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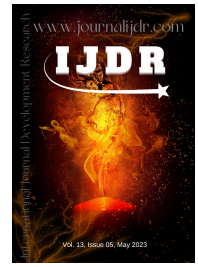
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RESEARCH ARTICLE

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FACTORS ASSOCIATED WITH COVID-19 VH IN FRAGILE AND CONFLICT SETTINGS: BENI HEALTH ZONE, EASTERN DRC

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ABSTRACT

Coronavirus Disease 2019 remains a serious health threat until it is declared eradicated worldwide; it can spread rapidly and mutate into new variants of concern. Although vaccines have been early available, vaccination has been hindered by COVID-19 vaccine hesitancy, including in conflict and fragile regions. Yet, COVID-19 vaccine hesitancy remains poorly understood in these settings. This study aimed to determine the scope of and identify associated factors to COVID-19 vaccine hesitancy in Beni city. As of August 2022, we conducted a multicenter cross-sectional population-based study with a sample of 1269 household heads in Beni city (Eastern DR Congo). We used a questionnaire for data collecting and performed descriptive and analytical analysis using SPSS and STATA softwares. Results indicated low definitive acceptance (7.81%), relatively high definitive refusal (27.93%), and high indecision (61.5%) (Not sure and probably volunteer) of COVID-19 vaccines. Trust in the government, trust in health authorities/workers, knowledge level, education level, beliefs, and religion were associated with COVID-19 vaccine hesitancy. Interventions and policies can leverage on these findings to contextualize COVID-19 response in Beni health zone.

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INTRODUCTION

Coronavirus Disease 2019 (COVID-19) has caused unprecedented threats worldwide. Vaccination has been early rolled for COVID-19 prevention and control. However, in many countries and population sub-groups, including the Democratic Republic of Congo (DRC), the share of populations needed to reach herd immunity (70% or over claimed by mid-2022) remains a distant target (WHO n.d, Kwok et al., 2020). Despite the availability of vaccines and vaccination services, individuals have delayed or refused to vaccinate. Delay and refusal of vaccines are the two main symptoms of what is currently called "Vaccine Hesitancy" (VH), one of the top ten threats to global health (Akbar, 2019; MacDonald, 2015). High COVID-19 VH rates are likely to be reported in Fragile and Conflict Situations (FCS) characterized by poor health infrastructure, limited COVID-19 vaccines access, security issues, disinformation, and misinformation (WHO, 2017; Desmond & Neat, 2021). Rates of COVID-19 VH ranging from 7-77.9% were reported in High Income Countries (HICs) where Russians ranked among the most reluctant populations (Aw, et al., 2021). African countries are not free of COVID-19 VH despite experience in outbreaks management, such as the last Ebola. By the end of the year 2021, 37% of Africans were hesitant to get vaccinated (AbdulAzeez et al., 2021).

South Sahara Africa (SSA) reported COVID-19 VH from 64.5% to 97.9% (Kanyanda et al., 2021) while the Democratic Republic of Congo (DRC) reported 55.8% (Ditekemena, 2020). Across different settings, scholars have identified diversified factors to be associated with COVID-19 VH namely fear of Adverse Events Following Immunization (AEFI) AEFI or safety concerns, COVID-19 risk perception, poor health literacy, misinformation or lack of accurate knowledge about the vaccines, doubts, corruption, political instability, mistrust and suspicion of medical companies, and political and economic intentions that are perceived to be driving the pandemic or vaccine preparation, FCS(Dhama et al. 2021; Dubé et al., 2021). Razai et al, (2021) suggested that COVID-19 VH can be tackled by the model of the "5C", namely Confidence, Complacency, Convenience, Communication, and Context. One year after the deadline of the WHO COVID-19 vaccination targets (70% by Jun 2022), the vaccination rate in the Beni health zone remains very low (< 10%) despite the availability of vaccines. Although national-level studies on this topic have provided a general trend of COVID-19 VH; they do not distinguish between contexts and so might underestimate or overestimate the phenomenon in some populations such as those in FCS. This is the case of the Eastern DRC under armed conflicts for more than 20 years, where the region of Beni is the epicenter (Yotama, 2021; OCHA, 2021). In the meanwhile, nothing is known about COVID-19 VH in the Beni region. This study is the first effort

to address the gaps surrounding the magnitude and associated factors with COVID-19 VH in the region of Beni.

METHODOLOGY

Study site: As described in our article on “Addressing the ten top root causes of COVID-19 vaccine hesitancy among household heads in fragile and conflicts contexts”, Beni city is located in North-Kivu province (Eastern DRC), near (70 km) Kasindi border between DRC and Uganda. The most common epidemic and diseases of public interest in Beni Health zone are COVID-19 pandemic, Ebola virus epidemic, onchocerciasis, helminthiasis, diarrhea and traumatism. In terms of security, Beni is under protracted armed conflicts and urban insecurity for more than two decades, in the widespread insecurity in eastern currently in “state of siege”. The Allied Democratic Forces-Ugandan National Liberation Army (ADF-Nalu) is currently the most deadly foreign terrorists (Stearns, 2012; Matthysen & Gobbers, 2022). Civilians killing, poverty, human rights violations and a worse humanitarian situation are among the direct consequences of the conflicts in the region. Health, economy and sociopolitical sectors disruption are the key characteristics of the fragility in Beni. Nevertheless, more than 300 facilities with more than of 618 workers continue to provide healthcare to a population esteemed as 503117 inhabitants (Beni health zone register, 2022).

Study design: We conducted a multicenter cross sectional population-based study on August 2022 using a questionnaire among household heads in Beni city. The household heads were selected randomly by trained interviewers in three health areas corresponding to three quarters where COVID-19 vaccines and vaccination services were available: Mabolio, Ngilinga and Kasabinyole health areas.

Sample size determination: Based on Fischer formula ($n = \frac{Z^2 p q}{d^2}$) a stratified sample size of 1269 (increased by 10% to cater for a non-response), or 423 respondents per strata was calculated.

Data collection technics: Two technics were used for data collection: documentary technic and a questionnaire. The first (documentary technique) was used for existing (routine) data collecting on COVID-19 vaccine uptake from COVID-19 vaccination registers in the health centers. The second (questionnaire) was adapted from the SAGE WG’s Vaccine Hesitancy Scale (VHS) (Larson et al., 2015) to explore the variables.

Variables: Simple and composite variables were explored (see the questionnaire in appendices): COVID-19 VH, socio-demographic variables, COVID-19 vaccination status, perceived vulnerability to COVID-19, knowledge about COVID-19 and vaccines, beliefs about COVID-19 and vaccines, knowledge levels, belief levels, Vulnerability to COVID-19 and fragility levels. Composite variables were obtained from indexes and scaled by Likert scales. The “COVID-19 vulnerability index” was obtained from Age (<18=0; ≥18=1), profession (Formal = 0, Informal=1, medical=2), Chronic diseases (No=0, Yes=1) where an index =0 (not at all vulnerable), index=1 (least vulnerable), index=2 (quite vulnerable), index=3 (more vulnerable) and index=4 (extremely vulnerable). The “belief index” was obtained from nine COVID-19 and vaccine-related beliefs scored 0 if the response is no and 1 if the response is yes. Then three levels were defined as low level (index 0-3), medium level (index 4-6) and high level (index 7-9). The “knowledge index” was based on six variables related to the knowledge about COVID-19 and vaccines and scored 0 if the response is no and 1 if the response is yes. Then three knowledge levels were poor level (index 0-1), medium level (index 2-3), and high level (index >3). The “fragility exposure index” (as used by Baliki et al., 2017 in the Hortinlea survey in Kenya and in the “Life in Kyrgyzstan Study” by Brück et al., 2014) was obtained in this study from three domains: human security, economic inclusion, and social cohesion. Each of the last three domains has several sub-domains which take a value between 0 and 1. $X_{ijt} = Norm(x_{ijt}) =$

$\frac{x_{ijt} - \min(x_{ijt})}{\max(x_{ijt}) - \min(x_{ijt})}$ where i, the individual; j, the sub-indicator and t, the time period.

From the sums of sub-indicators within the three domains, and after normalization (to obtain the same weight for each domain) $D_{it} = Norm(\sum X_{ijt}) + Norm(\sum Y_{ijt}) + Norm(\sum Z_{ijt})$ where X_{ijt} , Y_{ijt} , and Z_{ijt} are the three main domains. Finally, $FEI_{it} = 100 \times Norm(D_{it})$. Individuals obtained values between 0 and 3. Thus, Fragility Exposure Index (FEI) =0 (least fragile), FEI=1 (relatively fragile), FEI=2 (more fragile), FEI=3 (most fragile). The FEI has the advantage to be multidimensional and opened to more domains without jeopardizing the index because of normalization. It has been found closer to the Global Peace Index (GPI), used for states’ peacefulness measurement) in a case-study in Kenya. For better robustness and validation, it has been used in the “Life in Kyrgyzstan Study” (Brück et al., 2014).

Data analysis: Descriptive, bivariate and multiple logistic regression models were performed using SPSS and STATA softwares. Results have been presented in tables and figures.

RESULTS

Sociodemographic and COVID-19 related characteristics: Women were more represented (57.3%). The majority (88.73%) had an age inferior to 55 years, from Nande ethnic group (67.6%), catholic (40.3%) or protestant (34.1%) practicing, married (87.6%), working in the informal sector (76.4%), they have reached secondary school (47.12%) and were “more fragile” (53.51%). A proportion of 10.5% of the respondents was exclusively IDPs while 32.62% of their beliefs were poor. Only 2.13% of the respondents declared they were vaccinated, mostly for travel motivation (51.85%). They perceived themselves “not at all vulnerable” to COVID-19 (79.51%) but indexed as “quite vulnerable” (67.84%). They thought COVID-19 vaccines are not recommendable (63.3%). Respondents had a “poor level of knowledge” (48.4%) and “mean level of beliefs” (57.3%) about COVID-19 and vaccines. The “radio” (43.13%) was the most mentioned information channel. They were more or most fragile (63.29%) (Table 3.1).

The Scope of COVID-19 VH: Indecisive respondents (probably accept and not sure) were more represented (61.50%) while the refusal rate to get vaccinated against COVID-19 (definitively refuse) was 27.93% and the acceptance rate of COVID-19 vaccines (definitively accept) was 7.81%. The remaining (2.73%) kept secret their willingness to get vaccinated (Table 3.2).

Determinants of COVID-19 VH: In bivariate analysis, twelve variables were linked to covid-19 vaccine hesitancy (p-value ≥ 0.05, calculated chi-square > chi-square of the table): marital status, education level, profession, vaccine recommendation, knowledge level, beliefs level, fragility level, trust in the government, trust in vaccine producers, trust in health authorities and health workers, perceived vulnerability to covid-19, religion, and induced vulnerability to covid-19.

In multinomial regression analysis, statistically significant associations were observed:

- Between “I keep it secret” and the “knowledge level” about covid-19 disease and vaccines (p-value 0.032 < 0.05, ci [0.04; 0.98]); “being definitively volunteer” to get vaccinated against covid-19 and “trust in the government” (p-value 0.001 < 0.05, ci [0.27; 0.84]);
- Between “probably volunteer” and the “level of knowledge” (p-value 0.001 < 0.05, ci [0.20; 0.64]); “probably volunteer” and “beliefs” (p-value 0.001 < 0.05, ci [0.19; 0.75]);
- Between “definitively refuse” and “religion” (p-value 0.01 < 0.05, ci [-0.20; - 0.02]); education level (p-value

0.001<0.05, ci [-0.69; -0.29], “trust in health authorities and workers” (p-value 0.001<0.05, ci [-0.61; -0.29]); “knowledge level” (p-value 0.03<0.05, ci [-0.46; -0.02], “beliefs level (p-value 0.001<0.05, ci [-0.75; -0.24] (fig.1.1below).

Table 0.1. Distribution of respondents according to sociodemographic and COVID-19 related characteristics

Variables	Frequency (n=1269)	%
Sex		
Masculine	541	42.63
Feminine	728	57.37
Age (years)		
18-38	515	40.58
39-54	611	48.15
≥55	143	11.27
Ethnic group		
Nande	858	67.62
Mbuba	160	12.6
Bahema	47	3.7
Lesse	47	3.7
Bashi	47	3.7
Pygmy	46	3.62
Bamate	44	3.47
Luba	8	0.64
Others (Rega ...)	12	0.95
Religion		
Catholic	511	40.26
Islam	55	4.33
Revival	139	10.95
Protestant	433	34.12
Adventist	52	4
Jehova hwitwess	77	6.1
Kimbanguist	2	0.2
Education level		
Any	116	9.14
Primary	464	36.57
Secondary	598	47.12
University	91	7.17
Profession		
Formal	197	15.52
Informal	970	76.44
Medical	102	8.03
Marital status		
Married	1112	87.63
Widow/Widower	105	8.28
Separate/divorce	52	4.097
Fragility		
Least fragile	12	0.95
Relatively fragile	453	35.697
More fragile	679	53.51
Most fragile	125	9.78
Household status		
IDPs	133	10.48
Resident	845	66.59
Mixt	291	22.93
Beliefs		
Poor	414	32.62
Mean	727	57.29
High	128	10.09
Vaccination status		
Vaccinated	27	2.13
Unvaccinated	1242	97.87
Vaccination motivation		
Travel	14	51.85
Free choice	13	48.15
Vaccines recommendation		
Not recommendable	803	63.28
Not sure	442	34.83
All recommendable	24	1.89
Perceived vulnerability to COVID-19		
Not at all vulnerable	1009	79.51
Quitevulnerable	260	20.49
Induced vulnerability to Covid-19		
Least vulnerable	243	19.14

Quitevulnerable	861	67.84
More vulnerable	156	12.29
Extremelyvulnerable	9	0.71
Knowledge		
Poor	614	48.39
Mean	441	34.75
High	214	16.86
Information canal (n=888)		
Radio	383	43.13
Neighbors	173	19.48
Health workers	198	22.29
CHWs	92	10.36
Other (Church...)	42	4.73

Table 2. The scope of COVID-19 VH

Variable	Frequency (n=1242)	%
Vaccine Hesitancy		
Acceptdefinitively	97	7.81
Probablyaccept	223	17.95
Not sure	541	43.55
Refuse definitively	347	27.93
I keep itsecret	34	2.73

V_Dependante		Coefficient	Std. err.	z	P> z	[95% conf. interval]	
Abstention							
RELIGION		.0721599	.1088941	0.66	0.508	-.1412687	.2855884
education		.0794863	.2458958	0.32	0.747	-.4824606	.5614332
confiance_gouvernement		.2194656	.2288556	0.96	0.338	-.2290832	.6680144
confiance_autorité_sanitaire		-.1148827	.2212943	-0.52	0.604	-.5486116	.3188463
connaissance_synthese		.5172929	.2405502	2.15	0.032	.0458232	.9887626
croissance_synthese		.3770855	.3124751	1.21	0.228	-.2353544	.9895254
_cons		-4.964814	.9714589	-5.11	0.000	-6.868039	-3.05999
Définitivement_volontier							
RELIGION		-.0541922	.0683348	0.79	0.428	-.0797416	.1881259
education		-.0001398	.1518023	-0.00	0.999	-.2976669	.2973873
confiance_gouvernement		.5579264	.1461977	3.82	0.000	.2713841	.8444688
confiance_autorité_sanitaire		-.2227377	.1399381	-1.60	0.109	-.4952474	.049772
connaissance_synthese		.2586275	.1530138	1.69	0.091	-.0447224	.558529
croissance_synthese		.6417824	.1956307	3.28	0.001	.2583533	1.025212
_cons		-4.365702	.6292708	-6.94	0.000	-5.59905	-3.132354
Probablement_volontier							
RELIGION		-.0184738	.0502375	-0.37	0.713	-.1169375	.0799899
education		.0974649	.1123889	0.87	0.386	-.1228133	.3177432
confiance_gouvernement		.1530343	.1008591	1.52	0.106	-.0347224	.369791
confiance_autorité_sanitaire		.0546965	.1014048	0.54	0.590	-.1440532	.2534463
connaissance_synthese		.4292478	.112412	3.82	0.000	.2089244	.6495712
croissance_synthese		.4768359	.1440791	3.31	0.001	.194446	.7592259
_cons		-3.241382	.4482719	-7.23	0.000	-4.119979	-2.362785
Pas_sûr							
(base outcome)							
Refuse_définitivement							
RELIGION		-.1177554	.0461712	-2.55	0.011	-.2082493	-.0272615
education		-.4930067	.1011622	-4.87	0.000	-.6912811	-.2947324
confiance_gouvernement		-.0875186	.0930755	-0.94	0.347	-.2699432	.094906
confiance_autorité_sanitaire		-.4524982	.0837006	-5.41	0.000	-.6165485	-.288448
connaissance_synthese		-.2446932	.1131361	-2.16	0.031	-.4664359	-.0229506
croissance_synthese		-.4976898	.1314071	-3.79	0.000	-.755243	-.2401367
_cons		3.176496	.3567023	8.91	0.000	2.477372	3.875619

Figure 0.1. Multinomial logistic mode

DISCUSSION

The scope of COVID-19 VH: The acceptance rate of COVID-19 vaccines (7.8%) observed in this study was low compared with the ones reported in SSA (64.5% to 97.9%) (Kanyanda et al., 2021), in the Democratic Republic of Congo (55.8%) (Ditekemena, 2020), and among households heads in Zimbabwe (55.7%) (McAbee et al., 2021). It is similar to some low rates reported in Africa by Ngangue et al., (2022) systematic review (6 to 92%). The level of fragility may partly explain the low COVID-19 vaccine acceptance rate in Beni. Indeed, fragility is associated with poor health outcomes and a potential health efforts reversal (Ager et al., 2019). In this study, respondents were described as more or most fragile (63.29%), and their households were exclusively IDPS (10.48%) or host (22.93%). In addition, scholars lack a consensus about the definition and interpretation of VH. Some have used VH as a dichotomous variable (such as Ditekemena, 2020) while others (such as in this study) use it as a multinomial variable. This may underestimate or overestimate the results and so introduce bias in comparing them. Data collecting technics may constitute another source of difference. For example, studies conducted on phones (such as Ditekemena’s, 2020) may suffer selection bias by including only individuals of a given

socioeconomic status accessing the telephone. The refusal rate observed in this study (27.9%) was relatively high to meet the WHO goal for COVID-19 vaccination towards herd immunity (a vaccination rate of 70%) although relatively low compared to 44.1% reported by Ditekemena *et al.*, (2021) among the Congolese (nationwide). Consideration taken of the high rate of undecided individuals to get vaccinated against COVID-19 (61.5%) and those who kept secret their willingness (if considered as unwilling) to do so, we argue that the scope of COVID-19 VH as described in this study highlights the necessity of tailored intervention to scale up vaccination uptake in Beni health zone and North Kivu province. As of April 2023, Data from the WHO showed that the COVID-19 vaccination rate (fully vaccinated people) remains very low (9.2%) mainly in provinces with humanitarian crisis (4.62% in North Kivu) compared to other provinces (50.90% in Kasai oriental province) and in overall DRC (18%) (Fig. 0.1 in appendices) (Ministry of health 2023). Decision-makers need to turn to countries and population sub-groups with the lowest COVID-19 vaccination rates such as North Kivu to avoid them becoming a reservoir for COVID-19.

Determinants of CPVID-19 VH: Among the twelve factors linked with COVID-19 VH, a sub-group of six factors would explain better our variable of interest. If knowledge is not enough to explain behavior, our results showed that the higher the knowledge about COVID-19 and vaccines, the more respondents were definitively (coef. 0.2586275) or probably (coef. 0.4292478) voluntary to get vaccinated and likely to refuse definitively (coef. -0.4976898) to get vaccinated. Similarly, Mudenda *et al.* 2022 have recognized the role of knowledge in COVID-19 VH (Romate *et al.* (2022). To highlight that knowledge level is not enough for COVID-19 vaccination behavior in all the contexts and sub-groups, Jeonet *et al.* (2022) have observed a negative correlation between the knowledge level about the vaccines and the levels of COVID-19 VH in the US. Thus, COVID-19 VH among health workers supposed to have high level of knowledge about COVID-19 and vaccines is not a surprising. Likewise, the education level may negatively influence definitive acceptance of COVID-19 vaccines (-0.0001398) and definitive refusal (-0.4930067) while influencing positively (0.0974649) “probably volunteer” to get vaccinated against COVID-19. Thus, knowledge level and education level are not innocent nor enough in explaining VH as a complex phenomenon.

This study observed different patterns of the association between trust in the government and COVID-19 VH and trust in health authorities (workers) and COVID-19 VH. In the first case, the more household heads were trustful in the government, the more they were likely to accept definitively (coef. 0.5579264) or probably (coef. 0.1630343) the vaccines but the less to refuse them definitively (coef. -0.0875186). Similarly, Sato (2022) reported positive correlation between the trust in the government and COVID-19 VH in Nigeria. In our previous publication on this topic, we suggested that trust restoration would be a strategy to address COVID-19 VH depending on the “whys” of the distrust in each context. If in Nigeria people distrusting the government fear that the COVID-19 vaccine would harm them, our first article (qualitative) on the topic showed that reluctant individuals in Beni thought COVID-19 vaccines would be used by aggressors as a means for massacres, or that COVID kills less than massacres that the government never ended. A contrasting finding reported negative correlation between trust in the government and vaccine acceptance in New York and Phoenix (Trent *et al.* 2022). According to the authors, the negative correlation between the two was explained by the lack of the sample representativeness, the cultural differences, and political influence in those cities. In the second case, the more trustful respondents were in health workers, the less they refused definitively the vaccines (coef. -0.4524982) but were probably volunteer to get vaccinated (coef. 0.0546965). However, trust in health workers did not necessarily entail household heads to be definitively volunteer to do so (coef. -0.2227377). In their review, Adhikari *et al.*, (2022) have synthesized evidence about the effect of trust on COVID-19 acceptance including institutional trust and trust in the professionals (health authorities/workers). The authors argued

that trust is a lever for interventions aiming at COVID-19 vaccine acceptance. However, they warn that the relationship between the two (trust and vaccine acceptance) was complex because trust may depend on a range of factors such as cultural, institutional, local social, and individual attributes.

In the same way, in their review of trust in COVID-19 vaccine acceptance, Sapienza and Falcone (2023) recommended that it was fundamental to identify the reasons for trust (distrust) in its relations with COVID-19 vaccine acceptance. The level of COVID-19 and vaccine-related beliefs influenced positively (definitively volunteer and probably volunteer) and negatively (refuse definitively) the COVID-19 VH. In other words, the higher the belief level, the more household heads were likely to accept definitively or probably the vaccines; the lower it was, the more household heads were likely to refuse definitively COVID-19 vaccines. Similarly, Getachew *et al.*, (2023) have reported beliefs such as those related to the severity of COVID-19 or the benefit of its vaccines as predictors of COVID-19 VH/acceptance. In this study, the level of beliefs was mitigated: only 10.09% high, 32.62% low, and 57.29% mean level). Thus Interventions to improve the level of COVID-19 and vaccines such as health communication to combat mis/disinformation can decrease VH towards vaccine acceptance and uptake in Beni health zone. Our results showed a statistically significant correlation between COVID-19 VH and religion. However, we did not search about what were the religious conceptions which would lead to the COVID-19 VH. The literature (Garcia & Yap, 2021; Osur *et al.* 2022) has reported such a link between VH and religion. However, more future in-depth studies are needed to identify such conceptions among specific religious group members to avoid religious incrimination and marginalization in Beni.

CONCLUSION

The six COVID-19 VH predictors identified in this study namely trust in the government, trust in health authorities/workers, knowledge level, education level, beliefs, and religion can help design interventions and policies to modify the scope of COVID-19 VH and so improve COVID-19 vaccine uptake in Beni. Further in-depth studies will help understand by which mechanisms each of them influences COVID-19 VH and which sub-groups are subject to them for targeted interventions.

Study limitations: The limitation of this study was to explain the mechanisms through which some COVID-19 VH predictors influence COVID-19 VH, such as religion.

Conflict of interest statement: No conflict of interest was declared by the authors.

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Appendice

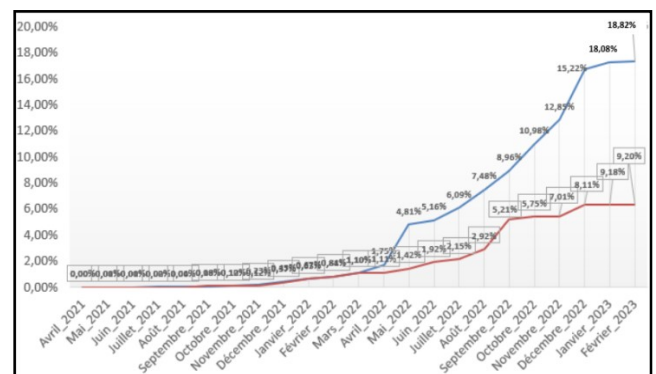


Figure 1. Covid-19 immunization curve in DRC as of february 2023 (ministry of health, DRC, 2023)
