

Original Research Article

Seroprevalence of hepatitis B and vaccine effectiveness in vertical transmission prevention: a hybrid study among pregnant mothers attending antenatal clinics in Abyei, South Sudan

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ABSTRACT

Background: Hepatitis B virus (HBV) is a global health threat, affecting millions worldwide and causing severe liver diseases such as cirrhosis and cancer. Low and middle-income countries (LMICs), particularly South Sudan, face challenges like limited healthcare infrastructure and public awareness, leading to high HBV prevalence. Infants born of seropositive women are at heightened risk due to vertical transmission, perpetuating the infection cycle.

Methods: This study assessed HBV seroprevalence among pregnant women in Abyei, South Sudan, and evaluated vaccine effectiveness in preventing mother-to-child transmission. A hybrid study of cross-sectional and cohort design included 384 pregnant women and 94 infants. Blood samples were tested for hepatitis B surface antigen (HBsAg), while socio-demographic data and awareness levels were gathered through structured questionnaires. Qualitative insights were also collected via focus group discussions and interviews with healthcare providers. Logistic regression was used to analyze risk factors.

Results: The seroprevalence of HBV was 19% among pregnant women. Younger age, lower education levels, and unemployment were associated with higher infection rates. Vertical transmission occurred in 4.3% of infants, despite vaccine availability. Awareness of HBV was notably low among participants, underscoring gaps in public health education.

Conclusions: HBV presents a significant health burden in Abyei, South Sudan. Enhancing health education, improving access to preventive strategies, and strengthening healthcare infrastructure are critical to reducing HBV prevalence and transmission. Implementing targeted public health interventions can mitigate the virus's impact on maternal and child health in the region.

Keywords: Hepatitis B, Seroprevalence, Vertical transmission

INTRODUCTION

Hepatitis B virus (HBV) is a major global health issue, affecting over 296 million people and leading to severe conditions like cirrhosis and liver cancer. In 2019, HBV-related cirrhosis and liver cancer caused an estimated 523,000 deaths.¹ Despite the availability of preventive interventions, inadequate diagnosis and underutilization of these measures persist, exacerbating the public health challenge. The World Health Organization (WHO) aims to

eliminate viral hepatitis by 2030, but projections suggest a 39% rise in HBV mortality if current trends continue, with over 300 million cases and 1.5 million deaths expected by that year.²

The lack of proper diagnosis for HBV leads to under-recognition of its extent, contributing to insufficient preventive measures. This situation is particularly dire in regions with high HBV prevalence, where the coverage of birth doses for HBV vaccinations remains suboptimal.

Effective preventive interventions, which could impede the transmission of the virus and hinder the progression of associated diseases, are notably underutilized, especially in low-income countries.¹ The estimated rise in HBV cases and mortality rates underscores the urgent need for improved diagnostic and preventive strategies.

Low and middle-income countries (LMICs), particularly in Africa, bear the brunt of HBV's impact, with over 60% of new cases and deaths occurring in these regions. In Africa alone, 65 million people are infected, and by 2030, this number could exceed 80 million.³ Chronic HBV in Africa often leads to severe complications like liver cirrhosis and cancer, making it a significant health burden. Efforts to combat HBV include WHO's recommendations for routine immunizations and improved access to testing and treatment, but challenges such as limited healthcare infrastructure and low public awareness hinder progress.⁴

The burden of HBV in Africa is particularly high because the virus is endemic in many parts of the continent, and transmission occurs through various routes, including mother-to-child transmission, unsafe healthcare practices, and sexual contact.⁵ Many people in Africa do not have access to effective vaccines or are unaware of their hepatitis B status. In Africa, liver cancer, largely driven by HBV, is the third leading cause of cancer-related deaths.⁴ The limited healthcare services and insufficient vaccination coverage further exacerbate the public health challenge posed by HBV in the region.

South Sudan exemplifies the challenges faced by many African nations, with a high HBV prevalence of 10-15% and significant mortality rates. Despite integrating HBV vaccination into national immunization programs and increasing public awareness, the country's efforts are hampered by inadequate healthcare infrastructure, ongoing conflict, and limited resources.⁶ The high transmission rates from mother to child underscore the urgent need for effective prevention and treatment strategies. This study aims to examine HBV seroprevalence and the effectiveness of prevention strategies in the Abyei Area of South Sudan, highlighting the critical need for targeted public health interventions.⁴

METHODS

This study was conducted for the period of six months from November 2023 to April 2024. It investigated HBV seroprevalence among pregnant women in Abyei, South Sudan, and evaluated the effectiveness of the Hepatitis B vaccine in preventing mother-to-child transmission. A cross-sectional study design was utilized, involving 384 pregnant women attending antenatal clinics. Blood samples were collected and analyzed for hepatitis B surface antigen (HBsAg) using enzyme-linked immunosorbent assay (ELISA). A structured questionnaire was administered to gather socio-demographic data, vaccination history, and awareness of HBV. Additionally, qualitative data were obtained through focus group

discussions and key informant interviews with healthcare providers to understand the barriers to effective HBV prevention and control. Statistical analysis included logistic regression to identify factors associated with HBV infection.

The study took place in Abyei, a region with high HBV prevalence and significant healthcare challenges. The target population included pregnant women attending antenatal care and their newborns. Historical data indicated a steady attendance of pregnant women at antenatal clinics, averaging 2711 annually.

Using the Fisher formula, the sample size for the cross-sectional study was calculated to be approximately 384 women. The study included pregnant women aged 18-49 years attending antenatal clinics in Abyei, South Sudan, who were sound of mind, able to comprehend and respond to questionnaires or interviews, and willing to participate with informed consent. Women who had not been previously diagnosed with chronic hepatitis B infection, as well as infants born to mothers who tested positive or negative for the hepatitis B surface antigen (HBsAg), were also included. Exclusion criteria encompassed pregnant women who had been vaccinated against hepatitis B, those who did not provide consent, or had lived in the Abyei area for less than six months. Additionally, infants of mothers who refused to be tested and women with prior chronic hepatitis B diagnosis, language barriers, cognitive impairments, or medical conditions that hindered participation were excluded from the study. Quantitative data collection focused on the prevalence and effectiveness of the hepatitis B vaccine. Blood samples were tested for HBsAg, and positive and negative mothers were followed until delivery. Newborns received the hepatitis B vaccine and were tested after six months to assess the vaccine's protective effectiveness.

Qualitative data from focus group discussions and key informant interviews provided insights into barriers and challenges in hepatitis B prevention. This approach ensured a comprehensive understanding of the research problem, balancing structured quantitative analysis with the in-depth exploration provided by qualitative methods.

Quantitative data were analyzed using the statistical package for the social sciences (SPSS) version 29.0, employing descriptive statistics and inferential analyses such as multilinear regression to examine the relationships between variables. Qualitative data were analyzed thematically, with narratives constructed around identified themes and triangulated with quantitative findings to provide a comprehensive understanding of the factors influencing hepatitis B infection and vaccine efficacy.

RESULTS

The study aimed to determine the seroprevalence of hepatitis B and assess the effectiveness of the hepatitis B vaccine in preventing vertical transmission among

pregnant mothers attending antenatal clinics in Abyei, South Sudan. A total of 384 pregnant mothers participated in the first phase of the study, with a 99% response rate (382 completed questionnaires). In the second phase, all 94 infants were present, achieving a 100% response rate.

The seroprevalence of hepatitis B among pregnant mothers was 19%, with 73 out of 382 participants testing positive for the virus (Figure 1). A statistically significant association was found between age and Hepatitis B status, with younger age groups showing higher rates of infection. Specifically, 43.3% of those aged 15-25 years tested positive, compared to 27.7% of those over 30 years ($\chi^2=14.72$, $p=0.0001$). Educational level was also significantly associated with hepatitis B status; 92% of those who tested positive had never been to school (Fisher's exact $p=0.0001$). Employment status showed that all employed participants tested negative, while a significant proportion of unemployed participants tested positive (Fisher's exact $p=0.0001$). Marital status indicated a high prevalence among polygamous marriages, with 92% of positive cases in this group (Fisher's exact $p=0.0001$) (Table 1).

All the study participants reported a lack of awareness about hepatitis B, highlighting a significant gap in public health education. Only 9.42% knew that hepatitis B is a virus, and a mere 7.33% were aware that it affects the liver. Awareness of transmission routes was also low, with only 11.52% knowing it can be transmitted through unsterilized instruments and 2.69% aware of transmission through blood products. This lack of awareness underscores the need for comprehensive health education programs.

The study identified several significant risk factors associated with hepatitis B seroprevalence. These included early sexual activity, a history of sexually transmitted infections (STIs), intravenous drug use, and nose or ear piercing. Among those who tested positive, 48% reported early sexual activity, and 37% had a history of STIs. Intravenous drug use and nose or ear piercing were also common among positive cases, with 26% and 22% reporting these practices, respectively (Table 2). The qualitative insights from focus group discussions highlighted additional risk factors such as unskilled delivery practices, lack of antenatal care, multiple sexual

partners, and cultural practices like wife inheritance. These practices contribute significantly to the transmission of hepatitis B and underscore the need for targeted interventions.

From the study, logistic regression analysis illustrated that respondents who have ever had a sexually transmitted disease were 12 times more likely to test positive for hepatitis B compared to those who did not have STIs (AOR=12.848, $p=0.0001$). The use of intravenous drugs was also a predictor of testing positive for hepatitis B. The probability 2.3 times of testing hepatitis B positive if a pregnant woman uses intravenous drugs (AOR=2.3, $p=0.004$) (Table 3).

The focus group discussions also identified several barriers and challenges to the prevention of hepatitis B among pregnant women. These include the lack of screening services specifically tailored for pregnant women, as well as the absence of prophylactic hepatitis B services for infants born to positive mothers. Limited awareness-raising activities and the low socio-economic status of the population were highlighted as additional challenges. Other barriers mentioned include the absence of linkages to treatment services, limited access to antenatal care, and low skills and training levels among healthcare workers. Cultural beliefs, taboos, and the affordability and availability of vaccines were also identified as significant challenges. Furthermore, the collapsed health system was noted as a contributing factor, leading to inadequate supply chains and exacerbating the challenges of hepatitis B prevention.

The effectiveness of the hepatitis B vaccine in preventing mother-to-child transmission was assessed through a cohort analysis of 47 infants born to HBV-positive mothers. Despite vaccination, 2 out of 47 infants tested positive for HBV, resulting in a risk ratio of 2.044. This indicates that while vaccination reduced the risk of transmission, it did not eliminate it. A Chi-square test comparing transmission rates between vaccinated infants of HBV-positive and HBV-negative mothers showed no significant difference, with a p value of 0.5241. This suggests that other factors may influence the risk of transmission, and further research is needed to explore these.

Table 1: Bivariate association between respondents' socio-demographic characteristics and hepatitis B status.

Characteristics	Hepatitis B		P value
	Negative	Positive	
Age (years)			
15-25	133 (43.3)	39 (52.0)	14.72 (1), p=0.0001
26-30	85 (27.7)	30 (40.0)	
More than 30	89 (29.0)	6 (8.0)	
Education level			
Never been to school	130 (42.4)	69 (92.0)	Fisher's exact p=0.0001
Primary	129 (42.0)	6 (8.0)	
Secondary	48 (15.6)	0 (0.0)	

Continued.

Characteristics	Hepatitis B		P value
	Negative	Positive	
Occupation			
Employed	139 (45.3)	0 (0.0)	Fisher's exact p=0.0001
Student	24 (7.8)	16 (21.3)	
Unemployed	144 (46.9)	59 (78.7)	
Income levels (SSP)			
10,000-20,000	51 (34.7)	0 (0.0)	N/A
>20,000	96 (65.3)	0 (0)	
Marital status			
Monogamy	179 (58.3)	0 (0.0)	Fisher's exact p=0.0001
Polygamy	98 (31.9)	69 (92.0)	
Unmarried	30 (9.8)	6 (8.0)	
Husband work status			
Not working	100 (33.9)	27 (39.1)	0.674 (1), p=0.412
Working	195 (66.1)	42 (60.9)	
Parity			
Granmultipara >4	80 (26.1)	16 (21.3)	5.869 (1), p=0.053
Multipara 4 children	174 (56.7)	53 (70.7)	
Primipara	53 (17.3)	6 (8.0)	

Table 2: Risk factors associated with viral hepatitis B infection among pregnant women at antenatal clinics in Abyei, South Sudan.

Characteristics	HBsAg result		Total, P value
	Negative	Positive	
Age of sexual life (years)			
13-15	173 (56.4)	54 (72.0)	6.1212 (df=1), p=0.013
16 and above	134 (43.7)	21 (28.0)	
Suffering from STI			
No	263 (85.7)	10 (13.3)	154.6550, (df=2), p=0.000
Yes	44 (14.3)	65 (86.7)	
Ever used by IV drugs			
No	232 (75.6)	23 (30.7)	54.7617, (df=1), p=0.000
Yes	75 (24.4)	52 (33.3)	
Husband living with HBV			
No	300 (97.7)	58 (77.3)	42.5457 (df=1), p=0.000
Yes	7 (2.3)	17 (22.7)	
Have you pierced your nose or ear			
No	63 (20.5)	0 (0.0)	18.4305 (df=1), p=0.000
Yes	244 (79.5)	75 (100.0)	

Table 3: Predictors of HBV.

Characteristics	Odds ratio	Std. err.	z	P>z	[95% conf. interval]	
Age of start of sexual life (years)						
13-15	Ref			0.968	Lower	Upper
16 and above	0.982	0.434	-0.041		0.413	2.337
Had surgical operation						
No	Ref			0.726		
Yes	1.169	0.52	0.35		0.489	2.794
Have STI						
No	Ref			0.0001		
Yes	12.848	6.388	5.135		4.848	34.045
Currently using IV drugs						
No	Ref			0.04		

Continued.

Characteristics	Odds ratio	Std. err.	z	P>z	[95% conf. interval]	
Yes	2.3	0.894	2.051		1.037	4.904
Living with someone infected with hepatitis B						
No	Ref					
Yes	1.84	0.976	1.15	0.25	0.651	5.205
Constant	0.059	0.026	-6.517	0	0.025	0.139

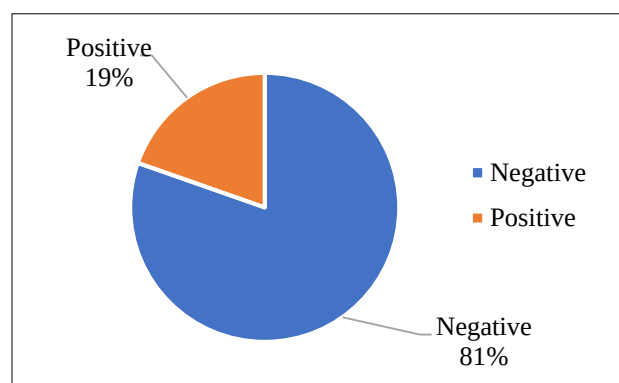


Figure 1: Seroprevalence of hepatitis B among pregnant mothers.

DISCUSSION

HBV infection remains a significant public health concern globally, particularly in resource-limited settings where access to healthcare and preventive measures may be limited.⁷ In South Sudan, like many other sub-Saharan African countries, HBV poses a substantial health burden, with pregnant women being particularly vulnerable due to potential vertical transmission to their infants during childbirth. According to the WHO, HBV infection affects about 257 million people worldwide, and it is estimated that 686,000 people die annually from complications of hepatitis B, including cirrhosis and liver cancer.⁸

Recent studies have highlighted varying seroprevalence rates of HBV among pregnant women across different regions. For instance, a study conducted in Oman found a seroprevalence rate of 1.5% among pregnant women.⁹ Conversely, a study in Japan reported a much lower prevalence of 0.54%.¹⁰ These differences underscore the variability in HBV burden among pregnant populations globally. In South Sudan, specific data on HBV prevalence among pregnant women, particularly in regions like Abyei, remains sparse. However, neighboring countries in East Africa have reported varying prevalence rates. For instance, a systematic review in Ethiopia indicated an overall HBV prevalence of 7.4% among pregnant women.¹¹ Similarly, in Nigeria, studies have reported varying prevalence rates ranging from 5.8% in Nnewi to 13.6% in Sokoto.^{12,13}

Understanding the seroprevalence of HBV among pregnant women in Abyei is crucial for developing targeted interventions to reduce transmission rates. Vaccination during pregnancy has been shown to significantly reduce the risk of perinatal transmission. For instance, a study in China demonstrated the impact of

vaccination in reducing vertical transmission rates among rural women.¹⁴ Such interventions can be adapted to the context of Abyei and other regions with similar demographic and healthcare challenges.

Awareness of HBV among pregnant women is essential for uptake of preventive measures such as vaccination and screening. Studies have shown varying levels of awareness among pregnant women globally. In a study conducted in Pakistan, awareness regarding HBV was found to be relatively low, with only 41.2% of pregnant women having adequate knowledge about the virus.¹⁵ Similar findings were reported in South India, where knowledge gaps regarding HBV transmission and prevention were identified among pregnant women attending primary health center.¹⁶

In contrast, studies in China have shown higher levels of awareness among pregnant women, attributed to extensive public health campaigns and education initiatives.¹⁷ These disparities highlight the importance of context-specific health education programs tailored to the needs of pregnant women in different regions. In South Sudan, limited research exists on the awareness of HBV among pregnant women, particularly in regions like Abyei. Enhancing awareness through community-based education and antenatal counselling can empower pregnant women to make informed decisions about their health and the health of their infants.¹⁸ Effective communication strategies that incorporate local languages and cultural beliefs are essential for improving awareness and promoting preventive behaviors.

Several factors contribute to the risk of HBV infection among pregnant women, including socioeconomic status, educational attainment, and healthcare access. Studies have identified various risk factors associated with HBV

prevalence among pregnant populations globally. For example, in Nigeria, factors such as lower socioeconomic status and lack of formal education were significantly associated with increased HBV prevalence among pregnant women.¹⁹ Similarly, in Ethiopia, studies have highlighted the role of demographic factors such as age and marital status in HBV transmission among pregnant women.²⁰ Understanding these risk factors is crucial for developing targeted interventions that address the specific needs of vulnerable populations.

In Abyei, South Sudan, where healthcare infrastructure is limited, addressing these risk factors requires a multifaceted approach. Improving access to prenatal care services, integrating HBV screening into routine antenatal care, and expanding vaccination coverage are essential strategies for reducing the burden of HBV among pregnant women.²¹ Community engagement and partnership with local healthcare providers are also critical for raising awareness and promoting preventive behaviors.

Despite the availability of effective vaccines and preventive measures, several barriers hinder the prevention of HBV among pregnant women in resource-limited settings. These barriers include inadequate healthcare infrastructure, limited access to screening and vaccination services, and cultural beliefs.⁷ In Ghana, for example, studies have identified healthcare system challenges such as vaccine shortages and inconsistent supply chains as significant barriers to HBV prevention among pregnant women.²² Similar challenges have been reported in other sub-Saharan African countries, where logistical constraints and competing health priorities often limit the implementation of comprehensive HBV prevention programs.²³

Cultural beliefs and practices also play a critical role in shaping health-seeking behaviors among pregnant women. In many communities, misconceptions about HBV transmission and prevention contribute to stigma and discrimination, further complicating efforts to promote vaccination and screening uptake.²⁴ Addressing these cultural barriers requires community engagement and targeted health education initiatives that are sensitive to local norms and values. In Abyei, South Sudan, addressing barriers to HBV prevention among pregnant women requires a coordinated effort involving government agencies, healthcare providers, and community leaders. Strengthening healthcare infrastructure, ensuring a stable supply of vaccines and screening tests, and promoting culturally appropriate health education are essential steps toward reducing the burden of HBV in this vulnerable population.⁷

Limitations

The study was limited to a subset of the population seeking care during the study period. To mitigate this, healthcare facilities from different regions within the study area were selected to ensure a representative sample across various

localities. Another limitation was the potential for incomplete or inaccurate information provided by participants during interviews. To address this, the knowledge and expertise of senior healthcare workers were leveraged to verify the accuracy and completeness of the data collected. Additionally, tracking infants born to hepatitis B-positive mothers for completion of the three-dose vaccination schedule was challenging due to factors such as displacement, migration, or death. To minimize loss to follow-up, contact information was used, and health promoters and community health volunteers followed up with the mothers via phone to ensure their children completed the vaccination series. Furthermore, some mothers delivered at home, complicating adherence to the vaccination schedule. Continuous monitoring of registered expectant mothers' expected delivery dates was implemented to ensure they were connected to healthcare facilities. If home delivery occurred, the newborns were brought to the facility for timely vaccination according to the prescribed schedule.

CONCLUSION

In conclusion, hepatitis B infection among pregnant women in Abyei, South Sudan, poses a critical public health challenge, with socioeconomic status, healthcare access, and awareness of preventive measures contributing to the high seroprevalence. This study advances knowledge by highlighting the need for a multifaceted approach that integrates vaccination, screening, and health education into routine antenatal care. Strengthening healthcare infrastructure, enhancing community engagement, and improving access to essential services are vital to reducing mother-to-child transmission and improving maternal and child health outcomes. The findings emphasize the importance of addressing cultural beliefs and systemic barriers while encouraging early antenatal care attendance and expanding healthcare accessibility. By integrating preventive services, training healthcare providers, and providing antiviral treatment to high-risk mothers, South Sudan can make significant strides in mitigating the impact of hepatitis B. The study also calls for future research into vaccine failures, cultural influences on transmission, and the long-term effects of maternal HBV infection, offering valuable insights for developing targeted interventions and improving health policies.

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