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RESEARCH ARTICLE

COVID-19 Vaccine Uptake and Associated Factors among Adults in the Post-Conflict Settings of the Tigray Region, Northern Ethiopia: Mixed Method Study

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Abstract

Background: Vaccination is regarded as one of the most cost-effective interventions for controlling pandemics, including COVID-19. Vaccine uptake among the general population is essential to enable a return to pre-pandemic status. However, evidence on COVID-19 vaccine uptake in settings where social and behavior communication (SBC) interventions have been implemented is limited.

Method: A concurrent mixed-methods study design was employed. The sample size (n = 1,666) was calculated using a 27% baseline uptake, 90% power, and a design effect of 2. For the qualitative component, six focus group discussions (FGDs) and six key informant interviews (KIIs) were conducted until data saturation. Binary and multivariable logistic regression models were used to examine the association between independent variables and the outcome variable. For the qualitative component, thematic analysis was conducted. For the qualitative part, thematic analysis was conducted.

Result: The prevalence of COVID 19 vaccine uptake among the participants was 90.1%. Being married [AOR: 0.44, CI: (0.257, 0.762)], being divorced [AOR: 0.39, CI: (0.195, 0.806)], daily laborer [AOR:2.13, CI (1.052-4.31 3)], Others (student and Tiray defense force (TDF)) [AOR: 2.3, CI: (1.016- 5.323)], having mobile phone [AOR: 1.8, CI: (1.29, 2.77)], heard about COVID-19 in last 6 month [AOR: 4.06 CI: (2.77, 5.94)], received SBC intervention [AOR: 2.1 CI: (1.92, 3.86)] and experienced perceived severity [AOR: 2.2 CI: (1.54, 3.60)] were associated with COVID-19 vaccine uptake.- (1). Barriers of vaccine uptake with categories such as fear of vaccine side effects (2) facilitators of vaccine uptake with categories such as community engagement, having source of the information, outreach intervention, having social support and behavioral intervention were identified.

Conclusions: Married and divorced marital status, daily laborer, being Tiray defense force, or student, have a mobile phone, heard about COVID-19, received SBC intervention, and perceived severity were significantly associated with COVID-19 vaccination uptake.

Keywords: Adults, COVID-19, Northern Ethiopia, Tigray region, Vaccine uptake

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1 Introduction

The Coronavirus Disease 2019 (COVID-19) is a communicable respiratory illness caused by a novel strain of coronavirus that infects humans [1]. As of early 2026, more than 700 million confirmed cases and over 7 million deaths have been reported worldwide [2]. Although the World Health Organization (WHO) has moved away from the emergency phase, COVID-19 remains a continuing public health concern, with the potential to re-emerge even after being brought under control due to factors that favor its resurgence, including environmental conditions and the virus's behavior, patterns of spread, and interaction with human hosts [3].

The development of a safe and effective COVID-19 vaccine is a major step toward controlling the pandemic [4] and is considered one of the most effective interventions for ending it [5]. Global vaccine acceptance rates vary widely, ranging from 23.6% to 97% [6]. Common barriers to vaccine uptake include social norms, religious beliefs, safety concerns, and low perceived risk [4]. In addition, misconceptions arising from the rapid development of the vaccines, misinformation, and persistent myths may further influence individuals' willingness to accept COVID-19 vaccination. Enhancing COVID-19 vaccine uptake among the general population is therefore essential for enabling a return to pre-pandemic normalcy [7].

Africa requires approximately 1.5 billion doses of COVID-19 vaccine to vaccinate about 60% of its population in order to help stop virus transmission and protect people [5]. Ethiopia is among the five African countries most severely affected by the COVID-19 pandemic [6] and remains one of the most burdened nations, reporting over 500,000 cases and 7,500 deaths [2]. Previous studies indicate that COVID-19 vaccine uptake among adults in Ethiopia ranges from 31.4% to 92.3% [8]. War is a major social determinant of health that increases vulnerability to infection and limits access to vaccination services.

In the Tigray region, the health system experienced catastrophic disruptions during two years of conflict, with many health facilities becoming non-functional [9]. Although prior studies have reported varying findings, there is a critical gap in evidence on vaccine uptake in post-conflict settings where Social and Behavior Change (SBC) interventions have been implemented [10]. Therefore, this study aimed to assess COVID-19 vaccine uptake and associated factors in SBC-intervention districts in Northern Ethiopia.

2 Methods

2.1 Study Setting and period

The study was conducted in the Tigray region of Northern Ethiopia, excluding the western zone due to security and accessibility constraints. According to the Central Statistical Agency (CSA), the region had a total population of 5,700,000 in 2022, comprising 985,654 households, with an average household size of 4.4 persons. The region includes 93 districts (36 urban and 57 rural) across seven zones: Mekelle, East, South, Southeast, Northwest, Western, and Central. The health system comprises two specialized comprehensive hospitals, 12 general hospitals, 28 primary hospitals, 256 health centers, and 740 health posts [11]. The predominant livelihood in these areas is agriculture, and social structures are largely shaped by traditional and religious norms. Health services in these zones were severely disrupted by the conflict and war, which lasted for two years, limiting access to both preventive and curative care.

The study was carried out in four intervention districts as part of a larger project titled "Health and Nutrition Emergency Response and System Strengthening (MNCAH and COVID-19) in Tigray." The project is implemented through UNICEF's partner, Mums for Mums, and includes a comprehensive package of interventions: a pre-vaccination campaign, advocacy, social mobilization, sensitization workshops, distribution of social and behavior change materials, and training for key actors (health and media professionals). In the advocacy component, the target groups included leaders from the Tabiya (the smallest administrative unit) up to the regional level, while community members were the focus

of community mobilization and dialogue activities. Data were collected from October 13, 2023, to November 26, 2023.

2.2 Study design

A concurrent parallel mixed-methods study design was employed. A community-based cross-sectional approach was used for the quantitative component, while a descriptive qualitative approach was used for the qualitative component to provide depth and context to the findings.

2.3 Study Population

The source population comprised adults aged 18 years and above living in the Tigray region. The study population included randomly selected community members residing in four SBC intervention districts for COVID-19 vaccination: Raya Azebo, Kilte Awlealo, Adigudom, and Ahiferom. For the qualitative component, participants included selected religious, community, and administrative leaders, as well as representatives from key associations (including Local Religious Leaders and Elders Councils and the Women Development Army).

2.4 Inclusion and Exclusion Criteria

Inclusion Criteria: Adult household heads (or acting heads) aged $\geq$ 18 years who resided in the selected intervention districts during the study period were included as the primary household respondents.

Exclusion Criteria: Households without an available adult household head/acting head or those with no members aged $\geq$ 18 years were excluded.

2.5 Sample size determination

The sample size (n = 1,666) was calculated using Epi Info 7.2.6.0, assuming a 27% baseline uptake [12], a 90% power, and a design effect of 2. For the qualitative component, participants were selected using purposive sampling to ensure diverse representation across religious, community, and administrative leadership. Data saturation was reached after six focus group discussions (FGDs) and eight key informant interviews (KIIs).

2.6 Sampling procedure

A multi-stage sampling technique was used. First, districts were purposively selected based on their intervention status, followed by the random selection of four kebeles per district. Proportional allocation was applied, and households were selected using systematic sampling techniques from health extension worker registries. First, four districts: Ahiferom from central zone (38,934 households), Kilte Awlealo from Eastern zone (21,657 households), Adigudom from Southeastern zone (34,360 households) and Raya Azebo from South zone (32,360 households) were selected purposively as these districts were intervention areas for SBC like community mobilization, community dialogue, and mobile vans.

Next, a minimum of four kebeles (the smallest administrative unit) were randomly selected from each of the four districts. Proportional allocation was then used to determine the number of participants from each selected kebele based on population size.

Finally, after obtaining a complete household list from health extension workers, study households were selected using systematic random sampling. The head of each selected household was identified as the study participant.

For the qualitative component, participants were selected using purposive sampling to ensure diverse representation across religious, community, and administrative leadership. Data saturation was reached after six focus group discussions (FGDs) and eight key informant interviews (KIIs).

Dependent Variable

COVID-19 Vaccine Uptake

Independent Variables

Demographic variables: Sex, Marital status, educational level etc.

Information & Access Factors: Having a mobile phone, Exposure to / receiving Social and Behavior Change (SBC) interventions etc.

Psychosocial / Behavioral Perception Factors: Perceived susceptibility to COVID-19 and Perceived severity of COVID-19.

2.7 Operational definitions and definition of terms

Risk Perception: Perceived severity and susceptibility were measured using a 5-item Likert scale. For analysis, these were dichotomized into "High" vs "Low/Uncertain" based on the strength of agreement ("Definitely/Probably Yes").

Exposure to SBC interventions: Community engagement during SBC interventions like community mobilization, community dialogue, mobile van and exposure media like radio, TV and SMS message.

COVID-19 Vaccine Uptake (Outcome): Defined as the receipt of at least one dose of any COVID-19 vaccine, verified by self-report or vaccination card.

2.8 Data collection procedure, tool and data quality assurance

The study used a validated questionnaire adapted from previous related literature with minor modifications [12,13], including WHO documents. To ensure data quality, pre-tested structured questionnaires were used for data collection. The questionnaire was first developed in English, translated into the local language (Tigrigna) for ease of administration, and then translated back into English to ensure consistency. The finalized tool was programmed in Open Data Kit (ODK).

Sixteen data collectors with a BSc degree in public health or nursing were recruited, and four experienced supervisors with master's-level expertise in public health were hired to oversee data collection. Enumerators and supervisors received three days of intensive training on the study objectives, and both teams conducted daily checks for questionnaire completeness and data quality. Data were collected using KoboToolbox installed on smartphones and uploaded to Mekelle University's server. The principal investigators provided daily oversight through on-site supervision and real-time server monitoring. The reliability of the instrument was assessed using items with a Cronbach's alpha of 0.7 or higher, and these items were included in the analysis.

For the qualitative component, four principal investigators participated in data collection. An interview guide was used for key informant interviews (KIIs) and focus group discussions (FGDs). During interviews, audio-recorders were used to capture participants' responses. Participation was voluntary, and written informed consent was obtained from each participant prior to the interviews. After consent, all KIIs and FGDs were conducted in Tigrigna. Field notes were also taken during each interview session.

In total, six FGDs were conducted with community members (eight participants per FGD), and eight KIIs were conducted with leaders, including religious leaders, community leaders, administrative leaders, and representatives of key associations.

Rigour and trustworthiness of the qualitative study were ensured using the criteria of credibility, confirmability, dependability, and transferability. Credibility was strengthened through the use of probing techniques and multiple data sources (the combination of KIIs and FGDs). In addition, preconceptions of the investigator were bracketed prior to data collection to minimize potential investigator bias. Confirmability was ensured through peer debriefing, during which data analysis, interpretations, and preliminary conclusions were discussed with experienced qualitative researchers before finalizing the results.

Dependability and transferability were achieved by documenting the procedures in detail, including the study setting, data collection processes, and sampling methods, so that readers could understand the basis for the study conclusions.

2.9 Data processing and analysis

Quantitative data were exported to SPSS version 26. Prior to conducting the main analyses, the dataset was cleaned, and variables were assessed

for normality and multicollinearity. Missing data were handled using complete case analysis. Demographic characteristics of the sample were summarized using descriptive statistics.

Binary logistic regression was used to examine the association between the outcome variable (COVID-19 vaccine uptake) and the predictor variables. To control for potential confounders, variables with a p-value < 0.25 in the bivariable logistic regression were entered into the multivariable binary logistic regression model. A p-value < 0.05 was used as the cut-off point to identify statistically significant predictors. The Hosmer–Lemeshow test was applied to assess the goodness of fit of the model.

For the qualitative data, each audio-recorded interview and FGD was transcribed verbatim, translated into English, saved in MS Word, and imported into ATLAS.ti qualitative data analysis software version 7.0. Transcripts were coded against the study objectives and analyzed thematically. Investigators read and reread the transcripts prior to assigning initial codes (open coding) and developing a preliminary coding framework. The study team then reviewed the coded transcripts to reach consensus on the coding system and code definitions used throughout the analysis. Findings were organized into themes and sub-themes based on relevant quotations.

Peer debriefing was conducted with the research team to explore alternative explanations and to support formal and informal discussions to aid interpretation. This study followed COREQ (Consolidated Criteria for Reporting Qualitative Research) to report the findings of qualitative research [14]. Finally, qualitative results were used to support and interpret the quantitative findings, rather than being presented as standalone categories; illustrative quotes were used to strengthen each finding.

2.10 Ethical Consideration

For this study, ethical clearance was secured from the Institutional Review Board (IRB) of Tigray Health Research Institute (THRI) with unique protocol number THRI/4031/0008/15 and permission letter was obtained from the Tigray regional Health Bureau, Zonal and district health office based on the hierarchal structure. Informed verbal consent was obtained from the study subjects. All procedures were conducted in compliance with the applicable regulatory frameworks and the ethical principles of the Declaration of Helsinki [15].

3 Results

3.1 Socio-demographic Characteristics

The study focused on assessing post-COVAX intervention effects in four main districts: Raya Azebo, Kilte Awlealo, Adigudom, and Ahiferom. A total of 1,599 participants were included, yielding a response rate of 95.9%. The majority of respondents were female, comprising 1,149 (72%).

The age distribution showed that the largest group was aged 35–49 years, accounting for 32.8% (525) of the population. Regarding marital status, most respondents were married, representing 66.7% (1,066). In terms of education, 42.2% (674) of participants were unable to read and write, while only 5.7% (91) had attended college or higher education.

An overwhelming majority, 98.5% (1,575), identified as Orthodox Tewahido. The most common occupation was farming, with 51.5% (823) of participants, followed by housewives at 22.0% (352). Most participants lived in small households; 55.2% (883) lived in families of 1–4 members (Table 1).

3.2 Socio-Demographic Characteristics of Qualitative Study Participants

A total of 6 Key Informant Interviews (KIIs) and 6 Focus Group Discussions (FGDs) were conducted. Of the 57 participants, 35 were female. Participants' occupational statuses ranged from unemployed individuals to a health office head. Regarding educational level, eight participants had no formal education, 41 were below grade 12, one was a diploma holder, and seven had a degree or higher (Tables 2 and 3).

Table 1 Socio-demographic characteristics of study participants on COVID-19 vaccine uptake Tigray region, North Ethiopia, 2023 (N = 1599)

Variable	Category	Frequency	Percentage
District	Raya Azebo	400	25.0
	Kilte Awlealo	400	25.0
	Adigudom	400	25.0
	Ahiferom	399	25.0
Sex of the participant	Female	1149	71.9
	Male	450	28.1
Age of the participant	18 to 24 years	184	11.5
	25 to 34 years	427	26.7
	35 to 49 years	525	32.8
	50 and above	463	29.0
Marital status	Single	149	9.3
	Married	1066	66.7
	Divorce	210	13.1
	Widowed	163	10.2
	Separated	11	0.7
Educational level	Unable to read and write	674	42.2
	Able to read and write	70	4.4
	Grade 1-12	764	47.8
	College and above	91	5.7
Religion of the participant	Orthodox Tewahido	1575	98.5
	Muslim	24	1.5
Occupation	Farmer	823	51.5
	Housewife	352	22.0
	Merchant /self employed	215	13.4
	Employed	72	4.5
	Daily laborer	83	5.2
	Other (Student and TDF*)	54	3.4
Partner's occupation	Farmer	591	55.4
	House-wife	173	16.2
	Merchant /self employed	118	11.1
	Employed	71	6.7
	Daily laborer	65	6.1
	(No job, student, TDF, construction)	48	4.5
Family size	1 to 4 members	883	55.2
	5-7 members	589	36.8
	$\geq$ 8 members	127	7.9

*TDF= Tigray Defense Force

Table 2 Description of KII study participant's profile (N = 6)

KII Demography	Category	Frequency	Percentage
Age	≤ 30	2	33.3
	>30	4	66.7
Sex	Male	5	83.3
	Female	1	16.7
Educational level	12-Sep	3	3.0
	BSC	2	33.3
	MPH	1	16.7
Marital status	Single	1	33.3
	Married	5	83.3
Occupation	Community leader (Farmer)	1	16.7
	Kebele leader	1	16.7
	Health worker	4	66.7

Table 3 Description of FGD study participant profile (N = 51)

FGD participants Demography	Category	Frequency	Percentage
Age	25-30	4	7.8
	30-35	10	19.6
	35-40	10	19.6
	40-45	10	19.6
	45-50	7	13.8
	≥ 50	10	19.6
Sex	Female	34	66.7
	Male	17	33.3
Educational level	Illiterate	4	7.8
	Can read and write	4	7.8
	Grade 1-8	24	47.1
	Grade 8-12	14	27.5
	Diploma	1	2.0
	Degree	4	7.8
Marital status	Married	28	55.0
	Widowed	9	17.6
	Divorced	5	9.8
	Single	9	17.6
Occupation	Farmer	27	52.9
	Self-employed	1	2.0
	Merchant	5	9.8
	Housewife	10	19.6
	Community leaders	8	15.7

3.3 Themes and categories

Themes and categories are used to present and organize the conclusions derived from the key informant interviews and the focus group discussions. Data analysis revealed two themes that explore COVID-19 vaccine uptake in the Tigray Region.

The themes are: (1) barriers to vaccine uptake, which include two categories—fear of vaccine side effects and lack of knowledge about the COVID-19 vaccine; and (2) facilitators of vaccine uptake, which include five categories: community engagement, access to information about COVID-19, outreach interventions, having social support, and behavioral interventions.

The description of each category is presented as supportive of the quantitative findings.

3.4 Source of information related to COVID-19 and COVID-19 vaccine

In this study, 1,345 (84.1%) of respondents had heard about the COVID-19 vaccine within the six months prior to data collection. The COVID-19 uptake of the study participant was and 1444 (90.10%) (Figure 1). Community platforms were the main source of information for 1,109 (64%) participants, followed by media sources (television and radio), reported by 319 (20%) participants (Table 4).

Table 4 Information and source of information related to COVID-19 and COVID-19 vaccine, 2023 (N = 1599)

Variable	Frequency	Percentage
Ever heard COVID-19 vaccine in last 6 months		
Yes	1345	84.1
No	254	15.9
Source of information for COVID-19 vaccine		
HEW	712	44.5
WDG	458	28.6
HCW (Other than HEW)	241	15.1
Directly from Advocacy/Social Mobilization/Community Dialogue/Mobile Van	192	12.0
Overall community platform [HEW/Hw/WDG/Directly at Community Platform]	1109	69.4
Media (Television/Radio)	319	19.9
Others (printed material, School by /girl)	78	4.9

This finding is consistent with the qualitative data, where participants emphasized the role of community engagement efforts. For example, a key informant described their training and involvement in public health initiatives:
"*Yes, even yesterday, we (GBV focal persons) were given training in Mekoni town regarding COVID-19. They educated us to prevent COVID-19. In addition, they have informed us to vaccinate our children in a routine child vaccination program.*" (Male, age 33).

Additionally, focus group discussants highlighted the effectiveness of mobile van as a source of information.

One discussant remarked:
"*Here was also a mobile van organized by the Woreda health office to mobilize the community in each village. I do not know who the people inside the car were, but they were talking about the vaccine (COVID-19) using a microphone. They were going to each village. Everybody heard about the COVID-19 vaccination campaign.*" (Male, age 42).

Similarly, the media played a significant role during the campaign. Public media, including radio and television, helped boost community confidence by disseminating information about vaccine availability.

A key informant explained:
"*When people heard. through public media, like radio and TV, that the vaccine was available in different districts, their confidence grew. This wide dissemination of information reassured the community and encouraged them to participate in the vaccination program.*" (Male, age 53).

3.5 Vaccination status for COVID-19

Of the 1,599 participants, the majority—1,441 (90%)—were vaccinated with at least one dose of the COVID-19 vaccine (95% CI: 88.6%, 91.6%). Among those who were vaccinated, 535 (37%) received only one dose, while 848 (58.8%) received two doses.

In the qualitative data, participants discussed the significant impact of SBC interventions in increasing awareness and encouraging vaccine uptake. For example, a key informant reflected on the role of community mobilization efforts in promoting vaccination, stating:

"*Before the war, women's affairs, women's associations, and youth's associations were actively participating in COVID-19 prevention and control activities. However, all these platforms did not exist after the war*" (Male, age 53).

Despite the loss of these platforms, the qualitative data revealed the resilience and adaptability of other community engagement methods, such as mobile vans and media outreach, which continued to play an essential role in promoting vaccination.

One focus group participant shared:
"*Here was also a mobile van organized by the Woreda health office to mobilize the community in each village. I do not know who the people inside the car were but they were talking about the vaccine (COVID-19) using a microphone. They were going to each village. Everybody heard about the COVID-19 vaccination campaign*" (FGD, Female, age 45).

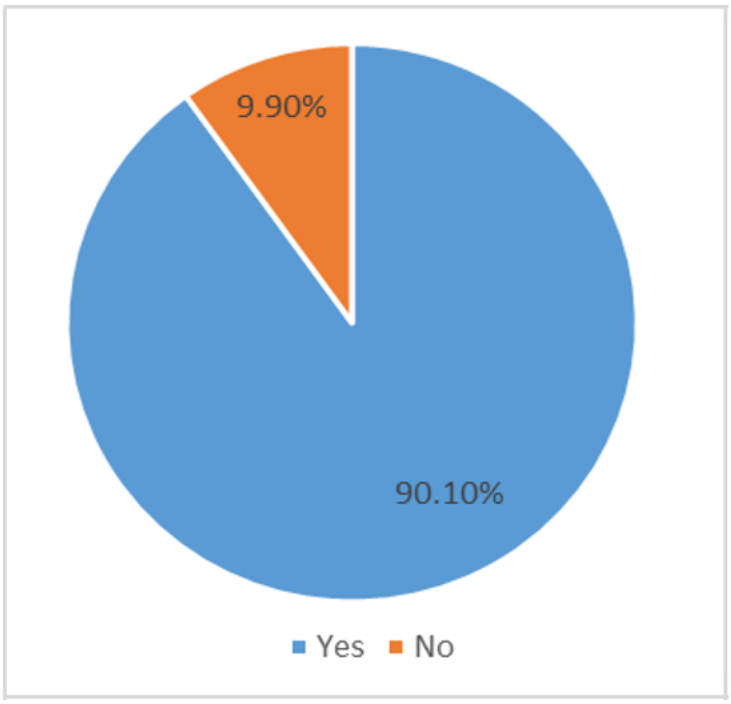


Figure 1 COVID 19 vaccine uptake Tigray region, North Ethiopia (N = 1599)

Participants who received vaccination were asked whether they had experienced any side effects related to the vaccine. Subsequently, 482 (33%) reported experiencing side effects, of whom 222 (46%) reported moderate side effects and 53 (11%) reported severe side effects (Figure 2). In addition, regardless of the severity, more than three-fourths of the individuals—211 (77%)—reported that the side effects persisted for one to three days (Table 5).

This finding is consistent with qualitative insights from the focus group discussions (FGDs) and key informant interviews (KIIs), where many participants described experiencing similar side effects. For instance, some participants reported mild symptoms such as fever and fatigue for a few days, but emphasized that these symptoms were manageable and temporary.

One female focus group discussant stated: "*It was uncomfortable for a day or two, but I felt much better after that*" (FGD, Female, age 50).

Another key informant explained: "*The side effects were mostly mild, lasting one or two days. It wasn't serious, and people were able to continue with their daily activities afterward*" (Male, age 33).

Table 5 Adult participants' Covid-19 vaccine uptake experience in Tigray, 2023 (N = 1599)

Items	Responses	Number	Percentage
Vaccinated for COVID-19	Yes	1441	90.1
	No	144	9.0
	I don't know	14	0.9
Number of COVID-19 vaccination doses	One	535	37.1
	Two	848	58.8
	Three	58	4.0
Vaccination sites	In the region	13.5	90.6
	Out of the region	136	9.4
Experienced side effects following vaccination	Yes	482	33.4
	No	959	66.6
Severity of experienced side effects	Mild	207	42.9
	Moderate	222	46.1
	Severe	53	11.0
Duration moderate or severe side effect persists	Less than one hour	12	4.4
	1-3 days	211	76.8
	More than three days	52	18.9

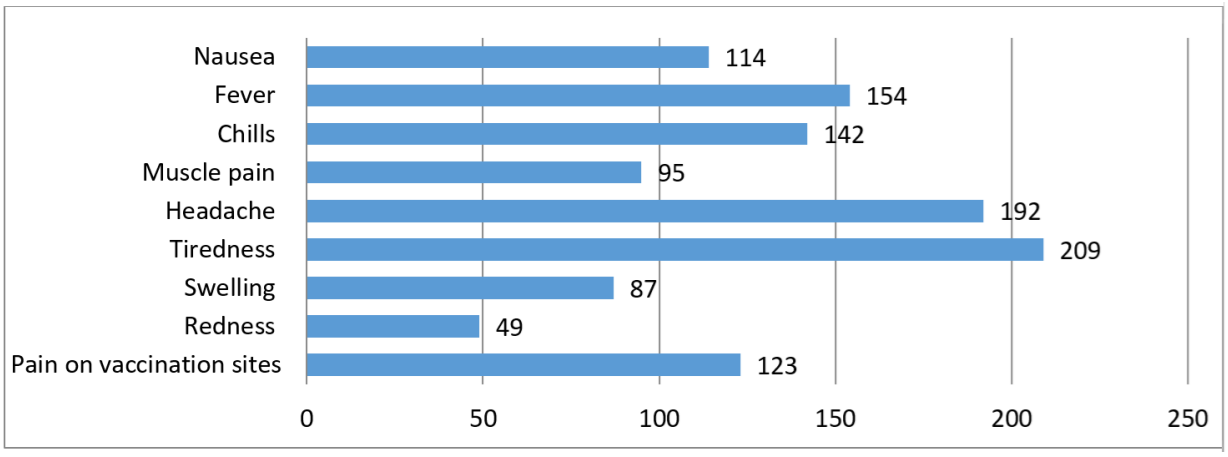


Figure 2 Adult participants' Covid-19 vaccine side effect in Tigray, 2023 (N = 1599)

3.6 Factors associated with COVID-19 vaccine uptake

In multivariable logistic regression, occupation, marital status, heard about COVID 19, received at least one SBC intervention and perceived severity were found to be statistically associated with COVID-19 vaccination.

Those study participants who were married [AOR: 0.44, CI: (0.257, 0.762)] and divorced [AOR: 0.39, CI: (0.195, 0.806)] were 44% and 39% less likely took vaccine compared to single respondents respectively.

This was consistent with insights from focus group participants, where married and divorced individuals expressed concerns that differed from their single counterparts.

Table 6 Factors associated with COVID-19 vaccination among study participants in Tigray region, North Ethiopia

Background Characteristics	COVID-19 Vaccination		COR [95% CI]	AOR [95% CI]	P Value
	Yes	No			
Sex					
Male	405	40	1		1
Female	1036	104	1.01(0.65-1.93)	0.784(0.499-1.231)	0.29
Marital Status					
Single	118	31	1		1
Married	979	87	0.338(0.215-0.532)	0.442(0.257-0.762)	0.003
Divorce	193	17	0.335 (0.178-0.632)	0.396(0.195-0.806)	0.011
Widowed	140	23	0.625(0.346-1.131)	0.65(0.326-1.315)	0.234
Separated	6	5	0.436(0.316-5.90)	0.89(0.579-2.417)	0.435
Occupation					
Farmer	749	74	1		1
Housewife	315	37	1.18(0.78-1.80)	1.55(0.939-2.583)	0.086
Merchant/Self-employed	195	20	1.03(0.61-1.74)	1.38(0.770-2.50)	0.275
Government employee	61	11	0.14(0.02-1.04)	0.24(0.032-1.80)	0.166
Daily laborer	68	15	2.5(1.28-5.23)	2.13(1.052-4.313)	0.036
Other (student, TDF)	43	11	1.28(1-5.235)	2.3(1.064-5.323)	0.035
Have a mobile phone					
No	475	82	1		1
Yes	966	76	2.1(1.57-3.05)	1.8(1.293-2.77)	0.001
Heard about COVID-19 in last 6 month					
No	185	69	1		1
Yes	1256	89	5.26(3.70-7.47)	4.06(2.77-5.94)	0.001
Received SBC intervention					
No	186	9	1		1
Yes	1250	154	2.55(1.28-5.07)	2.1(1.92-3.86)	0.021
Perceived suitability					
No	769	98	1		1
Yes	674	60	1.43(1.02-2.00)	1.15(0.797-1.66)	0.453
Perceived severity					
No	116	30	1		1
Yes	1325	128	2.6(1.72-4.16)	2.2(1.34-3.60)	0.002

A married woman in an FGD shared,
"*I was hesitant because I had to consider my family's needs first. The risks felt greater to me*" (FGD, Female, age 45).

This sentiment was echoed by a divorced man who stated,
"*I was skeptical; especially since I am not sure how the vaccine affects people with different health conditions like mine*" (FGD, Female, age 36).

Regarding occupation, study participants who were daily laborers [AOR: 2.13, CI (1.052–4.313)] and those whose occupation was not fixed [AOR: 2.30, CI (1.064–5.323)] were about two times more likely to take the COVID-19 vaccine compared with farmers.

Participants who owned a mobile phone [AOR: 1.80, CI (1.29–2.77)] were 1.8 times more likely to take the COVID-19 vaccine than those who did not have a mobile phone.

Participants who had ever heard about COVID-19 within the previous six months [AOR: 4.06, CI (2.77–5.94)] were four times more likely to take the vaccine compared with those who had not.

In addition, participants who were exposed to SBC messages about COVID-19 [AOR: 2.10, CI (1.92–3.86)] were two times more likely to take the COVID-19 vaccine than those who were not exposed (Table 6).

4 Discussions

In this study, the prevalence of COVID-19 vaccine uptake was 90.1%. This is significantly higher than findings from studies conducted in non-intervention areas, such as Dangela (47%) and Debre Markos (51.6%) [16,17]. The high uptake in this setting is likely attributable to the intensive SBC interventions, including community mobilization and mobile vans, which remained effective even after the conflict-induced collapse of traditional platforms [18].

The study found that occupation, marital status, recent information (hearing about COVID-19 within the last six months), mobile phone ownership, and perceived severity were statistically associated with vaccine uptake. Participants exposed to a full package of SBC interventions were twice as likely to be vaccinated compared with those who were not exposed. This finding aligns with evidence from Eastern Ethiopia suggesting that community-based behavioral interventions are effective measures for improving immunization demand [19].

The main sources of information for the COVID-19 vaccine were community platforms, mobile vans, and media. These platforms increased awareness and improved attitudes toward vaccine uptake [20]. A significant proportion of study participants (46%) reported moderate side effects that persisted for 1–3 days. Side effects such as fever and fatigue may serve as perceived barriers to COVID-19 uptake, which is consistent with a study conducted in Eastern Ethiopia [19].

Similarly, findings from Addis Ababa showed that 58% of participants took at least one dose of the vaccine. This prevalence is lower than in the current study setting. One possible explanation is that the present study was conducted after SBC interventions in four districts, which would be expected to result in higher vaccine uptake compared with non-intervention areas [21]. Likewise, vaccine uptake in the current study remains higher when compared with studies from North West Ethiopia (Dangela and Debre Markos), which reported 47% and 51.6%, respectively [16,17].

The present study revealed that participants who were daily laborers or who did not have permanent jobs were less likely to uptake the COVID-19 vaccine. This finding is similar to a study conducted in south and central Ethiopia [7]. This may be because SBC interventions often target more stable population groups, such as farmers or housewives, suggesting a need for more mobile or workplace-based outreach.

In this study, participants who were exposed to a full package of SBC interventions—such as community mobilization, dialogue, and mobile vans—were more likely to uptake the COVID-19

vaccine than those who were not exposed. This finding is consistent with a study conducted in Eastern Ethiopia [19]. In addition, SBC interventions were perceived as effective measures for improving COVID-19 immunization uptake [20]. Mobile phone ownership also increased the likelihood of vaccine uptake, likely because participants received text message alerts. This mirrors findings from Lebanon, where digital communication significantly influenced vaccine attitudes [22].

Consistent with the Health Belief Model, perceived severity was a strong predictor of uptake. This suggests that when individuals internalize the risks of the disease, it can act as a precursor to behavior change. However, approximately 33% of participants experienced side effects, and 46% reported moderate symptoms such as fever and fatigue lasting 1–3 days. As noted in the qualitative data, fear of these side effects remains a primary barrier to uptake, which is consistent with studies conducted in Eastern Ethiopia [19].

5 Conclusion

This study demonstrates a high prevalence of COVID-19 vaccine uptake (90.1%) among adults in the post-conflict districts of the Tigray region. The success of the vaccination campaign was significantly driven by the implementation of Social and Behavior Communication (SBC) interventions, particularly community-based platforms such as mobile vans and local community dialogues. Key predictors of vaccine uptake included being single, having a mobile phone, being exposed to SBC interventions, and having a high perceived severity of the disease. Conversely, being married or divorced and certain occupational categories, such as daily laborers, were associated with lower uptake. Qualitative findings further emphasized that community engagement is an essential component for ensuring the effectiveness of behavioral interventions.

Strengths and limitations of the study

The primary strength of this study is its mixed-methods approach, which triangulated quantitative findings with qualitative insights from community leaders. However, the study was limited to four intervention districts, meaning the results cannot be generalized to the entire Tigray region during the post-war period. In addition, because the study used a cross-sectional design, it provides a snapshot of the situation and cannot establish causality; determining causality would require a randomized controlled trial design.

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Competing interests

The authors declare that they have no competing interests.

Data availability

The data generated and analyzed is included in the submitted manuscript. Further data can be obtained from the corresponding author under reasonable request.

Author Contributions

YA, AD, BT, GK, EK, SH, TD, MM, LM, BA, ZH, and MA were responsible for the study's conceptualization, epidemiological study design, and data collection. YA, YG, AF, EG, FA, MT, and NG contributed to data analysis and interpretation, drafting of the manuscript, and critical revision. They also approved the final version for publication and selected the target journal. All authors reviewed and accepted responsibility for the integrity of the work.

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