



Seroprevalence of Hepatitis B Virus Infection, Mother-To-Child Transmission, and Associated Risk Factors Among Delivering Mothers in Tigray Region, Northern Ethiopia: a Cross-Sectional Study

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ABSTRACT

Introduction: High prevalence of hepatitis B virus (HBV) infection among pregnant women is the primary source of infection for their children and the general population. Mother-to-child transmission (MTCT) is the primary mode of transmission in endemic areas like Ethiopia. The aim of this study was to determine the prevalence of HBV infection, rate of MTCT, and associated risk factors among delivering mothers.

Methods: This health facility-based cross-sectional study was conducted in four public hospitals of the Eastern zone of Tigray among 473 delivering mothers. Structured questionnaires and laboratory results were used to collect the data. The data were checked for completeness and entered into EpiData manager

version 4.6.0.0. Then the data were exported to Statistical Package for Social Sciences (SPSS) version 23. The odds ratio, along with a 95% confidence interval, was estimated to identify predictors of HBV infection using multivariable logistic regression analysis. Significant association was considered at $p < 0.05$.

Results: A total of 473 mothers were enrolled, and the response rate was 100%. The prevalence of HBV infection among the mothers and the rate of MTCT of the infection were 11.6% and 30.9%, respectively. History of home delivery [adjusted odds ratio (AOR) = 4.5, 95% confidence interval (CI) (2, 10.6)], history of hospital admission [AOR = 5, 95% CI (2.2, 11.5)], working at health facility [AOR = 5.4, 95% CI (1.4, 20.7)], body tattoos [AOR = 5.8, 95% CI (2.4, 13.6)], sharing personal care materials [AOR = 3.8, 95% CI (1.4, 9.9)], insufficient knowledge [AOR = 5.6, 95% CI (1.6, 19)], and having human immunodeficiency virus (HIV) [AOR = 5.1, 95% CI (1, 26.2)] were significantly associated with HBV infection.

Conclusion: HBV infection among delivering women is becoming highly endemic, and the rate of MTCT was high. Therefore, administering hepatitis B vaccine to all neonates within 24 h of birth is mandatory to prevent MTCT of HBV infection and related complications. Furthermore, health education and dissemination of information about HBV for the pregnant mothers are needed to reduce HBV infection and vertical transmission in Ethiopia.

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Key Summary Points

Why carry out this study?

The burden of hepatitis B virus (HBV) infection is highest in sub-Saharan African countries, particularly in those with under-resourced health care systems. In Ethiopia, the prevalence of HBV infection among pregnant women ranges from 4.9% to 8.1%. High prevalence of HBV infection among pregnant women is the primary source of infection for their children and the general population. Even though there is a high magnitude of HBV infection and mother-to-child transmission among delivering mothers in Ethiopia, it is not well studied.

What was learned from the study?

Overall, the prevalence of HBV infection and the rate of mother-to-child transmission (MTCT) among delivering women was high.

The determinant factors for the high prevalence of HBV infection were home delivery, hospital admission, having body tattoos, working at a health facility, sharing personal care materials, insufficient knowledge of HBV, and having human immunodeficiency virus (HIV).

Administering the hepatitis B vaccine to all neonates within 24 h of birth is mandatory to prevent MTCT of HBV infection and related complications. Furthermore, health education and dissemination of information about HBV for pregnant mothers are needed.

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INTRODUCTION

Hepatitis B virus (HBV) infection is one of the major diseases that cause devastating public health impacts in the world. Viral hepatitis kills more people than a human immune virus and malaria, but it has received less global attention [1]. Globally, about 257 million people are chronically infected with HBV. Of those, African and Western Pacific regions contribute 68% of the total infections. HBV infection was responsible for 887,000 deaths, mostly from cirrhosis and hepatocellular carcinoma [2]. Although there is improved childhood HBV vaccination, vertical transmission accounts for 35–40% worldwide, and about 50% of new HBV infections in high endemic countries [3].

The burden of HBV infection is highest in sub-Saharan African countries, particularly in those with under-resourced health care systems [4]. In Ethiopia, around 10 million people were infected with HBV, and the majority of the infected population was unaware of their disease status [5].

A recent systematic review done in Ethiopia reports that the prevalence of HBV infection among the general population was 7.4%, which classifies the country among higher to intermediate endemicity areas [6]. In Ethiopia, the prevalence of HBV infection among pregnant women ranges from 4.9% to 8.1%, with variations among the regions [7–11].

Newborns infected with HBV through mother-to-child transmission (MTCT) have an 85–90% risk of developing chronic HBV infection. Acute HBV infection in early pregnancy is associated with a 10% risk of prenatal transmission, but infection close to or during labor may infect more than 60% of neonates [12]. The rate of MTCT of HBV infection was not well studied in Ethiopia. However, one study done in Addis Ababa revealed that 75% of neonates born from HBV-infected women were positive for hepatitis B surface antigen (HBsAg) [9]. Insufficient coverage of HBV vaccination, unsafe blood transfusion, poor prevention

practices, and inadequate knowledge are major risk factors for HBV infection among pregnant mothers in Ethiopia [13–15].

Ethiopia is classified under the geographical regions with intermediate to hyperendemic HBV infection. However, the country's health system pays little attention to the prevention and control of viral hepatitis among pregnant women [15, 16]. Even though the prevalence of HBV infection and the rate of MTCT are high among delivering women in Ethiopia, it is not well studied. Therefore, the study aimed to assess the prevalence of HBV infection, the rate MTCT, and associated factors among delivering women in health facilities of the eastern zone of Tigray.

Specific Objectives

1. To determine the magnitude of HBV infection among delivering women in Northern Ethiopia.
2. To determine the rate of transmission of HBV infection to newborn babies in Northern Ethiopia.
3. To identify the associated risk factors of HBV infection among delivering women in Northern Ethiopia.

METHODS

Study Area, Design, and Participants

The study was conducted in the eastern zone of the Tigray region. This zone is located at 898 km from Addis Ababa, Ethiopia's capital city, and 120 km from Mekelle, the capital city of the Tigray region. There are two general hospitals and seven primary hospitals in the eastern zone of Tigray. Of those, four public hospitals were selected using a simple random sampling method. The study was conducted using a hospital-based cross-sectional study design. All selected pregnant women who came for delivery to the chosen four hospitals during the study period were included and delivering mothers who were vaccinated for HBV infection were excluded from this study.

Sample Size Determination and Sampling Technique

The single population proportion formula was used. The estimated proportion was the rate of MTCT of HBV infection among delivering women in Addis Ababa, Ethiopia, which was 75% [9]. Accordingly, sample size (n) was estimated with a confidence level of 95% and a 4% margin of error, and adding a 5% non-response rate, the final sample size was 473. The total sample was proportionally allocated to the selected hospitals. We used a systematic random sampling method to select the study participants.

Data Collection Tools and Procedures

The questionnaire was developed by reviewing different related literature [3, 9, 17–21]. It contains items regarding sociodemographic data, hospitalization-related factors, risky cultural/behavioral factors, and HBV status of the mothers and their newborns. A structured questionnaire was used to collect the data through a face-to-face interview by eight BSc (Bachelor of Science) midwives and four BSc laboratory technologists working in the selected hospitals. Three milliliters of venous blood was obtained from the mother and newborn baby, according to the standard blood collection procedure. Finally, mothers and newborn babies who were positive for HBV were referred to senior physicians for further evaluation and treatment.

Laboratory Procedure

The blood was centrifuged for at least 10 min at room temperature, and the serum obtained was collected using a test tube and stored in a refrigerator ($-20\text{ }^{\circ}\text{C}$). Then the serum was tested for HBsAg using HBsAg Rapid Test Cassette (Zhejiang Orient Gene Biotech Co., Ltd). Samples positive for HBV were retested by the same method, and samples repeatedly positive for HBsAg were considered as positive.

Data Quality Control

The questionnaire was prepared in English and translated into Tigrigna language and back to English for accuracy. Two days of training were given on the objective of the study and data collection procedure for the supervisors and data collectors.

The pretest was done at Fatsi hospital on 5% ($n = 24$) of the total sample size to check the logical sequence and consistency of the tool with the desired objectives. After the pretest, respondents were asked about the clarity of items, and then adjustments were made to the questionnaire to ensure validity. The laboratory tests were done following the standard operating procedures. The supervisor and the principal investigator supervised the implementation of the data collection procedure. The questionnaires were checked for completeness every day by the principal investigator.

Operational Definitions

Level of Knowledge

Level of knowledge was assessed on the basis of 12 knowledge questions; mothers who answered greater than 50% of knowledge-related questions were considered as having sufficient knowledge, and those who answered less than 50% were considered as having insufficient knowledge.

Data Processing and Analysis

The collected data were coded, entered, and cleaned using EpiData manager version 4.6.0.0 and exported to SPSS version 23.0/IBM software for analysis. Descriptive statistics were computed and presented using tables and texts. Binary logistic regression was used to determine the magnitude, direction, and strength of association between a set of independent variables and the dependent variable at $p < 0.25$ significance level. Variables significant at $p < 0.25$ with the dependent variable were selected for multivariable analysis. Odds ratio with 95% confidence level was computed, and a significant association was declared at $p < 0.05$.

Multicollinearity was assessed by a variance inflation factor to control confounders. Hosmer and Lemeshow test was used to check the goodness of fit of the model, and the model was fitted at $p = 0.944$.

Compliance with Ethics Guidelines

The study was done according to the Helsinki Declaration. Ethical approvals were obtained from Adigrat University ethical review committee (ID number ADU/CMHS/086/11). An official letter was written from the Tigray regional health bureau to each hospital, and a letter of permission was obtained from the medical director's office to communicate with head nurses/midwives of the selected hospitals. The mothers were informed about the purpose, right to participate, and the confidentiality of information. Written consent was obtained from the mothers.

RESULTS

Sociodemographic Characteristics

A total of 473 delivering women and their infant cord blood samples were collected, and the response rate was 100%. The mean age was 26.5 years. Thirty six point two percent of the mother's age ranged from 20 to 24 years. The majority of the mothers were orthodox followers (90.3%) and from the Tigray region (95.8%). Thirty five point nine percent of the study participants completed secondary school, and 74.0% of the study participants were urban residents. Forty six point one percent of the mothers were housewives. Besides, 68.3% and 61.5% of the mothers were multigravidas and multipara, respectively (Table 1).

Cultural and Clinical Factors

Out of 473 delivering mothers, 16.7% and 28.6% of the mothers had a history of unsafe abortion and circumcision, respectively. Thirteen point five percent of the mothers had a history of multiple sexual partners, and 10.4%

Table 1 Sociodemographic characteristics of delivering mothers in Northern Ethiopia

Variable	Category	Number (n)	Percentage (%)
Age category	15–19	32	6.8
	20–24	171	36.2
	25–29	130	27.5
	> 29 [21]	140	29.5
Religion	Orthodox	427	90.3
	Protestant	24	5.1
	Catholic	12	2.5
	Muslim	10	2.1
Marital status	Married	424	89.6
	Divorced	41	8.7
	Widowed	8	1.7
Ethnicity	Tigray	453	95.8
	Amhara	20	4.2
Educational status	Can not read and write	59	12.5
	Primary school	134	28.3
	Secondary school	170	35.9
	Diploma and above	110	23.3
Occupational status	Housewife	218	46.1
	Government employee	116	24.5
	Merchant	85	18.0
	Farmer	45	9.5
	Student	9	1.9
Average monthly income	< 1000	75	15.9
	1000–1500	62	13.1
	1501–2300	77	16.3
	> 2300 [22]	259	54.7

Table 1 continued

Variable	Category	Number (n)	Percentage (%)
Residential area	Urban	350	74.0
	Rural	123	26.0
Gravidity	Primigravida	150	31.7
	Multigravida	323	68.3
Parity	1	182	38.5
	≥ 2	291	61.5

of the mothers were sharing personal care materials. Besides, 17.3% of the mothers had a history of home delivery. Of those, 31.7% gave birth at home more than two times in their previous pregnancy. The majority (91.3%) of the mothers had a history of antenatal care (ANC) follow-up during their current pregnancy. However, 21.8% of the mothers were not screened for HBV infection.

Prevalence of HBV Infection

The prevalence of HBV infection among delivering mothers was 11.6% [95% CI (8.9, 14.4)]. Mothers from rural residents had a high prevalence of HBV infection compared to their counterparts, 18.7% vs. 9.1%. Out of all delivering mothers with HBV infection, 38.2% were among the age group of 20–24 years, and 94.5% of them were orthodox followers. Forty seven point three percent of delivering mothers with HBV infection had completed secondary school education. Besides, 96.4% and 92.7% of the delivering mothers with HBV infection were from Tigray region and were married, respectively (Table 2).

Rate of MTCT of HBV Infection

The rate of MTCT of HBV infection among delivering women was 30.9% [95% CI (20, 43.6)]. It was higher among HIV-positive mothers (66.7%) and mothers who had no

Table 2 Prevalence of HBV infection among delivering women in Northern Ethiopia

Variable	Category	HBV infection	
		Positive <i>n</i> (%)	Negative <i>n</i> (%)
Age category	15–19	2 (3.6)	30 (7.2)
	20–24	21 (38.2)	150 (35.9)
	25–29	12 (21.8)	118 (28.2)
	> 29	20 (36.4)	120 (28.7)
Religion	Orthodox	52 (94.5)	375 (89.7)
	Protestant	3 (5.5)	21 (5.0)
	Catholic	0	12 (2.9)
	Muslim	0	10 (2.4)
Marital status	Married	51 (92.7)	373 (89.2)
	Divorced	4 (7.3)	37 (8.9)
	Widowed	0	8 (1.9)
Ethnicity	Tigray	53 (96.4)	401 (95.9)
	Amhara	2 (3.6)	17 (4.1)
Educational status	Can not read and write	6 (10.9)	53 (12.7)
	Primary school	9 (16.4)	125 (29.9)
	Secondary school	26 (47.3)	144 (34.4)
	Diploma and above	14 (25.4)	96 (23.0)
Occupational status	Housewife	27 (49.1)	191 (45.7)
	Government employee	12 (21.8)	104 (24.9)
	Merchant	11 (20.0)	74 (17.7)
	Farmer	4 (7.3)	41 (9.8)
	Student	1 (1.8)	8 (1.9)
Average monthly income	< 1000	13 (23.6)	62 (14.8)
	1000–1500	4 (7.3)	58 (13.9)
	1501–2300	10 (18.2)	67 (16.0)
	> 2300	28 (50.9)	231 (55.3)

Table 2 continued

Variable	Category	HBV infection	
		Positive <i>n</i> (%)	Negative <i>n</i> (%)
Residential area	Urban	32 (58.2)	318 (76.1)
	Rural	23 (41.8)	100 (23.9)
Gravidity	Primigravida	19 (34.5)	131 (31.3)
	Multigravida	36 (65.5)	287 (68.7)
Parity	1	26 (47.3)	156 (37.3)
	≥ 2	29 (52.7)	262 (62.7)

history of ANC follow-up (64.7%). In this study, around 67.3% of the mothers who were positive for HBsAg were not aware of the vertical transmission of HBV infection. Of those, 70.6% of their newborn babies were HBsAg positive. Mothers who had insufficient knowledge about HBV infection had a high rate of MTCT (88.2%) compared to mothers who had sufficient knowledge (22.8%).

Associated Risk Factors of HBV Infection

Multivariable logistic regression analysis was used to determine the predictor of HBV infection among delivering mothers. Mothers who had a history of home delivery were 4.5 times more likely to have HBV infection compared to their counterparts [AOR = 4.5, 95% CI (2, 10.6)]. The odds of having HBV infection were five times higher among mothers who had a history of hospital admission [AOR = 5, 95% CI (2.2, 11.5)]. Mothers working at the health facility were 5.4 times riskier for HBV infection [AOR = 5.4, 95% CI (1.4, 20.7)]. Besides, HBV infection was 5.8 times higher among mothers who had tattoos on their bodies compared to their counterparts [AOR = 5.8, 95% CI (2.4, 13.6)].

Mothers who were sharing personal care materials such as scissors, blade, toothbrush, or others were 3.8 times more likely to have HBV infection [AOR = 3.8, 95% CI (1.4, 9.9)]. The

Table 3 Factors associated with HBV infection among delivering women in Northern Ethiopia, 2019

Variable	Category	HBV infection		COR (95% CI)	AOR (95% CI)	<i>p</i> value
		Positive	Negative			
Home delivery	Yes	30 (54.5)	52 (12.4)	1	1	
	No	25 (45.5)	366 (87.6)	8.4 (4.6, 15.5)	4.5 (2, 10.6)	<i>p</i> < 0.001
Hospital admission history	Yes	35 (63.6)	86 (20.6)	1	1	
	No	20 (36.4)	332 (79.4)	6.8 (3.7, 12.3)	5 (2.2,11.5)	<i>p</i> < 0.001
Body tattoos	Yes	31 (56.4)	91 (21.8)	1	1	
	No	24 (43.6)	327 (78.2)	4.6 (2.6,8.3)	5.8 (2.4,13.6)	<i>p</i> < 0.001
Working at the health facility	Yes	10 (18.2)	19(4.5)	1	1	
	No	45 (81.8)	399 (95.5)	4.7 (2, 10.7)	5.4 (1.4, 20.7)	0.014
Sharing personal care materials	Yes	21 (38.2)	32 (7.7)	1	1	
	No	34 (61.8)	386 (92.3)	7.5 (3.9, 14.3)	3.8 (1.4, 9.9)	0.007
Knowledge status	Sufficient	5 (9.1)	150 (35.9)	5.6 (2.2, 14.3)	5.6 (1.6,19)	0.006
	Insufficient	50 (90.9)	268 (64.1)	1	1	
HIV status of mother	Positive	6 (10.9)	13 (3.1)	1	1	0.049
	Negative	49 (89.1)	405 (96.9)	3.8 (1.4, 10.5)	5.1 (1, 26.2)	

COR crude odds ratio, *AOR* adjusted odds ratio, *CI* confidence interval
p < 0.05 considered significant

odds of HBV infection among mothers who had insufficient knowledge of HBV infection were 5.6 times higher compared to those who had sufficient knowledge [AOR = 5.6, 95% CI (1.6, 19)]. The odds of having HBV infection were 5.1 times higher among mothers who were HIV positive compared to HIV-negative mothers [AOR = 5.1, 95% CI (1, 26.2)] (Table 3).

DISCUSSION

In our study, the overall prevalence of HBsAg among delivering women was 11.6%. Of those, around 16.4% were unaware of their HBV status. According to the World Health Organization classification, the study region is classified as a highly endemic area for HBV infection [8]. This might be due to inadequate knowledge of HBV infection, rising prevalence of HIV infection in our country, and the lack of preventing

and monitoring HBV infection according to national health policy [6, 23].

Our overall prevalence is also higher than the prevalence of HBV infection among the general population in Ethiopia, which was 7.4% [6]. This indicates that pregnant women are more liable and exposed to HBV infection compared to the general population. This might be due to their exposure to different potential risk factors. Therefore, special attention should be given to pregnant mothers to prevent and control HBV infection.

Our finding is comparable with studies conducted in Uganda (11%), Yemen (10.8), and Nigeria (12.0%) [24–26]. However, it is higher than in studies conducted in Dawuro zone (3.5%), Gambela (7.9%), Yirgalem hospital (7.2%), and Bahir Dar (4.7%) [18, 19, 22, 27]. The variation could be due to the difference in study participants, cultural and behavioral

characteristics of the study participants, and level of awareness.

In this study, the rate of MTCT of HBV infection was 30.9%. This is similar to that in a study conducted in Ghana (34.7%) [28]. However, it is lower than the rate in Ethiopia, Nigeria, and Libya, where MTCT was 75.0%, 51.6%, and 60.9%, respectively [9, 29, 30].

Generally, MTCT of HBV infection is still high in Ethiopia. This might be due to inadequate treatment for HBsAg carrier mothers and inadequate vaccination coverage for pregnant mothers. Therefore, preventing MTCT is essential to achieving the WHO goal of HBV elimination by 2030 [31]. This can be achieved through the antiviral treatment of HBeAg-positive pregnant women and birth dose vaccination for newborns from HBsAg carrier mothers [18, 32]. However, it is not yet implemented in Ethiopia [13]. Therefore, early recognition and treatment of HBV carrier pregnant women and introducing birth dose vaccination for newborns from HBsAg-positive mothers will reduce MTCT in Ethiopia.

In our study, home delivery had a significant association with HBV infection. This is in agreement with the studies done in Ethiopia and Nigeria [7, 16, 33]. The reason might be due to unsafe delivery and the use of unsterilized materials during delivery by traditional birth attendants.

History of hospital admission was another significant risk factor for HBV infection. This is supported by studies conducted in Gambela, Addis Ababa, and Shashemene [27, 34, 35]. This might be due to inadequate sterilization, cross-contamination, and poor vaccination coverage of health professionals against HBV infection. Another variable that was a significant risk factor for HBV infection was a history of working at a health facility. This is in accordance with a study conducted in Iran and Nigeria [36, 37]. This might be due to occupational exposure to blood and different body fluids.

Previous studies conducted in Ethiopia and Nigeria reported that a body tattoo is a potential risk factor for HBV infection [14, 35, 38]. This is in agreement with our findings. Sharing personal care materials was another variable that had a significant association with HBV

infection. This is in accordance with studies done in Ethiopia and Egypt [16, 39]. This might be due to a lack of awareness of the mode of transmission of HBV infection.

Knowledge of delivering mothers was another significant risk factor for HBV infection. Around, 67.2% of the mothers had insufficient knowledge of HBV infection. This is supported by a study conducted in Hawassa, Ethiopia [18]. This insufficient knowledge of mothers on HBV infection could raise the rate of MTCT of the virus. Around 55.8% of the mothers were not aware of the transmission of HBV from mother to child. This rate is higher compared to that in a study conducted in Ghana, which revealed that 39.3% of the mothers knew that newborns are a risk for acquiring HBV infection from their mothers [28]. This might be due to the weak emphasis and commitment of the national health policy and health professionals to create awareness to prevent and monitor HBV infection in Ethiopia [15].

The prevalence of HBV/HIV co-infection in our study was 10.9%. Our findings showed that HIV infection was significantly associated with HBV infection. This is in agreement with a study conducted in Ethiopia and Cameroon [18, 40, 41]. This might be because both HBV and HIV have a common mode of transmission.

Strengths and Limitations of the Study

- Standard and valid questionnaire used in other studies was adopted and adapted.
- Most of the previous studies were done only for those who come to ANC follow-up; however, our study includes all women who come to the delivery room.
- A confirmatory method like ELISA was not used because of the lack of laboratory setup.
- Since our study was an institutional-based study, it may lack representativeness to all pregnant mothers.

CONCLUSIONS AND RECOMMENDATIONS

HBV infection among delivering women is becoming highly endemic, and the rate of MTCT was high. Home delivery, hospital admission, having body tattoos, working at a health facility, sharing personal care materials, insufficient knowledge of HBV, and having HIV were determinant factors for raising the prevalence of HBV infection among delivering mothers. Administering hepatitis B vaccine to all neonates within 24 h of birth is mandatory to prevent MTCT of HBV infection and related complications. Furthermore, health education and dissemination of information about HBV for the pregnant mothers are needed, giving special consideration to young women of child-bearing age to reduce HBV infection and MTCT in Ethiopia. Further studies using a larger sample size will be essential to determine the significant risk factors of MTCT.

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Data Availability. The data sets used and analyzed during this study are available from the corresponding author on reasonable request.

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