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Dynamic of Knowledge, Perception and Acceptance of Coronavirus Disease 2019 (COVID-19) Vaccines in Brazzaville

Faust René Okamba[1,2,*] ,Mandingha Kosso Etoka-Beka[2], Cyr Jonas Morabandza[3], Sagesse Loko[2], Brave Nzoussi[2], Adelon Dane Pambou Tsaty[2], Nivale Brevia Elgha[2] Prudence Spinelie Koumba Pambou[2], and Arnaud Wilfrid Ossibi Etou[1]

[1]Faculté des Sciences de la Santé (FSSA), Université Marien Ngouabi, B.P, Brazzaville, République du Congo
[2]Laboratoire d'immunologie, Institut de Recherche en Sciences de la Santé (IRSSA), Brazzaville, République du Congo
[3]Laboratoire de Microbiologie, Infectiologie et Immunologie, ENS, UMNG B.P, Brazzaville, République du Congo

***Corresponding author:** Faust René OKAMBA, Institut de Recherche en Sciences de la Santé (IRSSA), Cité Scientifique (ex OROSTOM), route de l'Auberge de Gascogne, quartier Ngangouoni-Château d'eau, Brazzaville Congo, Tel: +242-068574952; E-mail: frokamba1@gmail.com

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Abstract

Coronavirus disease 2019 (COVID-19) vaccines are crucial tools to prevent most people from contracting the disease and getting out of the pandemic. However, getting people to accept these vaccines remains a challenge, especially for many African countries. This study aimed to assess the dynamic of knowledge, perceptions and acceptance of COVID-19 vaccine in the Congolese population. To do this, we conducted series of cross-sectional surveys in Brazzaville, before (February10 to March 22, 2021) during (August 3 to September 4, 2021) the vaccine rollout. A self-administered questionnaire was designed to collect data from participants, and the chi-square test was performed to compare data between both study periods. The statistical significance was defined at $P<0.05$. Of the 806 and 768 participants surveyed, only 234 (29.03%) and 282 (37.2%) showed fairly good knowledge of covid-19 vaccines (score >50%) before and during the vaccine rollout, respectively. Approximately 57.8% of the participants exhibited a positive perception towards COVID-19 vaccines prior to the vaccine rollout. This proportion dropped significantly at 50.15% in August-September, while the rate of hesitancy and refusal to be vaccinated significantly increased (45.53% *vs* 57.26%; $P<0.001$). Before the vaccine rollout, 439 (54.47%) of participants intended to be vaccinated, whereas they were only 324 (42.74%) during the vaccine rollout ($P<0.001$). It was also found that women were less willing to be vaccinated than men in both study periods. Taken together, this study revealed a low level of knowledge and a lack of confidence towards COVID-19 vaccines in Brazzaville. These findings may inform public health public health authorities in developing relevant strategies that promote COVID-19 vaccines acceptance in Congo.

Keywords: COVID-19 vaccine; Vaccine knowledge; Vaccine perception; Vaccine acceptance; Brazzaville

Introduction

The Coronavirus disease 2019 (COVID-19) is a communicable respiratory disease caused by a virus in the Coronavirus family, named severe acute respiratory syndrome -2 (SARS-CoV-2). This virus is phylogenetically close to SARS-CoV-1, which was responsible for the first major human coronavirus outbreak in 2002-2003 [1]. SARS-CoV-2 emerged from China in December 2019 [2], and it has quickly spread to the rest of the world infecting millions of people and causing hundreds of thousands of deaths. Consequently, the World Health Organization (WHO) declared COVID-19 as a pandemic on March 11, 2020 [3].

It is globally recognized that vaccines play a critical role in global health by preventing infection and transmission of multiple diseases worldwide. So, from the beginning of the COVID-19 pandemic, it was quickly understood that global vaccination against COVID-19 is necessary and urgent to control this pandemic and save lives. Consequently, in historically record time, several potential COVID-19 vaccines have been developed in different types, including inactivated virus vaccines, RNA-based vaccines and adenovirus vector vaccines [4]. The latter two are considered subunit vaccines because they contain a single antigen encoding the spike (S) protein of the virus. The spike (S) protein that mediates SARS-CoV-2 entry into host cells, and is a major target for vaccines and therapeutics [5]. Importantly, prior to their widespread use, the immunogenicity, efficacy and safety of these vaccines have been demonstrated in clinical trials [6]. Regarding the immunogenicity, it has been shown that the COVID-19 vaccines are able to stimulate both humoral and cellular immune responses [6]. The magnitude of the humoral response is correlated with protection from symptomatic [7]. SARS-CoV-2-specific CD4+ and CD8+T cell responses and recovery from COVID-19 have been observed in patients who have not produced antibodies, suggesting that the cell-mediated immunity also plays a role in protecting against the COVID-19 disease [8].

In the Republic of Congo, the COVID-19vaccine rollout was launched on 25 March 2021 with the objective of vaccinating 60% of total population. By the end of August 2022, only about 12% of the population was fully vaccinated, despite the availability of

vaccine doses. This means that many Congolese remain hesitant in the face of COVID-19 vaccination. Indeed, vaccine hesitancy is a major global problem that represents a barrier to efforts to control the COVID-19 pandemic [9]. As a result, studies to assess the acceptability of COVID-19 vaccines in each community are essential, as the resulting information can help the relevant authorities develop strategies to convince people to get vaccinated. It is also essential to monitor temporal changes in acceptability as COVID-19 vaccination progresses. Thus, the purpose of this study was to assess the dynamic of knowledge, perceptions and acceptance In Brazzaville, which is the capital of the Republic of Congo.

Materials and Methods

Study design and periods

This was series of cross-sectional study conducted before the vaccine rollout (February10 to March 22, 2021) and during the vaccine rollout (August 3 to September 4, 2021) in Brazzaville. The latter Brazzaville is the capital and largest city of the Republic of Congo. According to the 2021 national household census, Brazzaville has a total population of about 2.4 million.

Study population

The study population was composed of individuals residing in different districts of Brazzaville. Any adult aged 18 years or older, who could read and write in French, residing in Brazzaville and who voluntarily agreed to participate in the study was included in the starting population. People who reported having already been vaccinated against COVID19 were not included in the study. The sample size of the study population was estimated using the Raosoft sample size calculator. To do this, we hypothesized a 95% confidence interval (CI), a 5% margin of error, and that 50% of the adult population agreed to be vaccinated against COVID-19. As result, the minimum sample size for this study was 385 participants.

Data collection

Three age groups were defined, 18-34, 35-49 and 50 years or above. People to participate in this study were recruited through face-to-face interviews. Their data were collected using a self-administered questionnaire which consisted of four sections. The first section was to collect socio-demographic data from participants. The second section contained statements to assess participants' knowledge about COVID-19 vaccines. The third section contained statements to assess participants' perceptions about COVID-19. Finally, the fourth section was to investigate the acceptability of participants to get vaccinated against COVID-19. The estimated time to complete the questionnaire was approximately 10 minutes but the participants had the choice to take more time to complete it. For sections 1, 2 and 3, the answer options for each question or statement were "yes", "no" or "don't know". Participants who did not complete the questionnaire in full were excluded from statistical analysis.

Statistical analysis

The numeric score of 1 or 0 was assigned to each response and entered into Microsoft Excel 2016. Data were analyzed using GraphPad Prism Software Version 9.4.1. The descriptive statistics were presented as frequency, percentage, mean and standard deviation (SD).The Comparison between the variables were performed using the chi-square test. Statistical significance was defined at $P<0.05$.

Ethical Consideration

The study protocol was submitted to the Committee of Ethics of Research in Health Sciences (CERSSA) of the Ministry of Scientific Research and Technological Innovation of the Republic of Congo. Before giving the questionnaire to each of the participants, the purpose and expectations of the study were explained to them by the investigators. The participation in this study was voluntary, without any form of coercion or compensation. The survey was completely anonymous, with no identifiable information such as name, phone number or address. Participants were given the right to refuse to take part in the study.

Results

Socio-demographic characteristics of participants

Total of 806 and 758 of participants were successfully interviewed on February-March (before the COVID-19 vaccine rollout) and August-September (during the COVID-19 vaccine rollout), respectively, in Brazzaville. Table 1 shows the socio-demographic characteristics of the participants. The majority of were men, with 430 (53.35%) and

Table 1: Sociodemographic characteristics of the participants.

Characteristics	Before COVID-19 vaccine rollout N (%)		During COVID-19 vaccine rollout; N (%)			
	Men 430 (53.35%)	Female 376 (46.65%)	Total 806	Men 404 (53.3%)	Female 354 (46.7%)	Total 758
Age (years)						
18-34	174 (40.46%)	150 (39.9%)	324 (40.02%)	152 (37.62%)	128 (36.16%)	280 (36.94%)
35-49	147 (34.19%)	128 (34.04%)	275 (34.12%)	138 (34.16%)	138 (38.98%)	276 (36.41%)
≥ 50	109 (25.35%)	98 (26.06%)	207 (25.68%)	114 (28.22%)	88 (24.86%)	202 (26.65%)
Heard about COVID-19 vaccines						
Yes	328 (76.28%)	275 (73.14%)	603 (74.82%)	371 (91.83%)	300 (84.74%)	671 (85.48%)
No	102 (23.72%)	101 (26.86%)	203 (25.18%)	29 (8.17%)	58 (16.38%)	87 (14.52%)
Sources of information about COVID-19 vaccines						
Mass media (e.g., TV, Radio)	237 (55.12%)	234 (62.23%)	471 (58.44%)	225 (55.69%)	226 (63.84%)	451 (59.50%)
Social media (e.g., WhatsApp, Facebook)	162 (37.67%)	155 (41.22%)	317 (39.33%)	163 (40.35%)	152 (42.94%)	315 (41.56%)
Internet (e.g., Google)	64 (14.88%)	61(16.22%)	125 (15.51%)	75 (18.56%)	52 (14.69%)	127 (16.75%)
Newspapers	26 (6.05%)	15 (3.99%)	41 (5.09%)	31 (7.67%)	13 (3.67%)	44 (5.80%)
Friends/colleagues/family members	180 (41.86%)	172 (45.74%)	352 (43.67%)	177 (43.81%)	170 (48.02%)	347 (45.78%)

404 (53.3%) before and during the vaccine rollout, respectively. People aged 50 or older were the least represented in this study, with only 207 (25.68%) of the participants in February-March and 202 (26.65%) in August-September. A large majority of the participants (74.82% and 85.48%) reported having heard about COVD-19 vaccines prior to our study. Mass media, friends/colleagues/family members and social media were the main sources of information about COVID-19 vaccines for the participants during the two study periods.

Knowledge of the participants towards COVID-19 vaccines

Participants' level of knowledge about COVID-19 vaccines was assessed through 8 statements (Table 2). Before and during the vaccine rollout, the majority of participants were aware that COVID-19 vaccines are the biologics product that boost the immune system to prevent COVID-19(529 (65,63%) and 528 (69,66%), are not the antibiotics (458 (56,82%) and 433 (57,12%), are made from the killed coronavirus (427 (52,9%) and 430 (56,73%) and stimulate the body to produce specific antibodies (462 (57,32%) and 473 (62,40%). By contrast, they were not the majority to know that COVID-19 vaccines can also be in the form of RNA-based vaccines (30,89% and40,37%) and of adenovirus vector-based vaccines (17,12% and 20,84%), and that COVID-19 stimulate the body to produce specific T-cells (19,23%) and they induce the immune memory(22,43%).The mean knowledge score was 4.12 ± 1.94 before the vaccine rollout and did not differ significantly (P=0,878)from that during the vaccine rollout (4.4 ± 2.0). Only 234 (29.03%) of the participants had good comprehensive knowledge about the COVID-19 vaccine (mean score >50%) before the vaccine rollout and 282 (37.2%) during the vaccine rollout (Figure 1).

Perception of the participants towards COVID-19 vaccines

This was evaluated through 6 questions (Table 3). In February-March, before the COVID-19 vaccine rollout, of the 806 participants surveyed, 575 (71.34%) recognized that vaccines are the best tools to stop the COVID-19 pandemic (question 1). More than half of the participants also stated that COVID-19 vaccines are effective in stopping infection and its transmission (61.39% and 61.16%), are safe (55.81%) and do not contain toxic substances (52.09%).Similar data were observed in August-September, except for questions related to the vaccine safety. Less than half of the participants accepted that vaccines are safe (43.8%) and do not contain toxic substances (40.76%). Expect for the question 1, the perception of participants about COVID-19 vaccines tended significantly (P<0.05) to be negative on all aspects during the vaccine rollout compared to before the vaccine rollout.

Table 2: Knowledge of the participants about COVID-19 vaccines.

Correct response; N (%)							
Statements	**Period**	**18-34 years**	**35-00349 years**	**≥ 50 years**	**Men**	**Women**	**Total**
1. COVID-19 vaccines are the biological products that boost the immune system to prevent COVID-19 **(True)**							
	FM	212 (65,43%)	188(68,73%)	129 (62,32%)	293 (68,14%)	236 (62,76%)	529 (65,63%)
	AS	195 (69,64%)	184 (66,67%)	149 (73,76%)	284 (70.3%)	244 (68,93%)	528 (69,66%)
2. COVID-19 vaccines are like antibiotics disease(F)							
	FM	176 (54,32%)	171 (62,54%)	111 (53,62%)	248(57,67%)	210 (55,85%)	458 (56,82%)
	AS	162 (57,86%)	166 (60,14%)	105 (51,98%)	240 (59.4%)	193 (54,52%)	433 (57,12%)
3. COVID-19 vaccines are made from the killed coronavirus (inactivated vaccine)(True)							
	FM	166 (51,85%)	151 (55,64%)	108 (52,17%)	226 (52,56%)	201 (53,46%)	427 (52,9%)
	AS	157 (56,07%)	161 (58,33%)	112 (55,44%)	233 (57,67%)	197 (55,65%)	430 (56,73%)
4. COVID-19 vaccines are made from a coronavirus gene introduced into an adenovirus(adenovirus-based vaccine) (True)							
	FM	61 (18,83%)	60 (21,82%)	17 (8,21%)	111 (25,81%)	27 (7,18%)	138 (17,12%)
	AS	71 (25,36%)	65 (23,55%)	22 (10,89%)	86 (21,29%)	72 (20,34%)	158 (20,84%)
5. COVID-19 vaccines are made from the messenger RNAs of coronavirus (RNA-based vaccine) (True)(True)							
	FM	95 (29,32%)	96 (34,91%)	58 (28,02%)	155 (36,05%)	94 (25%)	249 (30,89%)
	AS	118 (42,14%)	114 (41,30%)	74 (36,63%)	195 (48,27%)	111 (31.07%)	306 (40,37%)
6. COVID-19 vaccines stimulate the body to produce specific antibodies to fight the COVID-19 infection (True)							
	FM	182 (56,17%)	174 (63,27%)	106 (51,21%)	272 (63,25%)	190 (50,53%)	462 (57,32%)
	AS	175 (62,5%)	183 (66,30%)	115 (56,93%)	287 (71,04%)	186 (52,54%)	473 (62,40%)
7. COVID-19 vaccines stimulate the body to produce specific T-cells to fight COVID-19 infection (True)							
	FM	75 (23,15%)	51 (18,54%)	30 (14,01%)	91 (21,16%)	64 (17,02%)	155 (19,23%)
	AS	82 (29,28%)	57 (20,65%)	31 (15,35%)	127 (31,43%)	43 (12,15%)	170 (22,43%)
8. COVID-19 vaccines induce the immune memory that protect n the long term against COVID-19 disease(True)							
	FM	94 (29,32%)	109 (39,64%)	43 (20,28%)	90 (20,93%)	156 (41,49%)	246 (30,52%)
	AS	89 (31,78%)	66 (23,91%)	33 (16,34%)	85 (21,04%)	103 (29,1%)	188 (24,80%)
Mean score ± SD	**FM**	**4.18 ± 1.77**	**4.56 ± 1.96**	**3.62 ± 2.09**	**4.32 ± 1.87**	**3.92 ± 2.03**	**4.12 ± 1.94**
	AS	**4.72±1.97**	**4.51 ± 2.01**	**3.97 ± 2.04**	**4.80 ± 2.02**	**4.01 ± 1.98**	**4.4 ± 2.0**
p-value		**0.999**	**0.959**	**0.798**	**0.999**	**0.959**	**0.878**

Overall, 57.79% of the participants exhibited a positive perception of COVID-19 vaccines prior to the vaccine rollout. This proportion dropped significantly (P<0.01) at 50.15% during the vaccine rollout (Figure 2A). By gender, the proportion of women with a positive perception of vaccines was 56.91% before the vaccine was rolled out, and dropped significantly to 48.16% in August-September. Similar proportions and a downward trend in positive perception of COVID-19 vaccines were also observed in men (Figure 2B).

Acceptance of the participants towards COVID-19 vaccines

We investigated the acceptability of participants for COVID-19 vaccines through a single question: "would you accept to be vaccinated against COVID-19?". Before the vaccine rollout), of the 806 participants, 439 (54.47%) indicated that they would agree to be vaccinated, while 232 (28.78%) would hesitate and 135 (16.75%) would refuse (Figure 3A). In August-September, out of 758 participants, 324 (42.74%) would be willing about getting vaccinated, 247 (32.59%) did not know and 187 (24.67%) would refuse (Figure 3B). Overall, before the vaccination campaign, 54.47% of participants accepted to be vaccinated, while they represented only 42.74%) in August-September, indicating a significant decrease (P<0.001) in the desire to be vaccinated in Brazzaville (Figure 3C). Among the men, 245/430 (56.98%) said they agreed to be vaccinated before the vaccination campaign. This rate dropped significantly (P<0.05) in August-September where less than the majority, 192/404 (47.52%) wanted to be vaccinated (Figure 4A). In women, there was a very significant decrease (P<0.001) in the intention to be vaccinated in August-September (137/354 (38.7%)) compared to before the vaccine rollout (194/376 (51.6%)). These findings indicated that men were likely more willing about receiving the COVID-19 vaccine than women. Considering age, the participants aged 18 to 35 years appeared to be less supportive of vaccination than older participants during the two study (Figure 4B).

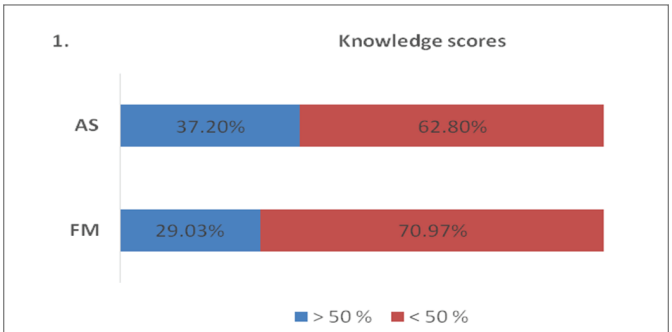

Figure 1: Overall knowledge score of the participants about the COVID-19 vaccine.
FM: February-March 2021 (before the COVID-19 vaccine rollout); AS: August-September 2021 (during the COVID-19 vaccine rollout).

Discussion

Vaccine hesitancy results from a complex decision-making process that is influenced by a wide range of contextual, individual and group, and vaccine-specific factors, which can change overtime. These factors may include, among many others, communication and media, religion, culture, gender, age, politics, geographic barriers, experience with

Table 3: Perception of the participants about COVID-19 vaccines.

Before the COVID-19 vaccine rollout				During the COVID-19 vaccine rollout				
Questions	**Response**	**Men N (%)**	**Women; N (%)**	**Total N (%)**	**Men N (%)**	**Women N (%)**	**Total N (%)**	**P-value**
1. Do you think that COVID-19 vaccines are the best tools to stop theCOVID-19 pandemic?								
	Yes	305 (70.93)	270 (71.81)	575 (71.34)	297 (73.51)	250 (70.62)	547 (72.16)	0,182
	No	66 (15.35)	57 (15.16)	123 (15.26)	68 (16.83)	53 (14.97)	121 (15,96)	
	Don't know	59 (13.72)	49 (13.03)	108 (13.4)	39 (9.65)	51 (14.41)	90 (11,87)	
2. Do you think COVID-19 vaccines are effective for protecting vaccinated people from COVID-19 infection?								
	Yes	264 (61.39)	243 (64.63)	507 (62.9)	212 (52.47)	197 (55.65)	409 (53.96)	0,008*
	No	69 (16.05)	58 (15.42)	127 (15.76)	97 (24.01)	67 (18.93)	164 (21.63)	
	Don't know	96(22.32)	74 (19.68)	170 (21.1)	95 (23.51)	90 (25.42)	185 (24.41)	
3. Do you think COVID-19 vaccines are effective for stopping the transmission of COVID-19 infection between people?								
	Yes	263 (61.16)	233 (61.97)	496 (61.54)	219 (54.21)	182 (51.41)	401 (52.90)	0,009*
	No	68 (15.81)	68 (18.08)	136 (16.87)	98 (24.26)	77 (21.75)	175 (23.09)	
	Don't know	99 (23.02)	75 (19.45)	174 (21.59)	87 (21.53)	95 (26.84)	182 (24.01)	
4. Do you think COVID-19 vaccines are safe and do not contain substances that are hazardous to health?								
	Yes	240 (55.81)	190 (50.53)	430 (53.35)	198 (40.01)	134 (37.85)	332 (43.8)	0,017*
	No	70 (16.28)	94 (25.0)	164 (20.35)	97 (24.01)	117 (33.05)	214 (28.23)	
	Don't know	120 (27.91)	92 (24.47)	212 (26.30)	109 (26.98)	103 (29.1)	212 (27.97)	
5. Do you think COVID-19 vaccines contain toxic substances that could cause sterility or cancer?								
	Yes	76 (17.67)	89 (23.67)	165 (20.47)	93 (23.01)	127 (35.87)	220 (29.02)	
	No	224 (52.09)	189 (50.26)	417 (51.24)	185 (45.79)	124 (35.03)	309 (40.76)	<0,0001*
	Don't know	129 (30.0)	98 (26.07)	227 (28.29)	126 (31.19)	103 (29.01)	229 (30.21)	
6. Do you think public health authorities talk enough about COVID-19 vaccines?								
	Yes	195 (45.35)	159 (42.29)	354 (43.92)	147 (36.39)	136 (38.42)	283 (37.33)	0,004*
	No	183 (42.56)	166 (44.15)	349(43.30)	202 (50.0)	167 (47.17)	369 (48.68)	
	Don't know	52 (12.09)	51 (1±±3.56)	103 (12.78)	55 (13.61)	51 (14.41)	106 (13.98)	

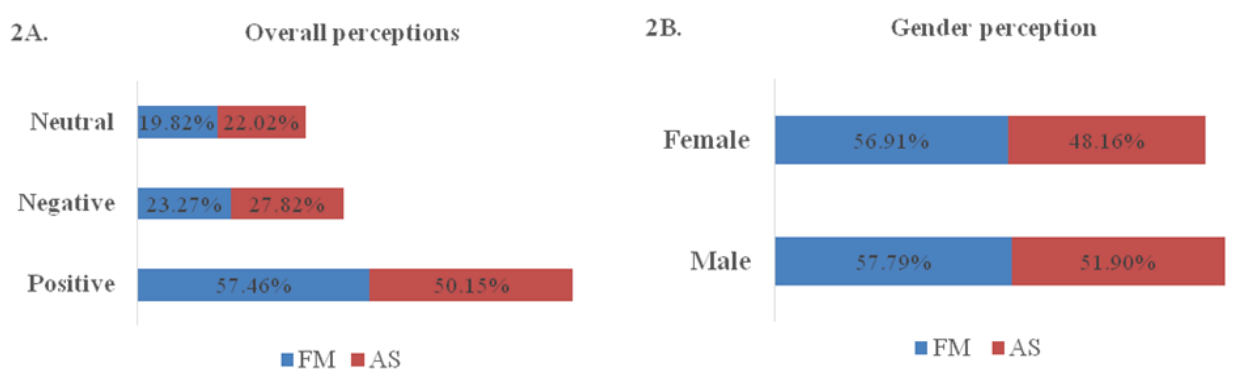

Figure 2: Overall and gender perception towards COVID-19 vaccines in the study populations.
FM, February-March (before the vaccine rollout); AS, August-September (during the vaccine rollout).

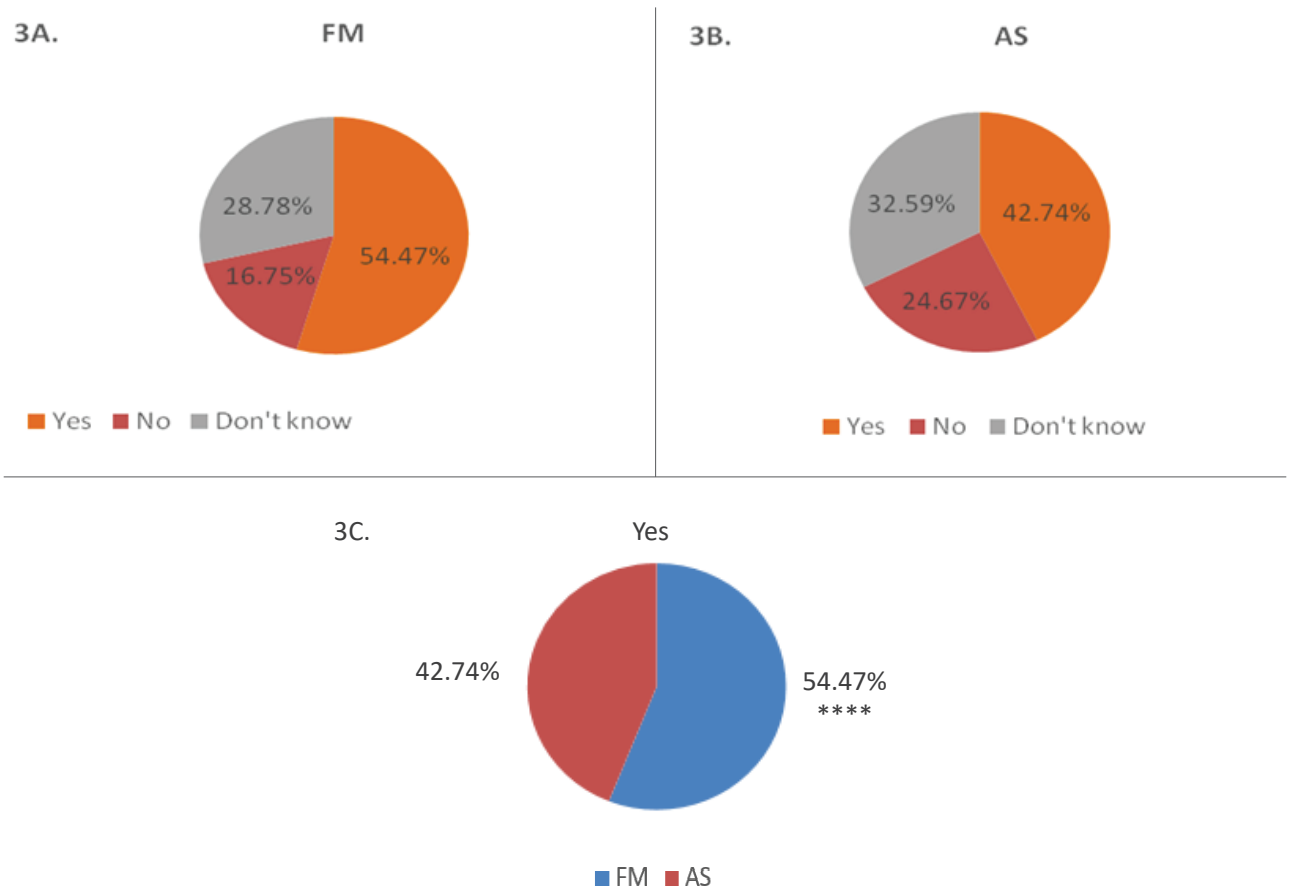

Figure 3: COVID-19 vaccine acceptance in the study populations
A, before the vaccine rollout (FM, February-March); B, during the vaccine rollout (AS, August-September); C, FM *vs* AS for the participants who accepted to get vaccinated. 54.47, P<0.0001.

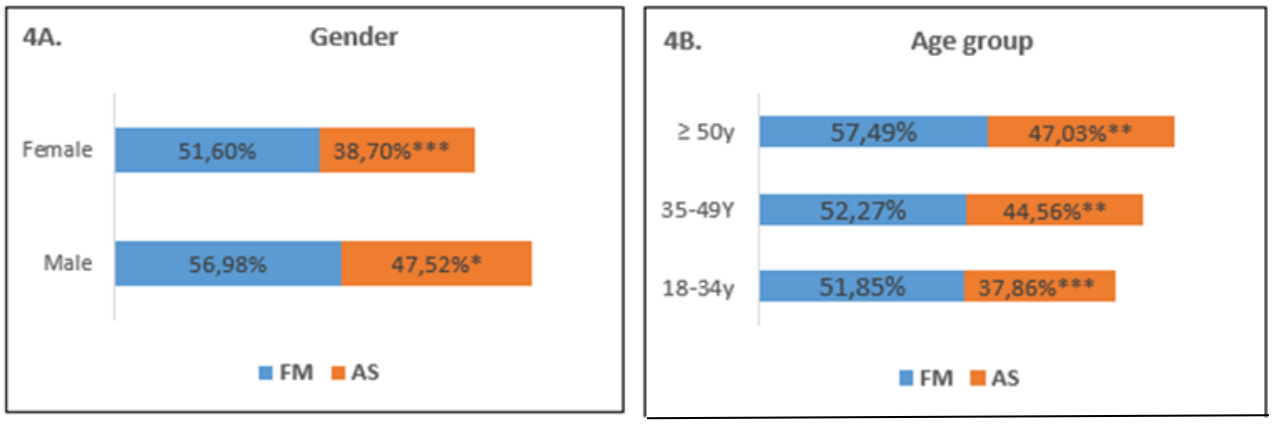

Figure 4: COVID-19 vaccine acceptance between age groups (A) and gender (B).
FM, February-March (before the vaccine rollout); AS, August-September (during the vaccine rollout). *, significant (P<0.05).

vaccination and risk perception [10]. In this study, the participants were asked to indicate their knowledge, perception and acceptance regarding COVID-19 vaccines, before and during the vaccine rollout.

As might be expected, a large majority (>70%) of the participants had already heard about COVID-19 vaccines before taking part in this study. However, only a few of them had fairly good knowledge of COVID-19 vaccines, before the vaccine rollout (29.03%) and during vaccine rollout (37.2%). This is in line to the finding of Mohamed et al. who reported that the majority of Malaysians (62.0%) had poor knowledge about COVID-19 vaccines [11]. A similar trend of insufficient knowledge levels was also reported in a study conducted among the Bangladeshi population (Islam et al., 2021). Our findings contrasted considerably with those of Abebe et al. who reported that the majority of Ethiopians (74%) had a good knowledge of COVID-19 vaccines [12]. It should be noted that the questions asked to the participants to assess their level of knowledge about COVID-19 vaccines are generally not the same from one study to another. This could explain the disparities of the levels of vaccine related knowledge between different studies.

We included in the survey form, questions about how vaccines are made and how they work. These aspects are not often taken into account in other studies, while they should also be important for a better appreciation of the level of knowledge about vaccines in the populations. They may have contributed to the low COVID-19 vaccines knowledge scores in this study. Indeed, although the majority of participants knew that COVID-19 vaccines can be in the form of inactivated viruses, only a few were able to identify that these vaccines can also be in the form of RNA-based vaccines (30 and 40% before and during the vaccine rollout, respectively) and adenovirus vector-based vaccines (17.12 and 20.84%). The participants remained unknowingly, despite the fact that these types of vaccines have been listed by the World Health Organization for emergency use in the COVID-19 vaccination campaigns, and their availability in Congo. Also, despite the fact that the conception of RNA and adenovirus vector-based vaccines, as well as their application in clinical trials, predates the COVID-19 pandemic [13,14]. Another aspect for which the participants' knowledge about COVID-19 vaccines was very insufficient concerned their functioning in the body. Under ideal conditions, an effective vaccine must induce stimulation of both humoral and cell-mediated immune responses, and confer protection by inducing the production of antibodies as well as of effect or cells and memory cells for long-term protection against the pathogen [15]. In this study, it was clear that the participants were not familiar with the notion of cell-mediated immunity. Whether before or during the vaccine rollout, only a few knew that COVID-19 vaccines stimulate the body to produce specific T cells (19,23% and 22,43%) and immune memory (30,52% and 24,80%) against the COVID-19 infection. Nevertheless, nearly three-fifth participants knew that COVID-19 vaccines induce the production of antibodies production to fight infection. This may be explained by the fact that, for practical reasons, serological tests are the most frequently used methods in the diagnosis of infectious diseases such as malaria and human immunodeficiency virus (HIV), which makes people more familiar with the notion of antibodies. Taken together, our results highlighted a low level of general knowledge about COVID-19 vaccines in Brazzaville, which did not improve significantly between the two study periods. This implies that there has been a lack of effective communication about COVID-19 vaccines even when vaccines were available. As there is a positive link between a high level of knowledge and vaccine acceptance [12,15]. Our findings indicate that more efforts are needed in Congo to ensure that people gain sufficient knowledge about COVID-19 vaccines. This would help improve public perceptions and acceptance of covid-19 vaccines.

Perceptions about COVID-19 vaccines are among the important factors that have been found to affect public acceptance and hesitancy of vaccines [16,17]. Thus, in this study we also assessed the dynamic of perceptions about COVID-19 vaccines in Brazzaville. Overall, nearly three fifth of the participants (57.46%) had positive perceptions of COVID-19 vaccines before the vaccine rollout, in February-March, which were not associated with being women or men. In our opinion, this rate is unsatisfactory when compared to those reported in other populations [17,18]. Unsatisfactory also because having a positive perception does not necessarily lead to accepting to be vaccinated, and it could undermine the goal of vaccinating 60% of the Congolese population to achieve herd immunity. In August-September, as the vaccination campaign continued, perceptions of COVID-19 vaccines among participants tended to be negative. Overall, the proportion of participants with a positive perception of COVID-19 vaccines dropped

to 50.15 %. The excessive media coverage of thrombosis cases believed to be associated with the Oxford-AstraZeneca COVID-19 vaccine, as well as the rejection of this vaccine in some countries including Congo, may have contributed to the negative perception of COVID-19 vaccines within the population. This has certainly reinforced in people the misconception that covid-19 vaccines contain toxic substances to kill people in order to reduce the world's population. On the other hand, the government's decision to make COVID-19 vaccination mandatory was not well appreciated by the population; therefore, and it may also have contributed to the lack of public confidence in COVID-19 vaccines. Indeed, by examining the consequences of mandatory vaccination in Germany and the United States, Sprengholz et al reported that this can lead to lower vaccination intentions not only for COVID-19 but also for other diseases such as influenza [19].

Multinational studies exploring people's intention to accept the COVID-19 vaccine have been conducted, and showed a cross-country variability in the vaccine acceptance. In this study, before the vaccine rollout, 54.47% of the participants reported they were willing to receive a COVID-19 vaccine. Similar proportions of the vaccine intention were reported among the Italian (53.7%), Russian (54.9%), and Polish 56.3 [20]. Whereas Asian countries such as Malaysia (94.3%) and China (91.3%) exhibited the highest acceptance rates [9-21]. Comparatively, higher vaccination acceptance (>80%) rates were also reported in Africa countries such as Burkina Faso, Ethiopia, Malawi, Mali, Nigeria and Uganda [22]. Note that we began this study in early February, when cases of thrombosis associated with the AstraZeneca vaccine were reported by the mass media and exaggerated on social media. This may be one of the reasons for people's lack of enthusiasm for receiving the COVID-19 vaccine and, at the same time, the increase in refusal and hesitation rates observed in August-September. On the other hand, doubt about the effectiveness of vaccines in preventing COVID-19 infection could also be the reason why people become hesitant to get vaccinated. Indeed, one of the recurring questions that people asked us during this was why a vaccinated person can still get the COVID-19 infection. This indicated that most participants were unaware that no vaccine is 100% effective and does not necessarily prevent infection, and that the ultimate benefit of vaccination is to protect vaccinated individuals from severe forms of the disease [23].

Consistent with previous studies on COVID-19 vaccination [24-26]. Our study finds lower vaccine acceptance, on average, among women than men. Yet, we did not reveal a gender difference in the overall perception of COVID-19 vaccines. In this study, we were unable to identify the reasons that might explain this difference between men and women for intention to be vaccinated. Nevertheless, we found that women, particularly those aged 18 to 34, were more likely to state that COVID-19 vaccines are not safe and may cause infertility. This hypothesis that COVID-19 vaccines may impair women fertility stems from a blog post that claimed that there is a similarity between a SARS-CoV-2 surface glycoprotein and syncytin-1 (a protein essential for placenta formation), that this antigenic similarity may induce the production of antibodies against this protein in vaccinated women and, as a result, cause the destruction of the placenta. Have also circulated in social networks unfounded statements that COVID-19 vaccines cause the disruption of the menstrual cycle. Interestingly, studies have shown that anti-syncitin-1 antibodies are not produced in people who have received covid-19 vaccines [27]. In addition, studies have also shown that COVID-19 vaccines do not impair fertility in either women or men [28,29]. Despite this scientific evidence, erroneous theories persisted throughout the vaccination campaign, which may also have contributed to the very low acceptance rate of COVID-19 vaccines in women as observed in August-September.

Considering age, the participants aged 18 to 35 years appeared to be less supportive of vaccination than older participants during the two study. A few studies have also reported the prevalence of higher vaccine hesitancy against COVID-19 among young people, younger women particularly, for example in Japan [30], France [31] and UK [32]. The fact that young people are more connected to the internet than older people and, therefore, more influenced by negative social media narratives could explain these findings.

Conclusions

The originality of this study is to have evaluated knowledge, perceptions and acceptability towards COVID-19 vaccines over two periods, before and during the vaccine rollout, which gives an overview of the evolution of these aspects in a population. Thus, our study revealed a low level of knowledge and a negative dynamic of the perception and acceptance of covid-19 vaccines in the population of Brazzaville. These results may inform public health public health authorities in developing relevant strategies that promote COVID-19 vaccines acceptance in Congo. An education campaign is needed to enable the population to acquire essential knowledge about vaccines. Because intention to get the COVID-19 vaccine and its perceived safety and efficacy were strongly associated, there is a need to counter misinformation through awareness and education activities that promote positive perception towards COVID-19 vaccines.

Study limitations

This study was limited in Brazzaville and lacks rural data. So, findings cannot be generalized to the entire population of the Republic of Congo. We also did not explore the socio-demographic determinants that may affect participants' perceptions and hesitation about COVID-19 vaccines. These determinants could include ethnicity, political or religious affiliation, previous vaccination experience, geographic location and trust in the health care system or traditional medicine. Finally, the data presented in this study are self-reported and, therefore, depend on the honesty of respondents. This method of data collection can lead to information bias.

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Competing Interests

The authors declared that no competing interests exist.

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