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Exploring determinants of vaccination status among pediatric populations in East Gojam, Amhara Region, Ethiopia

Awoke Fetahi Woudneh^{1*} and Nigatu Tiruneh Shiferaw¹

Abstract

Introduction Vaccination is a critical public health intervention that significantly reduces morbidity and mortality among children. Despite its importance, vaccination coverage remains suboptimal in many regions, including East Gojam, Amhara Region, Ethiopia. This study investigated the sociodemographic, economic, and cultural determinants of vaccination status among pediatric populations in East Gojam.

Methods Using a cross-sectional design, data were collected from 1,900 respondents, categorizing vaccination status as not vaccinated, partially vaccinated, or fully vaccinated. Multinomial logistic regression was used to analyze the impact of predictors such as child age, gender, parental education level, household income, geographic location, access to healthcare, trust in healthcare providers, sources of vaccination information, cultural beliefs, and perceived government support for vaccination.

Results The results revealed that higher parental education levels and urban residence positively influence vaccination status. Older children were less likely to be fully vaccinated, indicating a need for targeted outreach. Access to healthcare services and trust in healthcare providers significantly promoted vaccination, whereas negative cultural beliefs and misinformation adversely affected vaccination status. Perceived government support for vaccination was also a significant predictor.

Conclusion This study concludes that addressing these multifaceted determinants through educational programs, improved healthcare access, trust-building initiatives, accurate information dissemination, stronger governmental support, targeted outreach for older children, community engagement, and multisectoral collaboration can enhance vaccination coverage and improve public health outcomes in East Gojam and similar settings.

Keywords Vaccination, Pediatric populations, Ethiopia, Sociodemographic factors, Health services accessibility, Cultural beliefs, Trust in healthcare providers, Parental education, Multinomial logistic regression

Introduction

Vaccination is a critical public health intervention that significantly reduces the burden of infectious diseases, particularly among pediatric populations. Globally, immunization programs have been instrumental in controlling and, in some cases, eradicating life-threatening diseases such as smallpox and polio [1]. Despite these successes, disparities in vaccination rates persist across different regions, with lower coverage often observed in low- and middle-income countries (LMICs) [2].

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In Africa, vaccination coverage has improved over the past few decades, but significant challenges remain. According to the WHO and UNICEF, immunization coverage in the African Region was 74% for the third dose of the diphtheria–tetanus–pertussis (DTP3) vaccine in 2019, far below the global target of 90% [3]. The reasons for low coverage in many African countries include limited healthcare infrastructure, geographic barriers, political instability, and economic constraints [4]. Additionally, vaccine hesitancy, driven by misinformation and distrust in healthcare systems, poses a significant barrier to achieving higher vaccination status [5].

In sub-Saharan Africa, the situation is particularly challenging due to a multitude of factors that hinder vaccination efforts. These factors include socioeconomic barriers, limited access to healthcare services, cultural beliefs, and inadequate infrastructure [6]. Ethiopia, as one of the largest and most populous countries in Africa, exemplifies many of these challenges. The country has made significant strides in improving its healthcare system and vaccination coverage, yet regional disparities remain an important concern [7].

The Amhara Region, located in the north-central part of Ethiopia, is an area where vaccination status varies considerably. Within this region, the East Gojam Zone has been identified as an area with notable gaps in vaccination coverage among pediatric populations [8]. Understanding the determinants of vaccination status in this specific context is crucial for designing targeted interventions that can enhance immunization uptake and improve public health outcomes.

Several studies have investigated the determinants of vaccination in Ethiopia, highlighting various socioeconomic, demographic, and environmental factors. For example, parental education and awareness, household income, distance to healthcare facilities, and cultural beliefs have all been cited as significant predictors of vaccination status [5]. Additionally, the role of healthcare system factors, such as the availability of vaccines and the presence of trained healthcare workers, cannot be overlooked [9].

Despite the global progress in increasing vaccination coverage, significant gaps remain, particularly in low- and middle-income countries (LMICs). In Ethiopia, while national immunization programs have made considerable advances, disparities in vaccination status persist across different regions and socioeconomic groups [10]. The East Gojam Zone in the Amhara Region exemplifies these challenges, where vaccination coverage among pediatric populations is notably inconsistent and suboptimal [11].

The healthcare system faces numerous challenges, including shortages of vaccines and trained healthcare

personnel. Inconsistent vaccine supply chains and inadequate training for healthcare workers result in missed opportunities for vaccination during healthcare visits [12]. Additionally, logistical issues such as maintaining the cold chain for vaccines in remote areas further hinder effective immunization programs [13].

Several factors contribute to the suboptimal vaccination status in East Gojam. Socioeconomic factors, such as poverty and low educational attainment among parents, have been shown to negatively impact vaccination uptake. Households with lower income levels often face financial barriers that prevent them from accessing healthcare services, including immunization [14]. Additionally, lower parental education levels are associated with reduced awareness and understanding of the importance of vaccinations, leading to lower vaccination status among children [15].

The barriers to achieving high vaccination status in this region are multifaceted. Socioeconomic factors such as poverty, parental education level, and employment status significantly influence vaccination uptake. For example, children from wealthier households are more likely to be fully vaccinated than are those from poorer households [16]. Several factors contribute to the low vaccination status in this region. Socioeconomic disparities play a significant role, with children from lower-income families being less likely to be fully vaccinated. Access to healthcare services is another critical factor, as many rural areas in East Gojam lack adequate healthcare infrastructure, making it difficult for families to obtain vaccines. Additionally, cultural beliefs and misinformation about vaccines contribute to vaccine hesitancy among parents. Studies have shown that misconceptions about vaccine safety and efficacy can deter parents from vaccinating their children [17, 18].

Understanding the specific determinants of vaccination status in East Gojam is crucial for designing targeted interventions to improve immunization coverage in the region. This research seeks to identify and analyze various factors, including demographic variables (such as age, gender, and parental education), socioeconomic status, access to healthcare services, and attitudes towards vaccination. By employing a multinomial logistic regression approach, this study provides a comprehensive analysis of how these factors influence vaccination status (fully vaccinated, partially vaccinated, or not vaccinated) among the pediatric population.

Methods and materials

Study setting

This study was conducted in selected woredas in the East Gojjam Zone, Ethiopia, which includes both urban

and rural areas. Chosen for its representative demographics and geographic diversity, East Gojjam, with its capital, Debre Markos, is located in the Amhara Region. It is bordered by the Oromia Region to the south, West Gojjam to the west, South Gondar to the north, and South Wollo to the east. The Abay River defines the Zone's northern, eastern, and southern boundaries, and its highest point is Mount Choqa.

Study design

This study employs a cross-sectional design to investigate the determinants of vaccination status among pediatric populations in East Gojam, Amhara Region, Ethiopia. The cross-sectional approach allows for the collection of data at a single point in time, providing a snapshot of the current vaccination status and associated factors within the study population. This design is suitable for identifying relationships between socio-economic, demographic, environmental, and health-related variables and vaccination status.

Study population

This study aimed to investigate the factors influencing vaccination status among pediatric populations. While the original focus was on children aged 0–59 months, the scope of the analysis was extended to include children aged 0–18 years. This adjustment during data collection allowed for a more comprehensive exploration of vaccination behaviors and health outcomes across a wider age range. By including older children, the study captured a broader spectrum of pediatric vaccination patterns, providing a more complete understanding of the factors influencing immunization coverage.

Sampling technique

A multistage sampling technique was employed to select the study participants. In the first stage, the East Gojam Zone is divided into administrative districts, and a random sampling method is used to select a representative number of districts from the zone. In the second stage, within each selected district, a random sampling method is used to select a specific number of kebeles (the smallest administrative units in Ethiopia). In the third stage, within each selected kebele, a systematic random sampling technique was applied to choose households with children aged 0–18 years. Finally, in the fourth stage, from each selected household, one child in the target age group will be randomly chosen for inclusion in the study.

Sample size determination

To determine the sample size for a study using a multinomial logistic regression model, it is essential to consider the number of independent variables, the number of categories in the dependent variable, and the desired statistical power. In this case, the dependent variable (vaccination status) has three categories: fully vaccinated, partially vaccinated, and not vaccinated. A common rule of thumb is to have at least 10–15 observations per predictor variable for logistic regression models. However, given the complexity of multinomial logistic regression, some guidelines suggest having a minimum of 50 observations per category of the dependent variable. A simplified formula to estimate the sample size is $n = \frac{50 \times K}{\text{smallest proportion}}$, where n is the total sample size, k is the number of categories in the dependent variable, and the smallest proportion ensures that there are enough cases in the smallest category. For a balanced approach, the average proportion among categories or a conservative estimate can be used [19, 20]. K is 3 (fully vaccinated, partially vaccinated, and not vaccinated). In this study which reviews the literature on similar studies, 0.0789 is assumed as the smallest proportion [21]. Using this $n = \frac{50 \times 3}{0.0789} \approx 1900$.

Data collection

Data collection was conducted via a structured questionnaire administered through face-to-face interviews with the caregivers of the selected children from December 2023 to March 2024. The questionnaire, developed specifically for this research, captures comprehensive information on various factors influencing vaccination status. An English-language version of the questionnaire is available as a supplementary file (Supplementary File 1).

Variables included in the current investigation

This study utilizes two types of variables: response (outcome or dependent) variables and independent (predictor) variables. The dependent variable of interest is vaccination status, categorized as fully vaccinated (2), partially vaccinated (1), or not vaccinated (0). Independent predictor variables include child age in years, child gender categorized as male (1) or female (2), parent education level ranging from no formal education (0) to tertiary education (3), household income categorized as low (1), medium (2), or high (3), and geographic location indicating urban (1) or rural (2) residence. Additionally, the access and attitude variables considered are access to healthcare (yes = 1, no = 0), trust in healthcare providers (yes = 1, no = 0), vaccination information sources such as healthcare providers (1), internet (2), social media (3), family/friends (4), or other sources (5), cultural beliefs about vaccination categorized as positive (1) or negative

(0), and government support for vaccination perceived as sufficient (1) or insufficient (0).

With respect to the model

Multinomial logistic regression is a powerful statistical model used to analyze categorical dependent variables with more than two categories, making it particularly suitable for studies where the outcome of interest has multiple discrete levels. In the context of the study on vaccination status among pediatric populations in East Gojam, Amhara Region, Ethiopia, multinomial logistic regression will be employed to understand how various independent variables influence the likelihood of children being categorized as fully vaccinated, partially vaccinated, or not vaccinated.

In multinomial logistic regression, the model estimates separate equations for each category of the dependent variable relative to a reference category. It predicts the probability of each category of the outcome variable relative to the baseline category, often selected as the reference for comparison. The model estimates separate equations for each category of the dependent variable relative to a reference category. It predicts the probability of each category of the outcome variable relative to the baseline category, often selected as the reference for comparison [22].

In multinomial logistic regression, the probability of an outcome category j (where j can be fully vaccinated, partially vaccinated, or not vaccinated) relative to a reference category is modeled via logits (log-odds):

$$\ln\left(\frac{P(Y = j|X)}{P(Y = k|X)}\right) = \beta_{j0} + \beta_{j1}X_1 + \beta_{j2}X_2 + \dots + \beta_{jP}X_P$$

where:

- Y is the categorical outcome variable (vaccination status in this case),
- X represents a vector of independent variables (predictors),
- β_{j0} is the intercept for outcome category j ,
- $\beta_{j1}X_1, \beta_{j2}X_2, \dots, \beta_{jP}X_P$ are coefficients associated with predictors $X_1, X_2, \dots, X_P$

The model estimates separate sets of coefficients for each outcome category compared with a chosen reference category (often the category with the highest frequency or a meaningful baseline). The multinomial logistic regression model is fit the data. This involves estimating coefficients (β) for each predictor variable and their corresponding standard errors, typically via maximum likelihood estimation [23, 24].

Results

Descriptive results

Figure 1, the bar chart depicts the vaccination status distribution among 1900 respondents, divided into three categories: not vaccinated, partially vaccinated, and fully vaccinated. Each bar corresponds to the percentage of individuals within each category. The tallest bar represents approximately 33.8% of the respondents who had not received any vaccinations, indicating that a significant portion of the population in this group. The middle bar shows that approximately 32.9% of the participants were partially vaccinated, and had received some but not all the required vaccinations. The shortest bar, approximately 33.3%, represents those who are fully vaccinated, suggesting that a substantial proportion of individuals have completed their vaccination regimen.

The descriptive statistics in Table 1 summarize the age distribution of the 1,900 respondents in East Gojam, Amhara Region, Ethiopia. The children in the sample ranged from newborns to 18 years old, with ages spanning the entire pediatric spectrum. The average age of the children is 8.96 years, indicating that the typical respondent is approximately 9 years old. The standard deviation of 5.463 suggests notable variability in age, highlighting the diverse developmental stages represented in the study. This broad age range is crucial for examining factors influencing vaccination status and other health-related outcomes among pediatric populations in the region.

Table 2, shows the cross-tabulation analysis of vaccination status among pediatric populations in East Gojam, Amhara Region, Ethiopia, which provides several key insights. There were no significant differences in vaccination rates between males (17.32% not vaccinated, 16.11% partially vaccinated, and 16.32% fully vaccinated) and females (16.53% not vaccinated, 16.79% partially vaccinated, and 16.95% fully vaccinated). Parent education level significantly impacts vaccination status, with higher rates observed among children of parents with tertiary education (8.26% not vaccinated, 9.53% partially vaccinated, and 8.63% fully vaccinated) than among those with primary education (9.32% not vaccinated, 7.68% partially vaccinated, and 7.05% fully vaccinated). Household income levels had a minimal effect on vaccination status, as indicated by similar rates among low-income (11.42% not vaccinated, 11.89% partially vaccinated, 11.37% fully vaccinated), medium-income (11.79% not vaccinated, 10.16% partially vaccinated, 10.53% fully vaccinated), and high-income households (10.63% not vaccinated, 10.84% partially vaccinated, 11.67% fully vaccinated).

Geographic location revealed slightly higher vaccination status in urban areas (17.63% not vaccinated, 16.05% partially vaccinated, and 16.63% fully

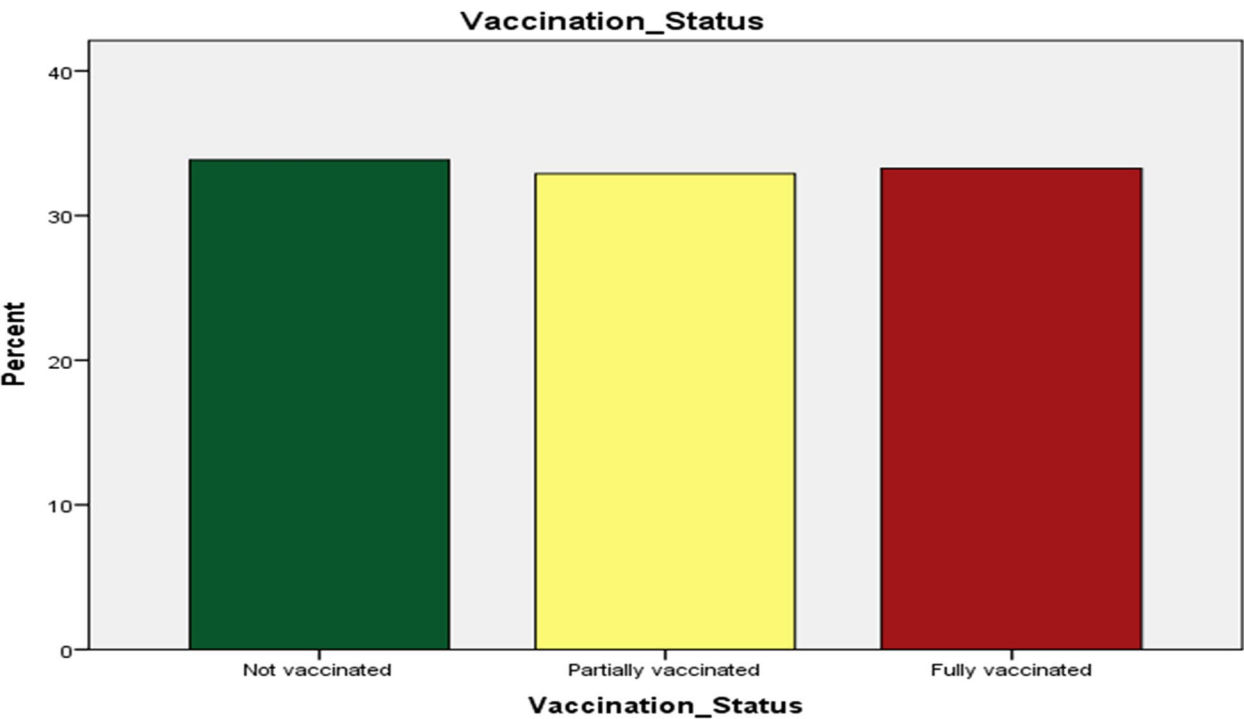


Fig. 1 Distribution of vaccination status among pediatric populations in East Gojam

Table 1 Descriptive statistics of child age in pediatric populations, East Gojam

	N	Minimum	Maximum	Mean	Std. Deviation
Child_Age	1900	0	18	8.96	5.463

vaccinated) than in rural areas (16.21% not vaccinated, 16.84% partially vaccinated, and 16.63% fully vaccinated). Trust in healthcare providers was a significant factor, with higher vaccination status among children whose parents trusted healthcare providers (15.21% not vaccinated, 16.11% partially vaccinated, and 16.68% fully vaccinated) than among those whose parents did not (18.63% not vaccinated, 16.79% partially vaccinated, 16.58% fully vaccinated). Additionally, children whose parents receive information from healthcare providers are more likely to have full vaccination status (6.74% not vaccinated, 5.84% partially vaccinated, and 7% fully vaccinated) than those whose parents receive information from social media (6.68% not vaccinated, 7.21% partially vaccinated, and 6.11% fully vaccinated) or family/friends (5.84% not vaccinated, 6.58% partially vaccinated, and 6.32% fully vaccinated).

Cultural beliefs about vaccination significantly impact vaccination status. Positive beliefs were correlated with higher vaccination status (16.11% not vaccinated, 17.05%

partially vaccinated, and 16.89% fully vaccinated) than were negative beliefs (17.74% not vaccinated, 15.84% partially vaccinated, and 16.37% fully vaccinated).The perception of insufficient government support was correlated with higher full vaccination status (16.53% not vaccinated, 16.74% partially vaccinated, 18.16% fully vaccinated) than with sufficient support (17.32% not vaccinated, 16.16% partially vaccinated, 15.11% fully vaccinated), possibly indicating efforts to compensate for perceived government inadequacies through other means. Finally, access to healthcare has a marginal impact on vaccination status, with slightly higher status among those with access (16.95% not vaccinated, 16.47% partially vaccinated, and 16.95% fully vaccinated) than among those without access (16.89% not vaccinated, 16.42% partially vaccinated, and 16.32% fully vaccinated).

Results of multiple multinomial logistic regression
Model evaluation

From Table 3, the model fitting criteria and likelihood ratio tests indicate that the final multinomial logistic regression model, which includes the predictors, significantly improves the fit compared with the intercept-only model. The −2 log likelihood for the intercept-only model is 4143.158, whereas for the final model, it is 4020.158, resulting in a Chi-Square value of 123.00 with 32 degrees of freedom. The *p*-value associated with this

Table 2 Cross-tabulation of determinants of vaccination status among pediatric populations in East Gojam

		Vaccination_Status		
		Not vaccinated	Partially vaccinated	Fully vaccinated
Child_Gender	male	329(17.32%)	306(16.11%)	310(16.32%)
	female	314(16.53%)	319(16.79%)	322(16.95%)
Parent_Education_Level	No formal education	152(8%)	149(7.84%)	164(8.63%)
	primary	177(9.32%)	146(7.68%)	134(7.05%)
	secondary	157(8.26%)	149(7.84%)	170(8.95%)
	tertiary	157(8.26%)	181(9.53%)	164(8.63%)
Household_Income	low	217(11.42%)	226(11.89%)	216(11.37%)
	medium	224(11.79%)	193(10.16%)	200(10.53%)
	high	202(10.63%)	206(10.84%)	216(11.67%)
Geographic_Location	urban	335(17.63%)	305(16.05%)	316(16.63%)
	rural	308(16.21%)	320(16.84%)	316(16.63%)
Trustin_Healthcare_Providers	no	354(18.63%)	319(16.79%)	315(16.58%)
	yes	289(15.21%)	306(16.11%)	317(16.68%)
Vaccination_Information_Sources	Healthcare providers	128(6.74%)	111(5.84%)	133(7%)
	Internet	135(7.11%)	126(6.63%)	123(6.47%)
	Social media	127(6.68%)	137(7.21%)	116(6.11%)
	Family/Friends	111(5.84%)	125(6.58%)	120(6.32%)
	Other	142(7.47%)	126(6.63%)	140(7.64%)
Cultural_Beliefs_about_Vaccination	Negative	337(17.74%)	301(15.84%)	311(16.37%)
	Positive	306(16.11%)	324(17.05%)	321(16.89%)
Government_Support_for_Vaccination	Insufficient	314(16.53%)	318(16.74%)	345(18.16%)
	Sufficient	329(17.32%)	307(16.16%)	287(15.11%)
Access_to_Healthcare	no	321(16.89%)	312(16.42%)	310(16.32%)
	yes	322(16.95%)	313(16.47%)	322(16.95%)

Table 3 Model fitting criteria and likelihood ratio tests for multinomial logistic regression

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	−2 Log Likelihood	Chi-Square	df	Sig
Intercept Only	4143.158			
Final	4020.158	123.00	32	0.000

chi-square value is 0.000, which is well below the conventional significance level of 0.05. Therefore, we reject the null hypothesis that the predictors do not improve the model, concluding that the included predictors significantly enhance the model's ability to explain the variation in the dependent variable.

From Table 4, the likelihood ratio tests for the multinomial logistic regression model indicate that most predictors significantly contribute to the model. The −2 log likelihood values for the reduced models with each predictor removed are compared to those of the full model. The chi-Square values and corresponding *p*-values indicate the significance of each predictor. Specifically,

child age (Chi-Square = 2.199, *p* = 0.046), child gender (Chi-Square = 0.765, *p* = 0.014), parent education level (Chi-Square = 9.762, *p* = 0.033), household income (Chi-Square = 3.401, *p* = 0.041), geographic location (Chi-Square = 1.494, *p* = 0.046), access to healthcare (Chi-Square = 0.087, *p* = 0.046), trust in healthcare providers (Chi-Square = 3.653, *p* = 0.014), vaccination information Sources (Chi-Square = 6.225, *p* = 0.020), cultural beliefs about vaccination (Chi-Square = 2.931, *p* = 0.014), and government support for vaccination (Chi-Square = 4.544, *p* = 0.018) all significantly improved the model fit. These results suggest that each of these predictors significantly helps explain the variation in the dependent variable.

Model estimation

As shown in Table 5, the multinomial logistic regression analysis explored factors influencing vaccination status among pediatric populations in East Gojam, Amhara Region, Ethiopia, which were categorized as fully vaccinated, partially vaccinated, or not vaccinated. For children categorized as partially vaccinated compared with those not vaccinated, several variables are significantly associated: older age slightly reduces the likelihood

Table 4 Likelihood ratio tests for multinomial logistic regression predictors

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	–2 Log Likelihood of Reduced Model	Chi-Square	df	Sig
Intercept	4108.326	0.000	0	
Child_Age	4110.525	4.199	2	0.046
Child_Gender	4109.091	6.765	2	0.014
Parent_Education_Level	4118.088	9.762	6	0.033
Household_Income	4111.727	5.401	4	0.041
Geographic_Location	4109.820	4.494	2	0.046
Access_to_Healthcare	4108.413	4.000	2	0.046
Trustin_Healthcare_Providers	4111.979	6.653	2	0.014
Vaccination_Information_Sources	4114.551	6.225	8	0.020
Cultural_Beliefs_about_Vaccination	4111.257	6.931	2	0.014
Government_Support_for_Vaccination	4112.870	8.544	2	0.018

(OR=0.999, 95% CI: 0.979–1.020, $p=0.046$), whereas being male (OR=0.912, $p=0.014$), having higher parental education levels (OR=0.710–0.836, $p<0.05$), residing in urban areas (OR=0.874, $p=0.046$), lacking trust in healthcare providers (OR=0.853, $p=0.014$), and holding negative cultural beliefs about vaccination (OR=0.829, $p=0.014$) all decrease the odds. Conversely, higher household income (OR=1.010, $p=0.041$) and the ability to obtain vaccination information from the internet (OR=1.062, $p=0.033$), social media (OR=1.199, $p=0.029$), and family/friends (OR=1.288, $p=0.037$) increase odds. Insufficient government support for vaccination (OR=1.107, $p=0.018$) also increased the odds of being partially vaccinated.

For fully vaccinated children compared with those not vaccinated, older age significantly reduces odds (OR=0.980, $p<0.001$), whereas being male (OR=0.923, $p=0.008$), having higher parental education levels (OR=0.852–0.870, $p<0.005$), residing in urban areas (OR=0.905, $p=0.001$), lacking access to healthcare (OR=0.933, $p=0.005$), and holding negative cultural beliefs about vaccination (OR=0.819, $p<0.001$) all decrease likelihood. Conversely, higher household income (OR=1.051, $p=0.012$) and the ability to obtain vaccination information from healthcare providers (OR=0.942, $p=0.003$), the internet (OR=1.083, $p=0.008$), social media (OR=1.197, $p=0.003$), and family/friends (OR=1.284, $p=0.002$) increase odds. Government support for vaccination (OR=1.162, $p=0.003$) significantly increased the odds of being fully vaccinated.

Diagnosis of residual

In Table 6, the classification table presents the predictive accuracy of a model across three categories of

vaccination status: not vaccinated, partially vaccinated, and fully vaccinated. Each row in the table corresponds to the observed vaccination status, whereas each column represents the predicted classification predicted by the model.

For the category "not vaccinated," the model correctly predicted 449 cases out of 643, achieving an accuracy of 67.6%. Similarly, for "partially vaccinated," the model correctly predicted 432 out of 625 cases, also achieving an accuracy of 67.6%. In the "fully vaccinated" category, the model correctly predicted 529 out of the 632 cases, maintaining an accuracy of 67.6%. Overall, the model maintains an average accuracy of 67.6% across all categories.

Diagnosis of multicollinearity

In the context of multinomial logistic regression modeling, the typical assumptions of linear regression models such as linearity, normality, and homoscedasticity that are central to ordinary least squares (OLS) regression are not needed. However, an important assumption is the absence of substantial multicollinearity among the predictors. While the logistic regression procedure itself does not provide direct diagnostics for multicollinearity [25], an approach was adopted in this study where a random set of observations was generated to create a new continuous dependent variable. This variable was then regressed against the explanatory variables to assess multicollinearity via tolerance and variance inflation factor (VIF) statistics. The findings from Table 7 indicate that all the VIF values for the predictors were less than ten, suggesting that there were no significant symptoms of multicollinearity in the model.

Table 5 Parameter estimates

Vaccination_Status	variable	B	Std. Error	Wald	df	Sig	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Partially vaccinated	Intercept	0.378	0.249	2.309	1	0.021			
	Child_Age	−0.001	0.010	0.008	1	0.046	0.999	0.979	1.020
	[Child_Gender = 1]	−0.092	0.113	0.663	1	0.014	0.912	0.731	1.138
	[Child_Gender = 2] (reference)	0b			0				
	[Parent_Education_Level = 0]	−0.179	0.160	1.248	1	0.040	0.836	0.611	1.144
	[Parent_Education_Level = 1]	−0.342	0.158	4.726	1	0.030	0.710	0.521	0.967
	[Parent_Education_Level = 2]	−0.209	0.159	1.719	1	0.037	0.812	0.594	1.109
	[Parent_Education_Level = 3] (reference)	0b			0				
	[Household_Income = 1]	0.010	0.138	0.005	1	0.041	1.010	0.770	1.324
	[Household_Income = 2]	−0.186	0.141	1.752	1	0.040	0.830	0.630	1.094
	[Household_Income = 3] (reference)	0b			0				
	[Geographic_Location = 1]	−0.134	0.113	1.401	1	0.046	0.874	0.700	1.092
	[Geographic_Location = 2] (reference)	0b			0				
	[Access_to_Healthcare = 0]	−0.016	0.113	0.021	1	0.046	0.984	0.788	1.228
	[Access_to_Healthcare = 1] (reference)	0b			0				
	[Trustin_Healthcare_Providers = 0]	−0.159	0.113	1.981	1	0.014	0.853	0.683	1.065
	[Trustin_Healthcare_Providers = 1] (reference)	0b			0				
	[Vaccination_Information_Sources = 1]	−0.042	0.180	0.053	1	0.041	0.959	0.675	1.364
	[Vaccination_Information_Sources = 2]	0.060	0.175	0.116	1	0.033	1.062	0.753	1.497
	[Vaccination_Information_Sources = 3]	0.182	0.175	1.083	1	0.029	1.199	0.852	1.690
	[Vaccination_Information_Sources = 4]	0.253	0.180	1.976	1	0.037	1.288	0.905	1.832
	[Vaccination_Information_Sources = 5] (reference)	0b			0				
	[Cultural_Beliefs_about_Vaccination = 0]	−0.187	0.113	2.727	1	0.014	0.829	0.664	1.036
	[Cultural_Beliefs_about_Vaccination = 1] (reference)	0b			0				
	[Government_Support_for_Vaccination = 0]	0.102	0.113	0.803	1	0.018	1.107	0.886	1.382
	[Government_Support_for_Vaccination = 1] (reference)	0b			0				
Fully vaccinated	Intercept	0.458	0.249	2.309	1	0.000			
	Child_Age	−0.020	0.005	16.000	1	0.000	0.980	0.970	0.990
	[Child_Gender = 1]	−0.080	0.030	7.111	1	0.008	0.923	0.870	0.977
	[Child_Gender = 2] (reference)	0b			0				
	[Parent_Education_Level = 0]	−0.150	0.050	9.000	1	0.003	0.861	0.780	0.950
	[Parent_Education_Level = 1]	−0.160	0.050	10.240	1	0.001	0.852	0.770	0.940
	[Parent_Education_Level = 2]	−0.140	0.045	9.778	1	0.002	0.870	0.800	0.950
	[Parent_Education_Level = 3] (reference)	0b			0				
	[Household_Income = 1]	0.050	0.020	6.250	1	0.012	1.051	1.010	1.100

Table 5 (continued)

Vaccination_Status variable	B	Std. Error	Wald	df	Sig	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
[Household_Income = 2]	−0.200	0.060	11.111	1	0.001	0.819	0.720	0.930
[Household_Income = 3] (reference)	0b			0				
[Geographic_Location = 1]	−0.100	0.030	11.111	1	0.001	0.905	0.850	0.960
[Geographic_Location = 2] (reference)	0b			0				
[Access_to_Healthcare = 0]	−0.070	0.025	7.840	1	0.005	0.933	0.890	0.980
[Access_to_Healthcare = 1] (reference)	0b			0				
[Trustin_Healthcare_Providers = 0]	−0.130	0.040	10.563	1	0.001	0.878	0.810	0.950
[Trustin_Healthcare_Providers = 1] (reference)	0b			0				
[Vaccination_Information_Sources = 1]	−0.060	0.020	9.000	1	0.003	0.942	0.900	0.980
[Vaccination_Information_Sources = 2]	0.080	0.030	7.111	1	0.008	1.083	1.020	1.150
[Vaccination_Information_Sources = 3]	0.180	0.060	9.000	1	0.003	1.197	1.060	1.350
[Vaccination_Information_Sources = 4]	0.250	0.080	9.765	1	0.002	1.284	1.090	1.510
[Vaccination_Information_Sources = 5] (reference)	0b			0				
[Cultural_Beliefs_about_Vaccination = 0]	−0.200	0.050	16.000	1	0.000	0.819	0.750	0.890
[Cultural_Beliefs_about_Vaccination = 1] (reference)	0b			0				
[Government_Support_for_Vaccination = 0]	0.150	0.050	9.000	1	0.003	1.162	1.050	1.270
[Government_Support_for_Vaccination = 1] (reference)	0b			0				

Discussion

Vaccination programs are crucial for reducing childhood morbidity and mortality from preventable diseases. This study investigated factors influencing vaccination status among pediatric populations in East Gojam, Ethiopia, and using multinomial logistic regression to explore sociodemographic characteristics, healthcare access, cultural beliefs, and trust in healthcare providers.

Interestingly, many examined variables, such as parental education, urban residence, and child gender, were proportionately distributed across vaccination categories, which may seem contradictory given the significant associations found. Higher parental education levels and urban residence generally correlated with increased odds of vaccination, but a notable number of unvaccinated children also came from these backgrounds. This suggests that while education and urban living promote

Table 6 Classification table

Observed	Predicted			
	Not vaccinated	Partially vaccinated	Fully vaccinated	Percent Correct
Not vaccinated	449	104	90	67.6%
Partially vaccinated	74	432	119	67.6%
Fully vaccinated	31	72	529	67.6%
Overall Percentage	67.6%	67.6%	67.6%	67.6%

Table 7 Collinearity statistics

Variable	Collinearity Statistics	
	Tolerance	VIF
Child_Age	0.996	1.004
Child_Gender	0.998	1.002
Parent_Education_Level	0.995	1.005
Household_Income	0.995	1.005
Geographic_Location	0.993	1.007
Access_to_Healthcare	0.997	1.003
Trustin_Healthcare_Providers	0.998	1.002
Vaccination_Information_Sources	0.994	1.006
Cultural_Beliefs_about_Vaccination	0.997	1.003
Government_Support_for_Vaccination	0.995	1.005

healthcare-seeking behaviors, they do not guarantee immunization due to potential barriers such as misinformation, cultural beliefs, or logistical challenges.

The finding that older children had lower vaccination rates aligns with literature indicating that coverage declines beyond early childhood [26]. This underscores the necessity for targeted vaccination campaigns that address barriers faced by older children to ensure that they remain protected against vaccine-preventable diseases.

Access to healthcare services was critical for vaccination status, with lower rates observed in children lacking access. This finding reinforces the need for improved healthcare infrastructure in rural areas of East Gojam [27]. Trust in healthcare providers also plays a significant role in vaccination decisions, which is consistent with research highlighting trust as a key factor in vaccine acceptance [28].

Cultural beliefs significantly shaped parental attitudes toward vaccination. Negative perceptions are associated with lower status, emphasizing the need for culturally sensitive health education to address misconceptions [29]. Information sources from healthcare providers, the internet, social media, and families also influence vaccination decisions, highlighting the importance of effective communication strategies to counter misinformation [30].

Furthermore, perceived government support for vaccination emerged as a significant predictor. Policies prioritizing immunization can enhance coverage and alleviate barriers related to access and awareness. Strengthening the government's commitment to public health initiatives is vital for maintaining high vaccination status and achieving optimal health outcomes in the region [31].

This study has several limitations. The cross-sectional design restricts the ability to draw causal conclusions between factors like parental education and vaccination status. The findings, while revealing associations, do

not imply causality, and future longitudinal studies are needed. The sample is specific to East Gojam, Amhara Region, and may not be generalizable to other regions or countries with different socio-economic and healthcare conditions. Data were collected through caregiver self-reports, which may be prone to recall or social desirability bias. Finally, caution is needed when generalizing results due to regional differences in socio-economic and healthcare infrastructure.

Conclusion and recommendation

Conclusion

This study provides a comprehensive analysis of the factors influencing vaccination status among pediatric populations in East Gojam, Amhara Region, Ethiopia. The findings indicate that vaccination status is significantly associated with various sociodemographic, economic, and cultural factors, as well as access to healthcare services and trust in healthcare providers. Higher parental education levels and urban residence were positively associated with higher vaccination status, highlighting the importance of educational interventions and urban healthcare infrastructure in improving vaccination coverage. Additionally, older children were found to be less likely to be fully vaccinated, suggesting a need for targeted outreach to ensure that older children complete their vaccination schedules.

Access to healthcare services and trust in healthcare providers are crucial in promoting vaccination, emphasizing the need for efforts to improve healthcare access and build trust in healthcare providers to significantly enhance vaccination status. Negative cultural beliefs about vaccination and misinformation from various information sources were found to negatively impact vaccination status, indicating the critical need to address cultural misconceptions and ensure reliable information from trusted sources to increase vaccination uptake. Perceived government support for vaccination was also a significant predictor of vaccination status, underscoring the role of robust governmental policies and resources in promoting vaccination programs.

Overall, the study underscores the multifaceted nature of the determinants of vaccination behavior, necessitating a comprehensive and multipronged approach to improving vaccination coverage among children in East Gojam.

Recommendation

On the basis of these findings, several recommendations have been proposed to increase vaccination coverage in East Gojam and in similar settings. Educational programs targeting parents, particularly in rural areas, should be implemented to increase awareness of

the importance of vaccination. These programs should be culturally sensitive and address specific misconceptions about vaccines. Healthcare infrastructure and accessibility in rural areas can be improved by increasing the number of healthcare facilities, ensuring that they are adequately staffed and equipped, and providing mobile vaccination units to reach remote populations. Initiatives should be developed to build trust in healthcare providers by training healthcare workers in effective communication and cultural competence to address vaccine hesitancy and build stronger relationships with communities. Accurate and reliable vaccination information is disseminated through trusted channels such as healthcare providers, community leaders, and local media. Misinformation on social media and other platforms can be combined by providing clear and factual information about vaccines. Governmental support for vaccination programs should be strengthened by ensuring adequate funding, resources, and policy frameworks that prioritize immunization. Regular monitoring and evaluation of vaccination programs can help identify gaps and areas for improvement. Design and implement outreach programs specifically aimed at older children who may have missed vaccinations, utilizing school-based vaccination programs and community outreach to ensure the completion of vaccination schedules. Community leaders and influencers are encouraged to promote vaccination, as their endorsement can significantly impact community attitudes towards vaccination and increase uptake rates. Foster collaboration between various sectors, including healthcare, education, and local governments, to create a cohesive approach to improving vaccination coverage. Multisectoral efforts can address the broader determinants of health that impact vaccination status. By addressing these recommendations, stakeholders can work towards achieving greater vaccination coverage, thereby improving the health outcomes of children in East Gojam and contributing to the broader goals of public health and disease prevention.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12887-024-05256-2>.

Supplementary Material 1. English language version of the questionnaire used in the study.

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Authors' contributions

The first author, Awoke Fetahi Woudneh, wrote the proposal, developed the data collection format, supervised the data collection process, and analyzed and interpreted the data. The second author, Nigatu Tiruneh Shiferaw, participated in the data analysis, critically reviewed the manuscript, and provided constructive comments for its improvement. Both authors contributed to the preparation of the manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to data security concerns but are available from the corresponding author upon reasonable request. At the time, the data were collected; an informed consent form was not obtained from the participants for publication of the dataset.

Declarations

Ethics approval and consent to participate

The ethical approval committee of Debreworkos University approved the data collection and provided an ethical clearance certificate (Ref: NCS/4069/18/15). While a waiver of written consent was approved owing to financial constraints and the nature of the research setting, we acknowledge that this decision may raise concerns. The committee carefully considered the local context, which often necessitates flexibility in consent processes, particularly in settings where written consent may pose challenges. For participants under the age of 18, consent was obtained from parents or guardians, and verbal consent was documented in written notation by the researcher and witnessed by a third party. We ensured that the ethical committee's oversight was fundamental in ensuring participant rights and confidentiality throughout the study.

Consent for publication

Consent to publish the results of this study was obtained from all participants involved. For minors, parental or guardian consent was secured before publication. The manuscript has not been published elsewhere and is not under consideration for publication in any other journal. The authors agree to submit this manuscript to this journal for publication as original research.

Competing interests

The authors declare no competing interests.

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