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Hepatitis B virus serological profiles, susceptibility and associated factors among adolescents in a conflict-affected district of Cameroon: a community-based cross-sectional study

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Abstract

Background

Hepatitis B virus (HBV) infection remains a major public health challenge in sub-Saharan Africa despite the availability of an effective vaccine. Adolescents constitute an important population for HBV prevention because they may remain susceptible to infection due to inadequate vaccination coverage and increasing exposure to behavioural risk factors. Evidence on HBV infection and immunity status among internally displaced adolescents in conflict-affected settings remains limited. This study determined the serological profile, susceptibility status, and determinants of HBV infection among internally displaced and host adolescents in the Tiko Health District of Cameroon.

Methods

A community-based cross-sectional study was conducted among 312 adolescents aged 10–19 years between March and May 2025. Participants were selected using a multistage sampling technique. Data on socio-demographic characteristics, behavioural factors, and hepatitis B-related knowledge, attitudes, and practices were collected using a structured questionnaire. Blood samples were analysed using a five-marker hepatitis B serological panel comprising hepatitis B surface antigen (HBsAg), hepatitis B surface antibody (anti-HBs), hepatitis B core antibody (anti-HBc), hepatitis B e antigen (HBeAg), and hepatitis B e antibody (anti-HBe). Multivariable logistic regression was used to identify factors independently associated with HBV infection.

Results

The mean age of participants was 14.5 ± 2.8 years, and 54.5% were females. The prevalence of HBV infection was 4.8% (95% CI: 2.4%–7.2%). Serological profiling showed that 59.0% had no detectable serological evidence of current/past HBV infection or anti-HBs immunity,

30.8% had immunity from previous natural infection, and only 5.4% had a serological pattern consistent with vaccine-induced immunity. Acute and chronic HBV infections accounted for 1.6% and 3.2% of participants, respectively. Internal displacement (AOR = 10.67, 95% CI: 2.93–38.78), family history of HBV infection (AOR = 6.97, 95% CI: 1.68–28.93), smoking (AOR = 8.24, 95% CI: 2.53–26.80), alcohol consumption (AOR = 6.69, 95% CI: 1.57–28.00), and sexual activity (AOR = 5.85, 95% CI: 1.81–18.84) were independently associated with HBV infection. Adequate knowledge of HBV was associated with lower odds of infection (AOR = 0.07, 95% CI: 0.01–0.84).

Conclusions

HBV prevalence among adolescents in the Tiko Health District was intermediate; however, a substantial proportion remained susceptible to infection and very few demonstrated vaccine-derived immunity. Internally displaced adolescents were at particularly high risk of HBV infection. Strengthening adolescent-focused screening, catch-up vaccination, and health education interventions, especially among displaced populations, may contribute to HBV elimination efforts in Cameroon.

Keywords: Hepatitis B virus; adolescents; susceptibility; seroepidemiologic; internally displaced persons; vaccine-derived immunity; Cameroon.

Introduction

Hepatitis B virus (HBV) infection remains a major global public health challenge despite the availability of safe and effective vaccines and antiviral therapies[1]. HBV is a highly infectious blood-borne virus that can be transmitted through perinatal exposure, contact with infected blood and body fluids, unsafe medical procedures, and unprotected sexual intercourse[2,3]. Acute infection may progress to chronic hepatitis, liver cirrhosis, hepatocellular carcinoma, and premature death, contributing substantially to the global burden of liver disease[4]. Globally, an estimated 240 million people were living with chronic hepatitis B virus (HBV) infection in 2024, approximately 0.9 million people acquired new HBV infections, and 1.1 million people died from HBV-related cirrhosis and liver cancer[5]. Despite global efforts to eliminate viral hepatitis as a public health threat by 2030, HBV remains one of the leading causes of mortality from communicable diseases globally.

The burden of HBV infection is disproportionately concentrated in low- and middle-income countries, particularly in sub-Saharan Africa[6,7]. The WHO African Region remains one of the most affected regions, with more than 91 million individuals estimated to be living with chronic hepatitis B or C infection[8]. Furthermore, Africa accounts for nearly 70% of HBV infections among children globally and continues to experience significant HBV-related morbidity and mortality[9,10]. Although the hepatitis B vaccine is highly effective and has been incorporated into childhood immunization programs across the region, vaccination coverage remains below levels required to achieve elimination targets[11,12]. Persistent gaps in vaccination, screening, diagnosis, and treatment continue to sustain HBV transmission in many African settings[13].

Adolescents represent a critical but often overlooked population in HBV prevention and control efforts[14,15]. This stage of life is characterized by increasing independence and potential engagement in behaviours that may increase exposure to HBV infection, including sexual activity, alcohol consumption, substance use, and the sharing of sharp objects[16,17]. Moreover, adolescents who were not adequately vaccinated during childhood or who failed to develop protective immunity remain susceptible to infection. As countries move towards hepatitis elimination targets, understanding HBV epidemiology among adolescents is essential for identifying immunity gaps, informing catch-up vaccination strategies, and preventing transmission into adulthood. However, community-based epidemiological data on HBV infection among adolescents remain limited in many African countries, including Cameroon.

Population displacement resulting from armed conflict and humanitarian crises may further amplify the risk of HBV infection[18]. Internally displaced persons (IDPs) frequently experience disruptions in healthcare access, reduced vaccination opportunities, overcrowded living conditions, poverty, and limited access to health information and preventive services[18]. Since 2016, the sociopolitical crisis in the North-West and South-West regions of Cameroon has resulted in large-scale internal displacement, forcing thousands of families to relocate to safer communities. The Tiko Health District has become one of the major host destinations for displaced populations within the South-West Region[19]. Despite the growing size of this vulnerable population, little is known about the burden of HBV infection among internally displaced adolescents and whether displacement status influences susceptibility to infection.

Cameroon is considered a highly endemic country for HBV infection[20]. Previous studies have reported prevalence estimates ranging from approximately 6% to 11% across different populations, while a national systematic review and meta-analysis reported a pooled HBV prevalence of 11.2%[21]. Although hepatitis B vaccination has been integrated into the national Expanded Program on Immunization, several studies have highlighted persistent challenges, including low vaccination uptake, inadequate awareness, poor health-seeking behaviour, and continued transmission within communities[22]. Most HBV studies conducted in Cameroon have focused on adults, pregnant women, blood donors, healthcare workers, or university students, with relatively limited attention given to adolescents. Moreover, many studies have relied exclusively on hepatitis B surface antigen (HBsAg) testing, providing limited information on susceptibility, prior exposure, and immunity patterns within the population.

Comprehensive serological profiling using multiple HBV markers, including hepatitis B surface antigen (HBsAg), hepatitis B surface antibody (anti-HBs), hepatitis B core antibody (anti-HBc), hepatitis B e antigen (HBeAg), and hepatitis B e antibody (anti-HBe), provides a more complete understanding of HBV epidemiology than HBsAg testing alone. Such an approach enables the identification of active infection, previous exposure, vaccine-induced immunity, natural immunity, and susceptibility to infection. These data are essential for guiding targeted vaccination, screening, and health education interventions, particularly among vulnerable populations living in conflict-affected settings.

Therefore, this study aimed to determine the serological profile, susceptibility status, infection burden, and determinants of hepatitis B virus infection among internally displaced and host

adolescents in the Tiko Health District of Cameroon. By providing comprehensive seroepidemiological evidence from a conflict-affected setting, the study seeks to generate information that can support adolescent-focused HBV prevention strategies and contribute to national and global hepatitis elimination efforts.

Materials and Methods

Study setting

This study was conducted in the Tiko Health District (THD), located in the Fako Division of the South-West Region of Cameroon. The district serves an estimated population of over 140,000 inhabitants and has experienced substantial demographic changes resulting from the ongoing sociopolitical crisis in the North-West and South-West Regions of Cameroon, which has led to an influx of internally displaced persons (IDPs). Administratively, the district comprises eight health areas: Holforth, Kange, Likomba, Missellele, Mondoni, Mudeka, Mutengene, and Tiko Town.

The district consists of both urban and rural communities and hosts a heterogeneous population of host residents and internally displaced populations. Healthcare services are provided through the Tiko District Hospital, integrated health centres, mission hospitals, and private healthcare facilities. Despite the availability of healthcare services, access to preventive interventions such as hepatitis B screening, health education, and vaccination remains suboptimal in some communities, particularly among vulnerable populations. The district's mix of conflict-related displacement, urbanization, socioeconomic challenges, and behavioural risk factors makes it a suitable setting for investigating HBV epidemiology among adolescents.

Study design and period

A community-based cross-sectional study was conducted between 28 March and 28 May 2025 among adolescents residing in the Tiko Health District. The study aimed to determine the serological profile, susceptibility status, infection burden, and determinants of HBV infection among internally displaced and host adolescents.

Study population

The study population consisted of adolescents aged 10–19 years living in the Tiko Health District during the study period. Adolescents were eligible for participation if they had resided in the district for at least six months before data collection, provided written assent, and had

parental or guardian consent where applicable. Participants were also required to agree to both questionnaire administration and blood sample collection.

Adolescents who were severely ill at the time of data collection, declined blood sample collection, were unable to provide reliable responses because of cognitive impairment, or had a documented diagnosis of chronic liver disease unrelated to HBV infection were excluded from the study.

Sample size determination

The minimum sample size was calculated using Cochran's formula for estimating a single population proportion:

$$n = \frac{Z^2 p(1 - p)}{e^2}$$

where n is the minimum required sample size, Z is the standard normal deviate corresponding to a 95% confidence level (1.96), p is the estimated prevalence of HBV infection in Cameroon and e is the margin of error set at 5%.

An HBsAg prevalence of 5.0% was used based on a recent study among school children in Yaoundé, Cameroon[23]. A precision of 2.5% was specified. Substituting these values into the formula yielded a minimum sample size of 292 participants. To allow for potential non-response and to enhance the precision and statistical power of the study, the target sample size was increased to 312 adolescents. A total of 312 adolescents were ultimately recruited and included in the analysis.

Sampling procedure

A multistage sampling approach was employed. In the first stage, the eight health areas within the Tiko Health District constituted the sampling clusters. In the second stage, four health areas (Holforth, Likomba, Mutengene, and Tiko Town) were selected through simple random sampling using a lottery method.

In the third stage, the required sample size was allocated among the four selected health areas using probability proportional-to-size (PPS) sampling, based on the estimated population of adolescents aged 10–19 years in each health area (Table 1). The number of participants allocated

to each health area was determined by multiplying the proportion of the total adolescent population residing in each health area by the total sample size of 312. Accordingly, 54 participants were allocated to Tiko, 136 to Mutengene, 92 to Holforth, and 30 to Likomba, giving a total of 312 participants.

In the final stage, households within each selected health area were approached consecutively until the allocated sample size for that health area was attained. Eligible adolescents were identified within each household according to the predefined inclusion criteria. Where a household contained more than one eligible adolescent, one adolescent was selected for participation to ensure that each household contributed no more than one participant. Households were not revisited when household members or eligible adolescents were unavailable during the initial visit. Recruitment continued with subsequent households until the required number of participants for each selected health area was reached. Adolescents who met the eligibility criteria and provided the required consent and/or assent were enrolled in the study.

Table 1: Allocation of participants across selected health areas using probability proportional-to-size sampling

Health area	Total population (10-19)	Proportion	Number participants to be selected per health area
Tiko	2532	0.18	54
Mutengene	6099	0.43	136
Holforth	4315	0.30	92
Likomba	1378	0.10	30
Total	14324	1	312

Data collection procedures

Data collection involved interviewer-administered questionnaires and laboratory-based serological testing. Prior to data collection, community entry activities were undertaken through consultations with district health authorities, community leaders, and local administrative authorities to facilitate community participation and acceptance of the study. Written informed consent was obtained from participants aged 18–19 years. For participants younger than 18 years, written parental or guardian consent and participant assent were obtained before enrolment.

A structured questionnaire was developed by the research team following a review of published literature on hepatitis B virus epidemiology and previously reported hepatitis B knowledge, attitude, and practice (KAP) questionnaires and was adapted to the study objectives and local context[24–26]. The instrument was pretested among adolescents in the Buea Health District prior to implementation to assess clarity, comprehensibility, and suitability. The final questionnaire collected information on socio-demographic characteristics, displacement status, behavioural risk factors, family history of hepatitis B virus infection, and knowledge, attitudes, and practices related to HBV infection and prevention. Interviews were conducted in either English or Pidgin English according to participants' preferences. Data were collected electronically using KoboCollect software installed on mobile devices. The English-language version of the questionnaire is provided as Supplementary File 1.

Assessment of knowledge, attitudes and practices

Knowledge regarding HBV infection was assessed using nine questions covering awareness of HBV, disease definition, modes of transmission, risk groups, prevention, symptoms, treatment, curability, and the organ affected by the disease. The questionnaire was adapted to the study context and adolescent population from previously reported hepatitis B knowledge, attitudes and practices (KAP) instruments. All 312 participants were included in the overall knowledge assessment. Participants who reported that they had not previously heard of HBV were not asked the subsequent knowledge questions and were assigned a score of zero for those items. Among participants who had heard of HBV, each correct response was awarded one point, while incorrect and “don't know” responses received zero points. For questions with multiple correct responses, each correctly identified response was awarded one point. The maximum obtainable knowledge score was 13 points. For descriptive classification, the knowledge score was converted to a percentage of the maximum obtainable score. Participants who scored at least 60% ($\geq 8/13$ points) were classified as having adequate

knowledge, whereas those scoring below 60% were classified as having inadequate knowledge. The 60% threshold was used as an operational criterion, consistent with categorical scoring approaches used in previous hepatitis B KAP studies.[27,28].

Attitudes towards HBV infection were assessed using nine statements measured on a four-point Likert scale. Responses to positively worded statements were scored from 0 to 3 (strongly disagree = 0, disagree = 1, agree = 2, and strongly agree = 3), while negatively worded statements were reverse-coded so that higher scores consistently indicated more positive attitudes. The maximum obtainable attitude score was 27 points. The total attitude score was converted to a percentage of the maximum obtainable score. Participants scoring at least 60% ($\geq 17/27$ points) were classified as having positive attitudes, whereas those scoring below 60% were classified as having negative attitudes. The 60% threshold was used as an operational classification criterion, consistent with its use in previous HBV KAP research[27]. The internal consistency of the nine-item attitude scale was assessed using Cronbach's alpha.

Practices related to HBV prevention were assessed using four questions. Desirable practices were assigned one point and undesirable practices were assigned zero points. The maximum obtainable practice score was four points. The total practice score was converted to a percentage of the maximum obtainable score. Participants scoring at least 60% ($\geq 3/4$ points) were classified as having good practices, while those scoring below 60% were classified as having poor practices. The 60% threshold was used as an operational criterion for descriptive classification and was not considered a clinical or diagnostic threshold.

For statistical analyses, the underlying knowledge, attitude and practice scores were retained as continuous measures in addition to the categorical classifications. Continuous scores were used where appropriate for exploratory analyses to minimize the loss of information associated with dichotomization. This approach is also consistent with HBV research among adolescents in which KAP scores were retained as continuous measures and summarized as mean scores rather than being dichotomized using a fixed threshold[29].

Measurement of internally displaced person status

Internally displaced person (IDP) status was assessed using the structured study questionnaire. Participants were classified as IDPs if they reported having been forced or obliged to leave their home or place of habitual residence because of the armed conflict in the North-West and/or South-West Regions of Cameroon and having relocated to another location within Cameroon. Participants who had not experienced such conflict-related displacement were

classified as non-IDPs. IDP status was recorded as a binary variable (IDP: yes/no) and was subsequently included as an explanatory variable in the analysis of factors associated with HBV infection.

Blood sample collection and laboratory analysis

Following questionnaire administration, approximately 5 mL of venous blood was collected aseptically from each participant by trained healthcare personnel. Specimens were appropriately labelled with unique study identification numbers and transported to the designated laboratory for processing and analysis.

Serological testing was performed using a commercially available five-marker hepatitis B rapid diagnostic test (RDT) panel for the qualitative detection of hepatitis B surface antigen (HBsAg), hepatitis B surface antibody (anti-HBs), hepatitis B core antibody (anti-HBc), hepatitis B e antigen (HBeAg), and hepatitis B e antibody (anti-HBe). The assay uses lateral-flow chromatographic immunoassay principles, with sandwich immunoassay formats for HBsAg, anti-HBs and HBeAg and competitive immunoassay formats for anti-HBc and anti-HBe. This five-marker panel has also been used for HBV serological profiling in studies conducted in Cameroon.

Following serum separation, 60–90 µL of serum was applied to the appropriate sample well of each test cassette according to the manufacturer's instructions. The test cassettes were allowed to develop at room temperature and results were read after approximately 15 minutes. Results were interpreted qualitatively according to the appearance or absence of the test and control lines. The control line served as an internal procedural control; tests without a valid control line were considered invalid.

The five serological markers were interpreted together to determine participants' HBV serological profiles. Participants were classified as susceptible to HBV infection, immune due to vaccination, immune due to previous natural infection, acutely infected, or chronically infected based on the predefined combinations of HBsAg, anti-HBs, anti-HBc, HBeAg and anti-HBe results.

For anti-HBs, a positive result indicated detectable anti-HBs according to the qualitative assay's detection criteria. Because the RDT provided a qualitative rather than quantitative anti-HBs result, an exact antibody concentration could not be determined from the test.

Consequently, anti-HBs positivity was interpreted as evidence of detectable antibody rather than as a quantitative measurement of the conventional protective concentration of ≥ 10 mIU/mL. The distinction is important because a qualitative positive anti-HBs result does not establish the exact antibody titre.

Participants received post-test counselling and their laboratory results after testing.

Adolescents who tested positive for HBsAg were referred to appropriate healthcare facilities for further clinical evaluation and management.

HBsAg-positive samples were not independently confirmed using enzyme-linked immunosorbent assay (ELISA), chemiluminescent immunoassay (CLIA), neutralization testing, or another confirmatory assay. Therefore, HBsAg positivity in this study was based on the qualitative RDT result. The absence of independent laboratory confirmation may have resulted in some misclassification of HBV infection status and is acknowledged as a limitation of the study.

Quality assurance

The questionnaire was pretested among adolescents in the Buea Health District before commencement of the study. Findings from the pretest were used to improve clarity, consistency, and comprehensibility of the questionnaire.

Research assistants received training on study objectives, ethical principles, administration of questionnaires, blood sample collection procedures, and data management. Completed questionnaires were reviewed daily for completeness and consistency. All laboratory procedures were performed according to standard operating procedures and manufacturer recommendations.

Study variables

The primary outcome variable was HBV infection status, defined by the presence or absence of hepatitis B surface antigen (HBsAg).

Independent variables included age, sex, educational level, marital status, occupation, religion, displacement status, family history of HBV infection, smoking status, alcohol consumption, sexual activity, knowledge level, attitude towards HBV infection, and preventive practices.

Data management and statistical analysis

Data collected using KoboCollect were exported into Microsoft Excel for cleaning and coding before being analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

Descriptive statistics were used to summarize participants' characteristics. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations. The prevalence of HBV infection was calculated as the proportion of participants testing positive for HBsAg and presented with corresponding 95% confidence intervals (95% CI).

HBV serological markers were interpreted collectively to determine susceptibility status, vaccine-induced immunity, immunity following natural infection, acute infection, and chronic infection. Knowledge, attitude, and practice scores were summarized using means and standard deviations and subsequently categorized according to the predefined 60% cut-off for descriptive analyses.

Bivariable logistic regression analyses were performed to identify factors associated with HBV infection. Variables with a p-value less than 0.20 in the bivariable analysis were entered into a multivariable logistic regression model to determine factors independently associated with HBV infection. Adjusted odds ratios (AORs) and their corresponding 95% confidence intervals were reported. Statistical significance was established at $p < 0.05$.

Results

Characteristics of the study participants

A total of 312 adolescents participated in the study. The mean age was 14.5 years (SD = 2.8 years), with 190 (60.9%) participants aged 15–19 years. Females accounted for 170 (54.5%) participants, while males represented 142 (45.5%). Secondary education was the most common educational level attained (43.3%), followed by primary education (36.9%). Most participants were single (90.4%), students (62.2%), and Christians (79.5%).

Overall, 93 (29.8%) participants were internally displaced persons (IDPs), whereas 219 (70.2%) belonged to the host population. Participants were recruited from four health areas, with the majority residing in Mutengene (43.6%), followed by Holforth (29.5%), Tiko (17.3%), and Likomba (9.6%) (Table 2).

Table 2: Socio-demographic characteristics of adolescents in the Tiko Health District, May 2025.

Variable	Category	Frequency (No)	Percentage (%)
Age group (years)	10-14	122	39.1
	15-19	190	60.9
	Total	312	100
Sex	Female	170	54.5
	Male	142	45.5
	Total	312	100
Level of education	No formal	29	9.3
	Primary	115	36.9
	Secondary	135	43.3
	University	33	10.6
	Total	312	100
Marital stats	Single	282	90.4
	Married	30	9.6
	Total	312	100
Occupation	Employed	30	9.6
	Self-employed	50	16.0
	Student	194	62.2
	Unemployed	38	12.2
	Total	312	100
Religion	Christian	248	79.5
	Muslim	63	20.2
	Other	1	0.3
	Total	312	100
Displacement status	Host	219	70.2
	IDP	93	29.8
	Total	312	100
Health area	Holfort	92	29.5
	Likomba	30	9.6
	Mutengene	136	43.6
	Tiko	54	17.3
	Total	312	100.0

Regarding behavioural characteristics, 165 (52.9%) participants did not know their family HBV status, while only 14 (4.5%) reported a family history of HBV infection. Smoking was reported by 22 (7.1%) adolescents, alcohol consumption by 71 (22.8%), and sexual activity by 106 (34.0%) participants (Table 3).

Table 3: Behavioral characteristics of adolescents in Tiko Health District, May 2025

Variable	Category	Frequency (No)	Percentage (%)
Family history of HBV	Don't know	165	52.9
	No	133	42.6
	Yes	14	4.5
	Total	312	100
Smoker	No	290	92.9
	Yes	22	7.1
	Total	312	100
Drink alcohol	No	241	77.2
	Yes	71	22.8
	Total	312	100
Sexually active	No	206	66.0
	Yes	106	34.0
	Total	312	100

¹HBV: Hepatitis B Virus.

Serological profile and HBV burden among adolescents

Prevalence of HBV infection

Overall, 15 of the 312 adolescents tested positive for hepatitis B surface antigen (HBsAg), resulting in an HBV prevalence of 4.8% (95% CI: 2.4%–7.2%).

Serological markers of HBV infection

The prevalence of hepatitis B serological markers varied among study participants (Table 4). Anti-HBs positivity was observed in 113 (36.2%) participants, anti-HBc positivity in 111 (35.6%), anti-HBe positivity in 106 (34.0%), and HBeAg positivity in 5 (1.6%).

Table 4: Seroprevalence of Hepatitis B Virus Markers Among Adolescents in Tiko Health District, May 2025.

Hepatitis B virus Markers	Status	Frequency (No)	Percentage (%)
HBsAg	Negative	297	95.2
	Positive	15	4.8
	Total	312	100
HBsAb	Negative	199	63.8
	Positive	113	36.2
	Total	312	100
HBeAg	Negative	307	98.4
	Positive	5	1.6
	Total	312	100
HBeAb	Negative	206	66.0
	Positive	106	34.0
	Total	312	100
HBcAb	Negative	201	64.4
	Positive	111	35.6
	Total	312	100

HBV susceptibility, immunity and infection status

Interpretation of the combined five-marker serological panel showed that 184 (59.0%) adolescents were susceptible to HBV infection. Evidence of immunity resulting from previous natural infection was identified in 96 (30.8%) participants, whereas only 17 (5.4%) demonstrated vaccine-derived immunity.

Active HBV infection was identified in 15 (4.8%) adolescents, comprising 10 (3.2%) chronic infections and 5 (1.6%) acute infections. These findings indicate that nearly six in every ten adolescents remained vulnerable to HBV infection despite the availability of effective vaccination strategies (Figure 1).

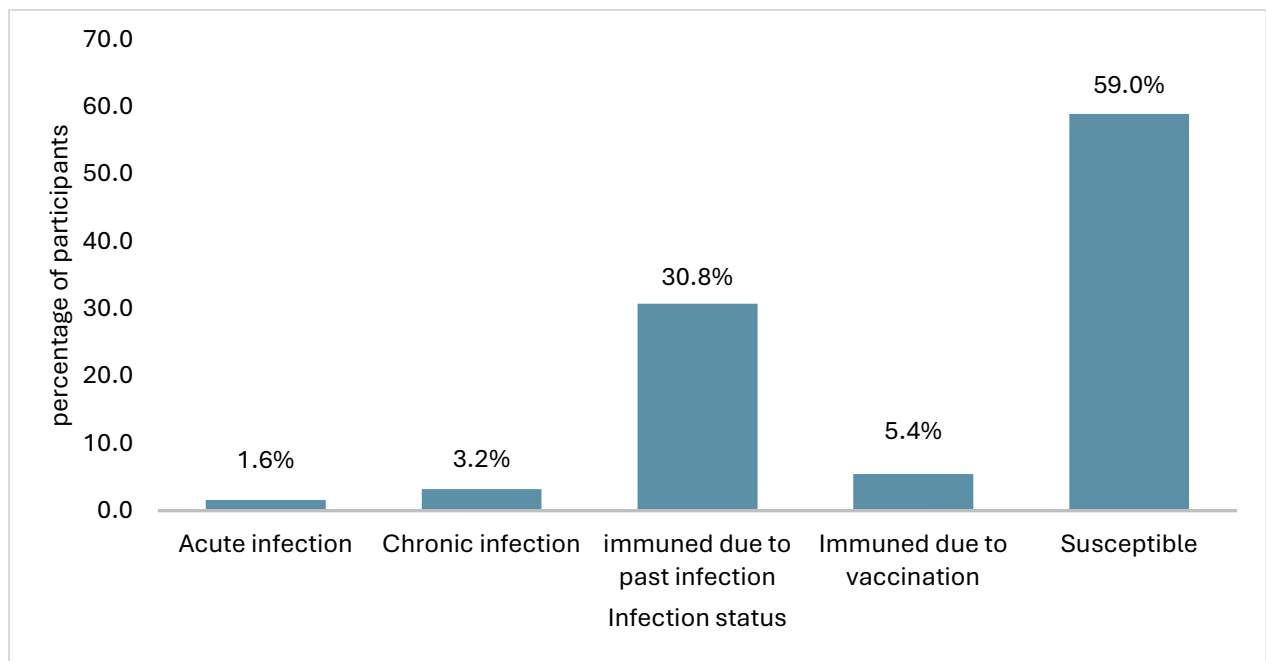


Figure 1: Hepatitis B Virus infection status of adolescents in Tiko Health District, May 2025.

Knowledge of hepatitis B virus among adolescents

The mean overall knowledge score was 5.5 (SD = 3.2) out of a maximum attainable score of 13 among all 312 participants. Of the 312 participants, 130 (41.7%) had previously heard of HBV. Among these participants, 47 (36.2%) correctly identified HBV as a viral infection, 77 (59.2%) identified blood as a mode of transmission, and 73 (56.2%) identified bodily fluids as a mode of transmission. Less than one-tenth identified vaccination as a preventive measure, while 25 (19.2%) correctly identified antiviral medication as a treatment option (Table 5). Overall, 39 (12.5%) participants had adequate knowledge of HBV.

Table 5: Knowledge of Hepatitis B Virus among adolescents in Tiko Health District, May 2025.

Variable	Category	Frequency(N _o)	Percentage (%)
Heard of HBV	No	182	58.3
	Yes	130	41.7
	Total	312	100
Definition of HBV	A type of cancer infection	4	3.10
	A bacterial infection	8	6.20
	A viral infection	47	36.20
	A fungi infection	6	4.60

Variable	Category	Frequency(N _o)	Percentage (%)
Transmission of HBV	Do not know	67	51.50
	Total	130	100
	Through contaminated food and water	4	3.10
	Through touching or shaking hands	6	4.60
	Through bodily fluids	73	56.20
	Through blood	77	59.20
	Through mosquito bites	1	0.80
	Do not know	36	27.70
At risk group	Total	130	100
	People who share needles and syringes	67	51.50
	People who work in healthcare environment	6	4.60
	People who share toothbrushes	32	24.60
	People with multiple sex partners	50	38.50
	Do not know	39	30.00
	Total	130	100
HBV prevention	Getting vaccinated	11	8.50
	Avoid shaking hands with people	27	20.80
	Avoid sharing needles or syringes	81	62.30
	Do not know	44	33.80
	Total	130	100
Common symptoms of HBV	Cough, running nose, and sore throat	8	6.2
	Fever, fatigue and yellowing of skin	2	1.5
	Headache, stomachache and diarrhea	2	1.5
	Don't know	116	89.2
	Total	130	100
Treatment of HBV	Do not know	101	77.7
	With antibiotics	2	1.5
	With antiviral medications	25	19.2
	With surgery	2	1.5
	Total	130	100
HBV can be cured	Do not know	82	63.1
	No	25	19.2
	Yes	23	17.7
	Total	130	100
Organ affected by HBV	Brain	5	3.8
	Heart	4	3.1
	Do not know	52	40
	Kidney	2	1.5
	Liver	67	51.5
	Total	130	100
Knowledge category	Inadequate	275	87.8
	Adequate	39	12.2
	Total	312	100

²HBV: Hepatitis B Virus

Attitudes towards hepatitis B virus infection

The mean attitude score was 11.7 (SD = 3.3) out of a maximum attainable score of 27.

Overall, 56 participants demonstrated positive attitudes towards HBV infection prevention and management, corresponding to 17.6% (95% CI: 14.1%–22.6%).

Negative perceptions and stigma towards individuals living with HBV were common. More than half of participants expressed discomfort sitting with HBV-infected individuals, and a substantial proportion reported unwillingness to shake hands with or hug an infected person. Misconceptions regarding the safety and effectiveness of the HBV vaccine and reliance on traditional treatment approaches were also observed among respondents (Table 6).

Table 6: Attitudes of adolescents towards Hepatitis B virus in Tiko Health District, May 2025.

Variable	Strongly disagree	Disagree	Agree	Strongly agree
Uncomfortable sitting with HBV infected persons	8(2.6)	136(43.6)	154(49.4)	14(4.5)
Okay shaking hands/hugging HBV infected person	7(2.2)	198(63.5)	102(32.7)	5(1.6)
Hepatitis B Virus vaccine is safe and effective	10(3.2)	173(55.4)	120(38.5)	9(2.9)
Need to be vaccinated to prevent HBV infection	3(0.9)	167(53.5)	124(39.7)	18(5.8)
At risk of acquiring HBV	11(3.5)	196(62.8)	96(30.8)	9(2.9)
Too much alcohol complicate HBV	12(3.8)	184(59.0)	107(34.3)	9(2.9)
Use of traditional treatments is better for HBV	7(2.2)	83(26.6)	93(29.8)	129(41.3)
HBV is a threat to my health	10(3.2)	148(47.4)	143(45.8)	11(3.5)
Comfortable having a friend with HBV	81(26.0)	162(51.9)	67(21.5)	2(0.6)
Attitudes category	Positive	56(17.6%)		
	Negative	256(82.4%)		
	Total	312(100%)		

³ HBV: Hepatitis B Virus

Practices related to HBV prevention

The mean practice score was 1.029 out of a maximum attainable score of four. Overall, 66 (21.2%; 95% CI: 16.9%–26.0%) adolescents demonstrated good preventive practices towards HBV infection.

Only 32 (10.3%) participants reported having been vaccinated against HBV, while 70 (22.4%) had previously undergone HBV testing. Sharing of blades or other sharp objects was reported by 113 (36.2%) participants. Furthermore, only 20 (6.4%) adolescents reported seeking medical attention following injuries involving sharp objects (Table 7).

Table 7: Practices of adolescents towards prevention of Hepatitis B Virus in Tiko Health District, May 2025.

Variable	Category	Frequency(N _o)	Percentage (%)
Vaccinated against HBV	No	280	89.7
	Yes	32	10.3
	Total	312	100
Tested for HBV	No	242	77.6
	Yes	70	22.4
	Total	312	100
Share blades/sharp objects	No	199	63.8
	Yes	113	36.2
	Total	312	100
Seek medical care after injury with sharp object	No	292	93.6
	Yes	20	6.4
	Total	312	100
Practice category	Good	67	21.2
	Poor	245	78.8
	Total	312	100

Factors associated with HBV infection among adolescents

In bivariable analyses, educational level, displacement status, family history of HBV infection, smoking, alcohol consumption, sexual activity, and knowledge level were associated with HBV infection.

In the multivariable logistic regression model, displacement status, family history of HBV infection, smoking, alcohol consumption, sexual activity, and knowledge remained independently associated with HBV infection.

Internally displaced adolescents had significantly greater odds of HBV infection compared with host adolescents (AOR = 10.67; 95% CI: 2.93–38.78; $p = 0.008$). Similarly, adolescents reporting a family history of HBV infection were nearly seven times more likely to have HBV infection than those without such a history (AOR = 6.97; 95% CI: 1.68–28.93; $p = 0.008$).

Behavioural factors were also independently associated with HBV infection. Smoking was associated with an eight-fold increase in the odds of infection (AOR = 8.24; 95% CI: 2.53–26.80; $p < 0.001$), whereas alcohol consumption increased the odds of HBV infection by approximately seven-fold (AOR = 6.69; 95% CI: 1.57–28.00; $p = 0.010$). Adolescents who were sexually active had significantly higher odds of HBV infection than those who were not sexually active (AOR = 5.85; 95% CI: 1.81–18.84; $p = 0.003$).

Conversely, adequate knowledge of HBV was associated with reduced odds of infection. Adolescents with adequate knowledge were 93% less likely to be infected with HBV than those with inadequate knowledge (AOR = 0.07; 95% CI: 0.01–0.84; $p = 0.036$).

No statistically significant associations were observed between HBV infection and age, sex, marital status, occupation, religion, attitude, or preventive practice after adjustment for potential confounders (Table 8).

Table 8: Factors associated to Hepatitis B Virus status among adolescents in the Tiko Health District, May 2025.

		HBV Status		95% CI for COR			95% CI AOR				
Variable	Category	Negative No (%)	Positive No (%)	COR	Lower	Upper	P-value	AOR	Lower	upper	P-value
Sex	Male	137(43.9)	5(1.6)	0.584	0.195	1.75	0.237	2.49	0.75	8.22	0.135
	Female	160(51.3)	10(3.2)	1				1			
Age group (years)	10_14	119(38.1)	3(1.0)	2.674	0.739	9.678	0.134	1.751	0.203	15.121	0.611
	15-19	178(57.1)	12(3.8)	1	.	.	.	1			
Education	Tertiary	31(9.9)	2(0.6)	0.403	0.068	2.385	0.317	1.112	0.133	9.293	0.922
	Secondary	132(43.2)	3(1)	0.142	0.03	0.674	0.014	2.873	0.483	17.080	0.246
	Primary	109(34.9)	6(1.9)	0.344	0.09	1.311	0.118	1.093	0.233	5.126	0.910
Marital status	No formal	25(8)	4(1.3)	1				1			
	Married	28(9)	2(0.6)	1.478	0.317	6.886	0.619				
	Single	269(86.2)	13(4.2)	1							
Religion	Muslim	62(19.9)	1(0.3)	0.271	0.035	2.099	0.265				
	Christian	235(75.3)	14(4.5)	1							
Internally displaced	Yes	81(26)	12(3.8)	10.667	2.934	38.776	<0.001	10.67	2.93	38.78	0.008
	No	216(69.2)	3(1)	1				1			
Family history of HBV	Yes	11(3.5)	3(1)	6.5	1.601	26.39	0.009	6.97	1.68	28.93	0.008
	No	286(91.7)	12(3.8)	1				1			
Smoker	Yes	17(5.4)	5(1.6)	8.235	2.531	26.798	<0.001	8.24	2.53	26.8	<0.001
	No	280(89.7)	10(3.2)	1				1			
Drink alcohol	Yes	61(19.6)	10(3.2)	7.738	2.551	23.475	<0.001	6.688	1.569	28.	0.010
	No	236(75.6)	5(1.6)	1				1			
Sexually active	Yes	95(30.4)	11(3.5)	5.847	1.815	18.841	0.003	5.85	1.81	18.84	0.003
	No	202(64.7)	4(1.3)	1				1			
Knowledge	Good	36(11.5)	2(0.6)	1.115	0.242	3.146	0.019	0.07	0.01	0.84	0.036
	Poor	261(83.7)	13(4.2)	1				1			
Attitudes	Positive	54(17.3)	1(0.3)	0.321	0.041	2.497	0.212	0.11	0.01	1.48	0.096
	Negative	243(77.9)	14(4.5)	1				1			
Practices	Good	63(20.2)	3(1)	0.929	0.254	3.391	0.911				
	Poor	234(75)	12(3.8)	1							

Discussion

This study provides comprehensive seroepidemiological evidence on HBV infection among adolescents in a conflict-affected district of Cameroon. The findings revealed an intermediate HBV prevalence of 4.8%, a high proportion of adolescents susceptible to infection (59.0%), very low vaccine-derived immunity (5.4%), poor hepatitis B-related knowledge, attitudes, and practices, and a strong association between HBV infection and internal displacement, family history of HBV, smoking, alcohol consumption, sexual activity, and knowledge of HBV.

The prevalence of HBV infection among adolescents in the present study was 4.8%. This prevalence is lower than the pooled national prevalence of 11.2% reported in Cameroon and lower than estimates reported among several adult populations within the country[30]. The lower prevalence observed in this study may reflect the impact of childhood vaccination initiatives and reduced cumulative exposure to risk factors among adolescents compared with adults[31]. However, the prevalence remains within the intermediate endemicity range according to World Health Organization classifications and indicates continued transmission within the community[32]. The finding suggests that HBV remains a significant public health concern among adolescents despite ongoing prevention efforts.

One of the most important findings of this study was that nearly six out of every ten adolescents were susceptible to HBV infection, while only 5.4% demonstrated vaccine-derived immunity. This finding highlights a substantial immunity gap and suggests that a large proportion of adolescents remain vulnerable to future infection. Given that hepatitis B vaccination is a highly effective preventive intervention, the low level of vaccine-associated immunity is concerning and may indicate poor vaccination uptake, incomplete vaccination schedules, waning immunity, or lack of access to vaccination services[33]. The high susceptibility observed underscores the need for adolescent-focused catch-up vaccination programs and intensified efforts to improve vaccine coverage among both host and internally displaced populations.

In contrast, approximately one-third of participants showed evidence of immunity resulting from previous natural infection. This finding suggests that a considerable proportion of adolescents had already been exposed to HBV during childhood or adolescence and subsequently developed natural immunity[34]. While naturally acquired immunity offers protection against reinfection, it also reflects previous circulation of the virus within the community and highlights missed opportunities for primary prevention through vaccination.

The study found that internally displaced adolescents were more than ten times more likely to be infected with HBV than adolescents from host communities. To the best of our knowledge, few studies in Cameroon have specifically evaluated the relationship between displacement status and HBV infection among adolescents. This finding may be explained by disruption of healthcare services, limited access to vaccination programs, overcrowded living conditions, poverty, reduced access to health information, and increased vulnerability associated with forced displacement[35]. Cameroon has experienced significant population displacement since the onset of the sociopolitical crisis in the North-West and South-West Regions, and the findings suggest that internally displaced adolescents may represent a particularly vulnerable population requiring targeted interventions. The strong association observed highlights the importance of integrating HBV screening, vaccination, and health education services into humanitarian and displacement-response programs.

Family history of HBV infection was also independently associated with HBV infection. Adolescents with a positive family history were nearly seven times more likely to be infected than those without such a history. This observation may reflect intrafamilial transmission through close household contact, sharing of personal items, or exposure to infected family members[36]. It may also indicate shared behavioral and environmental risk factors within households. Similar associations have been reported in previous studies where household exposure was identified as an important determinant of HBV infection. This finding emphasizes the need for family-based screening approaches and contact tracing strategies to identify and protect at-risk household members.

Behavioral factors played an important role in HBV transmission among study participants. Smoking, alcohol consumption, and sexual activity were all independently associated with HBV infection. Adolescents who smoked were more than eight times more likely to be infected, while alcohol consumers and sexually active adolescents had approximately seven-fold and six-fold greater odds of infection, respectively. Although smoking may not directly transmit HBV, it may serve as a marker of broader risk-taking behaviors that increase exposure to infection. Alcohol use may similarly reflect engagement in high-risk social and sexual practices, while the association with sexual activity supports the recognized role of sexual transmission in HBV epidemiology[37]. These findings reinforce the need for comprehensive adolescent health interventions that address behavioral risk factors alongside HBV prevention initiatives.

The study further demonstrated that adequate knowledge of HBV was associated with significantly lower odds of infection. Adolescents with adequate knowledge were substantially less likely to be infected than their counterparts with poor knowledge. This finding suggests that awareness and understanding of HBV transmission, prevention, and control may contribute to safer health behaviors and reduce exposure to infection[38]. Nevertheless, only a small proportion of adolescents demonstrated adequate knowledge, indicating substantial knowledge gaps within the study population. The observed association should be interpreted cautiously because of the relatively small number of HBV-positive participants, which may have affected the precision of the estimate. Nonetheless, the finding highlights the potential value of school-based and community-based educational programs in strengthening HBV prevention efforts.

Knowledge, attitudes, and practices related to HBV were generally poor among study participants. Fewer than one in eight adolescents had adequate knowledge, less than one-fifth demonstrated positive attitudes, and only one-fifth reported good preventive practices. Particularly concerning was the low proportion of adolescents who reported previous HBV vaccination or testing. Misconceptions regarding transmission, prevention, and treatment were common, and stigmatizing attitudes towards individuals living with HBV were frequently observed. These findings suggest that significant barriers remain to effective HBV prevention and control and underscore the need for enhanced public health education targeting adolescents.

Collectively, the findings of this study have important implications for HBV elimination efforts in Cameroon. The combination of substantial susceptibility, low vaccine-derived immunity, poor knowledge, and increased vulnerability among internally displaced adolescents indicates that current prevention strategies may not adequately reach this population. Strengthening adolescent-focused vaccination programs, expanding community-based screening services, improving access to health information, and targeting vulnerable groups such as internally displaced adolescents may contribute significantly to reducing HBV transmission and accelerating progress toward hepatitis elimination goals.

Strengths and Limitations

This study has several strengths. First, it employed a community-based design, allowing the inclusion of both host and internally displaced adolescents and providing findings that are more representative of the population than facility-based studies. Second, the study utilized a

comprehensive five-marker hepatitis B serological panel comprising HBsAg, anti-HBs, anti-HBc, HBeAg, and anti-HBe. This approach enabled detailed characterization of HBV susceptibility, vaccine-derived immunity, natural immunity, acute infection, and chronic infection, providing a more comprehensive assessment than studies relying solely on HBsAg testing. Third, the study investigated both biological and behavioral determinants of HBV infection, generating evidence that may inform targeted public health interventions.

However, several limitations should be considered when interpreting the findings. The cross-sectional design limits the ability to establish temporal or causal relationships between identified risk factors and HBV infection. Information on behavioral characteristics was self-reported and may therefore be subject to recall bias and social desirability bias. In addition, the relatively small number of HBV-positive participants may have reduced the precision of some estimated odds ratios, resulting in wide confidence intervals. Finally, the study was conducted in a single health district and may not be fully generalizable to all adolescents in Cameroon.

Conclusion

HBV infection remains an important public health problem among adolescents in the Tiko Health District. Although the prevalence of infection was intermediate, nearly 60% of adolescents remained susceptible to HBV infection and only 5.4% demonstrated vaccine-derived immunity, revealing a substantial protection gap. Internal displacement, family history of HBV infection, smoking, alcohol consumption, and sexual activity were associated with increased odds of infection, whereas adequate HBV knowledge was protective.

These findings highlight the urgent need for adolescent-focused HBV prevention strategies, including catch-up vaccination, routine screening, comprehensive health education, and targeted interventions for internally displaced populations. Strengthening these measures could substantially reduce HBV transmission among adolescents and contribute to achieving hepatitis elimination targets in Cameroon.

Declarations

Ethical considerations and consent to participate

Ethical approval for this study was obtained from the Institutional Review Board of the University of Buea, Cameroon (Reference number: 20251801-12/UB/SG/IRB/FHS).

Administrative authorization was obtained from the South-West Regional Delegation of Public Health and the Tiko Health District Health Service.

Participation was voluntary and confidentiality was maintained throughout the study. Unique identification numbers were assigned to participants instead of names during data collection and analysis. Written informed consent was obtained from participants aged 18–19 years, while parental or guardian consent and adolescent assent were obtained for participants younger than 18 years. Adolescents who tested positive for hepatitis B surface antigen were counselled and referred for appropriate clinical follow-up and management.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Competing interests

The authors declare that they have no competing interests.

Data availability statement

The datasets generated and/or analyzed during the current study are included in this published article and its supplementary information files. The data have been de-identified to ensure participant confidentiality.

Consent for publication

Not applicable.

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Authors Contributions

Supplementary file 1: English version of the study questionnaire

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Patient and Public Involvement Statement

Patients and the public were not involved in the design, conduct, reporting, or dissemination of this research.

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