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Hepatitis B vaccination coverage and associated factors among children living in northwest Ethiopia city administrations: A community-based study

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ABSTRACT

Objective: A study was being conducted to assess the current vaccination coverage, dropout rates, and associated risk factors in children under 15 years old in northwest Ethiopia.
Study design: A community-based cross-sectional survey.
Methods: A community-based survey was conducted in northwest Ethiopia from January to March 2024. A two-stage cluster-sampling technique was used to select a representative sample. Sociodemographic information, vaccination history, and epidemiological risk factors were collected using a pre-tested, structured questionnaire. Data analysis was performed using SPSS version 23, employing descriptive statistics, chi-square test, and logistic regression model. Associations of vaccination determinants were investigated, with a p-value <0.05 considered statistically significant.
Results: In the study, 808 children were surveyed, with 53.0 % being female and 53.0 % were born at hospitals. Most (52.5 %) were under 5 years old, with a mean age of 5.4 ± 3.5 years. Seven hundred thirty four (90.8 %) had received at least one dose of the hepatitis B vaccine, and 82.7 % had received three doses, with a 9.0 % dropout rate. Among children completely vaccinated against hepatitis B, 366 (54.8 %) were in the age group of 1–4 years. The vaccination coverage was 85.4 %, 82.9 %, and 76.5 % in Bahir Dar, Gondar, and Debre Markos, respectively. Several factors have been identified as predictors of complete hepatitis B vaccination in children, including mothers who attended primary school (AOR = 2.9; 95 % CI: 1.4–5.8) and those with secondary education or higher (AOR = 2.2; 95 % CI: 1.3–4.0), married mothers (AOR = 2.5; 95 % CI: 1.5–4.3), and mothers aged 21–30 years (AOR = 2.7; 95 % CI: 1.3–5.6) and those aged 31–40 years (AOR = 2.8; 95 % CI: 1.4–5.5) were more likely to have their children fully vaccinated. Additionally, children born in hospitals (AOR = 2.4; 95 % CI: 1.3–4.3) or health centers (AOR = 4.0; 95 % CI: 2.2–7.4), increased access to vaccination services (AOR = 2.5; 95 % CI: 1.5–4.3), children aged 1–4 years (AOR = 3.1; 95 % CI: 1.7–5.5) and 5–9 years (AOR = 3.8; 95 % CI: 2.1–7.1) had higher HB vaccination coverage.
Conclusion: The complete hepatitis B vaccination coverage in this study was lower than the WHO recommendation for developing countries. Therefore, enhancing the promotion of facility delivery and ensuring easy access to vaccines are crucial for improving children's vaccination coverage.

1. Introduction

Vaccination has had a significant impact on public health. It is a well-known and effective way to prevent childhood diseases [1,2]. Estimates suggest that 2–3 million lives are saved through immunization annually, and approximately 14.3 million children were unimmunized in 2022. The majority of these children are from sub-Saharan African countries [3,4]. According to the national vaccination coverage estimates of the World Health Organization (WHO) and United Nations Children's Fund (UNICEF), Ethiopia ranks fifth in the world for having a large number of unimmunized children. In 2018, 872,828 children did not receive the third dose of the pentavalent vaccine [5].

The Global Vaccine Action Plan (GVAP) established a goal for hepatitis B (Hep B) vaccination, aiming for 90 % national coverage and 80 % coverage for other administrative units by the year 2020 [4,6]. However, in 2022, 84 % of children worldwide received three doses of the hepatitis B vaccination [7]. According to the Global Alliance for Vaccines and Immunizations (GAVI), Ethiopia's national estimates for Hep B coverage were 85 % in 2018 [5].

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List of abbreviations

CHB	Chronic Hepatitis B
CI	Confidence Interval
EPI	Expanded Program on Immunization
GAVI	Global Alliance for Vaccines and Immunizations
GVAP	Global Vaccine Action Plan
HBV	Hepatitis B Virus
Hep B	Hepatitis B vaccine
Hep B1	First dose of Hepatitis B vaccine
Hep B3	Third dose of Hepatitis B vaccine
OR	odds ratio
SPSS	Statistical Package for Social Sciences
UNICEF	United Nations Children's Fund
WHO	World Health Organization

The WHO launched the global Expanded Program on Immunization (EPI) in 1974 to control and reduce vaccine-preventable diseases throughout the world [8]. Ethiopia started routine immunization in 1980 and hepatitis B vaccination in 2007, which has made notable progress in increasing vaccination coverage [9]. In Ethiopia, vaccination is one of the strategies under the government's health policy to improve child health [10]. The Hep B vaccination is scheduled to be administered as pentavalent (DTP-Hib-Hep B) at 6 weeks, 10 weeks, and 14 weeks [11]. In 2019, 61 % of children age 12–23 months receiving the recommended three doses of DPT-Hep B-Hib vaccine [12].

Many factors contribute to low vaccination coverage in certain countries, particularly in sub-Saharan Africa. Barriers to vaccination include lack of awareness, limited access to vaccination points, distrust of vaccines, respondents' demographic factors, educational levels, marital status, maternal media exposure, and health system organization [13–15]. In Ethiopia, vaccination rates are influenced by maternal awareness about vaccination, educational status, proximity to health facilities, mothers' understanding of vaccination schedules, and place of delivery [16–19]. Recent conflicts and internal displacement in Ethiopia have further decreased vaccination coverage, along with the destruction of the health system [4].

In Ethiopia, national surveys, such as the Ethiopia Demographic and Health Surveys (EDHS), provide valuable insights into immunization coverage [12]. However, these surveys often did not comprehensively address hepatitis B vaccination rates, barriers, or predictors. Additionally, they typically focus only on children under five years old, while our study included all children aged 1–14 years who were born after the introduction of the hepatitis B vaccine in the EPI. Therefore, this study aimed to fill these gaps by analyzing hepatitis B vaccination coverage, dropout rates, and predictors in northwest Ethiopia.

2. Methods

2.1. Study design, period and area

A community-based cross-sectional survey was conducted from January to March 202s4 in the city administrations of Bahir Dar, Gondar, and Debre Markos in northwest Ethiopia. Bahir Dar, Gondar, and Debre Markos are located 547 km, 727 km, and 300 km from Addis Ababa, the capital of Ethiopia, respectively. According to the health department of each city administration report, the total population of Bahir Dar, Gondar, and Debre Markos are 412,361, 443,156, and 200,542, respectively, with the respective numbers of children aged 1–14 years being 162,841, 175,003, and 79,214. Bahir Dar has 40 kebeles (14 rural and 26 urban); Gondar city administration has 11 rural and 25 urban kebeles, while Debre Markos city administration comprises 9 rural and 16 urban kebeles.

2.2. Populations

The source population of this study was all children born after the introduction of HB vaccine in the EPI in Ethiopia and living in city administrations of northwest Ethiopia. The study population was all children born after the introduction of HB vaccine in the EPI of Ethiopia and living in the selected city administrations during the study period. Moreover, the study participants were all children living in the selected city administrations, born after the introduction of the Hep B vaccine in EPI, their parents willing to participate in the study, and who fulfill the eligibility criteria during the study period. Children born after the introduction of the Hep B vaccine (1–14 years), living in the selected study setting at least 6 months before the data collection period, and residents of the selected households were eligible for this study. Children above 8 years giving their assent and mothers of other children giving their consent were also included.

2.3. Sample size

The sample size of this study was calculated using a single population proportion formula assuming a proportion of 85.1 % [20], 95 % confidence interval, 3.5 % precision, and a design effect of two to consider possible homogeneity due to cluster sampling with a 10 % non-response rate. Thus, the final sample size was 875. The total sample size was proportionally allocated to each study setting based on the number of children. Consequently, we expected to enroll 367, 342, and 166 children in Gondar, Bahir Dar, and Debre Markos, respectively, based on probability proportional to the size of eligible children in each city administration.

2.4. Sampling techniques

A two-stage cluster sampling technique was employed to select a representative sample of children in northwest Ethiopia who were born after the introduction of the Hepatitis B vaccine in the Expanded Program on Immunization (EPI). A house-to-house survey was conducted based on the sampled name list to recruit the study participants by a trained team. The fieldwork team, consisting of a community leader, health extension worker, interviewer, and supervisor, visited every household with eligible-aged children in the selected kebeles. First, three city administrations were randomly selected from the city administrations in northwest Ethiopia. Second, two urban and one rural kebeles were randomly selected from each city administration using a probability proportional to the number of kebeles. Third, the populations of children aged 1–14 years were selected by random walking to each household with an eligible child. The sample size was allocated to each kebele based on probability proportional to the number of children in each kebele. If there was more than one child in a household, one eligible child was randomly selected from the household. The age of eligible children was confirmed by reviewing the birth registration certificate or the child vaccination card. If neither document was available, the team verified the children's age by consulting with their parents.

Complete hepatitis B vaccination coverage was documented by reviewing the child's immunization card. If the card was not available, the team obtained the Hepatitis B vaccination history from the parents. Children with no vaccination card and whose parents could not recall their vaccination status were recorded as non-vaccinated.

2.5. Outcome measures

Complete hepatitis B vaccination coverage was defined as the percentage of children aged 1–14 years who had received all three doses of hepatitis B vaccines as pentavalent vaccines that are part of the national immunization program. Dropout rate of hepatitis B vaccination was also defined as a child receiving the first dose of Hep B but not the last (third)

dose of Hep B vaccine. Mathematically, the dropout rate is expressed as (Hep B1 - Hep B3)/Hep B1 * 100. Unvaccinated children were those who had not received any doses of the hepatitis B vaccine.

2.6. Data collection and quality

Public health and nursing professionals with data collection experience were chosen as data collectors and supervisors. They received training on the study's objectives, the importance of Hepatitis B vaccination (including schedules, eligibility, and contraindications), and informed consent. Questionnaires were translated and back-translated for consistency. A pre-test was conducted in a different setting to evaluate the tools. Trained interviewers used a structured, pretested questionnaire to collect sociodemographic information, hepatitis B vaccination history, and epidemiological risk factors. Supervisors monitored the fieldwork, ensuring adherence to protocols through regular meetings. Double data entry was used to ensure accuracy and correct any inconsistencies. To minimize potential biases**,** random sampling techniques were employed for a representative sample, and the study procedures were clearly explained to participants to ensure voluntary participation.

2.7. Statistical analyses and interpretation

The data were checked, sorted, categorized, and coded manually. After coding, the data were entered and analyzed using the SPSS version 23 statistical package for analysis. Descriptive statistics were used to summarize and understand the collected data. The categorized variables, including sociodemographic characteristics, were compared among different groups by analyzing the chi-square test ($\chi 2$). A logistic regression model was used to examine associations between the determinants of vaccination coverage. All statistical tests were two-sided, and results with a P-value <0.05 were considered statistically significant.

3. Results

3.1. Sociodemographic characteristics of children and their mothers

Eight hundred eight children were included in the study, with a response rate of 92.3 %. Of the total surveyed children, 428 (53.0 %) were female, 428 (53.0 %), and 276 (34.1 %) were born at hospitals and health centers, respectively. More than half of the children, 424 (52.5 %) were in the age groups of less than 5 years, with a mean age of 5.4 ± 3.5 years. While, less than half of the mothers, 378 (46.8 %), and 351 (43.4 %) were in the age groups of 21–30 and 31–40 years, respectively. The agrange of the mothers was from 16 to 65 years, and the mean age of the mothers was 32.2 ± 6.5 years. The majority of respondents, 670 (82.9 %), were married, and 739 (91.5 %) were Orthodox Tewahido by religion. Most of the mothers, 504 (62.4 %) attended secondary and above schools; however, 159 (19.7 %) of mothers did not attend formal education. More than half of the participants, 643 (79.6 %), were from urban areas. Moreover, most of the participants, 654 (80.9 %), travel to health institutions up to half an hour for vaccination (Table 1).

3.2. Hepatitis B vaccination coverage in children

Based on immunization cards and mothers' recall, 734 (90.8 % 95 % CI: 89.0–92.8) children had at least one hepatitis B vaccine dose. Children who had received three doses of hepatitis B vaccines were 668 (82.7 %) (95 % CI: 80.1–85.3), whereas 74 (9.2 %) had not received any dose of pentavalent vaccines. Besides, the complete hepatitis B vaccination coverage was computed by each city administration. Bahir Dar had higher vaccination coverage of 85.4 % (95 % CI: 81.6–89.6) than both Gondar and Debre Markos. But it was only significantly higher than the coverage in Debre Markos. Gondar had a complete Hep B vaccination coverage rate of 82.9 % (95 % CI: 78.8–86.4), which was also significantly higher than the complete Hep B vaccination coverage in Debre Markos. In contrast, Debre Markos had the lowest complete Hep B vaccination coverage rate of 76.5 % (95 % CI: 69.9–82.4). The overall hepatitis B vaccination dropout rate was 66 (9.0 %), with the respective dropout rates of 30 (9.6 %), 21 (7.2 %), and 15 (11.2 %) in Gondar, Bahirdar, and Debre Markos city administrations (Table 2). Among complete Hep B-vaccinated children, 366 (54.8 %), 216 (32.3 %), and 86

Table 1
Sociodemographic characteristics of study participants living in three city administrations, northwest Ethiopia, 2024 (n = 808).

Characteristics		Gondar (n = 339)		Bahir Dar (n = 316)		Debre Markos (n = 153)		Total (n = 808)	
		Number	%	Number	%	Number	%	Number	%
Age of Children	1–4 years	192	56.6	155	49.1 %	77	50.3 %	424	52.5 %
	5–9 years	91	26.8 %	118	37.3 %	40	26.1 %	249	30.8 %
	10–14 years	56	16.5 %	43	13.6 %	36	23.5 %	135	16.7 %
Sex of Children	Male	166	49.0 %	145	45.9 %	69	45.1 %	380	47.0 %
	Female	173	51.0 %	171	54.1 %	84	54.9 %	428	53.0 %
Place of Delivery	Home	32	9.4 %	50	15.8 %	22	14.4 %	104	12.9 %
	Hospital	240	70.8 %	131	41.5 %	57	37.3 %	428	53.0 %
	Health Center	67	19.8 %	135	42.7 %	74	48.4 %	276	34.2 %
Age of Mothers	≤ 20 years	5	1.5 %	6	1.9 %	3	2.0 %	14	1.7 %
	21–30 years	167	49.3 %	153	48.4 %	58	37.9 %	378	46.8 %
	31–40 years	140	41.3 %	135	42.7 %	76	49.7 %	351	43.4 %
	>40 years	27	8.0 %	22	7.0 %	16	10.5 %	65	8.0 %
Educational Status of Mothers	No Formal Education	50	14.7 %	63	19.9 %	46	30.1 %	159	19.7 %
	Primary school	70	20.6 %	56	17.7 %	19	12.4 %	145	17.9 %
	Secondary and above	219	64.6 %	197	62.3 %	88	57.5 %	504	62.4 %
Religion	Orthodox Tewahido	327	96.5 %	261	82.6 %	151	98.7 %	739	91.5 %
	Muslim	11	3.2 %	47	14.9 %	0	0.0 %	58	7.2 %
	Protestant	1	0.3 %	8	2.5 %	2	1.3 %	11	1.4 %
Marital Status	Married	282	83.2 %	257	81.3 %	131	85.6 %	670	82.9 %
	Divorced/Widowed/Separated	57	16.8 %	59	18.7 %	22	14.4 %	138	17.1 %
Accessibility to Vaccination Service	Up to half hour	284	83.8 %	240	75.9 %	130	85.0 %	654	80.9 %
	More than half hour	55	16.2 %	76	24.1 %	23	15.0 %	154	19.1 %
Residence	Urban	303	89.4 %	221	69.9 %	119	77.8 %	643	79.6 %
	Rural	36	10.6 %	95	30.1 %	34	22.2 %	165	20.4 %

Table 2
Complete hepatitis B vaccination coverage among children living in three city administrations, northwest Ethiopia, 2024.

Vaccination status	Hep B1	Hep B2	Hep B3	Dropout rate	Unvaccinated
Gondar (n = 339)	311 (91.7 %)	298 (87.9 %)	281 (82.9 %)	30 (9.6 %)	28 (8.3 %)
Bahir Dar (n = 316)	291 (92.1 %)	285 (90.2 %)	270 (85.4 %)	21 (7.2 %)	25 (7.9 %)
Debre Markos (n = 153)	132 (86.3 %)	125 (81.7 %)	117 (76.5 %)	15 (11.2 %)	21 (13.7 %)
Overall (n = 808)	734 (90.8 %)	708 (87.6 %)	668 (82.7 %)	66 (9.0 %)	74 (9.2 %)

(12.9 %) were in the age groups of 1–4 years, 5–9 years, and 10–14 years, respectively. Moreover, the vaccination card retention among children in the age group of 1–4 years, 5–9 years, and 10–14 years was 302 (74.2 %), 173 (74.5 %), and 43 (45.3 %), respectively. Among vaccinated children, 518 (70.6 %) were confirmed using vaccination cards, whereas 216 (29.4 %) were confirmed by maternal recall. The card retention rate was 70.6 % both in urban and rural areas. Moreover, the card retention rate was 62.7 %, 90.7 %, and 44.7 % in Gondar, Bahir Dar, and Debre Markos, respectively (Table 3).

3.3. Complete hepatitis B vaccination coverage rates by respondents' characteristics

Table 4 shows the complete hepatitis B vaccination among respondents' characteristics such as age group of mothers, educational status, place of delivery, accessibility to health facilities, and their residence. Accordingly, a higher overall complete hepatitis B vaccination was observed among younger mothers (21–30 years): 331 (87.6 %), primary school-attending mothers 127 (87.6 %), deliveries at health centers 242 (87.7 %), those nearest to health facilities 578 (86.3 %), and urban areas 411 (88.0 %).

Complete hepatitis B vaccination coverage was higher in children born to younger mothers (21–30- years -old) in Bahir Dar (89.5 %) and Debre Markos (93.1 %). However, in Gondar, higher hepatitis B vaccination coverage was observed in children born to 31-40-year-old mothers (87.1 %). In addition, hepatitis B vaccination coverage was higher among those near a health facility in Gondar (85.7 %), Bahir Dar (90.4 %), and Debre Markos (80.0 %). When disaggregated by place of delivery, the highest vaccination coverage rates were in mothers' deliveries at hospitals in Gondar (85.8 %), Debre Markos (82.5 %), and deliveries at health centers in Bahir Dar (94.1 %). The highest vaccination coverage was observed among respondents with a higher level of education in Debre Markos (84.1 %), primary school in Gondar (87.1 %), and primary school in Bahir Dar (96.4 %). The highest hepatitis B vaccination coverage among residents was observed in urban areas (85.5 %), (88.7 %) in Gondar and Bahir Dar respectively. However, in Debre Markos the highest compete hepatitis B vaccination was observed in rural areas (79.4 %) (Table 4).

3.4. Predictors of complete hepatitis B vaccination in children

The multivariable logistic regression model showed that educational status of mothers, place of delivery, marital status, age of mothers, accessibility to vaccination services, and age of children were independent predictors of full doses of hepatitis B vaccination in children.

Accordingly, children born from secondary and above schools attending mothers were 2.2 times more likely to be vaccinated for full doses of Hep B vaccine than children born from not attending formal education mothers (OR = 2.2, 95 % CI: 1.3–4.0), and children born from

Table 3
Assessment of hepatitis B vaccination with the age group of children living in three city administrations, northwest Ethiopia, 2024 (n = 808).

Variables		1–4 years (n = 424)			5–9 years (n = 249)			10–14 years (n = 135)			Total vaccination card (%)	Total recall (%)
		Vaccination card (%)	Recall (%)	Total Vaccinated (%)	Vaccination card (%)	Recall (%)	Total vaccinated (%)	Vaccination card (%)	Recall (%)	Total vaccinated (%)		
Vaccination	Hep B1	302 (74.2)	105 (25.8)	407 (96.0)	173 (74.5)	59 (25.5)	232 (93.2)	43 (45.3)	52 (54.7)	95 (70.4)	518 (70.6)	216 (29.5)
Source of vaccination	Hospital	85 (20.9)	56 (13.8)	141 (33.3)	35 (15.1)	27 (11.6)	62 (24.9)	13 (13.7)	19 (20.0)	32 (23.7)	133 (56.6)	102 (43.4)
	Health center	163 40.0)	22 (5.4)	185 (43.6)	114 (49.1)	29 (12.5)	143 (57.4)	29 (30.5)	29 (30.5)	58 (43.0)	306 (79.3)	80 (20.7)
	Health post	54 (13.3)	27 (6.6)	81 (19.1)	24 (10.3)	3 (1.3)	27 (10.8)	1 (1.1)	4 (4.2)	5 (3.7)	79 (69.9)	34 (29.1)
Residence	Urban	234 (36.4)	82 (12.8)	316 (74.5)	144 (22.4)	50 (7.8)	194 (77.9)	39 (6.1)	42 (6.5)	81 (60.0)	417 (70.6)	174 (29.4)
	Rural	68 (41.2)	23 (13.9)	91 (21.5)	29 (17.6)	9 (5.5)	38 (15.3)	4 (2.4)	10 (6.1)	14 (10.4)	101 (70.6)	42 (29.4)
Source of information	Health care workers	263 (62.0)	87 (20.5)	350 (82.5)	140 (56.2)	46 (18.5)	186 (74.7)	40 (29.6)	43 (31.9)	83 (61.5)	443 (54.8)	176 (21.8)
	Health Extension workers	114 (26.9)	26 (6.1)	140 (33.0)	81 (32.5)	28 (11.2)	109 (43.8)	13 (9.6)	26 (19.3)	39 (28.9)	208 (25.7)	80 (9.9)
	Media (TV, Radio etc.)	60 (14.2)	12 (2.8)	72 (17.0)	40 (16.1)	12 (4.8)	52 (20.9)	5 (3.7)	11 (8.1)	16 (11.8)	105 (13.0)	35 (4.3)
First vaccination time	6 weeks	268 (65.8)	103 (25.3)	371 (87.5)	150 (64.7)	23 (9.9)	173 (69.5)	41 (43.2)	42 (44.2)	83 (61.5)	459 (69.9)	198 (30.1)
	After 6 weeks	34 (8.4)	2 (0.5)	36 (8.5)	53 (22.8)	6 (2.6)	59 (23.7)	2 (2.1)	10 (10.5)	12 (8.9)	59 (76.6)	18 (23.4)
Cities	Gondar	124 (36.6)	65 (19.2)	189 (44.6)	58 (17.1)	27 (8.0)	85 (34.1)	13 (3.8)	24 (7.1)	37 (27.4)	195 (62.7)	116 (37.3)
	Bahir Dar	141 (44.6)	6 (1.9)	147 (34.7)	97 (30.7)	12 (3.8)	109 (43.8)	26 (8.2)	9 (2.8)	35 (25.9)	264 (90.7)	27 (9.3)
	Debre Markos	37 (24.2)	34 (22.2)	71 (16.7)	18 (11.8)	20 (13.1)	38 (15.3)	4 (2.6)	19 (12.4)	23 (17.0)	59 (44.7)	73 (55.3)

Table 4
Complete hepatitis B vaccination of children among respondents' characteristics in three city administrations, northwest Ethiopia, 2024.

Respondents' characteristics		Gondar (n = 339)		Bahir Dar (n = 316)		Debre Markos (n = 135)		Total (n = 808)	
		Vaccinated (%)	Non-vaccinated (%)	Vaccinated (%)	Non-vaccinated (%)	Vaccinated (%)	Non-vaccinated (%)	Vaccinated (%)	Non-vaccinated (%)
Age of mothers	≤20 years	4 (80.0)	1 (20.0)	4 (66.7)	2 (33.3)	2 (66.7)	1 (33.3)	10 (71.4)	4 (28.6)
	21–30 years	140 (83.8)	27 (16.2)	137 (89.5)	16 (10.5)	54 (93.1)	4 (6.9)	331 (87.6)	47 (12.4)
	31–40 years	122 (87.1)	18 (12.9 %)	119 (88.1)	16 (11.9)	55 (72.4)	21 (27.6)	296 (84.3)	55 (15.7)
	>40 years	15 (55.6)	12 (44.4)	10 (45.5)	12 (54.5)	6 (37.5)	10 (62.5)	31 (47.7 %)	34 (52.3)
Educational status	No formal education	39 (78.0)	11 (22.0)	34 (54.0)	29 (46.0)	31 (67.4)	15 (32.6)	104 (65.4)	55 (34.6)
	Primary school	61 (87.1)	9 (12.9)	54 (96.4)	2 (3.6)	12 (63.2)	7 (36.8)	127 (87.6)	18 (12.4)
	Secondary and above	181 (82.6)	38 (17.4)	182 (92.4)	15 (7.6)	74 (84.1)	14 (15.9)	437 (86.7)	67 (13.3)
Place of delivery	Hospital	206 (85.8)	34 (14.2)	122 (93.1)	9 (6.9)	47 (82.5)	10 (17.5)	375 (87.6)	53 (12.4)
	Health center	55 (82.1)	12 (17.9)	127 (94.1)	8 (5.9)	60 (81.1)	14 (18.9)	242 (87.7)	34 (12.3)
	Home	20 (62.5)	12 (37.5)	21 (42.0)	29 (58.0)	10 (45.5)	12 (54.5)	51 (49.0)	53 (51.0)
Marital status	Married	239 (84.8)	43 (15.2)	228 (88.7)	29 (11.3)	104 (79.4)	27 (20.6)	571 (85.2)	99 (14.8)
	Divorced/ widowed/ separated	42 (73.7)	15 (26.3)	42 (71.2)	17 (28.8)	13 (59.1)	9 (40.9)	97 (70.3)	41 (29.7)
Accessibility to vaccination service	Up to half hour	257 (85.7)	43 (14.3)	217 (90.4)	23 (9.6)	104 (80.0)	26 (20.0)	578 (86.3)	92 (13.7)
	More than half hour	24 (61.5)	15 (38.5)	53 (69.7)	23 (30.3)	13 (56.5)	10 (43.5)	90 (65.2)	48 (34.8)
Residence	Urban	259 (85.5)	44 (14.5)	196 (88.7)	25 (11.3)	90 (75.6)	29 (24.4)	545 (84.8)	98 (15.2)
	Rural	22 (61.1)	14 (38.9)	74 (77.9)	21 (22.1)	27 (79.4)	7 (20.6)	123 (74.5)	42 (25.5)

primary school attending mothers were 3 times more likely to be vaccinated for full doses of Hep B vaccine than children born from not attending formal education mothers (OR = 2.9, 95 % CI: 1.4–5.8). Children born in the age groups of 21–30 years were 2.7 times more likely to be vaccinated with full doses of Hep B vaccine than children born from mothers age greater than 40 years (OR = 2.7, 95 % CI: 1.3–5.6), and children born from mothers with the age groups of 31–40 years were 2.8 times more likely to receive three doses of Hep B vaccine than children born from mothers with the age groups of more than 40 years (OR = 2.8, 95 % CI: 1.4–5.5).

Children born from married mothers were 2.5 times more likely to be fully vaccinated than children from living alone mothers (OR = 2.42, 95 % CI: 1.5–4.3). On the other hand, children born in hospitals were 2.4 times more likely to receive three doses of Hep B vaccine than children born at home (OR = 2.4, 95 % CI: 1.3–4.3), and children born in health centers were 4 times more likely to be fully vaccinated for Hep B vaccine than children born at home (OR = 4.0, 95 % CI: 2.2–7.4). Moreover, children with age groups of 1–4 years were 3.1 times more likely to be vaccinated for Hep B vaccine than children with the age groups of 10–14 years (OR = 3.1, 95 % CI: 1.7–5.5), and children in the age groups of 5–9 years were 3.8 times more likely to receive three doses of Hep B vaccine than those under the age group of 10–14 years (OR: 3.8, 95 % CI: 2.1–7.1). Children living in the nearest health facilities were 2.4 times more likely to receive full doses of Hep B vaccine than children having low accessibility to vaccination services (OR = 2.4, 95 % CI: 1.5–4.0) (Table 5).

3.5. Reasons for hepatitis B vaccination failure among partially and unvaccinated children

The respondents who were defaulting and had not vaccinated their children were asked for reasons for vaccination failure. From the reasons they gave for not completing their children's vaccination, the majority of the respondents said 39 (27.9 %) lack of awareness about vaccination,

Table 5
Bivariable and multivariable logistic regression analysis of associated factors for hepatitis B vaccination coverage among children living in three city administrations, northwest Ethiopia, 2024 (n = 808).

Predictors		Hep B3		COR (95 % CI)	AOR (95 % CI)	P-value
		Yes (%)	No (%)			
Age of Children	1–4 years	366 (45.3 %)	58 (7.2 %)	3.595 (2.30–5.62)	3.1 (1.7–5.5)	<0.001
	5–9 years	216 (26.7 %)	33 (4.1 %)	3.73 (2.25–6.19)	3.8 (2.1–7.1)	
	10–14 years	86 (10.6 %)	49 (6.1 %)	1	1	
Place of Delivery	Hospital	375 (46.4 %)	53 (6.6 %)	7.35 (4.55–11.88)	2.4 (1.3–4.3)	<0.001
	Health Center	242 (30.0 %)	34 (4.2 %)	7.40 (4.37–12.52)	4.0 (2.2–7.4)	
	Home	51 (6.3 %)	53 (6.6 %)	1	1	
Age of Mothers	< =20 years	10 (1.2 %)	4 (0.5 %)	2.742 (0.78–9.64)	1.4 (0.3–5.8)	0.005
	21–30 years	331 (41.0 %)	47 (5.8 %)	7.72 (4.35–13.72)	2.7 (1.3–5.6)	
	31–40 years	296 (36.6 %)	55 (6.8 %)	5.90 (3.35–10.39)	2.8 (1.4–5.5)	
	>40 years	31 (3.8 %)	34 (4.2 %)	1	1	
Educational Status of Mothers	No formal Education	104 (12.9 %)	55 (6.8 %)	1	1	0.001
	Primary school	127 (15.7 %)	18 (2.2 %)	3.73 (2.06–6.75)	2.9 (1.4–5.8)	
	Secondary and above	437 (54.1 %)	67 (8.3 %)	3.45 (2.28–5.23)	2.2 (1.3–4.0)	
Marital Status	Married	571 (70.7 %)	99 (12.3 %)	2.44 (1.60–3.72)	2.5 (1.5–4.3)	<0.001
	Divorced/Widowed/Separated	97 (12.0 %)	41 (5.1 %)	1	1	
Accessibility to Vaccination Service	Up to half hour	568 (70.3 %)	92 (11.4 %)	3.56 (2.39–5.32)	2.4 (1.5–4.0)	0.004
	More than half hour	100 (12.4 %)	48(5.9 %	1	1	
Residence	Urban	545 (84.8)	98 (15.2)	1.90 (1.30–2.90)	1.4 (0.8–2.3)	0.215
	Rural	123 (74.5)	42 (25.5)	1	1	

19 (13.6 %) unaware of the need to return for the 2nd or 3rd dose, 14 (10.0 %) place and/or time of immunization unknown, 56 (40.0 %) postponed until another time, 20 (14.3 %) no faith in vaccination, 80 (57.1 %) inconvenient vaccination time, 56 (40.0 %) mothers too busy, 33 (23.6 %) child illness, 25 (17.9 %) family problem, including illness of mother, and 19 (13.6 %) vaccines not available. All these reasons were consistently mentioned in each city administration (Table 6).

4. Discussion

Childhood vaccination is a cost-effective public health measure to control and eliminate vaccine-preventable diseases [21,22]. Hepatitis B vaccination for newborns is vital to prevent hepatitis B virus (HBV) infection [23]. Administering three doses of the vaccine is highly effective in preventing viral infection and chronic carrier status in children, with an effectiveness of approximately 95 %. This approach can create significant herd immunity, reducing the virus's long latency period [24,25].

In this study, we focused on the first dose of Hep B and third dose of Hep B vaccination coverage, as well as the dropout rate of hepatitis B vaccination. The vaccination coverage for the first dose and third dose hepatitis B vaccination was 90.8 % and 82.7 % respectively, with a dropout rate of 9.0 %. The HepB3 vaccination coverage fell short of the WHO recommendation of 90 % for developing countries [26] and the Ethiopian national EPI plan target of 90 % by 2020 [27] but was higher than the WHO/UNICEF estimate of national immunization coverage (WUENIC) of Hep B3 for Ethiopia, which was 72 % [3,28]. The study revealed that Hep B3 vaccination coverage was high in urban areas (88.0 %), but lower in rural areas (75.4 %). It's unlikely that using vaccination to reduce chronic hepatitis B (CHB) will achieve the WHO goal of a 90 % reduction in new cases by 2030 [29]. The socioeconomic status, media exposure, service accessibility, knowledge about childhood vaccination, and maternal health service uptake might be barriers for vaccinating children in Ethiopia.

The Hep B3 vaccination coverage observed in the present study aligns with findings from prior research conducted in Ethiopia. Compared to the Hep B3 vaccination coverage reported in Gondar (83.2 %) [30] and Southeast Ethiopia (84.6 %) [31], our study produced similar results. However, our findings indicated higher vaccination coverage when compared to studies conducted in Ethiopia including in East Gojam (68.7 %) [32], Dessie (68.0 %) [33], Debre Birhan (79.7 %) [34], eastern Ethiopia in 2021 (72.5 %) [35], Ethiopia in 2023 (70.1 %) [1], Ethiopia in 2019 (57.8 %) [11], and southern Ethiopia (77.7 %) [8]. Conversely, the vaccination coverage in our study was lower in comparison to coverage reported in other regions, such as northeast Ethiopia (90.3 %) [10], Menz Lalo, northeast Ethiopia (92.6 %) [36], Ambo (92.4 %) [37], and the overall rate of 87 % reported for Ethiopia [38]. The observed disparities in full-dose hepatitis B vaccination coverage across different regions of Ethiopia may likely be attributed to variances in study design and the study period. Specifically, it is plausible that the study period has influenced the outcomes due to factors such as internal conflicts, instability, and social unrest experienced at varying times throughout the country.

Moreover, the Hep B3 vaccination coverage in this study was found to be similar to rates reported in Senegal (82.6 %) [39], Sierra Leone at 80.9 % in 2018 [40], Togo (81.2 %) [41], and Afghanistan (82.3 %) [42]. However, it was higher than in studies conducted in Cameroon (36.6 %) [43], Sierra Leone (70.3 %), Liberia (64.6 %), and Guinea (39.3 %) [44], Pakistan (69.7 %) [45], rural areas of Pakistan (53.8 %) [46], and (79.5 %) [4]. Conversely, it was lower than reported in studies in Kenya in 2019 (93 %) [47], Nigeria (96.9 %) [48], Cameroon (94.8 %) [49], Senegal (92.8 %) [50], Brazil (87.9 %) [51], Colombia (95 %) [52], and Southwest China (100 %) [53]. These variations might be due to differences in access to vaccination services, public awareness, and perceptions of the importance of vaccination in different countries. These differences might also be due to disparities in the study periods.

Our study found a decrease in hepatitis B vaccination coverage from the first dose to the third dose. This decline could be attributed to mothers' noncompliance and the time gap between each dose, leading to them forgetting the subsequent doses. The overall dropout rate of hepatitis B vaccination from the first dose to the third dose was 8.9 %, which aligned with the international goal set by the WHO to keep the dropout rate below 10 % [54].

The dropout rate in this study was similar to rates reported in other studies, all of which were less than 10 %. These studies were conducted in East Gojam, Debre Birhan in 2017, Ethiopia in 2023, and Pakistan, with dropout rates between the first and third doses of the hepatitis B vaccine at 3.73 % [32], 1.8 % [34], 8.6 % [11], and 6.9 % [4], respectively. However, it was lower than the study done in Gondar, southeast Ethiopia, Oromia region and Cameroon, with hepatitis B vaccination dropout rates at 12.8 % [30], 11.8 % [31], 33 % [54], and 41.45 % [55], respectively. The variations in the dropout rate might be due to geographical and sample size differences. A larger target group could include more dropout children [56,57].

In this study factors significantly associated with the complete hepatitis B vaccination were residence of the participants, educational status of mothers, place of delivery, marital status of mothers, age of mothers, accessibility to vaccination service, and age of children.

Similarly, children born from mothers attending formal education have been a determinant factor that positively influenced hepatitis B

Table 6
Reasons for vaccine failure in partially vaccinated and/or unvaccinated children living in three city administrations, northwest Ethiopia, 2024.

Reasons		Gondar (Partially vaccinated/ unvaccinated = 58)		Bahir Dar (Partially vaccinated/ unvaccinated = 46)		Debre Markos (Partially vaccinated/ Unvaccinated = 36)		Total (Partially vaccinated/ unvaccinated = 140)	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Lack of information	Unaware of need for vaccination	13	22.8	10	21.3	16	44.4	39	27.9
	Unaware of need to return for 2nd or 3rd dose	6	810.5	8	17.0	5	13.9	19	13.6
	Place and/or time of immunization unknown	5	8.1	5	10.6	4	11.1	14	10.0
	Fear of side effects	1	1.8	2	4.3	7	19.4	10	7.1
Lack of motivation	Postponed until another time	13	22.8	27	57.4	16	44.4	56	40.0
	No faith in immunization	4	7.0	8	17.0	8	22.2	20	14.3
	Rumors	2	3.5	2	4.3	2	5.6	6	4.3
Obstacles	Place of immunization too far	3	5.3	5	10.6	6	16.7	14	10.0
	Inconvenient vaccination time	40	70.2	29/54	53.7	17	47.2	80	57.1
	Vaccinator absent	5	8.8	0	0.0	4	11.1	9	6.4
	Vaccine not available	16	28.1	2	4.3	1	2.8	19	13.6
	Mother too busy	20	35.1	21	44.7	15	41.7	56	40.0
	Family problem, including illness of mother	19	33.3	3	6.4	3	8.3	25	17.9
	Child illness	11	19.3	7	14.9	15	41.7	33	23.6
	Long waiting time	0	0.0	8	17.0	1	2.8	9	6.4

vaccination completion. An increased level of education increases the Hep B3 vaccination coverage in the children. Studies conducted in Ethiopia in 2019 [8], northeast Ethiopia in 2012 [10], Senegal in the 2010–2011 DHS [39], Cameroon in 2021 [44], and Cameroon in 2018 [55] reported that maternal education has been a determinant factor for completion of hepatitis B vaccination. Thus, complete hepatitis B vaccination coverage of children was higher in taking formal-education mothers than in non-educated. The disparity in maternal education levels may contribute to divergent understandings and awareness regarding the significance of vaccination, whereas those lacking formal education may exhibit a deficit in understanding the associated benefits [58]. Maternal educational attainment plays a crucial role in communication with healthcare providers, resulting in an enhanced comprehension of vaccination schedules and practices. Furthermore, education serves to empower women to make well-informed decisions regarding their children's vaccination.

Likewise, the marital status of mothers was found to be significantly associated with the Hep B3 vaccination coverage of children. Children born to married mothers were more likely to receive the Hep B3 vaccine compared to those born to widowed, divorced, and separated mothers. Similar findings were also reported in other studies conducted in Ethiopia in 2021 [8], northeast Ethiopia in 2012 [10], and south Ethiopia in 2008 [59] highlighting the marital status of mothers as a factor in the vaccination of children. This may be attributed to the fact that divorced, widowed, and separated mothers may be facing challenges such as marital conflicts, loss of their husbands, and geographical distance, which could impact their ability to prioritize their children's vaccination schedule.

According to this study, children whose mothers delivered at hospitals and health centers were more likely to receive Hep B3 compared to those whose mothers delivered at home. A similar study conducted in Senegal in 2020 also found that children whose mothers delivered in health facilities were more likely to be vaccinated with Hep B3 than those whose mothers delivered at home [50]. This could be because mothers delivering in health facilities have better access to information about vaccinations from healthcare workers during their visits and because they start vaccinations soon after giving birth.

Additionally, the age of mothers in this study was found to be a significant predictor of Hep B3 vaccination coverage. The study revealed that younger mothers (aged 21–30 and 31–40) were more likely to vaccinate their children compared to older mothers (over 40 years old). However, there was no significant difference between the age groups of under 21 years and over 40 years. Surprisingly, contrary to our findings, children of mothers in the 35–49 age category had higher odds of receiving the Hep B3 vaccination compared to the 15–19 age group [8]. Additionally, children of mothers aged 35 years or older were more likely to be fully immunized compared to those under 20 years of age [50]. This may be because adults in Ethiopia have a more positive attitude toward vaccination than older and younger individuals. Therefore, it is not surprising that a positive attitude would lead to improved childhood vaccination practices [60].

In this study, children who lived near to the health facilities were more likely to receive the Hep B3 than those living farther away. This finding is consistent with a study in Northeast Ethiopia, which found that children with access to health services were more likely to be fully vaccinated compared to those without access to services [10]. The lack of access to vaccination services might be due to political instability, conflict, long distances to health facilities, and poor functional services for seeking vaccination. Moreover, the vaccination coverage for the Hep B3 vaccine was higher for children in the age groups of 1–4 years and 5–9 years compared to children aged 10–14 years. This difference may be attributed to factors such as better retention of vaccination cards, decreased maternal recall as children get older, increased community-level health extension activities to educate mothers about vaccination and child health, and improved health policies and strategies for vaccination.

The most common reasons for vaccination failure among parents who did not vaccinate their children were lack of awareness about vaccination, unawareness of the need to return for a second or third dose, postponed until another time, lack of faith in vaccination, inconvenient vaccination time, mothers being too busy, and child illness. This result was supported by studies conducted in different regions which showed similar reasons for not vaccinating or defaulting on their children [4,31,61,62].

The study had strengths, including all children born after the introduction of hepatitis B vaccination in the national EPI program, which showed comprehensive data for responsible bodies and was a community-based study. However, there were some limitations, including potential recall bias in reporting immunization status and the study's cross-sectional design. We discussed our findings with studies conducted on children under five, as there were not enough studies on children under 15 years old.

5. Conclusion

The complete hepatitis B vaccination coverage in this study was lower than the WHO recommendation for developing countries. The predictors significantly associated with complete hepatitis B vaccination included the age of children, place of birth, maternal educational status, maternal marital status, maternal age, and accessibility of vaccination services. Unawareness about hepatitis B vaccination, inconvenient times for vaccination, and mothers being too busy were the most common reasons for not vaccinating their children. Thus, the national EPI program should prioritize strategies to increase vaccination coverage. Moreover, policymakers need to consider factors influencing vaccination rates when developing vaccination policies. Strengthening the promotion of facility delivery and easy access to vaccines are crucial for improving children's vaccination coverage. Additionally, enhancing defaulters' tracing mechanisms and addressing reasons for incomplete vaccination provided by mothers are key.

Ethics approval and consent to participate

Ethical approval was obtained from the CDT Africa Scientific and Ethics Review Committee (SERC) and the Institutional Review Board (IRB) of the College of Health Sciences, Addis Ababa University. A permission letter was also obtained from the Amhara Public Health Institute and the city administrations. Additionally, community permission was obtained from community leaders. Written informed consent was obtained from the parents of the children who were enrolled in this study, whereas assent was obtained from the children who were 8–14 years old.

Consent for publication

Not applicable.

Availability of data and materials

The data used for this survey are available at the corresponding author so interested readers can get the data from the corresponding author with a reasonable request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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