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Original Article

Vaccination Coverage and Safety in Cameroon: Descriptive Assessment of COVID-19 Infection in Vaccinated Individuals

Couverture et sécurité vaccinales au Cameroun : analyse descriptive de l'infection au COVID-19 chez les personnes vaccinées

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RÉSUMÉ

Objective. To assess national vaccination coverage, adverse events following immunization (AEFI) and evaluate the vaccination status in COVID infected patients. **Methods.** Sociodemographic data on vaccination and clinical characteristics of Covid-19 cases were extracted from the national COVID-19 databases of the Public Health Emergency Center and the Expanded Program on Immunization. **Result.** A total number of 808 229 out of 27 869 965 (2.9%) were fully immunized on 13 February 2022 in the Cameroon. The most requested vaccine was Janssen with 48.24% of total doses administered. Women were less vaccinated than men and with a remarkable disparity in northern regions of the country. The Adamawa region presented the best performance 11.3% of adults fully immunized. Despite vaccinal coverage still insufficient among health care worker, they were the most vaccinated among priority groups (43.4%). Only 8% COVID-19 cases were vaccinated and 0.22 % of all vaccinated still developed COVID-19. Tolerability assessment identified 1.83 non-serious AEFI and 0.1 serious AEFI per 1000 doses administered. Only 7% of vaccinated individual still developed laboratory-confirmed COVID-19. **Conclusion.** COVID-19 vaccination coverage is still low in Cameroon compared to the target of 60%. Although data completeness is still an issue, the protection against severe forms of the disease provided by the vaccines currently used is quite satisfactory. There is however a need to intensify all strategies to make people adhere to vaccination in order to protect them against severe form of the disease.

ABSTRACT

Objectif. Évaluer la couverture vaccinale nationale, les manifestations adverses post-immunisation (MAPI) et d'évaluer le statut vaccinal des patients infectés par la COVID. **Méthodes.** Les données sociodémographiques sur la vaccination et les caractéristiques cliniques des cas de COVID-19 ont été extraites des bases de données nationales du COVID-19 du Centre des Urgences de Santé Publique et du Programme Élargi de Vaccination. **Résultat. U**n nombre total de 808 229 sur 27 869 965 (2,9%) a été complètement vacciné le 13 février 2022 au Cameroun. Le vaccin le plus demandé était Janssen avec 48,24 % des doses totales administrées. La région de l'Adamaoua présentait la meilleure performance (11,3% d'adultes totalement vaccines). Les personnels soignants étaient les plus vaccinés parmi les groupes prioritaires (43,4%). Seuls 8 % des cas de COVID-19 ont été vaccinés et 0,22 % de tous les vaccinés ont encore développé le COVID-19. L'évaluation de la tolérance a identifié 1,83 MAPI non graves et 0,1 MAPI grave pour 1000 doses administrées. Seuls 7% des individus vaccinés ont encore développé le COVID-19 confirmé en laboratoire. **Conclusion.** La couverture vaccinale COVID-19 est encore faible au Cameroun par rapport à l'objectif de 60%. La protection contre les formes graves de la maladie apportée par les vaccins actuellement utilisés est tout à fait satisfaisante. Il est cependant nécessaire d'intensifier toutes les stratégies pour faire adhérer la population à la vaccination afin de les protéger contre les formes graves de la maladie.

INTRODUCTION

Since WHO declared the emergence of coronavirus disease 2019 (COVID-19) pandemic, over 5.8 million people have died worldwide [1]including over 1915 people in Cameroon.[2]There has been an unprecedented worldwide effort by private and public institutions to develop a vaccine against its causative agent, the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). Concerning the SARS-CoV-2 strains characterized globally, as the pandemic was progressing, the world observed the emergence of new variants identified as Alpha (B.1.1.7 in UK September 2020), Bêta (B.1.351 in South-Africa, May 2020), Gamma (P.1 in Brazil, November 2020) , Delta (B.1.1.617.2 in India, October 2020) and the most recent

Omicron (B.1.1.529 in many countries in the world on November 2021)[3].

Cameroon health authorities represents by the National Immunization Technical Advisory Groups (NITAG) and the Scientific Advice for Public Health Emergencies have approved four vaccines against SARS-CoV-2. So, the BBIBP-CorV (Sinopharm), the ChAdOx1 nCoV-19 adenoviral (AZD1222; Oxford- Astra Zeneca), the JNJ-78436735 (Ad26.COV2. S; Johnson and Johnson) and more recently the BNT162b2 mRNA (Pfizer-BioNTech) for immunization against this disease. They responses prioritized the target populations for the vaccination against COVID-19 as follows: front-line health and social workers, people over 50 with morbidities or conditions, workers over 50 years who are critical for the functioning of the State.

The efficacy SARS-CoV-2 vaccine against severe forms of the disease vary from 73%, 86%, 94%; and 95% respectively for Sinopharm, Johnson and Johnson, AstraZeneca, and Pfizer[4]. The first administration of a COVID-19 vaccine in the Cameroon occurred on April 12, 2021 during the second wave, the country was facing. To achieve the objective of at least 60 % vaccinated population, 840 vaccination centers disseminated across the country were put in place and three rounds of national vaccination campaign were organized to boost national vaccination coverage.

To our knowledge, no study to date has evaluate the overall coverage of vaccination against SARS-CoV-2 and the impact of all this vaccination improvement in Cameroon. We carried out a descriptive cross-sectional analysis, in other to assess national vaccination coverage, adverse events following immunization and evaluate the vaccination status in COVID infected patients and their prognosis.

METHODS

Study design, period and setting

A cross-sectional observational study was used. It was conducted in Cameroon between April 2021 to February 2022. Cameroon is a country in Central Africa with an estimated population in 2022 of over 27.6 million[5,6]. The country is divided into ten regions with heterogeneous socio-demographic characteristics.

Study population

Cameroonian residents, aged 18 years or more whose data were recorder in the COVID-19 database of MINSANTE were included in this study.

Data collection tools and procedures

Data on COVID-19 pandemic in the country were recorded on daily basis across the national territory from 840 vaccinations Centres and all hospital based or related COVID-19 care centres disseminated throughout the country in a web platform called DHIS 2 (District Health Information Software) used by the Cameroon MINSANTE for national data collection of all programs and easily made available for extraction and analysis at all level of the health pyramid.

Databases and datasets

Databases and datasets were concerning:

- COVID-19 notifications/alerts (based on subject statements)
- The cases (PCR+ RDT laboratory confirmed)

Extracted data

- Socio-demographic: age, gender, vaccination status
- Clinical assessment (asymptomatic, symptomatic: mild, moderate and severe)
- Intensive Care Unit (ICU) admission
- Information on mortality.
- Vaccination information (dates and types of vaccines received)

Data quality assessment

Missing data analysis will be performed on all databases received from each region to determine the completeness of the raw data sets in addition to determining the relationship between missing variable values.

If the missing mechanism for missing variable values is determined to be completely missing at random (MCAR) and there is a low proportion of missing variable values (<30% of columns have less than 30% missing values . This is an arbitrary threshold, subject to change), these observations may be suppressed to allow for a full case analysis. Otherwise, multiple imputation should be implemented on the dataset.

If the determined absence mechanism is Missing at Random (MAR), multiple imputation must be implemented.

If the determined absence mechanism is Missing Not at Random (MNAR), then data recovery strategies must be implemented to recover missing values.

Operational definition

First shot: represents 1st vaccination with Astra Zeneca (AZ), Sinopharm, Pfizer and Johnson & Johnson (J&J).

Second shot: represents the second vaccination contact with AZ, Sinopharm, Pfizer.

Booster shot: means any supplementary shot received after having completed the vaccinal schedule to be considered fully immunized.

Confirmed cases: people identified as positive to SARS-CoV-2 using laboratory test, namely PCR and RDT tests of COVID-19.

Data procession and analysis

Data on vaccination, and clinical characteristics of Covid-19 cases were extracted from the national Covid-19 databases of the Public Health Emergency Center and the Expanded Program on Immunization available on DHIS 2. Extracted data in an Excel 2010 form, were then exported to SPSS Version 26 software for further processing and analysis.

RESULTS

National vaccinal coverage

As of 13 February 2022, so as the end of the fifth epidemiological week, a total number of 808 229 people were fully vaccinated representing 7.76% of target population (n=13 758 942) and 2.9% of total population (n=27 869 965). The Janssen/Johnson and Johnson was the most requested vaccine followed by Oxford-Astra Zeneca representing a proportion of 48.24% and 38.49%

respectively of all administered vaccine doses. The Pfizer vaccine which was recently acquired by the country is the least used vaccine with only 1689(0.13%) shots administered (Table I).

Table I : Distribution of vaccinated people according to type of vaccines and number of shots received, February 2022, Cameroon

People vaccinated	Administered vaccine				
	Astra Zeneca	Sinopharm	Pfizer	Janssen	Total
One shot	342 750	113 466	1 386	610 410	1 068 012
Two shots	144 555	52 961	303		197 819
Booster dose	28	0	0	356	384
Total	487 333	166 427	1 689	610 766	1 266 215
Percentage	38.49	13.14	0.13	48.24	100
Percentage of target population having received at least one shot : 7.76%			Percentage of total population fully immunized : 2.9%		
Percentage of target population fully immunized : 5.87					

Table II : Distribution of vaccinated people in ten regions, February 2022, Cameroon.

Region	Target Population	First shot*	Percentage	Second shots**	Booster dose	Fully immunized	Percentage
Adamawa	753 881	95 881	12.7	18 571	0	85 208	11.3
Centre	2 568 486	167 563	6.5	28 065	252	116 201	4.5
East	689 284	67 289	9.8	15 626	0	48 884	7.1
Far North	2 526 584	207 806	8.3	51 492	0	156 041	6.2
Littoral	2 166 869	123 168	5.7	17 974	108	91 187	4.2
North	1 533 515	161 097	10.6	19 283	0	123 598	8.1
North West	936 621	72 804	7.8	14 264	0	62 078	6.6
West	1 167 571	97 408	8.4	17 492	24	69 129	5.9
South	450 052	32 811	7.5	8 501	0	27 067	6.0
South West	966 080	42 185	4.4	6 551	0	28 836	3.0
Total	13 758 942	1 068 012	7.8	197 819	384	808 229	5.9

*First shot = 1st AZ shot + 1st Sinopharm shot +1st Pfizer shot + J&J shot
**Second shot = 2nd AZ shot + 2nd Sinopharm shot +2nd Pfizer shot

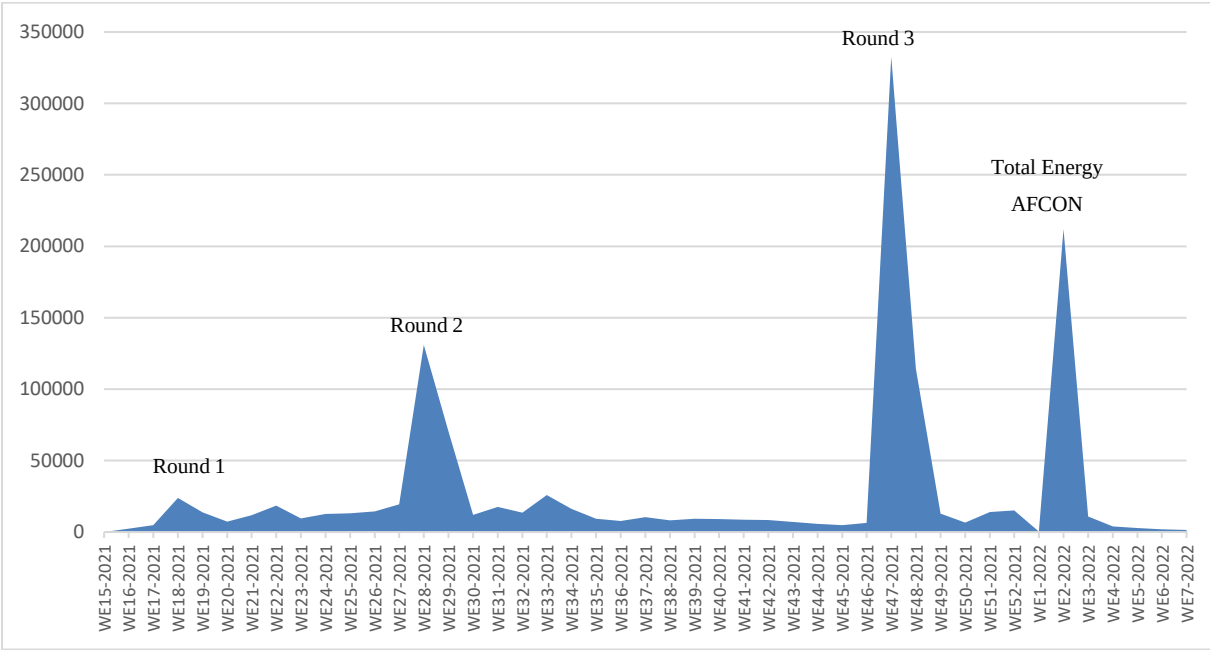

Figure 1 : Evolution of SARS-CoV-2 immunization on week 5, February 2022, Cameroon

The evolution of number of people vaccinated per week presented in Figure 1 shows four pics observed during different successive campaign rounds. We also note that the number of people vaccinated was increasing with time during mass vaccination rounds during which sensitization where done before the effective vaccination through fixed and mobile strategies. The country having hosted the Total Energy AFCON 2021during the period of 9th January to 6th February. The COVID-19 pass was in force in all the football stadiums associating a vaccination against SARS-CoV-2 and COVID-19 negative test of less than 24 hours for rapid antigenic diagnostic tests or 72 hours for PCR tests. This was an opportunity to boost again the vaccination coverage in the country. The round three was the most prolific with nearly 350 000 people caught up with the SARS-CoV-2 vaccine (Figure 1).

The distribution of vaccinated individual in the country showed, majority of people fully immunized were men 58%, women representing only 42% of the 808 229 fully immunized people in the country at week fifth. This disparity is observed as well in some northern regions where this difference is more flagrant. These are Adamawa, Far North and Adamawa regions with sex ratios of man/women of 1.83, 1.72 and 1.5 respectively (Figure 2).

The vaccination against SARS-CoV-2 among priority groups shows that health care worker (HCW) are the most

covered target (n= 133 304) with 43.4% of people vaccinated followed by elderly people (7.9%) and people with comorbidity 6.2% (see Table III).

Table III : Distribution of fully immunized people among priority groups by region, February 2022, Cameroon

Region	Health care worker			Elderly people			People with comorbidity		
	Target	Fully immunized	Vaccinal coverage	Target	Fully immunized	Vaccinal coverage	Target	Fully immunized	Vaccinal coverage
Adamawa	5 004	3 921	78.4	135 291	22 346	16.5	135 291	4 580	3.4
Centre	34 230	9 013	26.3	528 393	25 839	4.9	528 393	39 005	7.4
East	7 082	3 991	56.4	131 052	13 133	10.0	131 052	1 890	1.4
Far North	12 928	12 176	94.2	376 370	45 129	12.0	376 370	7 177	1.9
Littoral	24 693	6 392	25.9	525 279	16 345	3.1	525 279	36 520	7.0
North	8 068	5 601	69.4	232 884	23 615	10.1	232 884	22 903	9.8
Northwest	11 306	5 795	51.3	172 352	27 303	15.8	172 352	9 138	5.3
West	17 100	5 834	34.1	224 670	17 298	7.7	224 670	26 319	11.7
South	5 676	2 636	46.4	114 071	9 102	8.0	114 071	2 554	2.2
Southwest	7 217	2 549	35.3	185 022	6 157	3.3	185 022	12 992	7.0
Total	**133 304**	**57 908**	**43.4**	**2 625 384**	**206 267**	**7.9**	**2 625 384**	**163 078**	**6.2**

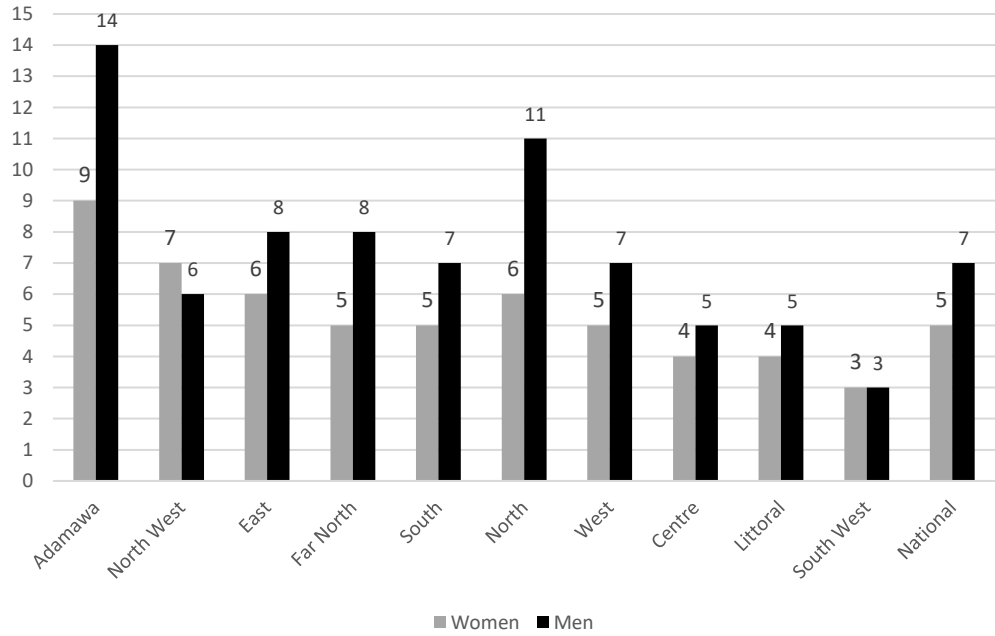

Figure 2 : Vaccinal coverage distributed by Sex and Region, February 2022, Cameroon

Among HWC, the Far North region presented the best performance (94.2%) followed by the Adamawa region (78.4%). In elderly people, the top is occupied by the Adamawa region (16.5%) followed directly by the North West region (15.8%). In this two groups the Center and the Littoral regions are the least performant (Table III).

Among people with comorbidity (n=2 625 384), the West region has the best coverage with 11.7% followed by the North region (9.8%).

SARS-CoV-2 cases among vaccinated

Since the start of vaccination (April 12, 2021), we have recorded 29 998 confirmed cases of COVID-19, including 2 326 vaccinated in the country. A total of 1 068 012 people who has received at least one dose of vaccines all type of vaccines comprised, 2 326 developed COVID-19 giving an overall proportion of 0.22 % cases of SARS-CoV-2 among vaccinated people.

The majority of COVID-19 cases in Cameroon were unvaccinated (74%) only 8 % of all cases were vaccinated. A proportion of individual (18%) did not confirm their vaccination status when they were diagnosed COVID-19 positive and they were therefore classified as having unknow immunization status (Figure 3).

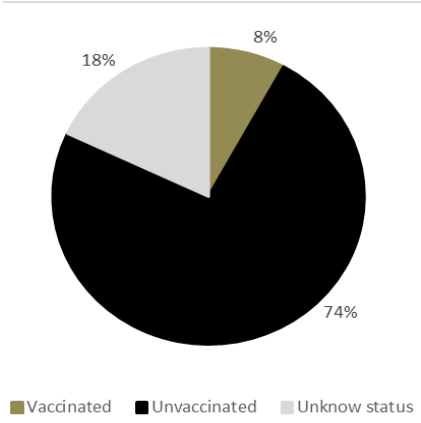

Figure 3 : Distribution of COVID-19 cases according to immunization status, February 2022, Cameroon

Among 2326 confirmed cases of COVID-19 recorded, 2267 that had information on individual characteristic were classified as presented in figure 4 below. Male were more represented than female with the 30-39 years being the most represented age group followed by the 40-49 years.
Among all vaccinated cases with COVID-19 58% were male and 42% were female (Figure 4).

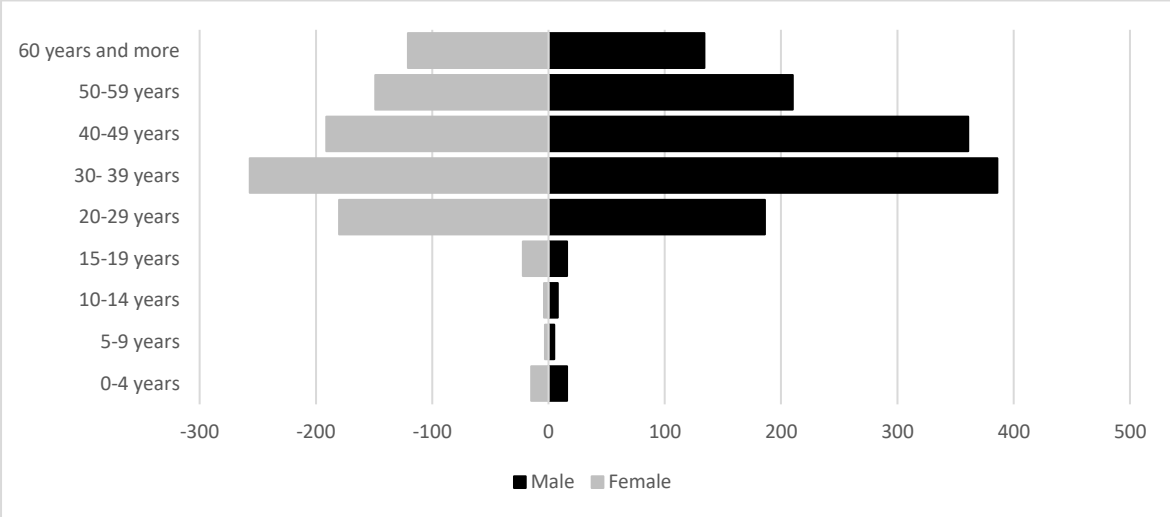

Figure 4: Distribution of COVID-19 cases among vaccinated individual, February 2022, Cameroon.

Tableau IV : Distribution of confirmed COVID-19 cases among vaccinated according to regions, February 2022, Cameroon

Regions	Vaccinated	Asymptomatic	Symptomatic	Vaccinates cases in UCI	Death
Adamawa	4	0	4	0	0
Centre	32	6	26	0	0
East	78	72	6	0	0
Far North	137	50	87	0	0
Littoral	1577	1352	225	0	0
North	0	0	0	0	0
North-West	369	25	344	0	4
West	54	5	49	0	0
South	75	21	54	1	0
South- West	0	0	0	0	0
Total	**2326**	**1531**	**795**	**1**	**4**

Table V : Synthesis of AEFI by region, February 2022, Cameroon

Regions	Administered doses	Non serious AEFI		Serious AEFI		Serious AEFI linked to vaccination by NCAE	
		Number	Proportion*	Number	Proportion*	Number	Proportion*
Adamawa	114 497	88	0.8	3	0.0	1	0.009
Centre	190 208	879	4.6	17	0.1	5	0.026
East	82 915	87	1.0	10	0.1	3	0.036
Far North	260 481	162	0.6	3	0.0	0	0.000
Littoral	142 228	302	2.1	12	0.1	2	0.014
North	182 147	77	0.4	0	0.0	0	0.000
North West	87 163	24	0.3	4	0.0	1	0.011
West	115 081	128	1.1	1	0.01	0	0.000
South	42 144	202	4.8	6	0.1	2	0.047
South West	48 957	113	2.3	8	0.2	3	0.061
Total	**1 265 821**	**2 062**	**1.83**	**64**	**0.1**	**17**	**0.013**

*Proportion per 1000 doses of administered vaccine

Table VI : Synthesis of AEFI by type of vaccine, February 2022, Cameroon

Vaccines	Administered doses	Non serious AEFI		Serious AEFI		Serious AEFI linked to vaccination by the NCAE	
		Number	Proportion*	Number	Proportion*	Number	Proportion*
Sinopharm	166 417	198	1.19	20	0.120	5	0.030
Astra Zeneca	487 305	476	0.98	18	0.037	6	0.012
Johnson & Johnson	610 410	1 388	2.27	26	0.043	6	0.010
Pfizer	1 689	0	0.00	0	0.000	0	0.000
Total	**1 265 821**	**2 062**	**1.63**	**64**	**0.051**	**17**	**0.013**

*Proportion per 1000 doses of administered vaccine

SARS-CoV-2 vaccines pharmacovigilance

The surveillance system established for pharmacovigilance of the COVID-19 vaccine investigated 64 serious AEFI since the beginning of the vaccination campaign in the country in April 2021. This corresponding to a proportion of 0.1 per 1000 shots and validated as linked to vaccination at only 0.013 per 1000 shots by the NCAE (National Committee of AEFI Experts). A total number of 2 062 non-serious AEFI was notified corresponding to 1.83 AEFI per every 1000 doses administered (Table IV).

Globally, the Johnson & Johnson vaccine were the biggest provider of non-serious AEFI with 2.27 cases per 1000 shots and followed by Sinopharm and Astra Zeneca. On the other hand, the proportion of serious AEFI was more important for Sinopharm with 0.120 per 1000 shots followed by Johnson & Johnson and Astra Zeneca. Apart from Pfizer which was recently acquired with little doses administered and with no AEFI notified to date, the vaccine with average AEFI according to our results was Astra Zeneca (Table V).

DISCUSSION

Our study revealed that a proportion of only 2.9 % of total population is fully immunized despite the fact that Cameroon health authorities have made the vaccine available in all district of the country with additional three round of mass vaccination campaign, all this activities being preceded by social mobilization in all media to raise eligible adult awareness on vaccine availability and utility in the fighting against SARS-CoV-2 pandemic. this weak performance could be explained by the high prevalence is vaccine hesitancy among Cameroon adult population.

Vaccine hesitancy is an old phenomenon that represents a serious threat to global health, as shown by the resurgence of some infectious diseases (e.g., outbreaks of measles and pertussis)[7,8]. The huge leaps in developing efficacious and safe COVID-19 vaccines within a short period were unprecedented[9,10] Nevertheless, COVID-19 vaccine hesitancy can be the limiting step in the global efforts to control the current pandemic with its negative health and socio-economic effects.[11,12] Psychological factors, especially the perception of adverse events and vaccine contents of COVID-19 vaccines is one the most important brake for vaccination against SARS-CoV-2[13].

A review of COVID-19 data at week five in Central Africa sub-regional countries showed higher performance than Cameroon, these are Equatorial Guinea, Central African Republic, Congo and Gabon with 14.08%, 120.9%, 10.58% and 10.29% of total population fully immunized against COVID 19 respectively. This result was also very low compare to France (71.19%), China (85.05%), USA (64.32%) and the all world (54.18%). This disparity is probably due sociocultural background that could influence the intention to receive the vaccine by the population. On the other hand, neighboring country like Nigeria had coverage almost similar to that of Cameroon with 2.58%, Chad presents a much lower vaccination coverage with only 0.8% of total population vaccinated[14,15]. In this study, the Johnson & Johnson vaccine was the most requested by population and this may be due to its easy schedule which requires only one shot to be considered fully immunized in Cameroon.

The number of people who got vaccinated over time was increasing progressively from round one to round three and during the AFCON Total Energy. This could be explained by the fact that social mobilizers whose sensitization work precede the effective campaign vaccination were doing a remarkable job of raising awareness of target population in order to recruit as many people as possible. Moreover, over time, health authorities adapted new essential messages and strategies to be more efficient. For example, during the round three the vaccination teams were prioritizing the mobile strategy instead of the fixed strategy so as to be as close as possible to the target population. During the Total Energy AFCON, the multiplication of vaccination post and the health pass relaunched again the vaccination coverage in the country.

Concerning the vaccination across region, our result showed that northern regions (Adamawa, Far North and North were presenting good performance compared to southern regions like Centre and Littoral regions. With the impact of social media, fake news and conspiracy are shared among adults who are more connected to networks like YouTube, Facebook and WhatsApp in the southern zone and get influenced by these misinformations that tarnish all the work of sensitization made by the health authorities. As fear and doubts on vaccines are psychologically installed in the mind of individuals, they become a serious barrier, preventing eligible targets from receiving the SARS-CoV-2 vaccine[13,16–20]. Despite the fact that women are the majority in the country, they represent only 42% of the 808 229 fully immunized people in the country at week fifth. This disparity is more flagrant in northern regions where sociocultural aspect marked patriarchal predominance in many families leads to reduce decision capacity among female gender.

Within priority groups so as HCW, elderly people and those with comorbidity, the firsts were the most vaccinated with a coverage of 43.4%. This might be due to much more

perception of risk by health care worker and also the rapid accessibility to vaccines by this group who naturally works around vaccination sites. This result is not far from the one revealed by a study in Ethiopia which found that 53.1% CI :[49.3–58.9] of HWC had the intention to received the vaccine if they were proposed one[21].

Our study showed that 74% of all cases were unvaccinated which is higher than results obtained on in Washington (61.5%)[22] and 55% obtained in Virginia[23] this could be due to the more efficacious vaccines which are mainly used in USA (Pfizer-BioNTech and Moderna).

Male were more represented 58% than female 42% with the 30-39 years being the most represented age group followed by the 40-49 years. This result is in accordance with national data which identified this age group as the most affected by against SARS-CoV-2 pandemic. Moreover, being younger and strong, this male age group represent the most active age group within the population and are more subject to social interaction which is one of the main drivers of COVID-19 spread.

We had a total of one (0.0009%) case admitted and managed in intensive care unit (UCI) due severe form of the disease and 4 death (0.004%) among vaccinated people. This results are lesser than those obtained in Virginia which obtained 3.1% of COVID-19, 0.082% of hospitalized and 0.0341% of death among all vaccinated individual[23]. These results suggest that vaccination was quite efficacious in preventing severe forms and death within Cameroon population.

Some adverse events have been observed after administration of SARS-CoV-2 vaccines. In our study Janssen vaccine provide most of the non-serious adverse event. Nevertheless, this vaccine remains approved in the fight against COVID-19 by the Cameroon health authorities. The same position has been adopted by the Advisory Committee on Immunization Practices in United States on July 2021 concerning Janssen vaccine. Despite the fact it was responsible of rare adverse events like Guillain-Barré syndrome and thrombosis with thrombocytopenia syndrome, they conclude that the benefits of Janssen outweigh the risks for rare serious adverse events after COVID-19 vaccination[24]. The proportion of serious adverse events linked to Sinopharm vaccine (BBIBP-CorV) were computed at 5 cases on 166 417 administered doses (0.03 cases per 1000 doses). Other study in Iran and in China revealed different result. Indeed, these studies found that the BBIBP-CorV is a safe and well tolerated vaccine from fewer serious adverse events compared to other vaccine like ChAdOx1 nCoV-19[25] to no serious adverse event at all [26,27]. Otherwise, Sigha *et al.* in Cameroon identified and illustrated a case of herpes zoster reactivation in a young person without any comorbidity after COVID-19 vaccination [28].

A proportion of 7% of vaccinated people later had laboratory-confirmed COVID-19 in this study. The titer of antibody after vaccination reducing with time, this exposes the individual to an eventual contamination by SARS-CoV-2 few months after vaccination. Besides, COVID-19 vaccines doesn't provide a 100 percent protection against asymptomatic, symptomatic and severe cases[4]. This proportion is higher than the 0.54% found in Israel among vaccinated HCW after receiving their complete doses of BNT162b2 mRNA[29]. This mRNA vaccine being one of the most efficacious vaccine, this could explain that difference because in Cameroon, the most used SARS-CoV-2 vaccines were Janssen, Astra Zeneca and Sinopharm which are less efficacious than Pfizer/BioNTech.

CONCLUSION

Covid-19 vaccination coverage is still low in Cameroon compared to the target of 60%. Although data completeness is still an issue the protection against severe forms of the disease provided by the vaccines currently used is quite satisfactory. Globally, SARS-CoV-2 vaccine was not only efficacious in preventing severe forms and death and also well tolerated by receivers. There is however a need to intensify all strategies to guaranty vaccines accessibility to all sections of the population especially to all priority groups, reduce gender disparity and make people adhere to vaccination in order to protect them COVID-19.

Ethical considerations

We could not obtain consent from participants because data came from a national database. Nevertheless, the authorizations of the health authorities responsible for the vaccination program at the Ministry of Public Health have been obtained. Moreover, no personal informations has been disclosed in the presentation of results, thus ensuring the confidentiality of all participants.

Limitations

In this study, we could not be able to clearly identify the fully or partially vaccinated status of confirmed COVID-19 cases.

Abbreviations

RDT: Rapid diagnostic test, PCR: Polymerase chain reaction

Author contributions

(I) Conception and design: A. Amani; (II) Administrative support: A. Amani; (III) Collection and analysis of data: Christian Mouangue; Cheuyem Lekeumo Fabrice Zobel; A. Amani; (IV) Data interpretation and discussion: Cheuyem Lekeumo Fabrice Zobel (V) Manuscript writing: All authors; (VI) Final approval of manuscript: A. Amani.

Competing interests

The authors declare no competing interest

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