaving 384 participants, giving a response rate of 87.3%.

Sampling technique

A total of 384 participants were recruited through multistage sampling: six of 11 wards were selected by balloting; from each ward, one public and one private school were chosen by simple random sampling using balloting (making a total of 12 schools). Within each school, participants were selected by systematic random sampling with proportionate allocation based on the school population. The total female adolescent population in each school

was obtained and used to proportionately determine the number recruited from each of the 12 selected schools by dividing the school's female population by the total female population across all schools and multiplying by the minimum sample size of 351. In each school, data on the distribution of female students by class level were obtained from the school registers, and only eligible students were included following age verification. Female adolescents were recruited from all classes (JSS1–SS3), while single-class arms were selected by simple balloting in classes with multiple arms. Thereafter, proportionate allocation was used to determine the number of students recruited from each selected class based on class size. Subsequently, the class registers served as the sampling frames, and participants were selected using systematic random sampling, with the sampling interval determined by dividing the total number of eligible female students in each class by the number selected from that class.

Data collection

A pretested, structured, self-administered questionnaire was used to obtain socio-demographic data (age, ethnicity, religion, family type, socioeconomic status determined by Olusanya *et al.* [17]) and risk factors (sexual activity, age at sexual debut, number of partners, condom use, abnormal vaginal discharge, vulvar rash, cigarette smoking and alcohol use). The questionnaire was prepared in English and Hausa. The questionnaire was pre-tested among 36 female adolescents (10% of the sample size) in one public and one private school in neighbouring Akko LGA that were not included in the main study. This was done to assess the suitability of the adapted questionnaire and study procedures, after which ambiguous items were revised. The questionnaires were administered in school halls/classrooms provided by the school authorities. The respondents were encouraged to answer truthfully and were assured of confidentiality to promote accurate responses, while teachers were excluded to maintain privacy. Trained female research assistants provided clarification when necessary. Completed questionnaires were retrieved the same day and reviewed for completeness and clarification of ambiguous responses.

Venous blood samples were drawn, centrifuged, and serum stored at −20°C. Analysis was performed in a single batch in the Microbiology Department using a commercially available ELISA kit (PARS BIOCHEM, Nanjing Biotechnology Company Ltd, China) designed to detect IgG antibodies to any HPV strain, as per the manufacturer's instructions. Optical density was read at 450 nm using an RT-2100C microplate reader (Rayto Life and Analytical Sciences Co., Ltd., China). The cut-off optical density was calculated as the mean of the negative control wells plus 0.15 as per the manufacturer's protocol. Samples with values above the cut-off points were classified as seropositive. Seropositive study participants were followed up and counselled on the need to seek regular cervical cytology screening tests from 25 years of age for early detection of any precancerous cervical lesion and for prompt treatment, thus preventing cervical cancer. [18]

Data management

Data were analysed using SPSS version 23.0 (IBM Corp., Armonk, NY). Categorical variables were summarised as frequencies and percentages. Associations were tested using the Chi-Square or Fisher's Exact test where appropriate. Variables significant at $p < 0.05$ on bivariate analysis were entered into a multivariate logistic regression model. Results were reported as adjusted odds ratios (AOR) with 95% confidence intervals (CI).

Results

A total of 384 female adolescents aged 10-19 years recruited from 12 secondary schools participated in the study. Most of the subjects (71.4%) were recruited from public schools. The mean age was 15.26±2.05 years. Hausa and Fulani ethnic groups together constituted

59.2% of the study population, broadly representative of the ethnic composition of Gombe. Islam was the dominant religion practised by 72.4%; most (64.8%) were from monogamous families, and the majority (60.2%) belonged to the middle social class.

The overall HPV IgG antibody seroprevalence was 9.4% (36/ 384). There was a clear age-dependent gradient in seropositivity: none of the 72 participants aged 10–13 years was seropositive, 13 of 209 (6.2%) in the 14–16 years group were seropositive, and 23 of 103 (22.3%) in the 17–19 years group were seropositive (χ^2 = 30.244, p<0.001). Seropositivity was significantly higher among the Tangale ethnic group (20.0%) and Waja ethnic group (19.0%) compared to the Hausa (6.5%) and Fulani (5.2%) groups (χ^2 = 13.777, p = 0.032). Religion, family type, socioeconomic status and school type showed no significant associations (Table I).

Only 14 participants (3.6%) reported sexual activity. Among these, seropositivity was 71.4% (10/14) compared with 7.0% (26/370) in those denying sexual activity (p<0.001). The mean age at self-reported sexual debut was 16.36±1.22 years. No sexual activity was reported among 10–13-year-olds. Cigarette smoking and alcohol use were each reported by two participants, and both showed significant associations with seropositivity (p = 0.048). A history of abnormal vaginal discharge and vulvar rash was not significantly associated with HPV serostatus. (Table II).

Among sexually active participants (n = 14), seropositivity was numerically higher in those with multiple partners, 75.0% (3/4) vs 70.0% (7/10) in those with single partners (p = 0.852). Regarding condom use, seropositivity was 75.0% (6/8) among those who never used condoms, 80.0% (4/5) among those who sometimes used condoms, and 0% (0/1) among the single participant who always used condoms (p = 0.255). Neither difference reached statistical significance.

On multivariate logistic regression incorporating all variables with significance on bivariate analysis, including age-group, ethnic group, sexual activity, alcohol-use and cigarette use, two factors emerged as independent predictors of HPV IgG seropositivity. Participants aged 17–19 years had 2.66 times higher odds of seropositivity compared to the 14–16-year age group (AOR = 2.66; 95% CI: 1.18–6.01; p = 0.019). A history of sexual activity was the strongest predictor, with sexually active participants having approximately 19-fold higher odds of seropositivity (AOR = 19.05; 95% CI: 5.22–69.54; p < 0.001). Ethnic group, cigarette smoking and alcohol use lost statistical significance after adjustment (Table III).

Discussion

This study provides the first HPV IgG seroprevalence data specific to female adolescents from Nigeria. The 6.2% prevalence among 14-16 year old adolescents in this study is lower than the 11% reported among Dutch adolescents of the same age by Mollers *et al.* [12] The combined seroprevalence for the 14-19 year old group (11.5%) is also below the 16% recorded by Liu *et al.* in the United States. [13] Cultural differences in sexual behaviour norms and the lower median age at sexual debut, 14.7 years [12] compared with 16 years in the present study, may contribute to the gap. A striking finding is the age-dependent gradient in seropositivity. The 10–13-year age group was 100% seronegative. By 14–16 years, 6.2% had seroconverted, and by 17–19 years, the rate had increased to 22.3%. This pattern mirrors what has been described in the Czech Republic [19] and Taiwan,[20] and almost certainly reflects cumulative sexual exposure as adolescents grow older.

Table I: Association between HPV IgG seropositivity and socio-demographic factors

Characteristic	n	Positive n (%)	Negative n (%)	χ^2	p-value
Age group (years)				30.244*	<0.001
10–13	72	0 (0.0)	72 (100.0)		
14–16	209	13 (6.2)	196 (93.8)		
17–19	103	23 (22.3)	80 (77.7)		
Religion				2.531	0.112
Christianity	106	14 (13.2)	92 (86.8)		
Islam	278	22 (7.9)	256 (92.1)		
Ethnic group				13.777*	0.032
Hausa	93	6 (6.5)	87 (93.5)		
Fulani	134	7 (5.2)	127 (94.8)		
Tangale	35	7 (20.0)	28 (80.0)		
Waja	21	4 (19.0)	17 (81.0)		
Tera	19	3 (15.8)	16 (84.2)		
Others†	82	9 (11.0)	73 (89.0)		
Marital status				23.548*	0.001
Unmarried	378	32 (8.5)	346 (91.5)		
Married	6	4 (66.7)	2 (33.3)		
Family type				0.369	0.544
Monogamous	249	25 (10.0)	224 (90.0)		
Polygamous	135	11 (8.2)	124 (91.8)		
Social class‡				0.105	0.949
Upper	34	3 (8.8)	31 (91.2)		
Middle	231	21 (9.0)	210 (91.0)		
Lower	119	12 (10.1)	107 (89.9)		
School type				2.039	0.153
Public	274	22 (8.0)	252 (92.0)		
Private	110	14 (12.8)	96 (87.2)		

*** Fisher's Exact test; † Kanuri, Cham, Wurkum, Yoruba, Igbo, Karekare; ‡ Olusanya et al. classification**

What makes our finding particularly useful for programme planners is the sharpness of the transition: the jump from zero to one-in-five within a few years of adolescence means the vaccination window closes rapidly. This pattern was also observed in the previous studies, [19, 20] and it holds in a conservative, predominantly Muslim population in Northern Nigeria, where cultural norms around sexual behaviour differ markedly from those in Western settings.

Sexual activity emerged as the dominant predictor, with 19-fold higher odds of seropositivity. This is consistent with HPV's established sexual transmission route. [21]

Table II: Association between HPV IgG seropositivity and selected risk factors

Characteristic	n	Positive n (%)	Negative n (%)	χ^2	p-value
Sexual activity				65.852	<0.001
Present	14	10 (71.4)	4 (28.6)		
Absent	370	26 (7.0)	344 (93.0)		
Vaginal discharge				0.030	0.863
Present	68	6 (8.8)	62 (91.2)		
Absent	316	30 (9.5)	286 (90.5)		
Vulvar rash				0.070	0.791
Present	48	5 (10.4)	43 (89.6)		
Absent	336	31 (9.2)	305 (90.8)		
Cigarette smoking				3.905	0.048
Yes	2	1 (50.0)	1 (50.0)		
No	382	35 (9.2)	347 (90.8)		
Alcohol use				3.905	0.048
Yes	2	1 (50.0)	1 (50.0)		
No	382	35 (9.2)	347 (90.8)		

Fisher's Exact test

However, despite ensuring privacy and assurance of confidentiality, only 3.6% of participants admitted to any sexual activity, which may be an underestimation in this conservative setting. [22] The fact that 72.2% of seropositive girls denied sexual contact reinforces this suspicion and suggests that serology captures exposure that self-report misses. Ethnic differences in seropositivity - the Tangale and Waja groups showing rates three to four times those of the Hausa and Fulani - are noteworthy but should be interpreted with caution. These differences lost significance on multivariate analysis once age and sexual activity were accounted for, suggesting mediation through behavioural pathways rather than biological susceptibility. The fact that no ethnic group showed any seropositivity at 10–13 years further supports a uniform approach to early vaccination across all communities.

Cigarette smoking and alcohol use, though reported by only two participants each, showed a suggestive association with HPV seropositivity on bivariate analysis. These behaviours are often correlated with sexual risk-taking in adolescent populations, [23] and the loss of significance on multivariate analysis is consistent with confounding by sexual activity. The very low reported prevalence of these behaviours may also reflect social desirability bias in this study population.

Limitations

The cross-sectional design of the study does not permit causal inferences. The ELISA detected antibodies to any-HPV broadly, not to specific genotypes, limiting vaccine-type-specific conclusions. Under-reporting of sexual behaviour is also likely, for reasons of social desirability. The findings in this study from northeast Nigeria may not be generalisable to all of Nigeria.

Table III: Multivariate logistic regression of predictors of HPV IgG seropositivity

Variable	p-value	AOR	95% CI (Lower)	95% CI (Upper)
Age group (years)				
10–13	0.063	–†	–	–
14–16 (Reference)	–	1	–	–
17–19	0.019	2.659	1.177	6.008
Ethnic group				
Hausa (Reference)	–	1	–	–
Fulani	0.744	0.814	0.236	2.807
Tera	0.181	3.180	0.583	17.334
Tangale	0.230	2.281	0.594	8.757
Waja	0.277	2.453	0.486	12.386
Others	0.373	1.747	0.512	5.966
Sexual activity				
Active	<0.001	19.048	5.217	69.537
Not active (Reference)	–	1	–	–
Cigarette smoking				
Yes	0.327	4.139	0.241	70.985
No (Reference)	–	1	–	–
Alcohol use				
Yes	0.327	4.130	0.241	70.985
No (Reference)	–	1	–	–

†Unstable CI due to zero events; AOR = Adjusted Odds Ratio; CI = Confidence Interval

Conclusion

These findings support vaccinating female adolescents early with HPV vaccines. The complete seronegativity at 10–13 years contrasted with 22.3% seropositivity by 17–19 years. This means that the greatest return on vaccination investment lies in targeting girls under 14 years. This is consistent with the World Health Organisation's recommendation of 9–14 years as the primary target age and with the adopted Nigerian national HPV vaccination schedule. Future studies should examine HPV genotype-specific seroprevalence to further refine vaccination strategies and should follow this cohort longitudinally to track seroconversion rates as the vaccination programme matures.

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Authors' Contributions: BAA, IEW and JI conceived the study, while BAA designed the study and did the literature review. BAA and MMM did data analysis, while BAA interpreted the data along with MMM. BAA and FHU drafted the manuscript, while JI, IEW, MMM and AR revised the draft for sound intellectual content. All the authors approved the final version of the manuscript.

Conflicts of Interest: None declared.

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