DO SOCIO-DEMOGRAPHIC AND SOCIO-CULTURAL FACTORS IMPACT ON COVID-19 VACCINATION UPTAKE IN NORTH KIVU PROVINCE?

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1.ABSTRACT

The Sustainable Development Goals three (SDG_3) highlighted that immunization impacts directly on health and it does contribute to 14 out of the 17 Sustainable Development Goals (SDGs), such as ending poverty, reducing hunger, and reducing inequalities especially in low and middle-income countries. However, there is no insight related to the role that play by socio-demographic, cultural, geographical distance, psychological, behavioural factors towards the low COVID-19 vaccination uptake. In order to fill this gap in the existing literature review, this paper has used random sample of 2123 people living in North Kivu, logistic and multiple linear regression to investigate, analyze and assess the effects of socio-demographic, geographical distance, psychological, behavioural factors that are driving the COVID-19 vaccine in the Province of Nord Kivu, which province was victim of outreach Ebola and pandemic of COVID-19. The results revealed that males were likely to adhere to COVID-19 vaccine than females, old people were 4 times to adhere to COVID-19 vaccine compared to young people and the high educated people were 3 times to adhere to COVID-19 vaccine than people with low education, catholic church believers were majority to adhere to COVID-19 vaccine compared to others churches, geographical distance, psychological, behavioural affect adherence to COVID-19 at 30.5%. The results from this study inform policymakers and health system to engage with sensitization, communication and training as strategies for increasing the adhere to COVID-19 vaccine among females, young and low educated people and leaders of churches and communities.

Key words: *COVID-19, COVID-19 vaccine, adherence, socio-demographic factors, cultural factors, geographical distance factors, psychological factors, behavioural factors, North Kivu.*

2.INTRODUCTION

There is no doubt nowadays that immunization plays a key role in the achievement of at least 6 of the 14 SDG_3 targets (WHO,2017). Immunizations have been saving the lives of millions of people since they were first used by Edward Jenner in 1796, and new vaccines are being developed all the time. The prior research shown that the immunization impacts directly on health (SDG_3) and it is consequently bringing a contribution to 14 out of the 17 Sustainable Development Goals (SDGs), such as ending poverty, reducing hunger, and reducing inequalities especially in low and middle-income countries (LMICs) (WHO, 2017). However, beside the shortage of vaccination against COVID-19 (coronavirus) in Africa countries, a new challenge was emerging: hesitancy to get vaccinated that implies a low rate of COVID-19 vaccine. Neia (2021) point out that the low trend to COVID-19 vaccination uptake in Africa countries, was a consequence of a severe shortage of vaccines, supply constraints, structural issues, logistical obstacles and national health system policy among others factors. But few is known about socio-demographic and cultural factors towards the COVID-19 vaccine in Low Middle Incomes Countries(LMICs) such Democratic Republic of Congo who was undergoing two outreach of Ebola. A survey conducted in 2020 by the Africa Centers for Disease Control and Prevention (Africa CDCP) in 15 countries revealed that while 79% of respondents were ready to get vaccinated against COVID-19, the rate hesitation could range from 4 to 38%. Neia (2021) in Afrobarometer survey in five countries (Benin, Liberia, Niger, Senegal and Togo) find that six out of ten citizens are hesitant to get vaccinated.

In addition, WHO (2021) argues that vaccination is the leading public health prevention strategy to prevent severe disease and deaths from COVID-19. However, most of the literature shown that the inhabitants are likely to reject COVID-19 vaccine because vaccine is not accepted by all researchers (no consensus between researchers on COVID-19 vaccine), others vaccine stopped the disease, effects side of COVID-19 with people who died and others presented the dilatation of muscle, information not well given to citizen, divergence between medical staff, effects side of COVID-19 on people with others disease and conspiracy (WHO,2021). However, there is no insight related to the role that play by socio-demographic and cultural factors towards the low COVID-19 vaccination uptake. In this view, this paper intends to fill this gap by using the logistic and multiple linear regression to analyze, investigate and assessing the effects of socio-demographic and cultural factors that are driving the COVID-19 vaccine in the Province of Nord Kivu, which province was victim of outreach Ebola and pandemic of COVID-19.

Immunizations have been saving the lives of millions of people since they were first used by Edward Jenner in 1796, and new vaccines are being developed all the time. Hopefully, a new vaccine for coronavirus disease 2019 (COVID-19) was developed in the few days, and perhaps even one for human immunodeficiency virus. Although the effectiveness of vaccinations has been proven over the years and adverse effects to currently available vaccinations are extremely rare, many people continue to defer immunizations for themselves and their families. World Health Organization (WHO) states that this phenomenon, known as “vaccine hesitancy,” is a major public health problem globally

3.Materials and Methods

Ethical clearance of this study was obtained from ‘COMITE D’ETHIQUE DE LA SANTE’ nominated by Ministerial Act n° 1250/CAB/MIN/S/ZKM/043/MC/2006 of 18 December 2006 (Reference: 13/BUR-CNES/NK/2022). A written informed consent signed by each participant before take the survey questionnaire that was given through Kobo collect. The participation was voluntary and freedom was guaranteed to each participant.

Descriptive and correlational design were used in order to describe the variables and the relationships that occur naturally between and among them. Population was constituted of all DRC Citizen and others citizens living in the North Kivu Province and a random sample of 2134 people was drawn from the population. To identify statistically significant factors, it was carried out a regression analysis in order to assess the effect of a specific parameter, all else being equal. Thus the binary logit model was used with the following specification:

$$\text{Model 1: } P(vacc_i = 1 / x_i) = \Lambda(x_i^{'}\beta_i) \quad (1)$$

where:

- Λ is the logistic distribution function,
- $vacc_i$ is the dependent variable, an indicator of an i-th individual getting vaccinated against coronavirus, which takes the value 1 if a person was vaccinated (or willing to get vaccination once it is available, or had taken rapid test or PCR test), and 0 otherwise, and x_i is the vector of socio-demographic characteristics of person i, including gender (male, female), age (seven groups), education (4 groups), marital status (single, married, divorced, widow), place of residence (rural, urban), religion (catholic, protestants, Islam, revival churches), current occupation (government, student, private, self-employed, not working, multi-services), nationality (DRC, Rwanda) and ethnic-group (nine groups).

Second model is expressed as:

$$\text{Model 2: } vacc_i = \beta_0 + \sum_{i=1}^{p} \beta_i z_i + \varepsilon \quad (2)$$

Where:

- $vacc_i$ is the dependent variable that is expressed as scores i-th individual getting vaccinated against coronavirus,

- z_i is the vector that including cultural, geographical distance, psychological and behavioral factors and β_i (i=1 to 4) are slopes respectively for cultural, geographical distance, psychological and behavioral factors,
- β_0 is the constant/intercept and ε is error term.

4.Literature review

Holder (2022) in tracking Coronavirus Vaccinations around the World as indicated by the New York Times mentioned that, there were more than 5.31 billion people worldwide have received a dose of COVID-19 vaccine, equal to about 69.2% of the world population. In low-income countries, only 20.7% of people have received at least one dose. The African countries had received a dose of 27% which is considered as very low compared to others continents.

Robinson (2020) conducted cross-sectional study……. in the United States and Canada found that 20% of Canadians would not get vaccinated if the vaccine were available. The most significant correlation was between refusing to be vaccinated was COVID-19 and distrust of the benefits of the COVID-19 vaccine. Among the significant factors of refusal of the vaccine, it was noted the female sex, the fact of having completed a complete or partial college education rather than not having completed it, the fact of being unemployed and the fact of belong to a minority

Salam (2021) conducted in the United States and Canada using a cross-sectional study and he found that 20% of Canadians would not get vaccinated if the vaccine were available. The most significant correlation was between refusing to be vaccinated COVID-19 and distrust of the benefits of the COVID-19 vaccine. Among the significant factors of refusal of the vaccine, it was noted the female sex, the fact of having completed a complete or partial college education rather than not having completed it, the fact of being unemployed and the fact of to belong to a minority.

Jantzen *et al.,*(2021) in their study entitled 'Socio-demographic factors associated with CCOVID-19 Vaccine Hesitancy Among Middle-Aged Adults During the Quebec's Vaccination Campaign' using online survey the CARTaGENE population-based cohort, of 6 105 participants of vaccine cohort, find that 3 553(58%) had at least one dose of COVID-19 vaccine, among 2 552 participants, 221(8.7%) did not want to be vaccinated (91) or were uncertain (130). The median age for the unvaccinated participants was 59.3 years [IQR 54.7–63.9]. The optimal hybrid tree-based model identified seven groups. Individuals having a household income lower than $100,000 and being born outside of Canada had the highest rate of vaccine hesitancy (28% [95% CI 19.8–36.3]). For those born in Canada, the vaccine hesitancy rate among the individuals who have a household income below $50,000 before the pandemic or are Non-retired was of 12.1% [95% CI 8.7–15.5] and 10.6% [95% CI 7.6–13.7], respectively. For the participants with a high household income before the pandemic (more than $100,000) and a low level of education, those who experienced a loss of income during the pandemic had a high level of hesitancy (19.2% [8.5–29.9]) whereas others who did not experience a loss of income had a lower level of hesitancy (6.0% [2.8–9.2]). For the other groups, the level of hesitancy was low of around 3% (3.2% [95% CI 1.9–4.4] and 3.4% [95% CI 1.5–5.2]). Public health initiatives to tackle vaccine hesitancy should take into account. These socio-economic determinants and deliver personalized messages toward people having socio-economic difficulties and/or being part of socio-cultural minorities.

Tan *et al.,*(2021) in Malasia, point out that COVID-19 pandemic presents major challenges in profound and still evolving ways, with high death tolls and extreme economic and social impacts worldwide. It also raises questions about how religious institutions, beliefs, leaders, and practices are contributing positively and less positively-to the ongoing coronavirus crisis and response. Religious actors have large roles to play, particularly in addressing challenges centered on safe religious gatherings and adaptations of rituals, building trust, promoting effective communication and advocacy, and identifying and responding to the needs of communities. They are also critically involved in countering hate speech and misinformation and in addressing various conflicts, ranging from domestic to geopolitical, associated with the crisis. In this rapidly evolving situation, religious voices should be part of the broad policy exchange, based on an informed and nuanced understanding of developments.

Zintel *et al.,* (2022) conducted a systematic review and meta-analysis to analyze gender differences in COVID-19 vaccination intentions related to gender differences. This systematic review and meta-analysis found lower vaccination intentions among women than men. Zintel *et al.,* (2022) revealed that males showed on average a higher COVID19 vaccination intention supports initial trends indicating systematic gender differences in reviews of COVID-19 vaccination intention (Galanis *et al*. 2020; Lin *et al*. 2021; Robinson *et al*. 2020). Sakou *et al.* (2011) find that vaccination coverage among adolescents, females had a lower likelihood of being fully vaccinated compared with men. Men have also been found to have higher vaccination rates than women in the case of infuenza and pandemic infuenza vaccinations (Bish *et al*. 2011; Pulcini *et al*. 2013; Jiménez-García *et al.* 2010).

Neia (2021) stated that religious beliefs also play a role in vaccine acceptance. Nearly 90% of respondents in Niger and Liberia say prayer is more effective than vaccination. Nicolas (2021) revealed that in the Geo-poll survey done in six African countries that religious beliefs were a key determinant of vaccine hesitancy.

Maleva *et al.,* (2021) in Russia, investigated the role of socio-demographic determinants of COVID-19 vaccination uptake in the context of mandatory vaccination of employees. The study focuses in particular on the role of mandatory vaccination

of workers in certain sectors of the economy. The study is empirically based on three rounds of a nationally representative telephone survey, conducted in February–October 2021, which investigated the situation and behavior of a cross section of the Russian adult population in the context of the spread of coronavirus. The results showed that the key factors behind vaccine uptake are age and education of the individual. People in older age groups and people with higher education are most inclined towards vaccination. By contrast, young people and people with low levels of education are least likely to be vaccinated. Other significant determinants of vaccination are experience of COVID-19 infection (self or a household member) and elderly or chronically ill members of the household. Among the employed, the economic sector where they work is an important determinant: workers in education, health care, and state and municipal administration are more likely to be vaccinated. The introduction of mandatory vaccination at a firm/organization with sanctions for unvaccinated employees has significant positive effect: the likelihood of an employee being vaccinated increases by 10 percentage points. The effect of mandatory vaccination is slightly greater for men than for women.

Liang *et al*., (2016) pointed out that the semantics that people use when structuring a message are a type of functional knowledge that reveals sociocultural factors. Bhatt & Bolonyai (2011) had find that social factors such as attitudes, motivations, and the social and political context are just as important as linguistic factors in multilingual environments. SoleimanvandiAzar *et al*., (2021) argued that It is worth to mention that cultural factors always play an important role in the nonobservance of norms and, especially, in health. Without knowing them, it is not possible to give a complete explanation of the reasons for not following the established norms. Suyanto *et al.,* (2020) stated that the COVID-19 pandemic has forced people to develop new social constructs to face the so-called new normality, and added that social change can occur in many ways, such as in economic activities, lifestyle, behaviors, structure of society, ideology, beliefs, values and even in things that were previously thought indispensable.

Rodríguez-Priego *et al*., (2022) confirmed that the linguistic expressions used by users demonstrate that they consume and post messages that reveal sociocultural factors such as sociocultural issues, information, reflection, news, politics, humor, rudeness, economy, and religion that impacted human COVID-19 behaviors especially COVID-19 vaccine adherence.

5.Results

In this section, it has been presented the results on hypothesis 'Socio-demographic and socio-cultural factors do not affect COVID-19 vaccine adherence' by considering the following variables as control variables: geographical distance, behavioral and psychological.

Table 1: Distribution of participants by gender, level of education and place of residence

Gender	Frequency	**Valid Percent**
Male	963	45.4
Female	1160	55.6
Total	**2123**	**100**
Level of education		
None	163	7.7%
Primary	240	11.3%
Secondary	1011	47.6%
University	709	33.4%
Total	**2123**	**100%**
Place of residence		
Urban	1586	74.7%
Rural	537	25.3%
Total	**2123**	**100%**

Source: Primary Data, April 2022

With regard to gender the results in Table 1 revealed that of 2123 participants interviewed, 963(45.4%) were male and 1160(54.6%). Thus it should be concluded that the results in Table 1 on gender, that the sample had more female than male. This gender differential might be originated to mortality of male since we are living in region where war and conflicts armed are still undergoing. With level of education, the results in Table 1 revealed that of 2123 participants interviewed, there were more participants 1011(47.6%) who finished secondary school, followed by 709(33.4%) who finished university, 240(11.3%) primary school and 163(7.7%) none educated. With place of residence, the results in Table 1 showed that of 2123 participants interviewed, there were more participants 1586 (74.7%) from urban area compared to 537(25.3%) from rural area.

5.2 Distribution of participants by marital status, religion and current occupation

Table 2 below presents the distribution of participants by marital status, religion and current occupation

Table 2: Distribution of participants by marital status, religion and current occupation

Marital status	Frequency	**Valid Percent**
Single	622	29.3%
Married	1338	63%
Divorced	25	1.2%
Widow	138	6.3%
Total	**2123**	**100%**
Religion	Frequency	
Catholic	893	42.1%
Protestant	979	46.1%
Islam	115	5.4%
Revival Churches	136	(6.1%)
Total	**2123**	**(100%)**
Current occupation		
Government	152	7.2%
Student	250	11.8%
Private	402	18.9%
Self employed	599	28.2%
Not working	657	30.9%
Multi services	63	3.0%
Total	**2123**	**100%**

Source: Primary Data, April 2022

The results in Table 2 revealed that of 2123 participants interviewed, there were 1338(63%) married, 622(29.3%) single, 138(6.3%) and 25(1.2%) divorced. With regards to religion, the results in Table 2 revealed that of 2123 participants interviewed, there were more participants 979(46.1%) from protestants church, followed by 893(42.1%) catholic 136(6.1%) revival and 115(5.4%) Muslim. The results in Table 2 showed that with current occupation, majority of participants 657(30.9%) were not working,402(28.2%) were self-employed and 63(3%) were the last category in multi-services.

5.3 Distribution of participants by ethnic group, age-group and nationality

Table 3: Distribution of participants by ethnic group, age-group and nationality

Ethnic Group	Frequency	**Valid Percent**
Nande	991	46.7%
Hunde	285	13.4%
Hutu	302	14.2%
Tutsi	20	0.9%
Twa	3	0.1%
Tembo	33	1.6%
Nyanga	81	3.8%
Kanu	2	0.1%
Kamu	406	19.1%
Total	**2123**	**100%**
Age group		
15-24	418	19,7.2%
25-34	899	42.3%
35-44	399	18.5%
45-54	234	11.0%
55-64	117	5.5%
65+	63	3.0%
Total	**2123**	**100%**
Nationality		
DRC	2115	96.6%
Rwanda	7	0.3%
Total	2122	100%

Source: Primary Data, April 2022

In Table 3 on ethnic group revealed that of 2123 participants interviewed, there were 991(46.7%) Nande, 406(19.1) Kamu, 305(14.2%) Hutu, 285(13.4%) and the smallest were Twa and Kanu ethnic with 0.1%. With age group, the results in Table 3 revealed that of 2123 participants interviewed, there were more participants 899(42.3%) in age-group 25-34, followed by 418(19.7%) in 15-24, 399(18.5%) in 34-45, 117(5.5%) in 55-64 and 63(3%) with 65+. In addition, with regard to nationality the results in Table 3 revealed that of 2123 participants interviewed, there were 2115(96.6%) Congolese and 7(0.3%) Rwandese

5.4 Level of adherence to COVID-19 vaccine

Table 4 Level of adherence to COVID-19 vaccine

Covid-19 vaccine	Frequency	Valid Percent
Not adhering	1642	77.4
Adherence	479	22.6
Total	2121	100.0

Source: Primary Data, April 2022

Table 4 shows that there was 479(22.6%) which indicated a low level of adherence to COVID-19 vaccine and 1642(77.4%) which indicated higher level of non-adherence to covid-19. These results present more similarities with what have been find in Holder (2022) and in Kadkhoda (2021).

Table 5 Relationship between Socio-demographic factors and Covid-19 vaccine

Dependent variable: COVID-19 vaccine			
	B	Exp(B)	95%CI for Exp(B)
Gender[males]	-0.50***	0.61	[0.47;0.79]
Age-group[15-24]			
25-34	0.95***	2.59	[1.74;3.84]
35-44	1.27***	3.55	[2.25;5.59]
45-54	1.18***	3.24	[1.90;5.53]
55-64	0.94***	2.56	[1.31;4.98]
65+	1.30***	3.66	[1.66;8.10]
Place of residence(urban)	-3.94***	0.02	[0.06;0.061]
Marital status(single)			
Married	0.32*	1.38	[0.97;1.96]
Divorced	-0.60	0.55	[0.14;2.11]
Widow	-0.34	0.71	[0.36;1.41]
Education level(None)			
Primary	0.63*	1.88	[0.95;3.74]
Secondary	1.08***	2.96	[1.58;5.53]
University	0.75**	2.11	[1.10;4.06]
Religion[Catholic]			
Protestant	-0.39***	0.68	[0.52;0.87]
Muslim	-0.55*	0.58	[0.31;1.78]
Revival churches	-0.42*	0. 66	[0.40;1.08]
Current Occupation[Government]			
Student	0.17	1.18	[0.64;2.18]
Working for private	-0.87***	0.42	[0.25;0.69]
Self-employed	-0.13	0.88	[0.58;1.35]
Not working	-0.006	0.98	[0.63;1.57]
Multi services	-0.40	0.67	[0.31;1.46]
Ethnic group[Ref:Nande]			
Hunde	-0.77***	0.46	[0.30;0.72]
Hutu	-1.09***	0.34	[0.21;0.54]
Tutsi	0.27	0.61	[0.46;3.71]
Tembo	-1.48*	0.23	[0.05; 1.07]
Nyanga	-1.03*	0.36	[0.16;0.80]
Kanu	4.57***	96.42	[4.32;21.48]
Kumu	-0.98***	0.38	[0.26;0.54]
Cons	-2.28***		
Cox-Snell R-square Nagelkerke R-square Hosmer and Lemeshow Test	0.23 0.35 $\chi^2(dl = 8) = 14.85, p = 0.06 > 0.05$		

Source: Primary Data, April 2022, *p<0.10; ** *p*<0.05; ** **p*<0.01

The results in Table 5 revealed that by holding all other predictors variables constant, the odds of COVID-19 respect measures occurring, for a one-unit increases in female compared to male, decreased by 39% (95% CI [0.47;0.79]). Furthermore, the results in Table 5 showed that for age-group 15-24 considered as a reference age-group, the odds of COVID-19 adherence to vaccine occurring increased respectively by 2.59 times (95% CI [1.74;3.84]) for a one-unit increased in age group 25-34, by 3.55 times (95% CI [2.25;5.59]) for a one-unit increased in age group 35-44, by 3.24 times (95% CI [1.90;5.53]) for a one-unit increased in age group 25-34, by 2.56 times (95% CI [1.31;4.98]) for a one-unit increased in age group 55-64 and by 3.66 times (95% CI [1.66;8.10]) for a one-unit increased in age group 65+ compared age group of 15-24. The results in Table 5 showed that for current occupation considered employed government as a reference, the odds of COVID-19 adherence to vaccine occurring decreased by 58% (95% CI [0.25;0.69]) for a one-unit increased by people working for private institution. Table 5 revealed that for ethnic group considered Nande as a reference, the odds of COVID-19 adherence to vaccine occurring decreased by 54% (95% CI [0.30;0.72]) for a one-unit increased for hunde ethnic group, the odds of COVID-19 adherence to vaccine occurring decreased by 76% (95% CI [0.21;0.54]) for a one-unit increased for Hutu ethnic group, the odds of COVID-19 adherence to vaccine occurring decreased by 77% (95% CI [0.05;0.1.07]) for a one-unit increased for Tembo ethnic group, the odds of COVID-19 adherence to vaccine occurring decreased by 64% (95% CI [0.16;0.80]) for a one-unit increased for Nyanga ethnic group, the odds of COVID-19 adherence to vaccine occurring increased by 96.42 times (95% CI [4.32;1.48]) for a one-unit increased for Kanu ethnic group, the odds of COVID-19 adherence to vaccine occurring decreased by 62% (95% CI [0.26;0.54]) for a one-unit increased for Kamu ethnic group.,the odds of COVID-19 adherence to vaccine of rural residence occurring decreased by 98% (95% CI [0.06;0.061]) for a one-unit increased for urban residence.

Table 5 revealed that for level of education considered none education as a reference, the odds of COVID-19 adherence to vaccine occurring increased by 1.88 (95% CI [0.95;3.74]) for a one-unit increased for none education, the odds of COVID-19 adherence to vaccine occurring increased by 2.96 (95% CI [1.58;5.53]) for a one-unit increased for none education, the odds of COVID-19 adherence to vaccine occurring increased by 2.11(95% CI [1.10;4.06]) for a one-unit increased for none education.

Table 6: Relationship between cultural, geographical and psychological and behavioural factors and COVID-19

Variables	COVID-19 Vaccine
Cultural	0.261***
Geographical	0.370***
Behavioural	-0.263***
Psychological	0.409***
Constant	0.672***
R-square	0.306
Adjusted R-square	0.305
Fisher test	233.75***
Durbin-Waston(DW)	0.89

Source: Primary Data, April 2022, *p<0.10; ** *p*<0.05; ** **p*<0.01

The results in Table 6 revealed that multiple regression analysis was used to test if the cultural, geographical, behavioural and psychological factors significantly predicted COVID-19 vaccine scores adherence. The results of the regression in Table 6 indicated that the overall predictors explained 30.5% of the variance (adj-R^2=.305, F(4,2116)=233.75, p<.01). It was found that cultural factors significantly predicted positively COVID-19 vaccine scores adherence (β = .261, p<.001), as did geographical factors (β = .37, p<.01) and as did psychological factors (β = .409, p<.01). However, behavioral factors significantly predicted negatively COVID-19 vaccine scores adherence (β = -.263, p<.01).

6. Discussion and conclusion

The outcomes of this research paper have provided insight into how socio-demographic factors such as gender, level of education, place of residence, marital status, religious, current occupation, ethnic group, age-group had impacted on COVID-19 vaccine adherence and how socio-cultural, behavioral, psychological and geographical distance factors had impacted on COVID-19 vaccine adherence. Of a random sample of 2334 participants, there were more female (54.6%) than male (41.7%) for COVID-19 vaccine adherence. However, with regard to adherence to COVID-19 vaccine the results suggest that 57.6% of male adhered to vaccine against 42.4% of females. Furthermore, the results revealed also that by holding all other predictors variables constant, the odds of COVID-19 vaccine adherence occurring, for a one-unit increases in female compared to male, decreased by 39% (95% CI [0.47;0.79]). In comparison with empirical studies, it should be noted that these results are in contradiction with Hearne and Niøo (2020) study entitled 'Understanding How Race, Ethnicity, and Gender Shape Adherence to Mask Wearing During the COVID-19 Pandemic: Evidence from the COVID Impact Survey' in which it is indicated men (OR = 0.69, p < 0.01) which were find less likely than females to report wearing a mask. However, results on adherence of males compared to females corroborated with Giyum (2020) and Salam (2021) studies which demonstrates that males are easily to commit with adherence to vaccination than females

because, being responsible in the household, they have the last decision and they are the ones who take care of referrals for health care issues. For instance, in West Africa, males have played a crucial role in guiding their wives and children on decision making regarding Ebola Virus Disease vaccination (WHO, 2020). This means that males were likely to adhere to vaccine than females and the reasons behind of this higher number of male than female could be noted by the demand that males are exposed to access to work and to travel among others while majority of females do not work and do not travel too much as males. In addition, the results from this study revealed that old people were likely 4 times to adhere to COVID-19 vaccine compared to young people and the high educated people were 3 times to adhere to COVID-19 vaccine than people with low education. These results contrast Maleva *et al.,* (2021) results that showed that the key factors behind COVID-19 vaccination uptake are age and education of the individual but people in older age groups and people with higher education are most inclined towards vaccination. The reason behind these contrast results might be related to Maleva *et al.,* (2021) study took place in the developed country while this study took place within the developing country. In addition, these results present similarities with Kadkhoda (2021) and Holder (2022) studies. This might be due the fact that higher educated people were likely to be exposed mandatory activities that are work, shopping school and travel among others. However, before to reach such work places, the accessibility requested vaccine and COVID-19 tests while people with low education were likely to be in lockdown in their homes.

With religion, catholic church is likely to adhere to COVID-19 vaccine than others churches, this might be related to the fact that the leaders of catholic church took publically the COVID-19 vaccine and that has pushed their believers to adhere more to COVID-19 vaccine compared to believers from others churches. However, these results corroborated with that has been found in Neia (2021).

With place of residence, it was find that by holding all other predictors variables constant, the odds of COVID-19 adherence to vaccine occurring decreased 98% (95% CI [0.06;0.061]). This disparity between urban and rural areas might be driven by the fact that rural residents had have less access to health care services, public health practitioners collaborating with health care providers, pharmacies, schools, community-based organizations, faith leaders, and local employers remain in small number to ensure vaccine confidence, ensure equitable vaccine access, and encourage staying up to date with recommended COVID-19 vaccinations and COVID-19 tests in rural communities. In addition, this disparity might be explained by higher percentages of vaccine hesitancy and less patient engagement during provider interactions.

In context of married status, category single was considered as reference and the results revealed that by holding all other predictors variables constant, the odds of COVID-19 adherence to vaccine occurring increased by 1.38 times (95% CI [0.97;1.96]) for a one-unit increased for married. The disparity between married and single might be rooted in the fact that married are feeling more responsible for their households, consequently they wish and support COVID-19 vaccine adherence for their families than single. The disparities were observed in current occupation and in ethnic groups. With regard to age-group, it was find that for age-group 15-24 considered as a reference age-group, the odds of Covid-19 adherence to vaccine occurring increased by 3 times for age-group of 25-34, 45-54 and 55-64 while for age-group of 35-44 and 65+, adherence to vaccine occurring increased by 4 times. The disparities observed are due to fact that old people were been considered as people at high risk for COVID-19 than younger people, thus all services such vaccination started by old people then after for youngest.

The results in this research paper have also provided insight that multiple regression analysis of cultural, geographical, behavioral and psychological factors were significantly predicted COVID-19 vaccine scores adherence with the overall predictors explained 30.5% of the variance (adj-R^2=.305, F(4,2116)=233.75, p<.01). It was found that cultural factors significantly predicted positively COVID-19 vaccine scores adherence (β = .261, p<.001), Similar findings were shown in the research works of Rodríguez-Priego *et al*., (2022) about Sociocultural factors during COVID-19 pandemic: Information consumption. For geographical factors (β = .37, p<.01) and as did psychological factors (β = .409, p<.01). However, behavioral factors significantly predicted negatively covid-19 vaccine scores adherence (β = -.263, p<.01).

The results from this study inform policymakers and health system to engage with sensitization, communication and training as strategies for increasing the adhere to COVID-19 vaccine among females, young and low educated people and leaders of churches and communities.

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8.References

[1] WHO, Vaccination programme increasingly confronted with public hesitation, Geneva, 2017, p25
[2] Nene, Sample study protocol for adapting and translating the 5C scale to assess the psychological antecedents of vaccination. BMJ open, 2020.
[3] David R, COVID-19: why some people don't want a vaccine, BBC News publication, August 2021.
[4] Papa G, Survey on knowledge, attitudes and practices regarding hygiene and Ebola virus disease in the regions of Kédougou, Kolda, Ziguinchor, Tambacounda and Sedhiou, CRS, September 2015.
[5] Finney , Adhesion to vaccination in France: results of the Baromètre santé, Insern, 2020.

[6] .Lisa P, Determinants of reluctance to vaccinate against COVID-19 and
a. ways to improve acceptance and confidence in the vaccine, Cancovid Issue Notes, 2021.
[7] Neia P, Understanding the barriers to vaccination against COVID-19 in sub-Saharan Africa, World Bank, August 2021
[8] WHO, Vaccine acceptability, a challenge, A Colin, October, 2015.
[9] Susane L, Accroitre la participation des tous à la vaccination, Paris, Ed Harmatan, 2020.
[10] Yemadje, Vaccination et son impact sur la prévalence des maladies infectueuses en Afrique subsaharienne, Ed Land Ber, 2008.
[11] Aminata, Who wants the COVID-19 vaccine? Strong reluctance in 5 West African countries, Dépeche, Paris, 2021
[12] Nicolas J, la religion et COVID-19, Insern, N°3, Paris, N°3, 2021.
[13] WHO, DRC facing the Ebola virus disease, Kinshasa, 2019.
[14] Lieno, Ethnicity and factors related to vaccine adherence in West Africa, Ed, A Colin, Paris, 2020
[15] Prudum S, Global strategies to combat vaccine ignorance Covd 19, Geneva, Insern, 2020.
[16] Auguste Reid Institute, COVID-19 immunisation in Bangladesh, Rio, 2020
[17] Ciony, Making immunisation safe and effective, Paris, 2021.
[18] UNICEF, Building community engagement, draft guidance, 31 June 2021.
[19] Pierre B, Origin of the refusal of the vaccination, published online on 07 May 2012
[20] Holder, J. (2022). Tracking Cornavirus Vaccinations Around the World. The New York Times. Available on https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html, 14-August, 2022, at 6:04pm.
[21] Di Meo, S & Bentivegna, E.(2021). Migrants' Quarantine and COVID-19 Pandemic in Italy: a Medico-anthropological View. Comprehensive Clinical Medicine (2021) 3:1858–1862. https://doi.org/10.1007/s42399-021-00993-2
[22] Canevelli M, Palmieri L, Raparelli V, Punzo O, Donfrancesco C, Lo Noce C, et al. Onder G; Italian National Institute of Health COVID-19 Mortality Group. COVID-19 mortality among migrants living in Italy. Ann Ist Super Sanita. 2020 Jul-Sep;56(3):373–7. https://doi.org/10.4415/ANN_20_03_16
[23] WebMD (2022) retrieve on https://www.webmd.com/cold-and-flu/what-are-epidemics-pandemics-outbreaks at 8:30am, on 15/08/2022
[24] Havard Medical School (2022). Preventing the spread of the coronavirus. Physical distancing, masks, vaccines, and other preventive measures. Havard Health Publishing retrieved on https://www.health.harvard.edu/diseases-and-conditions/preventing-the-spread-of-the-coronavirus, 15/08/2022, at 9:34am.
[25] Tan,M.M, Musa,A.F & Su,T.T,(2021). The role of religion in mitigating the COVID-19 pandemic: the Malaysian multi-faith perspectives, Health Promotion International, Volume 37(1), February 2022, daab041, https://doi.org/10.1093/heapro/daab041
[26] Zintel, S., Flock, C., Arbogast, A.L., von Wagner, C, & Sieverding, M.(2022). Gender differences in the intention to get vaccinated against COVID-19: a systematic review and meta-analysis. Journal of Public Health (Berl.) https://doi.org/10.1007/s10389-021-01677-w
[27] Galanis PA, Vraka I, Fragkou D, Bilali A, Kaitelidou D (2020) Intention of health care workers to accept COVID-19 vaccination and related factors: a systematic review and meta-analysis. medRxiv. https://doi.org/10.1101/2020.12.08.20246041
[28] Lin C, Tu P, Beitsch LM (2021) Confidence and receptivity for COVID-19 vaccines: a rapid systematic review. Vaccines. 9:16. https://doi.org/10.3390/vaccines9010016
[29] Bish A, Yardley L, Nicoll A, Michie S (2011) Factors associated with uptake of vaccination against pandemic infuenza: a systematic review. Vaccine. 29:6472–6484. https://doi.org/10.1016/j.vaccine.2011.06.107
[30] Robinson E, Jones A, Daly M (2020) International estimates of intended uptake and refusal of COVID-19 vaccines: a rapid systematic review and meta-analysis of large nationally representative samples. medRxiv. https://doi.org/10.1101/2020.12.01.20241729
[31] Sakou II, Tsitsika AK, Papaevangelou V, Tzavela EC, Greydanus DE,Tsolia MN (2011) Vaccination coverage among adolescents and risk factors associated with incomplete immunization. Eur J Pediatr 170:1419–1426. https://doi.org/10.1007/s00431-011-1456-z
[32] Pulcini C, Massin S, Launay O, Verger P (2013) Factors associated with vaccination for hepatitis B, pertussis, seasonal and pandemic infuenza among French general practitioners: a 2010 survey. Vaccine 31:3943–3949. https://doi.org/10.1016/j.vaccine.2013.06.039
[33] Jiménez-García R, Hernández-Barrera V, de Andres AL, JimenezTrujillo I, Esteban-Hernández J, Carrasco-Garrido P (2010) Gender infuence in infuenza vaccine uptake in Spain: time trends analysis (1995–2006). Vaccine 28:6169–6175. https://doi.org/10.1016/j.vaccine.2010.07.029
[34] Maleva TM, Kartseva MA, Korzhuk SV (2021) Socio-demographic determinants of COVID-19 vaccine uptake in Russia in the context of mandatory vaccination of employees. Population and Economics 5(4): 30-49. https://doi.org/10.3897/popecon.5.e77832
[35] Salam (2021) Abdou Salam Gueye et al. PAMJ - 41(Supp 2):1. 29 Mar 2022 COVID-19 Response in WHO African Region: country and regional office experiences

[36] Tan,M.M, Musa,A.F & Su,T.T,(2021). The role of religion in mitigating the COVID-19 pandemic: the Malaysian multi-faith perspectives, Health Promotion International, Volume 37(1), February 2022, daab041, https://doi.org/10.1093/heapro/daab041
[37] Liang T., Chen L., Wu J., Xu G., Wu Z. SMS: A Framework for Service Discovery by Incorporating Social Media Information. IEEE Transactions on Services Computing. 2019;12(3):384–397. doi: 10.1109/TSC.462938610.1109/TSC.2016.2631521.
[38] Bhatt R.M., Bolonyai A. (2011). Code-switching and the optimal grammar of bilingual language use. Bilingualism: Language and Cognition;14(4):522–546. doi: 10.1017/S1366728910000295.
[39] SoleimanvandiAzar N., Irandoost S.F., Ahmadi S., Xosravi T., Ranjbar H., Mansourian M., Lebni J.Y. (2021). Explaining the reasons for not maintaining the health guidelines to prevent COVID-19 in high-risk jobs: A qualitative study in Iran. BMC Public Health;21(1):1–15. doi: 10.1186/s12889-021-10889-4.
[40] Suyanto B., Egalita N., Sugihartati R. (2020). Facing the New Reality of Post Covid-19: A Demand for Lifestyle-Based Social Engineering. Talent Development & Excellence;12(1):2333–2342
[41] Rodríguez-Priego,N., Porcu,L., Kitchen,P.L. (2022). Sociocultural factors during COVID-19 pandemic: Information consumption. Journal of Business Research, 140(2022): 546-555
[42] Van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., ... & Munster, V. J. (2020). Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. New England journal of medicine, 382(16), 1564-1567.
[43] Sanche S, Lin YT, Xu C, Romero-Serverson E, HengaetneN, Ke R2020. High contagiousness and rapid spread of severe acute respirator syndrome coronavirus 2. Emerg Infect Dis.,; 26:1470-7.
[44] Cucinotta, D., & Vanelli, M. (2020). WHO declares COVID-19 a pandemic. Acta Bio Medica: Atenei Parmensis, 91(1), 157.
[45] Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P.
a. Understanding vaccine hesitancy around vaccines and vaccination
b. from a global perspective: a systematic review of published literature, 2007–2012. Vaccine. 2014;32(19):2150–59. doi:10.1016/j.vac
c. cine.2014.01.081.
[46] Dubé E, Vivion M, Macdonald NE. Vaccine hesitancy, vaccinerefusal and the anti-vaccine movement: influence, impact and implications. Expert Rev Vaccines. 2015 Jan;14(1):99–117. doi:10. 1586/14760584.2015.964212.
[47] Africa Centres Disease Control and Prevention (CDC Africa) and the London School of Hygiene & Tropical Medicine (LSHTM). Majority of Africans would take a safe and effective COVID-19 vaccine. Addis-Ababa: Africa CDC; 2020 Dec 17 [accessed 2021 Jan 12]. https://africacdc.org/news-item/majority-of-africanswould-take-a-safe-and-effective-covid-19-vaccine/.