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COVID-19 vaccine uptake among healthcare workers in the Limbe Health district of Cameroon

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Several efforts are made to control spread of COVID-19. Vaccines are one of the tools currently used to control spread of the disease. This study aimed to assess the uptake of COVID-19 vaccines and determinants among healthcare workers in the Limbe health district of Cameroon. A cross-sectional study was carried out among 405 health workers in selected health facilities. A multi-stage sampling technique was used to recruit participants and Chi-square and logistic regression were used to analyze data. Their mean age was 34.67±7.32 years. The findings revealed that only 27.4% of healthcare workers had received at least one dose of the COVID-19 vaccine, and just 23.2% were fully vaccinated. The uptake of the booster was just 4.4%. Among those who received the vaccine, the distribution was as follows: 11.7% received AstraZeneca, 63.1% received Johnson and Johnson, 13.5% received Pfizer, and 3.6% received Sinopharm. Factors associated to the vaccine uptake were sex (AOR=0.45 [95% CI: 0.26-0.79], P=O.OO6), longevity of service (AOR=0.29, [95% CI: 0.12-0.70], P=0.006), suffering from chronic disease (AOR=0.09 [95% CI:0.04-0.22], p<0.001) and had close one who had had COVID-19 (AOR=0.45, [95% CI:0.27-0.76], p=0.003). Also, health workers knowledge (AOR=2.15, [95% CI: 1.17-3.94], p=0.014), practices (AOR=4.17, [95% CI: 1.70-10.27], p=0.002) and attitudes (AOR=2.36, [95% CI: 1.37-4.07], p=0.002) were significantly associated to vaccine uptake. The proportion of healthcare workers who had taken the COVID-19 vaccine was low their knowledge of COVID-19 vaccine was below average. Sensitization, education and training programs therefore need to be intensified in this district to boost healthcare workers' knowledge of the vaccine. This will increase vaccine uptake.

Key words: COVID-19 vaccine, vaccine uptake, healthcare workers, knowledge, attitudes, practices.

INTRODUCTION

The COVID-19 pandemic is among the infectious diseases to have emerged in recent history (Gorbalenya et al., 2020). As with all past pandemics, the specific mechanism of its emergence in humans remains unknown. The SARS-CoV2 pandemic has disrupted the lives of people globally (Acuti Martellucci et al., 2020).

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Amidst this grim situation, one of the positive signs of human resilience is the development of effective and safe vaccines, within a year of onset of the pandemic (Haque and Pant, 2020). Vaccines are effective public health tools, which when given to sufficient numbers of people, can halt outbreaks of serious infections (Abeysinghe, 2021). The world currently faces a gross inequity in access to COVID-19 vaccines (Asundi et al., 2021). While high-income countries are making great strides in giving vaccines to its entire people, low and middle-income countries are still languishing with poor vaccine access (Siewe Fodjo et al., 2021).

The coronavirus disease 2019 (COVID-19) pandemic has spread across the world with millions infected and hundreds of thousands of dead. The resurgence of COVID-19 cases and the occurrence of a new wave of contaminations in Cameroon, between February 25 and March 3, 2021 (Chelo et al., 2021) arose at a time when the scientific community had a new response to this pandemic, the vaccination that is being introduced in many countries.

The National Immunization Technical Advisory Group (NITAG) and the Scientific Committee for COVID-19 responses in Cameroon prioritized the target populations for the vaccination against COVID-19 as follows: front-line health and social workers, people over 50 years with morbidities or conditions, workers over 50 years who are critical for the functioning of the state, refugees over 50, staff from embassies and diplomatic missions accredited to Cameroon. Also, people under the age of 50 with comorbidities with a significantly higher risk of serious illness or death, eligible refugees under the age of 50, and other people over 50 years old. In addition, workers under 50 years old critical functioning of the state (government, administrative bodies, parliament, judiciary, regional councils, municipal councilors), eligible teachers, students and pupil not taken into account in previous group; and finally other target groups like travelers, transporters, prisoners, refugees, and other basic social sectors (Amani et al., 2022).

On Sunday April 11, 2021, the Prime Minister of Cameroon received a donation of 200,000 doses of Sinopharm from the Chinese Government (Amani et al., 2022). On April 17, 2021, Cameroon received 391,200 doses out of the 1,200,000 doses wait of AstraZeneca vaccines (Mayin et al., 2021). The country aimed to vaccinate 5,400,000 people against Covid-19, by the end of 2021, then 15 million Cameroonians in 2022 in order to reach the threshold vaccination coverage, which confers herd immunity (Amani et al., 2022).

A second wave of the infection occurred in Cameroon in April 2021 (Mbopi-Keou et al., 2020). This was immediately after the African Women's Nation Cup was hosted in the country. This second wave led to more deaths.

According to WHO, as of April 9, 2020, 1484,811 infected cases and 88,538 deaths of COVID-19 were recorded not leaving out Cameroon as a whole and the Limbe Health District in particular (Yoo and Managi, 2020). Over 750 healthcare workers have been infected by the virus with many losing their lives (Yi et al., 2020). The development of vaccines against the SARS-CoV-2 provided the solution needed to control the virus. As at June 2021, there were 105 vaccines in the clinical development stage while 184 were in the pre-clinical development stage (Soleimanpour and Yaghoubi, 2021). Many vaccines have been demonstrated to be safe and effective for human use, including Pfizer, Oxford/ AstraZeneca, Moderna, Janssen, Sputnik V, Sinovac, and Sinopharm.

In Cameroon, Oxford/AstraZeneca, Sputnik, Johnsons and Johnsons, Pfizer and Sinopharm vaccines have been secured and approved for mass vaccination, with frontline healthcare workers being prioritized. Compared to the general population of Cameroon, vaccine acceptance has a crucial importance amongst Healthcare Workers (HCWs) because they are amongst the first subgroups of the Cameroonian population to have access to the vaccine (Ngasa et al., 2021). Healthcare workers also play an important role in fighting misinformation about vaccination among the general population. It was therefore essential to assess COVID-19 vaccine uptake: knowledge, attitudes, practices, predictors, and prevalence among HCWs. To the best of our knowledge, no previous study has been done to assess the level of COVID-19 vaccine uptake amongst healthcare workers in the Limbe Health district. In this study, we examined COVID-19 vaccine uptake among healthcare workers in the Limbe Health district.

MATERIALS AND METHODS

Study design, population, period and setting

A health facility-based analytical cross-sectional study among healthcare workers was carried out in public and private healthcare facilities in the Limbe Health District. This was carried out from March 27, 2022 to May 31, 2022 to assess the COVID-19 vaccine uptake among healthcare workers. It answered questions like the prevalence of COVID-19 vaccine uptake, the knowledge, attitudes, and practices of healthcare workers toward COVID-19 vaccine and predictors of vaccine uptake among healthcare workers.

The Limbe Health District is one of the 18 health districts found in the South West Region. The district is situated in the tropical rain forest of the Congo Basin. It is bounded to the North by Buea health district, to the East by Mbonge Health District, the South by Atlantic Ocean and the West by the Tiko health district. The health district has a total surface area of approximately 645 km^2.

It consists of highlands which form part of the Cameroon range of active volcanic mountains. There are many rivers meandering between the valleys and gorges. These features are attractive eco-touristic sites but with the potential of disaster leading to emergency situations.

It has eight health areas comprising 107 communities and total population of 206,887 inhabitants for the year 2021.

There are 38 functional health units in existence comprising 13 public, 5 para-public, 18 private, and 2 confessionals. The eight health areas are: Batoke, Bojongo, Edenau, Bota, Mabeta, Moliwe, Seaport, and Zone II. The Limbe Health District does COVID-19

vaccination and vaccines like the Johnson and Johnson, Pfizer, Astrazenecca and Sinopharm are available in the district for free.

Sample size determination

The sample size was obtained using the formula for estimation of confidence interval for a proportion since our major outcome is prevalence of COVID-19 vaccine uptake.

$$n = \frac{z^2 * P(1-P)}{e^2}$$

where n=Number of participants (least sample size needed), Z=the standard normal value corresponding to a significance criterion of 0.05 (95) = 1.960, e=amount of error we will tolerate = ± 5%, P=pre-study estimate of the prevalence of COVID-19 vaccine uptake in healthcare workers= 50%.

A pre-estimate value of P=50% was used. This was in accordance to a similar study in Bafoussam-Cameroon where 50% of health workers were willing to accept the COVID-19 vaccine if offered (Mayin et al., 2021).

$$\mathrm{n} = \frac{1.96^2 * 0.5(1-0.5)}{0.05^2}$$

where n= 385 participants (Healthcare Workers). We decided to add 5% participants to make up the sample size to 405 participants.

Sampling technique

A multi-stage sampling technique was used:

Stage 1: A simple random sampling technique (balloting) was used to select six out of the eight health areas in the Limbe Health District.

Stage 2: A simple random sampling technique was again used to select 22 of the 35 functional health facilities from the selected health areas.

Stage 3: A probability proportionate to size sampling technique was then used to know the number of participants selected per health facility to meet up with the total sample size of 405. The proportion of healthcare workers selected from the various health facilities was determined (Table 1).

Data collection

Data was collected by the investigators using structured questionnaires after pre-testing the questionnaires. The questionnaires were structured into four sections: socio-demographic variables, knowledge, attitudes, and practices. Most of the questions were coded into binary variables to ease data analysis and were closed-ended. The questionnaires were in English and were self-administered by the healthcare workers.

Ethical considerations

Ethical clearance was obtained from the Faculty of Health Sciences Institutional Review Board. This was after reviewing the protocol that was submitted to this board to ensure safe scientific procedures were used in collecting the data and ethics was respected.

Administrative authorizations from the Faculty of Health Sciences, South West Regional Delegation of Public Health and Limbe District Health Services were obtained before data collection.

Data management and analysis

Questionnaires were checked for proper completion on collection from the participants and incomplete questionnaires were discarded. The data was keyed in using the Kobo collect toolbox and an Excel file generated from the Kobo toolbox was then imported into SPSS version 26 for analysis.

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) software version 26 and presented in the form of tables and charts. Continuous variables such as age were summarized using means and standard deviations while categorical variables such as educational level and sex were described using frequency tables, bar charts and pie charts.

Study participants' vaccine knowledge, attitudes, and practices levels were defined in relation to the mean score of all variables for each section. Scores above the mean were defined as good and those below were defined as poor. This was adapted from another study (Adane et al., 2022).

All questions in each section of the knowledge, attitudes and practices sections of the questionnaire were attributed composite scores. A correct answer for each question was scored one (1) and the wrong answer scored zero (0). The mean score of each composite variable was determined and used as a cutoff point for categorizing the composite variables as good or poor.

Chi-square test was used to determine association between vaccine uptake and categorical variables like sex, education and profession. Significant predicators in the Chi-square bivariate analysis test (P<0.2) were taken to the multivariate analysis.

Multiple logistic regression was used to identify the factors associated with COVID-19 vaccine uptake from the bivariate analysis at 95% confidence level (P<0.05).

RESULTS

Socio-demographic characteristics of the study participants

Table 2 shows the socio-demographic characteristics of the 405 study participants who took part in the study. Their mean age was 34.67±7.32 years. About 181 (44.7%) were between the age range 31-40 years (Figure 1) and 273 (67.7%) were females. The study was carried out in six health areas of the Limbe health district. A vast majority 211 (52.1%) came from the Zone 2 health area (Table 6) and 213 (52.6%) were single as well as 176 (43.5%) had at least a university degree. The predominant profession of the healthcare workers was nursing 275 (67.9%) and Christianity was the most dominant religion 391 (96.5%). A vast majority 307 (75.8%) reported having worked for less than 10 years and 357 (88.1%) reported not suffering from any chronic disease as well as a majority 399 (98.5%) had never smoked before.

Most 348 (85.9%) of the healthcare workers did not have health insurance and 289 (71.4%) did not have any close relatives/friends who had suffered from COVID-19 disease.

Table 1. Proportion of healthcare workers selected per health facility.

S/N	Selected health areas	Selected health facilities	Total HCWs	Proportion	HCWs selected per health facility
1	Zone 2	Limbe Regional Hospital	421	0.49	196
		Shiloh Recovery Me Center	6	0.01	4
		Holy Mary Heal foundation	12	0.01	6
		Larosbi Maternity	4	0.001	2
2	Sea port	Ambition 24 Hour Center	14	0.02	6
		Balm of Gilead	8	0.01	8
		Divine Grace Health Center	10	0.01	9
		Limbe CMA	31	0.04	16
		Nightigale	8	0.01	4
3	Moliwe	Bonadikombo IHC	9	0.01	7
		Moliwe CDC Health	7	0.01	4
4	Bota	Bota District Hospital	21	0.02	90
		Bota CDC Clinic	21	0.02	10
		Community Health Center	5	0.01	3
		Family Healthcare Foundation	17	0.02	9
		Victoria Hope foundation	6	0.01	3
5	Bonjongo	Bonjono IHC	8	0.01	4
		Ewongo IHC	5	0.01	3
		Mukunda IH	2	0.00	1
6	Batoke	Batoke IHC	12	0.01	5
		God's Mercy	9	0.01	4
		Limbola IHC	9	0.01	4
		Total	858	1.00	405

Table 2. Demographic characteristics of healthcare workers.

Variable	Level	Frequency	Percentage
Age group (years)	21-30	146	36.0
	31-40	181	44.7
	41-50	68	16.8
	50-60	10	2.5
	Total	405	100
Sex	Female	273	67.4
	Male	132	32.6
	Total	405	100
Marital status	Divorced	6	1.5
	Married	178	44
	Single	213	52.6
	Widowed	8	2.0
	Total	405	100

Table 2. Cont'd

Educational level	Diploma	172	42.5
	Primary	2	0.5
	Secondary/High school	55	13.6
	University degree and above	176	43.5
	Total	405	100
Profession	Lab technician	49	12.1
	Medical doctor	20	4.9
	Midwife	23	5.7
	Nurse	275	67.9
	Others	11	2.7
	Pharmacist	18	4.4
	Public health officer	9	2.2
	Total	405	100
Religion	Christian	391	96.5
	Islam	14	3.5
	Total	405	100
Number of working years	< 10	307	75.8
	>10	98	24.2
	Total	405	100
Suffering from any chronic disease	No	357	88.1
	Yes	48	11.9
	Total	405	100
Smoking Status	Current smoker	3	0.7
	Ex-smoker	3	0.7
	Never smoked	399	98.5
	Total	405	100
Suffering from any chronic disease	No	357	88.1
	Yes	48	11.9
	Total	405	100
Have health insurance	No	348	85.9
	Yes	57	14.1
	Total	405	100
Any close relative or friend had Covid-19	No	289	71.4
	Yes	116	28.6
	Total	405	100

Knowledge of participants on COVID-19 vaccine

Table 3 shows participants' knowledge of COVID-19 vaccine. Out of the 405 participants recruited for the study, 105 (48%) had an overall good knowledge of the COVID-19 vaccine. The knowledge on COVID-19 vaccine was contributed by various aspects: 398 (98.3%) reported having heard of COVID-19 vaccine and 291 (71.9%) were able to name at least one of the COVID-19 vaccines. About 329 (81.2%) believed that, COVID-19 vaccine cannot change their genetic composition and 333 (82.2%) thought that, the COVID19 vaccine cannot cause infertility. Most 323 (79.8) knew that a fully vaccinated person can still be infected with the COVID-19 virus and

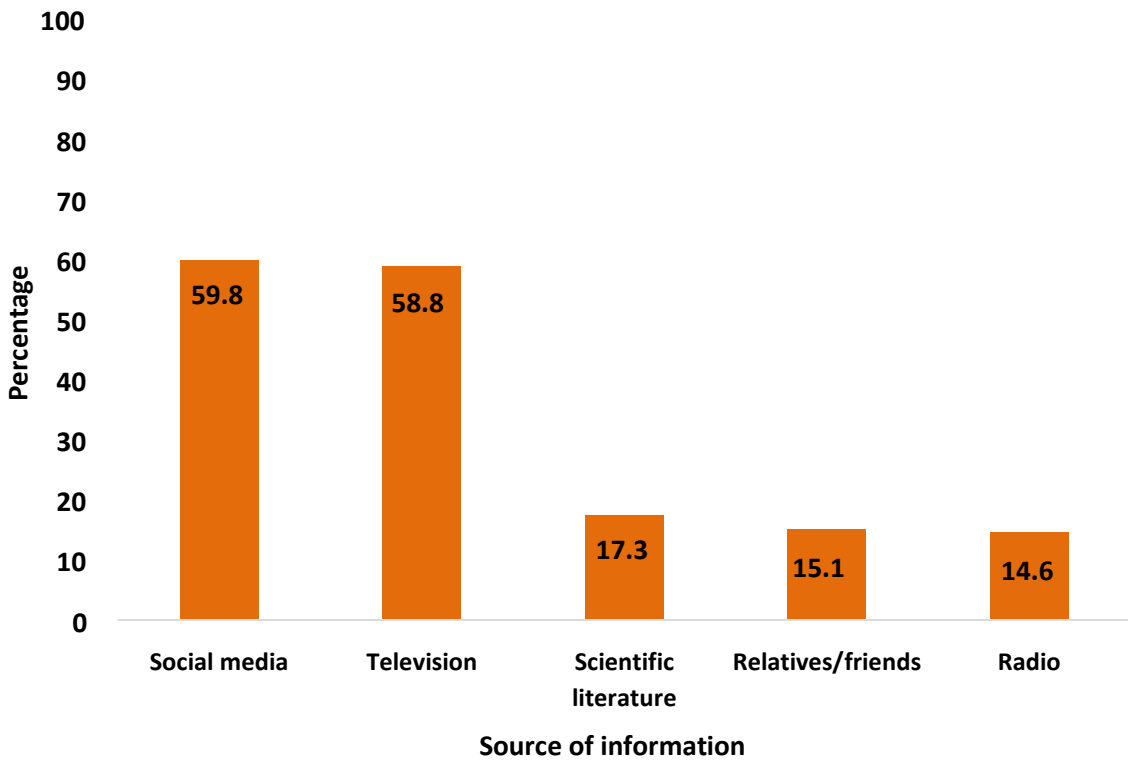

Figure 1. Distribution of healthcare workers according to their sources of information on the COVID-19 vaccine.

Table 3. Participants knowledge on COVID-19 vaccines.

Variable	Category	Frequency	Percentage
Had heard of COVID-19 vaccine	No	7	1.7
	Yes	398	98.3
	Total	405	100
Could name some of the COVID-19 vaccines	No	114	28.1
	Yes	291	71.9
	Total	405	100
COVID-19 vaccine changes your genetic composition	No	329	18.8
	Yes	76	81.2
	Total	405	100
COVID-19 can cause infertility	No	333	17.8
	Yes	72	82.2
	Total	405	100
A fully vaccinated person can still be infected with COVID-19 virus	No	82	79.8
	Yes	323	20.2
	Total	405	100
COVID-19 vaccine has sight effects	No	51	12.6
	Yes	354	87.4
	Total	405	100

Table 3. Cont'd

Pregnant women should take the COVID-19 vaccine	No	270	66.7
	Yes	135	33.3
	Total	405	100
Children of age less than eighteen years can take the COVID-19 vaccine	No	233	57.5
	Yes	172	42.5
	Total	405	100
All COVID-19 vaccines available require at least two doses to be fully vaccinated	False	233	57.5
	True	172	42.5
	Total	405	100
Breastfeeding mothers take the COVID-19 vaccine	No	253	62.5
	Yes	152	37.5
	Total	405	100
Level of knowledge	Poor	210	51.9
	Good	195	48.1
	Total	405	100

354 (87.4%) reported that, the COVID-19 vaccines have sight effects. About 270 (66.7%) reported that pregnant women should not take the COVID-19 vaccine and 233 (57.5%) thought that, children of age less than 18 years should not take the COVID-19 vaccine. More than half of the participants 233 (57.5%) knew that not all COVID-19 vaccines available require at least two doses to be fully vaccinated and 253 (62.5%) did not know that breastfeeding mothers can take the COVID-19 vaccine.

Out of the 405 participants recruited for the study, 105 (48%) had good knowledge of the COVID-19 vaccine.

Attitudes of study participants toward the COVID-19 vaccines

Table 5 shows the attitudes of healthcare workers toward the COVID-19 vaccine. Of the 405 participants, 276 (68.1%) believed that the Cameroon Ministry of Public Health could control the COVID-19 disease in Cameroon and 205 (50.6%) had general mistrust/uncertainty about the COVID-19 vaccine. About 206 (50.9%) of the participants reported being afraid of the COVID-19 vaccine and 164 (79.6%) were afraid of the vaccine because of unknown long-term effects. A majority of the participants 227 (56%) believed that people with chronic and severe diseases should get priority for the vaccine and 332 (82%) said that healthcare workers should get priority for the vaccines. Most of the study participants 362 (89.4%) reported that healthcare workers should adhere to government instructions to protect the public from COVID-19 infection.

Out of the 405 study participants, overall, 316 (77%) had good attitudes toward the COVID-19 vaccine.

Practices of study participants on COVID-19 vaccine

Table 4 shows participants' practices of COVID-19 vaccination. Of the 405 study participants, 256 (63.2%) had done the COVID-19 test and 209 (81.6%) had done the rapid diagnostic test. About 294 (72.6%) had not taken the COVID-19 vaccine and 70 (63.1%) of those that had taken the vaccine took the Johnson and Johnson COVID-19 vaccine. Most, 93 (83.8%) of the participants that had taken the COVID-19 vaccine had not taken the COVID-19 vaccine booster dose. Also, of the 405 participants, 111 (27.4%) had taken at least one COVID-19 vaccine dose and 94 (23.2%) were fully vaccinated. Out of the 405 study participants, only 18 (4.4%) had taken the COVID-19 vaccine booster dose.

Correlates of COVID-19 vaccine uptake

Table 6 captures COVID-19 vaccine uptake in a bivariate analysis model. Vaccine uptake was a binary (yes/no) outcome variable and socio-demographic characteristics were used as independent variables. A p-value of <0.05 was considered as the cutoff point for a variable to be suspected as having association with COVID-19 vaccine uptake. After running a bivariate analysis, the factors that appeared to be associated with COVID-19 uptake included religion, sex, having chronic disease, having a

Table 4. Practices of participants on COVID-19 vaccination.

Variable	Categories	Frequency (n)	Percentage
Tested for COVID-19	No	149	36.8
	Yes	256	63.2
	Total	405	100
Type of COVID-19 test done	I do not know	13	5.1
	PCR	34	13.3
	RDT	209	81.6
	Total	256	100
Vaccinated against COVID-19	No	294	72.6
	Yes	111	27.4
	Total	405	100
Type of vaccine taken	AstraZeneca	13	11.7
	I do not know	9	8.1
	Johnsons and Johnsons	70	63.1
	Pfizer	15	13.5
	Sinopharm	4	3.6
	Total	111	100
Doses of vaccine taken	One	87	78.4
	Two	24	21.6
	Total	111	100
Had taken the booster dose	No	93	83.8
	Yes	18	16.2
	Total	111	100
Overall practices of HCWs	Poor	295	72.8
	Good	110	27.2
	Total	495	100

Table 5. Attitudes of Healthcare workers toward COVID-19 vaccines.

Variable	Level	Frequency	Percent
The Cameroon Ministry of Public Health can control COVID-19 in Cameroon	No	129	31.9
	Yes	276	68.1
	Total	405	100
Had mistrust about the COVID-19 vaccine effectiveness	No	200	49.4
	Yes	205	50.6
	Total	405	100
Afraid of COVID-19 vaccine	No	199	49.1
	Yes	206	50.9
	Total	405	100
Reason being afraid of the COVID-19 vaccine	Infertility	3	1.5
	Severe allergic reactions	39	18.9

Table 5. Cont'd

	Unknown long-term effects	164	79.6
	Total	206	100
People with chronic and severe diseases get priority for COVID-19 vaccination	No	178	44
	Yes	227	56
	Total	405	100
Healthcare workers get priority for COVID-19 vaccination	No	73	18
	Yes	332	82
	Total	405	100
All healthcare workers be vaccinated to protect the public	No	86	21.2
	Yes	319	78.8
	Total	405	100
To protect the public, HCW should follow government guidance about vaccines	No	43	10.6
	Yes	362	89.4
	Total	405	100
Overall Attitudes	Poor	93	23.0
	Good	312	77.0
	Total	405	100

Table 6. Association between demographic factors and uptake of COVID-19 vaccine on a Bivariate analysis.

Variable	Category	No	%	Yes	Chi-square	P-value
Health area	Batoke	9	2.2	9	8.03	0.176
	Bojongo	7	1.7	1		
	Bota	85	21.0	31		
	Moliwe	6	1.5	5		
	Seaport	32	7.9	9		
	Zone2	155	38.3	56		
	Total	294	72.6	111		
Type of HF	Parastatal	12	3.0	3	3.08	0.25
	Private	44	10.9	10		
	Public	238	58.8	98		
	Total	294	72.6	111		
Age group (years)	51-60	4	1.0	6	62.95	<0.001
	21-30	124	30.6	22		
	31-40	141	34.8	40		
	41-50	25	6.2	43		
	Total	294	72.6	111		
Sex	Female	216	53.3	57	17.94	<0.001
	Male	78	19.3	54		
	Total	294	72.6	111		
Marital status	Divorced	2	0.5	4	28.03	<0.001
	Married	109	26.9	69		
	Single	177	43.7	36		
	Widowed	6	1.5	2		
	Total	294	72.6	111		

Table 6. Cont'd

Highest level of education	Diploma	126	31.1	46	2.72	0.353
	Primary	1	0.3	1		
	Secondary	44	10.9	11		
	University	123	30.4	53		
	Total	294	72.6	111		
Profession	Lab Technician	35	8.6	14	10.35	0.137
	Medical Doctor	9	2.2	11		
	Midwife	17	4.2	6		
	Nurse	204	50.4	71		
	Others	10	2.5	1		
	Pharmacist	12	3.0	6		
	PH officer	7	1.7	2		
	Total	294	72.6	111		
Religion	Christian	280	69.1	111	5.48	0.01
	Islam	14	3.5	0		
	Total	294	72.6	111		
Suffering from any chronic disease	No	286	70.6	71	85.604	<0.001
	Yes	8	2.0	40		
	Total	294	72.6	111		
Number of working years	< 10	256	63.2	51	74.311	<0.001
	≥10	38	9.4	60		
	Total	294	72.6	111		

closed relative/friend who has had COVID-19 before, longevity in service, age group, marital status and profession.

After controlling for all possible confounding variables by each of the socio-demographic variables (Table 7), sex, number of years worked, suffering from chronic disease and having a close one who had had COVID-19 before were significantly associated to the COVID-19 vaccine uptake. In fact, the odd of a female taking the vaccine was 0.45 (95%CI: 0.26-0.79, P=0.006) times less than that of a male taking the vaccine and the odd of a healthcare worker who has worked less than 10 years taking the vaccine was 0.29 (95%CI: 0.12-0.70, P=0.006) times less than the odd of a healthcare who had worked for 10 years and above. The odds of a healthcare worker not suffering from a chronic disease taking the vaccine was 0.09 (95%CI: 0.04-0.22, P≤0.001) times less than the odds of a healthcare worker suffering from a chronic disease taking the vaccine.

Association between vaccine uptake with knowledge and attitudes

Knowledge, attitudes, and perception of participants were significantly associated with vaccine uptake in the multivariate analysis (Table 8). The odds of a healthcare worker with adequate knowledge of the vaccine taking the vaccine were 2.145 (95%CI: 1.167-3.942, P=0.014) times higher than the odds of a healthcare worker with inadequate knowledge. The odds of a healthcare worker with good attitudes toward the vaccine taking the vaccine was 2.362 (95%CI: 1.371-4.072, P=0.002) times greater than that of a healthcare worker with poor attitudes toward the vaccine.

DISCUSSION

The uptake of the COVID-19 vaccine among healthcare workers and communities is an important health intervention in the fight against the COVID-19 pandemic. The World Health Organization actually advocates that to reduce the burden of COVID-19 disease globally, healthcare workers should get priority for vaccination and the vaccine uptake should be at least 70% by mid-2022 to provide herd immunity (MacIntyre et al., 2022).

This study assessed the proportion of healthcare workers with good knowledge, attitudes and practices regarding the COVID-19 vaccine. Also, association of socio-demographic characteristics of healthcare workers with vaccine uptake was assessed in this study.

Table 7. Factors independently associated to COVID-19 vaccine uptake.

Variable	Level	AOR	95% CI		P-value
			Lower	Upper	
Health area	Batoke	3.62	1.05	12.47	**0.042**
	Bojongo	0.51	0.05	4.84	0.558
	Bota	1.67	0.89	3.13	0.113
	Moliwe	5.59	1.42	22.10	**0.014**
	Seaport	2.41	0.97	5.98	0.059
	Zone2	1			
Age group	51-60	0.63	0.13	3.20	0.580
	21-30	0.42	0.15	1.23	0.112
	31-40	0.43	0.17	1.06	0.066
	41-50	1			
Sex	Female	0.45	0.26	0.79	0.006
	Male	1			
Number of years worked	<10	0.29	0.12	0.70	0.006
	≥10	1			
Suffering from any chronic diseases	No	0.09	0.04	0.22	<0.001
	Yes	1			
Had a close one who had had Covid-19	No	0.451			<0.001
	Yes	1			

Table 8. Association between Vaccine uptake and knowledge, attitudes, and perception in the multivariate analysis.

Variable	Uptake levels	AOR	95% CI of AOR		P-value
			Lower	Upper	
Knowledge	Good	2.145	1.167	3.942	0.014
	Bad	1			
Practices	Good	4.172	1.695	10.268	0.002
	Bad	1			
Attitudes	Good	2.362	1.371	4.072	0.002
	Bad	1			

It was documented that healthcare workers' good knowledge regarding the COVID-19 vaccine was average (47.9%). This knowledge level is below expectations from healthcare workers and it could be responsible in low vaccine uptake. Studies have shown that poor knowledge of the COVID-19 vaccine is negatively associated to vaccine uptake (MacIntyre et al., 2022). This low adequate knowledge could be due to the fact that, their highest source of information is social media as documented in this study which has a lot of false information about the vaccine. Low sensitization program on the COVID-19 vaccine in the Limbe health district could also be responsible for the below average good knowledge of the vaccine. The proportion of participants with good knowledge in our study was similar to the 46.7% reported among healthcare workers in Vietnam by MacIntyre et al. (2022) but however lower than 62.5% good knowledge reported by Adane et al. (2022) in

Northeastern Ethiopia. This difference could be due to the fact that, Adane et al. (2022) conducted a systematic review including studies from outside of Africa. This might have led to the high proportion of uptake in their study.

The overall good attitude of healthcare workers toward COVID-19 vaccine as a good strategy to fight the COVID-19 disease was 77.5%. This was higher than the 51.28% good attitudes reported in Western Ethiopia by Tolossa et al. (*2022)*. This high good attitude is a promoting factor for COVID-19 vaccine uptake Tolossa et al. (*2022)*. These differences could be due to the fact that, we used a probability sampling technique in our study which gave all participants equal opportunities of being recruited for the study whereas a snowball sampling was used in their study. Another difference could be accounted for by the fact that, their study was conducted in 2020. This two years' difference might have positively influenced the attitudes of health care workers in our study due to increases sensitization and education about the vaccine.

Their practices of COVID-19 vaccination were similar to the 27% uptake reported among health workers in Africa by Africa WHO regional office in Brazzaville, Congo and the 27.7% reported in DR Congo by Tolossa et al. (2022). The uptake was however different from the 82.5% uptake reported by Moucheraud et al. (2022) in Malawi. The 27.4% uptake reported in our study is too low as compared to the 70% global vaccine uptake coverage advocated by WHO to have been met by mid-2022 (Al-Metwali et al., 2021). It is just similar to the about 5,400,000 (25%) vaccination coverage expected by the Cameroon Ministry of Public Health to have been covered by the end of 2021. It is far below the about 15,000,000 (60%) vaccination uptake coverage expected to be covered in Cameroon by 2022 (Ojong, 2020). Hence, the Cameroon Ministry of Public Health needs to expand sensitization and training programs among health workers and communities to boost the vaccine uptake. The uptake proportion could even be lower among the general public given that health workers are a great force behind community vaccine uptake.

With regards to the relationship between vaccine uptake and socio-demographic variables, there was a significant association between vaccine uptake and sex, suffering from chronic disease, longevity of work, having a close one who had had COVID-19 before. Female showed lower odds of taking the vaccine as compared to males. Not suffering from a chronic disease showed lower odds of taking the vaccine and not having a close friend or relative who has had the COVID-19 disease had lower odds of taking the vaccine. Those who had worked for less than 10 years were negatively associated to vaccine uptake. These results of associated factors to vaccine uptake were similar to other studies that showed an association between sex (Malik et al., 2020), having a chronic disease (Abebe et al., 2021), having a close relative/friend who has had COVID-19 before (Elhadi et al., 2021). Although age group as a whole was not significantly associated to vaccine uptake as reported by other studies, the age group 41 and above showed a more positive association with vaccine uptake which is in conformity to many other studies (MacIntyre et al., 2022; Adane et al., 2022). Number of years worked was also significantly associated with vaccine uptake in this study and we did not find any similar study.

Also, knowledge, attitudes and practices were significantly associated to vaccine uptake. Participants with good knowledge had higher odds of taking the vaccine and participants with good practices and attitudes toward the COVID-19 vaccine had higher odds as well of taking the vaccine. These results were in conformity to other studies which showed an association between vaccine uptake and knowledge (Abebe et al., 2021; Yigit et al., 2021), practices Tolossa et al. (*2022)*; Abebe et al., 2021), and attitudes.

The results of this study may not reflect the real situation of the COVID-19 vaccine uptake as some healthcare workers were not easily accessible due to high administrative engagements. The results might have also been affected by potential recall bias on the part of the respondents and inadequate knowledge of some health workers on the name of the vaccine they received. This could alter the study results due to dose disparities among the different vaccines making it difficult to determine the proportion of fully vaccinated health workers. However, the quality of the study data was assured by doing the data collection ourselves. The sample size was increased above the minimum sample size to increase the accuracy of the results. As such, even if this study had some differences, the variation from the true situation of the vaccine uptake would not be significant.

Conclusion

About 1 in 4 healthcare workers had taken at least one dose of the COVID-19 vaccine and about 1 in 5 was fully vaccinated.

About 5 in 10 healthcare workers had overall good knowledge of COVID-19 vaccine. The proportion of health workers with good attitudes was high and the proportion of participants with good practice was low. There was a statistically significant association between vaccine uptake and sex, longevity of work, suffering from chronic disease and having a close one who had had COVID-19 before. Knowledge, attitudes and practices were also significantly associated to vaccine uptake.
Sensitization and education programs on COVID-19 need to be intensified among healthcare workers to boost vaccine uptake.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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