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# Uptake of combined immunoprophylaxis for newborns exposed to hepatitis B virus in a high hepatitis B endemic rural setting in Northern Ghana

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## Abstract

**Background** Mother-to-Child Transmission (MTCT) is a major route of Hepatitis B Virus (HBV) transmission, accounting for a substantial proportion of new infections, particularly in highly endemic areas. The timely administration of combined immunoprophylaxis of Hepatitis B Immunoglobulin (HBIG) and hepatitis B vaccine to newborns exposed to hepatitis B virus is a crucial strategy for preventing MTCT. This study investigated the determinants of hepatitis B virus immunoprophylaxis utilization for newborns of HBV-seropositive mothers in the North-East region of Ghana.

**Methods** A cross-sectional survey design was employed, involving 213 HBV seropositive mothers who had given birth in four selected study sites. Systematic random sampling was used to select mothers from the selected health facilities. Data was collected using a structured questionnaire. Data was coded entered and analyzed using SPSS version 26. Bivariate and multivariate analyses were undertaken, and the level of significance was set at 0.05.

**Results** Key findings revealed that mothers aged 30–39 were less likely to ensure their newborns received both hepatitis B immunoglobulin and vaccine compared to younger mothers (aOR = 0.24, 95% CI [0.09, 0.65], $p = 0.005$). Employment status significantly influenced utilization, with salaried workers (aOR = 6.78, 95% CI [1.34, 34.46], $p = 0.021$) and self-employed mothers (aOR = 3.38, 95% CI [1.39, 8.22], $p = 0.007$) more likely to utilize immunoprophylaxis compared to unemployed mothers. Higher monthly income (501–1000 currency units) was associated with increased utilization (aOR = 4.70, 95% CI [1.28, 17.32], $p = 0.020$). Mothers with good knowledge of hepatitis B were more likely to ensure immunoprophylaxis for their newborns (aOR = 3.60, 95% CI [1.72, 7.54], $p = 0.001$).

**Conclusion** This study found 63.4% HBV immunoprophylaxis uptake among newborns in rural Ghana, influenced by maternal age, employment, income, and knowledge. It recommends integrating immunoprophylaxis into the National Health Insurance Scheme to reduce financial barriers. Strengthening health education for mothers on HBV

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transmission is also crucial. Policy reforms and improved healthcare are needed to eliminate mother-to-child HBV transmission and achieve the global goal of eliminating viral hepatitis by 2030.

**Clinical trial registration number** Not applicable.

**Keywords** Combined immunoprophylaxis, Hepatitis B, Immunoglobulin, Mother-to-child-transmission, Vaccine

## Introduction

Hepatitis B Virus (HBV) infection remains a significant global health challenge, with an estimated 254 million people living with chronic HBV infection worldwide [1]. Africa and Asia bear the highest global burden of HBV infection, accounting for the majority of the world's chronic HBV cases with an estimated 97 million and 65 million people chronically infected, respectively. In sub-Saharan Africa, the virus is commonly acquired in early childhood mostly perinatally or through horizontal transmission leading to a high risk of chronic infection and serious complications such as liver cirrhosis and hepatocellular carcinoma [1]. Ironically, this high disease burden in Africa is associated with limited access to screening, diagnosis, and antiviral treatment further contributing to the substantial morbidity and mortality associated with HBV in these regions [2].

HBV remains highly endemic in Ghana with a systematic review estimating a prevalence of 12–14%, in the general population [3, 4], The prevalence of HBV in the northern sector of Ghana is the highest recorded in the country, ranging from 15 to 22% compared to 6.5 -11.5% in the southern sector [5].

There is also a corresponding high prevalence of HBV infection among pregnant women in Ghana, with estimates ranging from 8.0 to 16.0% [5, 6], and the the North East Region recording one of the highest prevalence rates [7]. This significant burden among pregnant women indicates a high risk of Mother-to-Child Transmission (MTCT]) of HBV.

In highly endemic populations where the risk of MTCT of HBV is very high, The WHO has recommended the screening and treatment of pregnant women and timely administration of Post-Exposure Prophylaxis (PEP) as important strategies for preventing HBV infection in newborns [8, 9]. The administration of HBIG and vaccine within 12–24 h of birth is the PEP package for exposed newborns and it tends to significantly reduce the risk of MTCT by 85–95% [10]. In many developed countries, these interventions have been vigorously undertaken and have contributed to a significant reduction in the incidence and prevalence of HBV among children under age 5 and the general population [11]. However, despite the availability and efficacy of these preventive measures, their utilization remains suboptimal in many resource-limited settings, including rural areas of Ghana [12] resulting in the failure of these settings to achieve the < 1% HBsAg positivity in children under 5 years [13].

Ghana has developed the National Viral Hepatitis Policy in response to the high burden of HBV [14]. The policy among many other strategies, outlined specific guidelines for the Prevention of Mother-to-Child Transmission (PMTCT) of HBV. The policy recommendations include screening all pregnant women for HBsAg, and providing antiviral therapy, such as Tenofovir, to high-risk mothers with HBsAg + status and high viral loads during the third trimester. The policy also gave guidelines on the administration of Hepatitis B Immunoglobulin (HBIG) and Hepatitis B birth dose vaccine to HBV-exposed newborns within 24 h, followed by completion of the full vaccination series and post-vaccination testing [14]. The implementation of the PMTCT program by the Ghana Health Service (GHS) as well as private health institutions has led to a notable increase in the proportion of pregnant women tested for HBsAg by the time of delivery, rising from 87.2% in 2017 to 94.3% in 2020 [5].

Unfortunately, Ghana has yet to implement and integrate the hepatitis B birth dose vaccine into its Expanded Program on Immunization [15]. Additionally, the cost of HBIG and the monovalent vaccine is borne by caregivers of exposed infants, as these interventions are not covered by the country's sole national health insurance scheme [16]. The unavailability and high cost of the HBV monovalent vaccine and HBIG have been cited as key contributors to the suboptimal utilization of PEP for newborns exposed to HBV in many parts of Ghana, resulting in the failure to achieve the World Health Organization's target of less than 1% HBsAg positivity among children under five years of age [13]. Previous studies conducted in Ghana have primarily focused on assessing the knowledge levels of healthcare providers and identifying systemic barriers to the implementation of interventions for the PMTCT of HBV [17–19]. However, little to no attention has been given to the actual coverage of immunoprophylaxis such as timely birth-dose vaccination and administration of HBIG among exposed newborns. Moreover, the factors associated with the uptake of these critical interventions remain poorly understood. This represents a significant research gap, as understanding both the extent of immunoprophylaxis coverage and its determinants is essential for informing targeted strategies to reduce perinatal HBV transmission in Ghana.

The Northern sector of Ghana, including the East Mamprusi District, offers a unique context for examining the uptake of interventions aimed at PMTCT of HBV, with a particular focus on the utilization of HBV immunoprophylaxis for newborns. This predominantly rural region faces significant challenges, including high poverty levels and low literacy rates, especially when compared to other parts of the country (Ministry of Local Government and World Bank, 2020) Access to healthcare is limited [20], and both HBV-related knowledge and vaccination coverage among adults have been reported to be very low [21, 22]. These contextual factors likely contribute to the settings' disproportionately high HBV prevalence, the highest recorded in Ghana [5]. These challenges and the unique characteristics of the setting highlight the urgent need to intensify efforts to prevent MTCT of HBV.

Therefore, understanding the determinants of HBV immunoprophylaxis utilization in this setting is essential for informing targeted strategies to improve coverage and reduce the burden of HBV infection. This study, therefore, aims to assess the utilization of HBV immunoprophylaxis for newborns of HBV-infected mothers in the North-East Region of Ghana and to identify factors associated with its uptake.

## Methods

### Study design

A cross-sectional research design was chosen for this study to provide a snapshot of the current state of HBV immunoprophylaxis utilization for newborns of HBV seropositive mothers. Through the implementation of a single time-point data acquisition approach, this methodological framework enabled the elucidation of the key factors impacting the adoption of immunoprophylactic measures within the designated cohort.

### Study setting/location

The study was conducted in the East Mamprusi District of the North-East Region of Ghana. The study area covers 1,706.8 square kilometres. The predominant language spoken by the people of this locality is Mampruli, and farming and petty trading are the main occupations. The population, size of the study area according to the 2021 population and housing census report is 188,006 [23, 24]. The municipality is mainly rural, with an extended family system and a mix of Islamic, Christian, and traditional religious practices. The municipality has one hospital, and seven Community-Based Health Planning and Services (CHPS) compounds scattered all over the subdistricts. The study was done in four health facilities in the municipality. These facilities include Baptist Medical Center (BMC), Gambaga, Langbensi Sakogu Health Center. These facilities are public facilities either owned by the Government or the Christian Health Association of Ghana (CHAG). The facilities provide maternal and child health services including Antenatal care, delivery and post-natal care services. PMTCT for HBV forms an integral part of the maternal and child health services provided by these facilities as they engage in HBV screening, HBV post-exposure prophylactic counselling and administration of post-exposure prophylaxis for newborns.

### Study population

The study was restricted to mothers who were 18 years and above. Setting the minimum age at 18 ensures that all participants are legal adults capable of providing informed consent without the need for parental or guardian approval. This is particularly important given the sensitive nature of the study, which involves participants' HBV status. Additional inclusion criteria were testing positive for HBsAg during pregnancy, residing in the North-East Region of Ghana and having a positive birth outcome. Mothers who had a diagnosis of HBV but were psychologically and physically unstable and those with stillbirths, and early neonatal deaths were excluded. Excluding psychologically and physically unstable participants helps ensure that participation in the study does not exacerbate their condition or cause additional distress. Mothers whose babies had conditions that contraindicated the use of vaccines were excluded from the study.

### Sampling size Estimation

The study utilized Cochran's formula for determining sample size adequacy [24] to determine the size of the target population.

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

Where $n$ is the required sample size, $Z$ is the Z-value corresponding to the desired confidence level (1.96 for a 95% confidence interval), $p$ is the estimated population proportion or prevalence of HBV in the study setting (which falls within 8 – 0% [6] and 15.6% [5]), $e$ is the desired margin of error (0.05, or 5%) and an anticipated non-response of 10%, a sample size of 224 was deemed appropriate for this study.

### Sampling procedure

A multi-stage cluster sampling technique was used in this study. Firstly, four healthcare facilities were purposively selected from the East Mamprusi Municipal in the North-East region of Ghana. These facilities included: Baptist Medical Center (BMC), Gambaga Health Center, Langbensi Health Center and Sakogu Health Center. These facilities were chosen based on their client load,

accessibility, and representation of different levels of healthcare services within the municipality. The selection ensured a comprehensive representation of both urban and rural areas. At each facility, mothers who tested positive for HBsAg had newborns and were in the postpartum period were identified through an extensive review of Antenatal Care (ANC) registers, delivery books and registers and finally, their individual ANC cards. The information obtained was facility-specific, and this helped in the development of a facility-specific sampling frame. The total sample size of 224 participants was proportionally allocated to each of the four healthcare facilities based on their client load and the number of eligible mothers identified. This yielded a sampling proportion ratio of 2:1:1:1 for MBC, Gambaga, Langbensi, and Sakogu respectively.

This ensured that larger facilities with more eligible participants were appropriately represented in the final sample. Utilizing the established sampling frame at the designated facilities, study participants were selected through the application of a systematic random sampling technique. The facility-specific sampling interval ($k_a$), approximately 2, was calculated by dividing the total number of eligible mothers by the desired sample size for each facility using a random starting point. The mothers were enrolled one after the other until the sample sizes were exhausted for all four selected facilities or study sites.

#### Data collection tool and procedure

Data was collected on the utilization of HBV immunoprophylaxis for newborns exposed to HBV. A structured questionnaire was developed solely or specifically for this study (Supplementary file). The tool has a section on demographic information such as age (years), highest education level achieved etc. The other section of the instrument solicited information on the use of HBIG and HBV vaccine for the exposed newborn. Information on the timing of the receipt of the immunoprophylaxis was also solicited from the participants. To validate the instrument, a pretest was conducted with 27 postpartum mothers who had tested positive for HBV during or before pregnancy. These participants were selected from health facilities in a district bordering the study area. An expert in HBV and maternal health, serving as the academic supervisor for the research reviewed the tool to ensure alignment with published literature and study objectives. Revisions were made based on both the expert review and pretest findings to enhance the reliability, logical flow, and coherence of the instrument. The instrument was finally administered to the participants in electronic format using mobile phones and tablets. Research assistants who received thorough training on the use of the Goole forms and the consenting process interacted with the study participants and engaged them face-to-face to administer the questionnaire. The interviews, which lasted for 30–40 min, took place at the post-natal clinics, delivery and post-natal wards within the selected health facilities. Privacy and confidentiality were ensured especially with the HBV status of mothers.

#### Data management and analysis

To minimize missing data issues in this study, the research instrument was pretested to minimize unclear questions and an electronic mode of questionnaire administration with required or mandatory fields was utilized. Participants were assured of confidentially prior to the administration of the questionnaire to help minimize social desirability bias. After data collection, the data was checked for completeness, omissions and errors. The data was coded using the Statistical Package for Social Sciences (SPSS), version 26 and the same software was utilized for the analysis. To offer an overview of the sample and the distribution of responses to specific questionnaire items, frequencies, percentages, means, modes, and standard deviations were calculated. Chi-square analysis was used to determine associations between sociodemographic variables and their influence on the utilization of hepatitis B virus immunoprophylaxis for newborns exposed to HBV. A binary logistic regression was undertaken to estimate Crude and Adjusted Odds Ratios (CORs and AOR) with their corresponding 95% confidence interval (CI 95%). Listwise deletion which is an acceptable method of removing cases with missing values was used in accordance with Hung Khangs' recommendation [25] Collinearity diagnostics, including assessment of variance inflation factors, tolerance values, and correlation coefficients [26], indicated no evidence of multicollinearity among the independent variables, as all VIFs were below 5 and correlation coefficients were within acceptable limits. In this study, all p-values were reported and considered statistically significant at $p < 0.05$.

#### Ethical considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki and received ethical approval from both the Christian Health Association of Ghana Institutional Review Board (CHAG-IRB06062023) and the Institutional Review Board of the Noguchi Memorial Institute for Medical Research (IRB0001276). The study's objectives and procedures were clearly and thoroughly explained to all participants, and written informed consent was obtained prior to their enrollment. Participants were informed that their participation was entirely voluntary and that they could withdraw from the study at any time without any consequences. The

study posed no physical, social, or psychological risks to participants.

## Results

### Socio-demographic characteristics of respondents

Complete data was available for 213 out of the 224 mothers who had been diagnosed with HBV infection, giving a response rate of 95%. As shown in Table 1, the result of the study shows that the majority of the participants, thus 108 (50.7%) were between the ages of 18-29 years. Most of the participants belonged to the Islamic religion 102 (47.9%). Regarding the highest level of education attained, the majority of participants, 80 (37.6%) had attained a tertiary level of education. It was found that slightly more than half of the participants came from extended families 124 (58.2%). Employment status varied, with the largest group being unemployed, that is, 97 (45.5%), and the smallest group comprising salaried workers, 27 (12.7%). The parity of participants varied across as the findings showed that the majority had 1-2 children, 106 (49.8%). In terms of marital status, most participants were married 153, (71.8%). Most of the study participants earned between 0-500 cedis 147 (69%) per month, while only a few earned more than 1000 cedis 24, (11.3%) (Table 1).

**Table 1** Socio-Demographic Characteristics of Respondents

| Variable | Frequency (*n*) | Percentage (%) |
|---|---|---|
| **Age** | | |
| 18–29 | 108 | 50.7 |
| 30–39 | 65 | 30.5 |
| 40–49 | 40 | 18.8 |
| **Religion** | | |
| Christians | 81 | 38.0 |
| Islam | 102 | 47.9 |
| Traditionalist/others | 30 | 14.1 |
| **Level of education** | | |
| No formal education | 37 | 17.4 |
| Primary/JHS | 65 | 30.5 |
| SHS/A' level | 31 | 14.6 |
| Tertiary | 80 | 37.6 |
| **Type of family** | | |
| Extended family | 124 | 58.2 |
| Nuclear family | 89 | 41.8 |
| **Employment status** | | |
| Unemployed | 97 | 45.5 |
| Self-employed | 75 | 35.2 |
| Salaried worker | 27 | 12.7 |
| Other | 14 | 6.6 |
| **No of children** | | |
| 1–2 | 106 | 49.8 |
| 3–4 | 76 | 35.7 |
| 5+ | 31 | 14.6 |
| **Marital status** | | |
| Single | 45 | 21.1 |
| Married | 153 | 71.8 |
| Divorced/separated/widowed/Co-habiting | 15 | 7.0 |
| **Monthly income** | | |
| 0-500 | 147 | 69.0 |
| 500–1000 | 42 | 19.7 |
| 1000+ | 24 | 11.3 |

### HBV-combined immunoprophylaxis use for newborns exposed to HBV

From Fig. 1 below, out of the 213 exposed newborns whose mothers participated in the study, 135 representing 63.4% received both immunoglobulin and the HBV vaccine as post-exposure prophylaxis against HBV (Fig. 1).

### Association between socio-demographics and hepatitis B immunoprophylaxis uptake

As indicated in Table 2, there was a statistically significant difference between respondents' employment status ($\chi^2$=18.275; $p$ = 0.007), family type ($\chi^2$=4.792; $p$ = 0.029) overall knowledge of HBV transmission ($\chi^2$=15.988; $p$ < 0.001), income level ($\chi^2$=16.950; $p$ = 0.001) and the utilization of PEP (HBIG and Vaccine)for the exposed newborn (Table 2).

### Factors associated with the utilization of both hepatitis B Immunoglobulin and vaccine for newborns

The results of the study showed that the age of the mother, employment status, monthly income, and knowledge of hepatitis B immunoprophylaxis are significantly associated with ensuring babies receive both HBV immunoglobulin and the vaccine. Mothers aged 30–39 were 76% less likely to ensure their children received both hepatitis B immunoprophylaxis and the vaccine compared to mothers aged 18–29 (aOR = 0.24, 95% CI [0.09, 0.65], $p$ = 0.005).

Salaried workers were 6.78 times more likely to ensure their children received both hepatitis B immunoprophylaxis and the vaccine compared to unemployed mothers (aOR = 6.78, 95% CI [1.34, 34.46], $p$ = 0.021). Similarly, self-employed mothers were also 3.38 times more likely to ensure their children received both hepatitis B immunoprophylaxis and the vaccine compared to unemployed mothers (aOR = 3.38, 95% CI [1.39, 8.22], $p$ = 0.007).

Mothers with a monthly income of 501–1000 units of currency were 4.7 times more likely to ensure their children received both hepatitis B immunoprophylaxis and the vaccine compared to those with a monthly income of ≤ 500 units (aOR = 4.70, 95% CI [1.28, 17.32], $p$ = 0.020). Mothers who had good knowledge of hepatitis B were 3.6

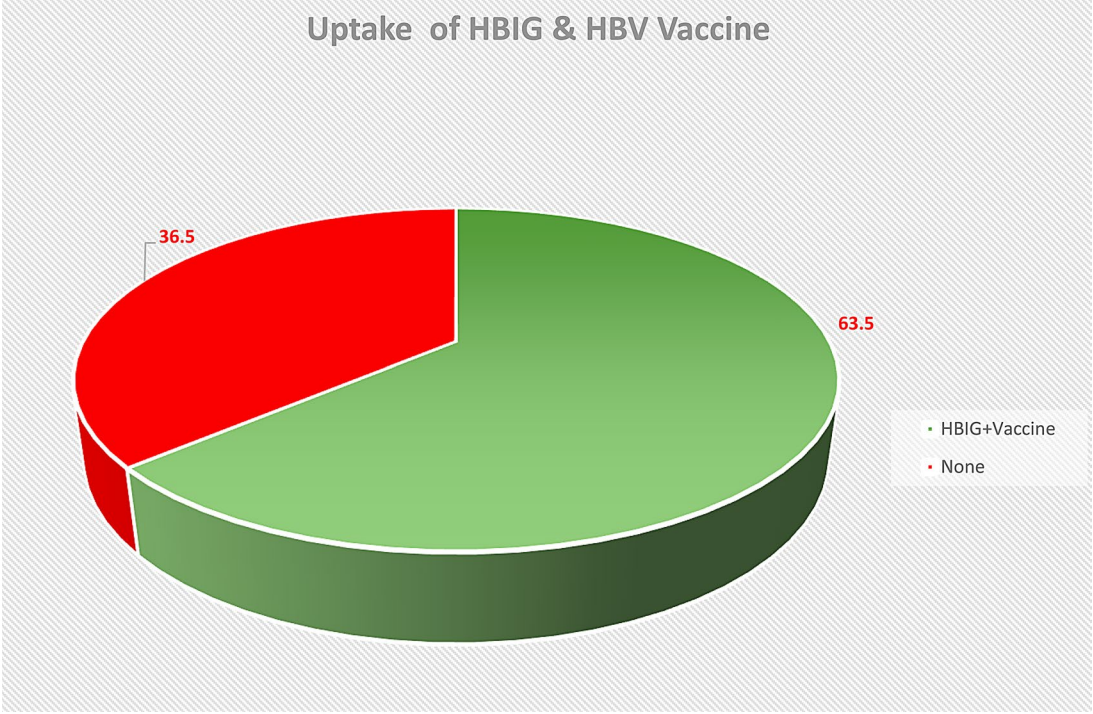


**Fig. 1** Uptake of combined immunoprophylaxis for exposed newborns

times more likely to ensure their children received both hepatitis B immunoprophylaxis and the vaccine compared to those with poor knowledge (aOR = 3.60, 95% CI [1.72, 7.54], $p = 0.001$) (Table 3).

## Discussion

This study was conducted among women who were seropositive for HBV and whose newborns were at risk of HBV infection and required combined HBV immunoprophylaxis to reduce their risk of vertical transmission. The study acknowledges that the cornerstone of HBV prevention and ultimately, elimination is the PMTCT to prevent early childhood acquisition of the virus. Accordingly, the study aimed to assess the utilization of combined immunoprophylaxis for HBV-exposed newborns in a hyperendemic rural setting in Ghana and found that the overall utilization rate for both HBIG and HBV vaccine was 63.4% with mothers' income level, age and overall knowledge of HBV transmission influencing the utilization of immunoprophylaxis for their exposed newborns.

The 63.4% immunoprophylaxis coverage in this study is notably three times higher than the 20/7% reported by a study in Ethiopia [27] but lower than the 89.4% reported in Victoria, Australia [28], pointing to an implementation gap in low-income countries. Of particular concern in this study is the finding that over 30% of HBV-exposed newborns did not receive any form of immunoprophylaxis, placing them at significantly higher risk of becoming chronic HBV carriers [29].

It is important to note that this study was conducted in a rural setting where the National Health Insurance Scheme does not cover the cost of HBV treatment and care. Consequently, mothers are required to pay out-of-pocket for both the HBV vaccine and HBIG, which are largely unaffordable for most individuals in these communities. These financial constraints may have contributed to the lower immunoprophylaxis coverage observed in this study, especially when compared to the higher coverage rates reported in Victoria, Australia. This finding highlights the need for health policy reforms to ensure availability of HBIG and vaccine at no cast for exposed newborns.

The study also found that mothers aged 30–39 were less likely to ensure that their newborns received combined immunoprophylaxis, compared to mothers aged 18–29. This finding aligns with a study by Miyakawa et al. (2021) in Vietnam, which reported higher rates of HBV immunoprophylaxis utilization among younger mothers [30]. This may suggest that younger mothers are more receptive to health education and preventive health interventions.

Perhaps in this present study, contextual factors peculiar to the study setting could probably explain the observation made. Younger women in this rural setting are more likely to engage with health services and receive immunization counselling during antenatal and postnatal care. Their limited parenting experience makes them more receptive to health worker guidance. They are also

**Table 2** Sociodemographic Variables and Uptake of HBIG and Vaccine for Newborns

| Variable | Taken Both HBIg and Vaccine | | $X^2$ | p-value |
|---|---|---|---|---|
| | No | Yes | | |
| **Age** | | | 5.190 | 0.75 |
| 18–29 | 33 (30.6) | 75 (69.4) | | |
| 30–39 | 31 (47.7) | 34(52.3) | | |
| 40–49 | 14 (35.0) | 26 (65.0) | | |
| **Religion** | | | 1.029[a] | 0.794 |
| Christians | 29 (35.8) | 52 (64.2) | | |
| Islam | 40 (39.2) | 62 (60.8) | | |
| Traditionalist | 4 (26.7) | 11 (73.3) | | |
| others | 5 (33.3) | 10 (66.7) | | |
| **Level of education** | | | | |
| No formal education | 16 (43.2) | 21 (56.8) | 1.332 | 0.721 |
| Primary/JHS | 25 (38.5) | 40 (61.5) | | |
| SHS/A' level | 10 (32.3) | 21 (67.7) | | |
| Tertiary | 27 (33.8) | 53 (66.3) | | |
| **No. of children** | | | 0.894 | 0.344 |
| 1–3 | 50 (34.5) | 95 (65.5) | | |
| 4+ | 28 (41.2) | 40 (58.8) | | |
| **Employment status** | | | 18.275[a] | **< 0.001** |
| Unemployed | 50 (51.5) | 47 (48.5) | | |
| Self-employed | 18 (24.0) | 57 (76.0) | | |
| Salaried worker | 5 (18.0) | 22 (81.5) | | |
| Other | 5 (35.7) | 9 (64.3) | | |
| **Marital status** | | | 6.457 | 0.264 |
| Single | 20 (44.4) | 25 (55.6) | | |
| Married | 50 (32.7) | 103 (67.3) | | |
| Divorced | 2 (66.7) | 1 (33.3) | | |
| Co-habitation | 5 (50.0) | 5 (50.0) | | |
| Separated | 1 (100.0) | 0 (0.0) | | |
| Widowed | 0 (0.0) | 1 (100.0) | | |
| **Family Type** | | | 4.792 | **0.029** |
| Extended family | 53 (42.7) | 71 (57.3) | | |
| Nuclear family | 25 (28.1) | 64 (71.9) | | |
| **Monthly Income** | | | 16.950 | **< 0.001** |
| 0-500 | 65 (44.2) | 82 (55.8) | | |
| 500–1000 | 4 (9.5) | 38 (90.5) | | |
| 1000+ | 9 (37.5) | 15 (62.5) | | |
| **Overall knowledge** | | | 15.988 | **< 0.001** |
| Poor | 48 (51.6) | 45 (48.4) | | |
| Good | 30 (25.0) | 90 (75.0) | | |

more socially connected and exposed to peer influence. Additionally, they benefit from greater access to education and health outreach programs. These factors probably accounted for a higher uptake of immunoprophylaxis.

However, our results contrast with findings from a study conducted in China by Wang et al. (2021), which observed higher rates of timely HBV immunoprophylaxis use among older mothers [31]. The authors attributed this to greater health awareness and experience associated with older maternal age. Similarly, Bierhoff et al. (2019) reported that in Thailand, older mothers were more likely to adhere to the complete HBV immunoprophylaxis regimen for their infants [32]. These discrepancies underscore the complex relationship between maternal age and health-seeking behaviours, which may be shaped by a range of contextual factors including cultural norms, educational background, and the structure and accessibility of health systems in different settings.

The results also indicated that salaried workers and self-employed women were more likely to ensure that their newborns received combined immunoprophylaxis, compared to unemployed mothers. This finding is consistent with a study conducted in Nigeria, which reported that employed women were more likely to utilize

**Table 3** Factors associated with both hepatitis B immunoprophylaxis and vaccine utilization for newborns

| Variable | cOR | 95% CI | *p*-value | aOR | (95% CI) | *p*-value |
|---|---|---|---|---|---|---|
| **Age** | | | | | | |
| 18–29 | Ref | | | Ref | | |
| 30–39 | 0.48 | 0.26–0.91 | 0.025 | 0.24 | 0.09–0.65 | **0.005** |
| 40–49 | 0.82 | 0.38–1.76 | 0.606 | 0.80 | 0.30–2.13 | 0.654 |
| **Religion** | | | | | | |
| Christians | Ref | | | Ref | | |
| Islam | 0.86 | 0.47–1.58 | 0.363 | 1.10 | 0.47–2.58 | 0.822 |
| Traditionalist/others | 1.30 | 0.53–3.21 | 0.568 | 1.01 | 0.30–3.37 | 0.982 |
| **Level of education** | | | | | | |
| No formal education | Ref | | | Ref | | |
| Basic | 1.22 | 0.54–2.77 | 0.36 | 0.48 | 0.16–1.47 | 0.198 |
| SHS/A' level | 1.60 | 0.59–4.33 | 0.355 | 0.28 | 0.07–1.14 | 0.075 |
| Tertiary | 1.50 | 0.67–3.32 | 0.673 | 0.57 | 0.14–2.32 | 0.430 |
| **No of children** | | | | | | |
| 1–3 | Ref | | | Ref | | |
| 4+ | 0.75 | 0.42–1.36 | 0.345 | 0.94 | 0.39–2.26 | 0.896 |
| **Employment status** | | | | | | |
| Unemployed | Ref | | | Ref | | |
| Salaried worker | **4.68** | **1.64–13.37** | **0.004** | 6.78 | 1.34–34.46 | **0.021** |
| Self-employed | 3.37 | 1.74–6.54 | 0.000 | 3.38 | 1.39–8.22 | **0.007** |
| Other | 1.92 | 0.60–6.13 | 0.274 | 0.97 | 0.24–3.99 | 0.965 |
| **Marital status** | | | | | | |
| Single | Ref | | | Ref | | |
| Divorced/separated/ widowed | 1.65 | 0.84–3.25 | 0.149 | 1.81 | 0.50–6.61 | 0.369 |
| Married | 0.7 | 0.22–2.26 | 0.551 | 0.44 | 0.07–2.60 | 0.363 |
| **Family type** | | | | | | |
| Extended family | Ref | | | | | |
| Nuclear family | 1.91 | 1.07–3.42 | 0.03 | 1.54 | 0.71–3.34 | 0.278 |
| **Monthly income** | | | | | | |
| ≤ 500 | Ref | | | Ref | | |
| 501–1000 | **7.53** | **2.56–22.19** | 0.000 | 4.70 | 1.28–17.32 | **0.020** |
| > 1000 | 1.32 | 0.54–3.21 | 0.539 | 0.76 | 0.17–3.31 | 0.710 |
| **Overall knowledge** | | | | | | |
| Poor | Ref | | | Ref | | |
| Good | **3.2** | **1.79–5.371** | **0.000** | 3.60 | 1.72–7.54 | **0.001** |

immunization services than their unemployed counterparts [33]. Similarly, Li et al. (2017) found in rural China that maternal employment was positively associated with the timely administration of HBV immunoprophylaxis for newborns [34]. These findings suggest that employed mothers may have greater access to health information and financial resources, affording them the autonomy and capacity to arrange immunoprophylaxis for their infants.

It is worth noting that the majority of women in this study were unemployed, which may have limited their ability to afford the HBV vaccine and HBIG both of which have been reported to be high in cost and largely unaffordable for most families [16]. Consequently, families with higher incomes, often due to stable employment, were more likely to afford and ensure access to combined immunoprophylaxis for their newborns.

Conversely, studies from Vietnam and Myanmar found no significant association between maternal employment and HBV immunoprophylaxis utilization, indicating that employment status did not significantly influence vaccination coverage for newborns in those contexts [35, 36]. These contrasting findings suggest that the relationship between maternal employment and immunoprophylaxis uptake may be context-specific and shaped by factors such as healthcare accessibility, workplace policies, and the structure of national immunization programs.

The study also found that mothers with a monthly income of 501–1000 units of Ghanaian currency were 4.7 times more likely to ensure that their newborns received both the HBV vaccine and HBIG, compared to those earning ≤ 500 units. This result is supported by a study from Indonesia, where Setyowati et al. (2024) reported that higher household income was significantly

associated with increased uptake of HBV immunoprophylaxis among newborns [37]. Similarly, Boisson et al. (2022) found that in sub-Saharan Africa, higher socioeconomic status was positively correlated with timely HBV vaccination, attributing this to improved healthcare access and affordability among higher-income households [38].

However, a study in India found no significant association between monthly income and HBV immunoprophylaxis utilization (Chhavi et al., 2024) [39]., suggesting that government-subsidized vaccination programs may have reduced income-related disparities in access. Likewise, Pham et al. (2018) reported that in Vietnam, household income did not significantly influence the timely administration of the HBV birth dose, possibly due to the country's universal free infant vaccination policy [40].

These findings reflect the importance of considering healthcare financing mechanisms and social protection systems when interpreting the relationship between socioeconomic status and immunoprophylaxis utilization. Contextual factors must be considered to design equitable and effective strategies for improving HBV prevention coverage.

The results of this study indicated that mothers with good knowledge of hepatitis B were 3.6 times more likely to ensure their children received both hepatitis B immunoprophylaxis and the vaccine compared to those with poor knowledge. This finding aligns with a study conducted by Ahmed et al. (2022) in Egypt, which found that higher maternal knowledge of HBV and its prevention was significantly associated with increased uptake of newborn HBV immunoprophylaxis [41]. Similarly, Ali et al. (2021) reported that a structured educational program significantly improved pregnant women's knowledge and attitudes toward HBV infection and prevention, resulting in a greater intention to utilize immunoprophylaxis for their newborns [42].

However, a study by Okenwa et al. (2020) in Nigeria found that although educational interventions improved maternal knowledge, this did not translate into a significant increase in actual HBV immunoprophylaxis uptake [43]. Likewise, a study conducted in Iraq reported that while mothers' knowledge of HBV improved following educational sessions, this did not lead to significantly higher rates of timely HBV vaccination for their infants [44].

These contrasting findings highlight the complex relationship between knowledge and health behaviour. While knowledge is an important determinant, it may not be sufficient on its own to drive uptake. Other factors such as healthcare access, financial constraints, cultural beliefs, and systemic barriers must also be considered when designing interventions aimed at increasing the utilization of combined immunoprophylaxis for hepatitis B.

### Limitations

The study's cross-sectional nature limits the ability to establish causal relationships between the identified factors and immunoprophylaxis utilization. As the study relied on self-reported data from mothers, there is a potential for recall bias, particularly regarding the timing of immunoprophylaxis administration. The purposive selection of healthcare facilities based on client load, accessibility, and representation may introduce selection bias and limit the generalizability of the findings. The chosen facilities may possess unique characteristics such as better resources or more structured services which may not be reflective of all healthcare settings in the municipality or region, potentially influencing study outcomes and reducing their broader applicability. This study was conducted in the North-East Region of Ghana, which may limit the generalizability of findings to other regions or countries with different socioeconomic contexts or healthcare systems.

## Conclusion

This study assessed the uptake of combined immunoprophylaxis among newborns exposed to HBV in a hyperendemic rural setting in Ghana and revealed suboptimal coverage, with 63.4% of exposed newborns receiving both interventions. This finding indicates progress but also highlights the need for continued efforts to improve coverage. The uptake was significantly influenced by maternal age, employment status, income level, and knowledge of HBV. Based on these findings, it is recommended that HBV immunoprophylaxis be integrated into the National Health Insurance Scheme to reduce financial barriers and enhance access, particularly for low-income and unemployed mothers. Health education programs should be strengthened to improve awareness among both younger and older mothers about HBV transmission and the importance of timely immunoprophylaxis. Addressing these challenges through strategic policy reforms, education, and improved healthcare delivery will be essential in advancing efforts to eliminate mother-to-child transmission of HBV in Ghana and contribute to the global goal of eliminating viral hepatitis as a public health threat by 2030.

#### Abbreviations

| | |
|---|---|
| HBIG | Hepatitis B immunoglobulin |
| HBV | Hepatitis B virus |
| HBsAg | Hepatitis B Surface antigen |
| MTCT | Mother to Child Transmission |
| PEP | Post Exposure Prophylaxis |
| PMTCT | Prevention of Mother to Child Transmission |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-025-05705-6.

Supplementary Material 1

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**Author contributions**
M.O; Conceptualization, Methodology, Data collection, Data Analysis. Writing, Original draft, preparation of manuscript. S-D V. E; Methodology, Supervision, Writing, Original draft preparation of manuscript. A.A.C Methodology, Supervision, Writing, Original draft preparation of manuscript. I.O.D; Writing, original draft, supervision. A.A.M; Writing, original draft, supervision.

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**Data availability**
The data is available from the corresponding author upon a reasonable request.

## Declarations

**Ethical approval and consent to participate**
This study was conducted in accordance to the Helsinki Declaration. The study obtained ethical clearance from the Christian Health Association of Ghana Institutional Review Board (CHAG-IRB06062023) as well as the Institutional Review Board of Noguchi Memorial Institute of Medical Research (IRB0001276). The details and objectives of this study were clearly and satisfactorily explained to all participants and written informed consent was obtained from all participants before recruitment.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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