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COVID-19 vaccine uptake and associated factors among health professionals: a facility-based, cross-sectional study in the Amhara region, Ethiopia

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ABSTRACT

Objectives To determine uptake of the COVID-19 vaccine and identify the associated factors among health professionals in major cities of the Amhara region in Ethiopia.

Design Institution-based, cross-sectional study.

Setting The study was conducted from July to September 2022 across 40 health centres and 13 hospitals, representing 10 major cities within the Amhara region.

Participants 1251 participants, all of whom were vaccine-eligible health professionals, were selected using a systematic random sampling procedure.

Outcome measures The level of vaccine uptake in the study was determined by the proportion of health professionals who had received at least one dose of a COVID-19 vaccine.

Results 1251 health professionals participated, with 848 (67.8%) reporting that they had received at least one dose of a COVID-19 vaccine. Key findings from the multivariable logistic regression analysis revealed that health professionals aged 46 years and older were four times more likely to be vaccinated (95% CI, 1.656 to 9.510), married participants were 1.4 times more likely to take the vaccine (95% CI, 1.010 to 1.933) and those with good knowledge of COVID-19 vaccines were 1.75 times more likely to get vaccinated (95% CI, 1.307 to 2.331). Additionally, participants with a positive attitude towards vaccination were 3.65 times more likely to have received a vaccine (95% CI, 2.753 to 4.732).

Conclusions The study reveals a commendable level of COVID-19 vaccine uptake among health professionals, emphasising their critical role in public health initiatives. However, the observed disparities in vaccination rates indicate the need for targeted interventions to improve vaccine coverage, particularly among younger professionals and those with limited knowledge of the vaccine. Addressing these gaps requires the implementation of tailored educational programmes that enhance understanding of COVID-19 vaccines. Furthermore, fostering positive attitudes through targeted campaigns, workplace-based initiatives and peer influence, particularly among younger and unmarried professionals, will be crucial. Encouraging vaccinated professionals to share their experiences and establishing regular follow-ups will also be essential strategies to improve vaccine acceptance and coverage in the region.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The focus on vaccine-eligible individuals strengthens the study by ensuring that its findings are directly relevant to the key issue of COVID-19 vaccine uptake and its associated factors among those most at risk.
⇒ The structured questionnaire covered sociodemographic, knowledge, attitude and practice-related variables, offering a comprehensive understanding of the factors associated with COVID-19 vaccine uptake.
⇒ Health facilities were selected through random sampling and participants were chosen systematically, minimising selection bias and ensuring representativeness.
⇒ The cross-sectional design limits the ability to establish causality between independent variables and vaccine uptake.
⇒ Reliance on self-reported data may introduce social desirability bias, potentially compromising the accuracy of participants' responses.

INTRODUCTION

A health professional is a licensed individual whose primary responsibility is to deliver healthcare services aimed at safeguarding and enhancing the health and well-being of individuals and populations.[1] Beyond the provision of direct healthcare, these professionals are instrumental in advancing public health initiatives, including immunisation programmes such as the COVID-19 vaccination campaign. In this context, they serve as trusted sources of credible health information

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and expert guidance.[2] The COVID-19 vaccine, developed by various pharmaceutical companies including Pfizer-BioNTech, Moderna and AstraZeneca, received emergency use authorisation through the WHO's Emergency Use Listing process, a mechanism designed to expedite global vaccine access.[3] These vaccines, noted for their high safety and efficacy, were rapidly distributed worldwide through initiatives such as COVAX, which aims to ensure equitable vaccine access, particularly in low-income and middle-income countries, including Ethiopia. As part of this global effort, Ethiopia, one of the 92 countries eligible for donor-funded vaccines through COVAX, initiated its national COVID-19 vaccination campaign on 13 March 2021 at Eka Kotebe Hospital, prioritising health professionals in the initial phase of vaccination efforts.[3 4]

The vaccination programme was subsequently expanded to additional healthcare facilities that met specific operational criteria, including the establishment of a designated task force and the presence of trained personnel, such as nurses and pharmacists, responsible for monitoring adverse reactions.[5] Despite these efforts, vaccine hesitancy, defined as the delay or refusal to accept vaccines despite their availability, remains a significant challenge, with implications for the uptake of vaccination among healthcare personnel.[6] The WHO recognised vaccine hesitancy as a global health threat as early as 2019, well before the onset of the COVID-19 pandemic, and its relevance has only intensified in the ensuing years.[7 8] Given their pivotal role in shaping public perceptions and attitudes, health professionals are crucial in influencing community vaccination behaviours. Their recommendations and actions significantly impact vaccine acceptance, making healthcare workers both a priority group for vaccination and a central focus of targeted public health communication strategies aimed at overcoming hesitancy and enhancing vaccine coverage.[9 10]

However, substantial disparities in vaccine uptake exist across countries. A comprehensive systematic review has highlighted significant variations in COVID-19 vaccine acceptance rates worldwide. Among adults surveyed within the general public, the highest acceptance rates were observed in Ecuador (97.0%), Malaysia (94.3%), Indonesia (93.3%) and China (91.3%). In contrast, the lowest acceptance rates were reported in Kuwait (23.6%), Jordan (28.4%), Italy (53.7%), Russia (54.9%), Poland (56.3%), the USA (56.9%) and France (58.9%). In the USA, vaccine hesitancy among healthcare workers was documented at 8%. In Africa, although five countries (Algeria, Ghana, Kenya, South Africa and Zimbabwe) account for approximately 70% of all COVID-19 infections reported among health workers, only one in four health workers are fully vaccinated against COVID-19.[11] In Ethiopia, a study conducted in Addis Ababa revealed that nearly two-thirds (60.3%) of healthcare workers were hesitant to receive the COVID-19 vaccine. These findings underscore the need for targeted interventions to address vaccine hesitancy among healthcare professionals and within diverse populations globally.[12]

The magnitude of vaccine hesitancy is influenced by a complex interplay of factors, including perceived risks, concerns about vaccine safety and lack of trust in health systems. These challenges are further influenced by the spread of misinformation, the rapid pace of vaccine development and the concerns regarding potential side effects, despite the demonstrated safety and efficacy of the vaccines. Perceptions of vaccine efficacy, safety and risk awareness play a critical role in shaping vaccination decisions.[13 14] Research has consistently shown that health professionals, despite their medical training, often harbour negative attitudes towards vaccination, which can significantly hinder their acceptance of COVID-19 vaccination.[15–17] Despite the global focus on vaccine hesitancy, there is a notable paucity of studies examining this issue specifically among health professionals in the Amhara region in Ethiopia. Addressing vaccine hesitancy in this region is therefore critical not only to strengthen Ethiopia's ongoing COVID-19 vaccination efforts but also to bolster public trust in immunisation campaigns.[4 9] Therefore, this study aimed to assess COVID-19 vaccine uptake and the associated factors among health professionals at healthcare facilities in 10 selected major cities of the Amhara region in Ethiopia.

METHODS

Study setting and period

The study was conducted across government health institutions in the Amhara region in Ethiopia, which operate within a three-tiered healthcare delivery system. At the primary level, the system is anchored by primary healthcare units at the district level, consisting of a primary hospital that serves a population of 60 000–100 000 people, along with four health centres that provide care for 15 000–25 000 individuals each. These health centres have five health posts, each serving between 3000 and 5000 people. The second tier comprises general hospitals, which serve a population ranging from 1 to 1.5 million people. In the third tier, referral hospitals serve larger populations, typically ranging from 3.5 to 5 million people.[18]

In the Amhara region of Ethiopia, the healthcare system is composed of 82 public hospitals, including 8 referral hospitals, 14 general hospitals and 60 primary hospitals. Additionally, the region is supported by 861 health centres and 3565 health posts. This study specifically targeted 10 major cities in the region: Bahir Dar, Injibara, Finote Selam, Debre Markos, Gondar, Debre Tabor, Woldia, Dessie, Kemise and Debre Birhan.[19] These cities were selected due to their dense populations, which heightened the risk of COVID-19 transmission and significantly impacted the delivery of healthcare services. Health workers in these urban centres were particularly vulnerable to the virus, with high patient load, making it crucial to examine the effects of the pandemic on their working conditions and overall health. The study was

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conducted at 40 health centres and 13 hospitals from July to September 2022.

Study design

An institution-based, cross-sectional study design was employed to assess COVID-19 vaccine uptake among vaccine-eligible healthcare workers in 10 major cities of the Amhara region in Ethiopia.

Source population

All health professionals who were eligible for the COVID-19 vaccine and who had been working in health facilities within the major cities of the Amhara region were the source population. Eligibility for vaccination was confirmed by asking participants about their vaccination eligibility during the enrolment process at each of the individual health facilities.

Study population

The study population included all COVID-19 vaccine-eligible health professionals who were working in the selected health facilities across major cities in Amhara region public facilities. upon enrolment at each facility, participants were asked to confirm their eligibility for vaccination.

Sample size determination

The sample size was determined using a formula for a single population proportion, assuming that 50% of health professionals do not intend to receive any of the COVID-19 vaccines. This assumption is based on the principle of maximum variability, which is crucial in sample size calculations. By using 50%, we ensure that the sample size is sufficient to detect the greatest variability in the population. This is because we did not identify published literature on vaccine uptake and its associated factors during the study, and we believed that the estimated proportion (p) of 0.5 yields the largest sample size compared with any other proportion. A 5% margin of error was chosen to ensure a reasonable level of precision in the results.

Additionally, a design effect of 2 was used to account for the clustering effect inherent in multistage sampling, leading to a sample size of 851 in hospitals. Since we had two strata, hospitals and health centres, the final sample size was 1702 respondents. However, the total number of health workers in the selected health centres was less than 10 000. Therefore, we applied the following sample size correction formula: n=N*X/(X+N−1), where n is the final sample size, X is the determined sample size (N=851) and N is the population size (N=760 health workers). Following the formula, n=760*851/(760+851−1)=400.37, we got 400 health workers from health centres. Therefore, the final sample size was 1251 health workers (851 from hospitals and 400 from health centres) across four types of health facilities in 10 major cities/towns of the Amhara region. Among health proffesionals, there were 606 health professionals at specialised hospitals and 56 health professionals at primary hospitals. General hospitals employed 189 health professionals and health centres employed 400 health professionals.

Sampling procedures

The sampling technique for this study involved a comprehensive approach using a list provided by the Amhara National Regional State Health Bureau, which included all primary, general and tertiary hospitals, as well as health centres, in the region. The study aimed to encompass all hospitals and health centres within each of the selected cities. To identify study participants, a systematic random sampling procedure was employed, with the complete list of health workers (3642 from hospitals and 760 from health centres) serving as the reference frame.

The sampling process was carried out in several stages. First, all hospitals and health centres in the selected cities were listed and categorised by type. Next, a full list of health workers (851 from hospitals and 400 from health centres) was obtained. To determine the number of health professionals to be selected from each city's health facilities, a proportional allocation method was applied. Specifically, the number of health professionals from each major city's health centres was calculated by multiplying the number of health professionals in each city by the total sample size for health centres (400), then dividing by the total number of health professionals in health centres across all 10 cities (760). Similarly, the number of health professionals selected from hospitals in each major city was determined by multiplying the number of health professionals in each city's hospitals by the sample size for hospitals (851), then dividing by the total number of health professionals in hospitals across the 10 cities (3642) (online supplemental figure 1). To ensure a representative sample, the study included health workers from various departments and positions within both hospitals and health centres. This approach allowed for a broad representation of healthcare professionals with different roles and responsibilities, reflecting the diversity of the workforce across the selected health facilities. Health workers who were on leave or had been employed for less than 6 months were excluded from the sampling process. This systematic approach aimed to ensure that the sample accurately reflected the demographic and professional diversity of health workers, thus enhancing the generalisability and robustness of the study's findings.

Data collection tools and procedures

The questionnaire for this study was designed based on a comprehensive review of relevant literature,[20–22] which informed the development of its content. The structured questionnaire comprised four main sections: (1) sociodemographic and economic characteristics, (2) knowledge and attitude towards the COVID-19 vaccine, (3) factors influencing vaccine acceptance and (4) intentions to accept the COVID-19 vaccine (see online supplemental material). Items assessing the knowledge and attitude towards the COVID-19 vaccine were carefully selected to ensure scientific acceptability and alignment with

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Table 1 Sociodemographic and economic characteristics of healthcare workers on COVID-19 vaccine in major cities of the Amhara region in Ethiopia, 2022 (N=1251)

Variables	Categories	n	%
Health facilities	Health centres	400	31.9
	Hospitals	851	67.1
Age (years)	≤25	159	12.7
	26–35	797	63.7
	36–45	229	18.3
	≥46	66	5.3
Sex	Male	652	52.1
	Female	599	47.9
Marital status	Single	381	30.5
	Married	850	67.9
	Others*	20	1.7
Educational status	Diploma	224	17.9
	BSc	834	66.7
	MD	78	6.2
	Others†	115	9.2
Profession	Medicine	96	7.7
	Nursing	605	48.4
	Midwifery	143	11.4
	Laboratory technology	151	12.1
	Pharmacy	105	8.4
	Public health	76	6.1
	Others‡	75	6.0
Family size	≤4	919	73.5
	≥5	332	26.5
Religion	Orthodox Tewahdo	1088	87.0
	Others§	163	13.0
Monthly family income (Ethiopian birr)	≤5000	169	13.5
	5001–10 000	832	66.5
	10 001–15 000	148	11.8
	≥15 001	102	8.2
Having chronic illness	Yes	81	6.5
	No	1170	93.5

*Other marital status: separated, divorced and widowed.
†Other educational status: MPH/MSc, MD plus specialisation, etc.
‡Other professions: anaesthesia, environmental health/occupational health, health extension and psychiatry/mental health.
§ other religion :Musilim,Protestant,Catholic

established standards for measuring vaccine-related perceptions. Data collection was carried out by 20 trained data collectors, all of whom were fluent in the local languages of the region. The data were gathered through face-to-face interviews, which provided an opportunity to clarify any participant concerns and ensure accurate responses. Prior to participation, each participant was fully informed about the study's objectives, procedures and confidentiality measures. Informed consent was obtained from all participants, ensuring that their involvement was voluntary and based on a clear understanding of the study's purpose and their rights.

Study variables

Dependent variable

- Uptake of COVID-19 vaccine (yes/no).

Independent variables

- Sociodemographic variables: age, sex, educational status, marital status, profession, family size and monthly income.
- Knowledge about the COVID-19 vaccine: good or poor knowledge of COVID-19 practice.
- Attitude towards the COVID-19 vaccine: positive or negative attitude towards the COVID-19 vaccine.
- Practice of COVID-19 prevention: good practice or poor practice of COVID-19 prevention measures.
- Clinical characteristics.

Operational definitions

Good knowledge of COVID-19 vaccines

Respondents were considered to have good knowledge if their score was equal to or above the mean value on a 13-item knowledge assessment. These items covered various aspects of vaccines, including their development, importance to personal and community health, and effectiveness. In addition, the questionnaire explored the respondents' trust in information provided by government vaccination programmes and their perceptions of the risks associated with COVID-19 vaccines compared with other vaccines. Other items assessed the beliefs about the necessity of vaccination for diseases that are no longer prevalent, understanding of the risks of vaccine overdose and concerns regarding the potential of COVID-19 vaccines to trigger allergic reactions or autoimmune diseases. The knowledge assessment was designed to capture a comprehensive understanding of the participants' awareness, beliefs and attitudes towards vaccination in general, as well as their specific perceptions of the COVID-19 vaccine.

Positive attitude towards the COVID-19 vaccine

Respondents were classified as having a positive attitude towards the COVID-19 vaccine if their total score on a 12-item Likert scale (ranging from 'Strongly Disagree' to 'Strongly Agree') met or exceeded the mean value. This scale assessed various dimensions of respondents' attitudes, with a focus on their perceptions of vaccine safety, necessity and the unique characteristics of newly developed vaccines. The questionnaire also explored regional biases, such as the belief that vaccines developed in Europe or America are safer than those produced in other regions. In addition, respondents were asked about their willingness to encourage family, friends or relatives to get vaccinated.

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Table 2 Uptake of COVID-19 vaccine by health professionals in major cities of the Amhara region in Ethiopia, 2022 (N=1251)

Cities/town	COVID-19 vaccine uptake		Total, n (%)
	Yes, n (%)	No, n (%)	
Bahir Dar	151 (59.9)	101 (40.1)	252 (100)
Debre Birhan	152 (73.8)	54 (26.2)	206 (100)
Debre Markos	77 (61.6)	48 (38.4)	125 (100)
Debre Tabor	73 (63.5)	42 (36.5)	115 (100)
Dessie	136 (82.4)	29 (17.6)	165 (100)
Finote Selam	30 (53.6)	26 (46.4)	56 (100)
Gondar	112 (67.9)	53 (32.1)	165 (100)
Injibara	29 (53.7)	25 (46.3)	54 (100)
Kemise	43 (81.1)	10 (18.9)	53 (100)
Woldia	45 (75.0)	15 (25.0)	60 (100)
Total	848 (67.8)	403 (32.2)	1251 (100)
	X^2=45.734, p=0.000		

Further items assessed the perceptions related to the broader context of COVID-19 vaccination, including the perceived need for vaccination to control the spread of COVID-19, the importance of equitable vaccine distribution and trust in government authorities to ensure vaccine safety and efficacy. Respondents were also asked to evaluate their confidence in the adequacy of vaccine testing, the vaccine's effectiveness in preventing infection and mitigating symptoms, as well as the likelihood and severity of potential side effects following vaccination. These items collectively provided a comprehensive assessment of the respondents' attitudes towards the COVID-19 vaccine, capturing both cognitive and affective aspects of vaccine acceptance.

COVID-19 vaccine uptake

COVID-19 vaccine uptake was defined as the percentage of healthcare professionals who had already received at least a single dose of any type of COVID-19 vaccine.

COVID-19 vaccine hesitancy

COVID-19 vaccine hesitancy was defined as refusal of individuals to take vaccines despite their availability.

Data quality control

Item-by-item feedback was solicited from panels of subject matter experts in the field to ensure the relevance, clarity and comprehensiveness of the data collection tools, as well as their alignment with the study's objectives. To standardise the data collection process, all data collectors and supervisors underwent a 2-day training session, which covered the study's aims, data collection methods, techniques and the specific template for data abstraction. During this training, the data collection tools were reviewed in detail, with particular attention given to each item to ensure a thorough understanding of the questions and their intended purpose.

To maintain high standards of data quality, the principal investigator and supervisors conducted regular reviews of the data collected to verify its accuracy, completeness and consistency. Any discrepancies or errors were addressed immediately, with on-the-spot corrections made as necessary. Supervisors were in continuous communication with senior researchers throughout the data collection process to ensure its smooth execution and to provide real-time support to any challenges that arose. This rigorous approach to training, monitoring and data review helped ensure the reliability and integrity of the study's findings.

Data management and statistical analysis

The collected data underwent a meticulous review process to ensure completeness and internal consistency before being coded for analysis. Data analysis was performed using SPSS V.23. Descriptive statistics, including frequencies and percentages, were used to summarise participants' sociodemographic and professional characteristics. To examine potential associations between vaccine uptake status and various factors, the χ^2 test was employed. This statistical test was used to explore the relationships between vaccine acceptance and health professionals' demographic characteristics (such as age, gender and educational level), professional backgrounds (including position and years of experience) and clinical factors (such as exposure to COVID-19 patients and vaccination history). The χ^2 test helped identify significant factors that could influence health workers' decisions to accept or decline the COVID-19 vaccine, providing insights into the determinants of vaccine hesitancy within this group.

To examine the association between COVID-19 vaccine uptake and key variables such as age, marital status and COVID-19-related knowledge and attitudes towards the vaccine, a multivariable logistic regression analysis was conducted. Variables with a p value less than 0.25 in the bivariate logistic regression analysis were included in the multivariable logistic regression model to account for potential confounders and identify independent predictors of vaccine uptake. Statistical significance was set at a threshold of p<0.05. The direction and strength of associations between the outcome variable (vaccine uptake) and the predictor variables were evaluated using ORs, along with 95% CIs.

Ethical considerations

Ethical clearance was obtained from Amhara Public Health Institute.Prior to participation, oral informed consent was obtained from all participants, with a thorough explanation of the study's objectives and procedures to ensure that they fully understood the purpose of the research and their voluntary participation. To protect the privacy and confidentiality of the data collected, stringent measures were implemented throughout the research process. These measures included the de-identification of personal information, the use of password-protected computers for data storage and the secure storage of

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Table 3 Uptake of COVID-19 vaccine by sociodemographic factors, knowledge, attitude, practice and experiences of health professionals in major cities of the Amhara region in Ethiopia, 2022 (N=1251)

Variable	Categories	COVID-19 vaccine uptake		Total, n (%)	X^2 and p value
		Yes, n (%)	No, n (%)		
Age (years)	≤25	76 (6.1)	83 (6.6)	159 (12.7)	
	26–35	534 (42.7)	263 (21.0)	797 (63.7)	53.025, p<0.001
	36–45	181 (14.5)	48 (3.8)	229 (18.3)	
	≥46	57 (4.6)	9 (0.7)	66 (5.3)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Sex	Male	476 (38.1)	176 (14.1)	652 (52.2)	16.994, p<0.001
	Female	372 (29.7)	227 (18.1)	599 (47.8)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Marital status	Single	220 (17.6)	161 (12.8)	381 (30.4)	
	Married	612 (48.9)	237 (19.0)	849 (67.9)	25.877, p<0.001
	Others*	16 (1.3)	5 (0.4)	21 (1.7)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Educational status	Diploma	150 (12.0)	74 (5.9)	224 (17.9)	
	BSc	555 (44.4)	279 (22.3)	834 (66.7)	5.185, p=0.159
	MD	61 (4.8)	17 (1.4)	78 (6.2)	
	Others†	82 (6.6)	33 (2.6)	115 (9.2)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Profession	Medicine	75 (6.0)	21 (1.7)	96 (7.7)	
	Nursing	423 (33.8)	182 (14.5)	605 (48.3)	
	Midwifery	87 (7.0)	56 (4.5)	143 (11.5)	
	Laboratory technology	74 (5.9)	77 (6.1)	151 (12.0)	47.640, p<0.001
	Pharmacy	68 (5.4)	37 (3.0)	105 (8.4)	
	Public health	66 (5.3)	10 (0.8)	76 (6.1)	
	Others‡	55 (4.4)	20 (1.6)	75 (6.0)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Family size	≤4	627 (50.1)	292 (23.3)	919 (73.4)	0.308, p=0.579
	≥5	221 (17.7)	111 (8.9)	332 (26.6)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Religion	Orthodox Tewahdo	728 (58.2)	360 (28.8)	1088 (87.0)	2.921, p=0.087
	Others§	120 (9.6)	43 (3.4)	163 (13)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Monthly family income (Ethiopian birr)	≤5000	112 (9.0)	57 (4.6)	169 (13.6)	
	5001–10 000	575 (46.0)	257 (20.5)	832 (66.5)	2.166, p=0.539
	10 001–15 000	95 (7.6)	53 (4.2)	148 (11.8)	
	≥15 001	66 (5.2)	36 (2.9)	102 (8.1)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Having chronic illness	Yes	50 (4.0)	31 (2.5)	81 (6.5)	1.455, p=0.228
	No	798 (63.8)	372 (29.7)	1170 (93.5)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	
Knowledge of COVID-19 vaccine	Good	645 (51.6)	239 (19.1)	884 (70.7)	36.999, p<0.001
	Poor	203 (16.2)	164 (13.1)	367 (39.3)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	

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Table 3 Continued

Variable	Categories	COVID-19 vaccine uptake		Total, n (%)	X^2 and p value
		Yes, n (%)	No, n (%)		
Attitude towards COVID-19 vaccine	Positive	600 (48.0)	151 (12.1)	751 (60.1)	126.143, p<0.001
	Negative	248 (19.8)	251 (20.1)	500 (39.9)	
	Total	848 (67.8)	403 (32.2)	1251 (100)	

*Other marital status: separated, divorced and widowed.
†Other educational status: MPH/MSc, MD plus specialisation, etc.
‡Other professions: anaesthesia, environmental health/occupational health, health extension and psychiatry/mental health.
§Other religion:Muslim,Protestant,Catholic

physical documents in lockable cabinets. These protocols were established to ensure the safeguarding of participants' sensitive information and to maintain the ethical integrity of the study at every stage.

Patient and public involvement

None.

RESULTS

Sociodemographic and economic characteristics of study participants

A total of 1251 health professionals participated in the study, achieving a 100% response rate. Of the participants, 652 (52.1%) were male and 850 (67.9%) were married. Regarding educational background, 834 (66.7%) had bachelor's degrees. In terms of professional roles, 605 (48.4%) were nurses. Furthermore, 332 (26.5%) respondents reported having four or more family members. Notably, 93.5% of the participants indicated that they did not have any chronic diseases (table 1).

Uptake of COVID-19 vaccines among health professionals

Among the health professionals in the study, a total of 848 (67.8%) individuals reported having received at least one dose of the COVID-19 vaccine. Vaccine uptake varied across different cities in the Amhara region, with the highest uptake observed in Kemise, where 48 professionals (81.1%) were vaccinated. In contrast, the lowest vaccine uptake occurred in Finote Selam, where only 30 professionals (53.6%) received the vaccine. This reflects varying levels of vaccine acceptance and access among healthcare workers in major cities of the region, with an overall vaccination coverage of 67.8% (table 2).

Of the healthcare workers who received the COVID-19 vaccine, 79.9% completed the full vaccination dose. The highest proportion of individuals who completed the full-dose vaccination was observed in Finote Selam, where 93.3% of health professionals were fully vaccinated. Conversely, the lowest full-dose vaccination rate was recorded in Injibara, where only 48.3% of healthcare workers completed full-dose vaccination (online supplemental figure 2).

Vaccine uptake by each categorical variable

In the study, 476 male health professionals, 181 professionals aged between 36 and 45 years and 612 married professionals received the COVID-19 vaccine. On the other hand, 164 health professionals with poor knowledge and 251 professionals with negative attitudes towards COVID-19 vaccination did not take the vaccine (table 3).

Factors associated with COVID-19 vaccine uptake among health professionals

In the multivariable logistic regression analysis, after adjusting for variables such as sex, profession, educational status, religion, age, marital status and knowledge and attitudes towards COVID-19, statistically significant associations were identified between these factors and COVID-19 vaccine uptake. Specifically, healthcare professionals aged 46 years and older were four times more likely to receive the COVID-19 vaccine compared with those aged 45 years and younger (AOR=3.99;95% CI, 1.656 to 9.510). Moreover, married healthcare professionals were 1.4 times more likely to get vaccinated than their unmarried counterparts (AOR=1.398; 95% CI, 1.010 to 1.933).

In the study, healthcare professionals with good knowledge of COVID-19 were 1.75 times more likely to be vaccinated than those with poor knowledge (AOR=1.745; 95% CI, 1.307 to 2.331). Additionally, healthcare professionals with a positive attitude towards the COVID-19 vaccine were 3.65 times more likely to have received the vaccine (AOR=3.609; 95% CI, 2.753 to 4.732) (table 4).

DISCUSSION

In this study, the uptake of COVID-19 vaccine among health professionals was 67.8%, which is higher than the rates reported in South Gondar but lower than those found in tertiary hospitals in Southwest Ethiopia.[23] This finding aligns closely with a study conducted in the United states,[10] but lower than a study done in Addis Ababa,[24] highlighting the variability in vaccine uptake across different regions. Such differences may be influenced by several factors, including public health initiatives, local perceptions of risk and the timing of vaccine availability, affecting information dissemination regarding vaccination.

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Table 4 Factors associated with uptake of COVID-19 vaccine by health professionals in major cities of the Amhara region in Ethiopia, 2022 (N=1251)

Variables	Categories	Uptake		COR (95% CI)	AOR (95% CI)
		Yes	No		
Age (years)	≤25	76	83	1	1
	26–35	534	263	2.22 (1.571, 3.129)	1.61 (1.060, 2.453)*
	36–45	181	48	4.12 (2.639, 6.427)	3.13 (1.794, 5.450)***
	≥46	57	9	6.92 (3.206, 14.920)	3.97 (1.656, 9.510)***
Sex	Male	476	176	1.65 (1.299, 2.096)	1.89 (1.428, 2.505)
	Female	372	227	1	1
Marital status	Single	220	161	1	1
	Married	612	238	1.88 (1.462, 2.422)	1.39 (1.010, 1.933)*
	Others†	16	4	2.93 (0.961, 8.921)	1.96 (0.569, 6.726)
Educational status	Diploma	150	74	1	1
	BSc	555	279	0.98 (0.717, 1.343)	0.68 (0.471, 0.972)*
	MD	61	17	1.77 (0.966, 3.243)	0.84 (0.200, 3.537)
	Others‡	82	33	1.23 (0.750, 2.002)	0.54 (0.295, 0.991)*
Profession	Medicine	75	21	1	1
	Nursing	423	182	0.65 (0.389, 1.088)	0.74 (0.205, 2.678)
	Midwifery	87	56	0.44 (0.241, 0.784)	0.66 (0.177, 2.475)
	Laboratory technology	74	77	0.27 (0.151, 0.480)	0.36 (0.098, 1.339)
	Pharmacy	68	37	0.52 (0.275, 0.964)	0.598 (0.156, 2.294)
	Public health	66	10	1.85 (0.812, 4.206)	2.08 (0.504, 8.589)
	Others§	55	20	0.77 (0.381, 1.557)	1.09 (0.278, 4.242)
Religion	Orthodox Tewahdo	728	360	1	1
	Others¶	120	43	1.38 (0.953, 1.999)	1.20 (0.795, 1.809)
Knowledge of the COVID-19 vaccine	Good	645	239	2.18 (1.692, 2.810)	1.75 (1.307, 2.331)***
	Poor	203	164	1	1
Attitude towards the COVID-19 vaccine	Good	600	151	4.04 (3.144, 5.185)	3.60 (2.753, 4.732)***
	Poor	248	252	1	1
Practice of COVID-19 prevention	Good	78	28	1.36 (0.866, 2.126)	1.37 (0.814, 2.286)
	Poor	770	375		1

*P≤0.05, **P≤0.01, ***P≤0.001.
†Other marital status: separated, divorced and widowed.
‡Other educational status: MPH/MSc, MD plus specialisation, etc.
§Other professions: anaesthesia, environmental health/occupational health, health extension and psychiatry/mental health.
AOR, adjusted OR; COR, crude OR.

The factors associated with vaccine acceptance among healthcare workers included heightened susceptibility to COVID-19 infection and the fear of transmitting the virus to family members. These factors suggest that effective public health messaging should emphasise the risk of infection, especially for those in close contact with vulnerable populations, thereby reinforcing the importance of vaccination for both personal and public health. Notably, the uptake of the COVID-19 vaccine was significantly higher among nurses and male health professionals, indicating a potential gender and role-based disparity in vaccine acceptance. This finding suggests that targeted educational campaigns could further improve vaccine uptake among specific professional groups, particularly those who may have lower acceptance rates.

The factors associated with vaccine uptake included age, marital status and knowledge and attitudes towards the COVID-19 vaccine. Older health professionals (aged 46 years and older) exhibited higher vaccination rates, consistent with the studies done among healthcare workers in Turkey, Lebanon and Palestine, as well as among nurses and midwives in Cyprus.[25–27] It is also consistent with the scoping review done on healthcare workers.[28] This phenomenon may be attributed to

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increased risk perception and vulnerability associated with older age groups, underscoring the need for age-targeted educational interventions that emphasise the benefits of vaccination in reducing the risk of severe COVID-19 outcomes.

The study also revealed that married health professionals were twice as likely vaccinated as their unmarried counterparts, and this finding is consistent with a study among healthcare workers in Jeddah, Saudi Arabia.[29] However, a study done in Palestine showed single healthcare workers had higher uptake of COVID-19 vaccines.[27] This disparity in vaccine uptake between married and unmarried healthcare workers in different contexts likely arises from a combination of cultural, psychological, social and healthcare system-related factors. This behaviour could be explained by the tendency of married individuals to prioritise the health of their families, thereby adopting protective measures against infection. Policymakers should consider leveraging family-centred health education initiatives that address the importance of vaccination for the safety of loved ones.

Additionally, healthcare workers with higher monthly salaries (between 6194 and 9056 Ethiopian birr) demonstrated significantly higher vaccine acceptance compared with those with lower earnings, aligning with existing literature that suggests economic factors influence health behaviour.[30] This indicates a potential area for targeted public health interventions, focusing on lower-income healthcare professionals who may face barriers to vaccination due to financial constraints. However, the finding of this study contrasts the study done in 23 countries where uptake was less likely to occur among those with less than the median income.[31] The disparity in vaccine uptake based on income is likely shaped by a combination of economic access, workplace policies, healthcare system trust and social determinants of health.

Of the health professionals, 67% demonstrated good knowledge of COVID-19. Health professionals with a robust understanding of the COVID-19 vaccine were 1.745 times more likely to be vaccinated compared with those with limited knowledge. Furthermore, a positive attitude towards the vaccine significantly influenced acceptance, with professionals who exhibit favourable attitude was 3.61 times more likely to receive the COVID-19 vaccine compared with those who held a negative attitude towards the vaccine. This finding is similar to a study done in Palestine, where those with sound knowledge of the COVID-19 vaccine were more likely to be vaccinated.[32] The association between knowledge and vaccination uptake highlights the critical role of education in promoting vaccine acceptance.

The positive attitude rate of 60% observed in this study is similar to the findings in South Gondar, but is lower than those reported by studies in the USA and Greece.[20 33 34] This variance may be attributed to differences in vaccine knowledge, government policies and the extent of social media influence on public perceptions. Previous research has documented that negative attitudes among health professionals can impede vaccine acceptance, emphasising the necessity for continuous education and public health campaigns that address concerns and misconceptions about COVID-19 vaccination. This phenomenon could potentially be attributed to variances in the level of knowledge regarding the vaccine, discrepancies in government policies and the extent of social media coverage. The findings of this study underscore the need for targeted public health strategies to enhance COVID-19 vaccine uptake among health professionals. First, tailored educational programmes should be developed to address the specific concerns of healthcare workers, focusing on the risks associated with COVID-19 and the benefits of vaccination. This should include materials that resonate with various professional roles, especially those with historically lower acceptance rates. Second, policymakers should consider implementing family-centred vaccination campaigns that leverage the protective instincts of married health professionals to encourage vaccine uptake among their peers. Such initiatives could foster a community approach to vaccination, enhancing acceptance rates across healthcare settings. Additionally, strategies to improve access to vaccines for lower-income health professionals should be prioritised. This might involve subsidised vaccination programmes or partnerships with local organisations to remove barriers to access, ensuring equitable vaccine distribution. Lastly, ongoing research and surveillance should be conducted to monitor changes in vaccine uptake and attitudes over time, allowing for adaptive public health responses to emerging challenges in vaccination efforts.

Strengths and weaknesses of the study

The study used a healthcare tier system, which includes primary healthcare units, general hospitals and referral hospitals, providing a valuable framework for studying vaccine uptake among health professionals in resource-limited settings and highlighting the impact of healthcare infrastructure on vaccination rates.[35] In the Amhara region, the study focuses on 10 major cities with densely populated urban areas due to increased exposure to COVID-19 helps to assess the uptake of the COVID-19 vaccine.[36]

Furthermore, the study's sample size calculation, which used the principle of maximum variability (assuming 50% vaccine hesitancy), along with its application of a design effect to account for clustering, is a robust methodological approach that ensures sufficient statistical power to detect significant differences. In addition, the systematic random sampling approach used in this study ensures that sample diversity across different healthcare settings was crucial to understanding vaccine uptake.

In terms of data collection and management, the study demonstrates rigour by training data collectors, using structured questionnaires and employing multiple levels of data review. These procedures helped ensure high data quality and reliability. Additionally, the study's focus on knowledge, attitude and practice towards the COVID-19

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vaccine provides a holistic view of the factors influencing vaccine uptake, a method widely used in global health research, including studies on vaccine hesitancy in other Low and Middle Income countries.[37]

The study was limited to 10 major cities and does not capture data from rural areas, where healthcare facilities, resources and attitudes towards vaccination might differ significantly. In addition, the study focuses exclusively on government health institutions, excluding private health facilities. These points potentially narrow the representativeness of the findings to the entire Amhara since healthcare workers in rural areas and private sectors might have different views or experiences regarding vaccine uptake.

Although systematic random sampling was used, the exclusion of health workers on leave or with less than 6 months of employment could omit perspectives from recent hires, who might have unique insights or experiences with COVID-19 vaccination policies. The study primarily considers the factors related to COVID-19 vaccine knowledge, attitudes and practices, and may overlook broader structural or systemic issues in the healthcare system that influence vaccine uptake, such as access to vaccines, institutional support or workload. The data collected on knowledge, attitudes and vaccine uptake rely on self-reported questionnaires, which can introduce response bias. Respondents may provide socially desirable answers or misreport their vaccination status. Even though input was sought from experts in the field to ensure content validity, we recognise that the lack of formal validation and reliability testing limits the robustness of our findings. However, we ensured that the questionnaire was carefully reviewed and refined by experts.

CONCLUSIONS

The study reveals a commendable level of COVID-19 vaccine uptake among health professionals, underscoring their essential role in public health initiatives. Nonetheless, observed disparities in vaccination rates highlight the necessity for targeted interventions aimed at further improving vaccine coverage, especially among younger professionals and those who possess limited knowledge about the vaccine. To address these gaps, tailored educational programmes that can significantly enhance understanding of COVID-19 vaccines should be implemented. Additionally, fostering positive attitudes through targeted campaigns, workplace-based initiatives and peer influence, particularly among younger and unmarried professionals, will be crucial. Encouraging vaccinated professionals to share their experiences and establishing regular follow-ups will also be essential strategies to improve vaccine acceptance and coverage. Furthermore, enhancing vaccine accessibility by ensuring convenient locations and flexible hours will be vital in increasing participation and ultimately improving public health outcomes.

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