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Research

Population Behavior and Practices during the First Wave of COVID-19 Pandemic in Low Resource-Conditions of South Kivu, East of Democratic Republic of Congo

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ABSTRACT

Backround: In DR Congo, South Kivu is among cities most affected by Covid 19 with its dense population and common mass movement. This study aimed at investigating the population behavior and practices during the spread period of Corona in South Kivu, East of Democratic Republic of Congo.

Subjects dan Method: A cross-sectional analytical study was undertaken in South Kivu province and included 800 hundred individuals. The survey questionnaire was designed and comprised information on independent variables including socio-demographic and socioeconomic parameters, travel history of individuals, and person's history of COVID-19 comorbidity factors. These data were used to explain the dependent variable which was the population behavior and practices which was linked to the COVID-19 positivity or negativity. A rapid test of the COVID-19 antigen for people suspected of having cough and fever followed by RT-PCR tests was conducted. Statistical analyses were performed under R, version 3.5.1.

Results: Results indicate three categories of people depending on their behavior and practices during the COVID-19. These include the negative group, those who contracted the disease and knew their serological status, and those who did not know their serological status. The behavior of these categories varied with age, education level, income, and their geographical location. Variable behaviors have been adopted, including lack of action, prayer, self-medication, lifestyle change, and change in feeding. Efforts to control the spread of the disease entailed two most commonly used barriers: wearing a mask (95%) and frequent hand washing (94%). In the COVID-19 infected category, type 1 individuals developed the most characteristic symptoms of COVID-19, mainly cough, asthenia, fever, and headache. Types 2 and 3 individuals were less likely to engage in any of the behaviors associated with COVID-19 because they have fewer comorbidities and have developed fewer of the symptoms characteristic of COVID-19.

Conclusion: Education level and socioeconomic conditions are among the factors to be considered in pandemic control strategies.

Keywords: Typology, SARS, comorbidity, population believe.

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BACKGROUND

Currently, the whole world is facing the COVID-19 pandemic. To date, more than 110.7 million people have been infected worldwide, with an estimated mortality of 2.53% among the infected population1. Although the most affected countries are the United States, Brazil, Italy, Spain, and France, the disease is currently reported in almost all African countries. The World Health Organization (WHO) has thus sounded an alarm for all African countries on the need to take precautions in the face of this imminent danger. The same concern have been expressed by various organizations like Melinda Gates especially regarding the Africa's ability to respond to COVID-19 due to precarious hygiene practices in the continent. Tedros Ghebreyesus, the General Director of WHO, raised similar concerns during press conferences of the WHO (WHO, 2020). This was alarming, especially in Sub-Saharan African (SSA) countries, where several health challenges, such as limited access to intensive care units is common (McKenzie, 2020). For example, in DRC, the 2.8 million population of Lubumbashi city and 0.5 million inhabitants of North Kivu's Goma capital are served by 257 and 141 intensive care units respectively (Dunser et al., 2006; Muteya et al., 2013). The country is listed among the SSA regions where a high burden of infectious diseases being reported including Lassa hemorrhagic fever and Ebola hemorrhagic fever, HIV, malaria, and tuberculosis2. However as predicted, SSA experiences a relatively lower level of infection rate compared to the European, Asian and American countries. This could be attributed to prior release of WHO guidelines before the disease entry into Africa, and subsequent strategic preparedness and response plan with reference to these guidelines. Equally, migration frequency and rural, sparse residence areas which is common in African countries hinders the spread due to limited interaction within the population. There could also be contribution of climatic conditions such as high temperature and humidity, which are associated with low prevalence of COVID-19 (Cambaza et al., 2020).

The Democratic Republic of Congo (DRC) is part of the most densely populated countries in Africa, with an estimated population of over 80 million, and is among the most affected countries on the continent. The country has recorded more than 28,377 cases including 745 deaths, according to the report of the national committee of response against COVID-19 as of 06/04/2021. The most affected areas are Kinshasa city, the epicenter of the disease in the country, the provinces of Congo Central, South Kivu, Ituri, North Kivu, Kwilu, and Haut Katanga. These cities are densely populated and mass movement is common. The contagiousness index of SARS-CoV-2 in the country is estimated to be between 1.5 and 3.5 according to models made in China (Hussi et al., 2020). These projections is a huge concern to Africa due to overcrowded cities, promiscuity, poverty, fragile health systems and low level of education which would hinder observation of the barrier measures against the spread. Additionally, internal conflicts, and infights that the country has experienced have weakened both political and social institutions and have disrupted the health organization. The recent Ebola outbreak led to skepticism and loss of trust in epidemic response teams, and beliefs that the virus was fabricated, and negative intentions such as hiding from health professionals with discourse (Dong et al., 2020). Beyond this, certain behaviors such as shaking hands, social and mass gatherings, contact with the dead and participation in mortuary vestments, and violation of quarantine rules were also difficult to discourage5.

In South Kivu province, as of 05 April 2021, there were 886 confirmed cases and healthcare centers were facing serious problem due to scarcity of diagnostic kits and lack of protection equipment (Mukwege et al., 2021). The National and provincial response committee has developed strategies for the mitigation of the pandemic. However, as experienced in the past for Ebola, avian influenza, and SARS epidemics, many of these approaches are limited in time and space, and that a large part of the population has no prior experience with these strategies (Cambaza et al., 2020; Mukwege et al., 2021). Following the spread of cases in the province, people have started applying several measures and practices related to culture. In this region people apply phototherapy and thermotherapy for treating respiratory-related disease. However, implementing strict containment of the population as recommended in industrialized countries is not feasible in South Kivu because most people have to go out for food every day. Given this, the population has adopted various behavior and practices as prevention strategies. Although, population behavior and its capability to adhere to the guidelines during the crisis depend on a series of factors, including people's perception of their susceptibility to the infection (Roy et al., 2020), the severity of infection if the disease is contracted, and the ability, confidence and resources needed to apply the developed strategies (Lau et al., 2020) and their socio-demographic status (Blake et al., 2010 et; Leung et al., 2003). In this regard, it is necessary to understand population's perceptions, willingness, and commitment to adopt the guidelines for effective response to the pandemic (Blake et al., 2010; et Leung et al., 2003). This study was proposed to investigate the population behavior and practices during the spread period of Corona in South Kivu.

SUBJECTS AND METHOD

1. Study Design

This was a descriptive, cross-sectional analytical study undertaken in Bukavu, South Kivu province, in the Democratic Republic of Congo from 11th March to 5th May 2020.

2. Population and Sample

A total of 800 hundred individuals were included in this study. They were divided into three groups: i) all COVID-19 confirmed cases, ii) contacts of confirmed cases, and iii) people from epidemic areas (High risk areas). The contacts of the confirmed positive test cases and individuals from high-risk areas who came mainly from the countries across the world and cities where the pandemic was reported were also included in the study.

3. Study Variables

Independent variables: The first part of the questionnaire focused on certain socio-demographic characteristics such as gender, age, education, and professional status, type of contact made, and origin and settlement of the respondent. The second section focused on socioeconomic parameters to assess dietary behavior and compliance with the practice of quarantine and access to health care. Alcohol consumption, cigarette smoking, and the most frequented places were also identified. Section 3 focused on practices and behavior during the pandemic period. This included information on mental sensation, practices used, which could be either self-medication, self-isolation, lifestyle changes, or inactivity. The potential for self-isolation was assessed, as well as the treatments used when self-medication is practiced. The fourth section looked at travel history and the most frequented areas in the town. The fifth section concerned clinical signs developed meantime. These included the recognized symptoms of the disease, mainly cough, fever, headache, myalgia and aches, asthenia, and dyspnea. The sixth and final section concerned the person's history of comorbidity factors known to have a negative impact on patients with COVID-19. The factors selected for this study included heart disease, respiratory pathologies, obesity, chronic renal pathologies, diabetes, immunosuppressive treatment with corticosteroids, chemotherapy or anti-rejection, and other immunosuppressive pathologies.

Dependent variable: The above listed independent variables were collected in order to explain the population behavior and practices during the first wave of COVID-19 pandemic in low resource-conditions of South Kivu, East of Democratic Republic of Congo and were linked to the positivity or negativity from the COVID-19.

4. Study Instruments

An algorithm was used to categorize participants, starting with a rapid test of the COVID-19 antigen for people suspected of having cough and fever. To do this, the COVID-19 Ag Respi-Strip (Coris Bio-Concept, Gembloux, Belgium) was used for triage. Positive cases were then confirmed by molecular RT-PCR. All participants went through an oral interview administered by a group of junior doctors who received two-days of training prior to the survey. The survey was electronically assisted by the Kobocollect software.

5. Data Analysis

Descriptive analysis was used to assess the sociodemographic and socioeconomic characteristics and the practices and behavior of respondents. Response percentages were calculated based on the number of respondents per response. A multivariate statistical analysis was then conducted to identify explanatory variables likely to help in the segregation of homogeneous groups16. We considered sociodemographic characteristics and those related to practices, behavior, and comorbidities. This made it possible to group the participating respondent into three groups. The comparison of qualitative data between the three groups was done using the chi-square test, chosen according to the absolute frequencies of the contingency tables. Multiple Correspondence Analysis (MCA), a data reduction method, was applied to all selected variables in order to derive a smaller set of uncorrelated main components. In MCA, the reduction is achieved by transforming the data set containing categorical variables into a new set of continuous variables (principal components) (Husson et al., 2010).

Subsequently, clustering analysis (CA) was applied to these principal components to identify groups with minimal intra-group variability and maximal differences intergroups. There are two commonly used methods of clustering: non-hierarchical clustering, such as K-means and hierarchical clustering. Both clustering methods are sometimes used to combine their strengths (Iraizoz et al., 2007; Kuivanen et al., 2016). In MCA, only the first axes are retained to stabilize clustering by removing noise from the data17. In order to retain as much variability in the data as possible, we chose to cluster using the first three components, which account for nearly 73% of the total data inertia. In order to identify the main characteristics of the different clusters, the Euclidean distances were calculated between the centroids of the clusters and all categories taking into account their main coordinates on the first three main components. All statistical analyses were performed under R, version 3.5.1 (R Development Core Team, 2018).

6. Research Ethics

This study was approved by the Research Ethics Committee of the Université Evangélique en Afrique. The consent of the participants was obtained before completing the survey. All participants were informed on the voluntary nature of their participation and on the anonymity and confidentiality of the information.

RESULTS

The results in table 1 provide information on the relationships between the different variables used in multiple correspondence factor analysis and the main components derived from them.

Table 1. Applied variables in multiple correspondence factor analysis and related main components

Variables	PC1	PC2	PC3
Behavior			
Prayer	0.00	0.01	0.00
Self-medication	0.02	0.29*	0.03
Self-isolation	0.01	0.02	0.08
Lifestyle change	0.03	0.13	0.03
Changing the feed mode	0.01	0.15	0.02
Conditions of Exposure			
Travel outside DR Congo	0.00	0.08	0.55*
Staying in a high-risk area	0.01	0.08	0.57*
Contact with a confirmed positive COVID-19	0.02	0.00	0.37*
Contact with a symptomatic co-exposed person	0.10	0.19	0.09
Contact with medical staff at a hospital treating COVID-19	0.06	0.11	0.02
Comorbidities			
Blood type	0.00	0.01	0.03
Heart Disease	0.66*	0.00	0.00
Arterial hypertension or cardiovascular pathology	0.71*	0.01	0.00
Respiratory pathology	0.85*	0.00	0.00
Obesity	0.79*	0.13	0.04
Kidney pathology	0.82*	0.00	0.00
Diabetes	0.70*	0.01	0.00
Immunosuppressive therapy	0.78*	0.00	0.02
Other immunosuppression	0.50*	0.01	0.00
Developed symptoms			
Fever	0.01	0.44*	0.00
Febrile non-febrile syndrome	0.00	0.13	0.00
Shivers	0.01	0.36*	0.00
Cough	0.01	0.30*	0.00
Sweaters	0.00	0.12	0.01
Dyspnea	0.00	0.03	0.01
Asthenia	0.01	0.48*	0.00
Myalgia or aches and pains	0.00	0.12	0.04

Diarrhoea	0.00	0.01	0.04
Headache	0.01	0.30*	0.04

PC: Principal component

Thus, it can be seen that the first component (PC1) accounts for up to 50.11% of the total inertia and is strongly related to the comorbidity variables, with the exception of blood type.

The second main component (PC2) accumulates up to 17.22% of the total inertia and is strongly related to the variables of developed symptoms. The main informative symptoms are fever, asthenia, chills, cough, and headache. Finally, the third main component (PC3), which contributes only by 5.59% of the total variance, has a greater relationship with the variables relating to the conditions of exposure to COVID-19. This includes traveling outside the country, staying in high-risk areas like Kinshasa-the epicenter of the epidemic in the country, contact with a confirmed positive COVID-19 case, or with asymptomatic exposed person or with medical staff at a hospital in charge of COVID-19 (Table 1).

Table 2. Loadings of modalities on the three principal components from the multiple correspondence analysis (MCA)

Variables	PC1	PC2	PC3
Behavior			
Practice of self-medication	-0.10	0.29*	0.07
Changing the feed mode	-0.14	0.37*	-0.11
Conditions of Exposure			
Contact with confirmed case of COVID-19	-0.12	0.00	0.29*
Travel outside DR Congo	-0.02	0.12	-0.29
Stay in a high-risk area	0.06	0.11	-0.29
Comorbidities			
Heart Disease – NSP	0.84*	0.01	0.04
Hypertension or Cardiovascular Pathology – NSP	0.97*	0.08	0.04
Chronic Respiratory Pathology – NO	1.21*	0.06	0.05
Obesity – NO	1.30*	0.03	0.01
Obesity – Yes	-0.10	0.51*	-0.22
Chronic Kidney Disease – NO	1.14*	0.04	0.04
Diabetes – NO	0.97*	0.08	0.05
Immunosuppressive therapy – NSP	1.39*	0.03	0.02
Immunosuppressive therapy – Yes	-0.03	-0.02	0.56*
Other Immunosuppression NO	0.93*	0.09	-0.05
Developed symptoms			
Fever	-0.18	0.90*	0.03
Febrile non-febrile syndrome	-0.05	1.11*	0.09
Shivers	-0.28	1.18*	0.03
Cough	-0.21	0.65*	0.06
Sweaters	-0.22	0.90*	0.18
Dyspnea	-0.16	0.57*	0.24
Asthenia	-0.16	0.83*	0.05
Myalgia or aches and pains	-0.13	0.89*	0.39*
Diarrhoea	0.10	0.46*	0.59*
Headache	-0.23	0.76*	0.21

NSP: 'doesn't know the status.

Table 2 shows that the first main component (PC1) best separates individuals with respect to their comorbidities. Individuals with no information on their comorbidity diagnosis differ significantly on this axis from those who are informed of their diagnoses with respect to comorbidities. The second main component (PC2) provides information on the symptoms developed and the behaviors adopted. It enables the best possible separation of people according to their state of obesity, the symptoms they have developed, and the behavior they have adopted. Obviously, obese people who have presented one or more symptoms adopted self-medication and/or changed their dietary regime. Finally, the third main component makes it possible to separate, as far as possible, the persons who have been in direct contact with the COVID-19 positive cases from those who have stayed outside the country and/or in a high-risk area. It also allows observation of a tendency by people under immunosuppressive treatment to develop myalgia and/or diarrhea if they have been in contact with people who have been tested positive to COVID-19 (Table 2).

Using the coordinates of the individuals on the main components from the multiple correspondence factorial analysis in the hierarchical ascending classification and consolidation of the classes with the k-means procedure, the aggregation of the individuals into three distinct classes (Figure 1 and Figure 2) whose characterristics on the main components are presented in Table 3.

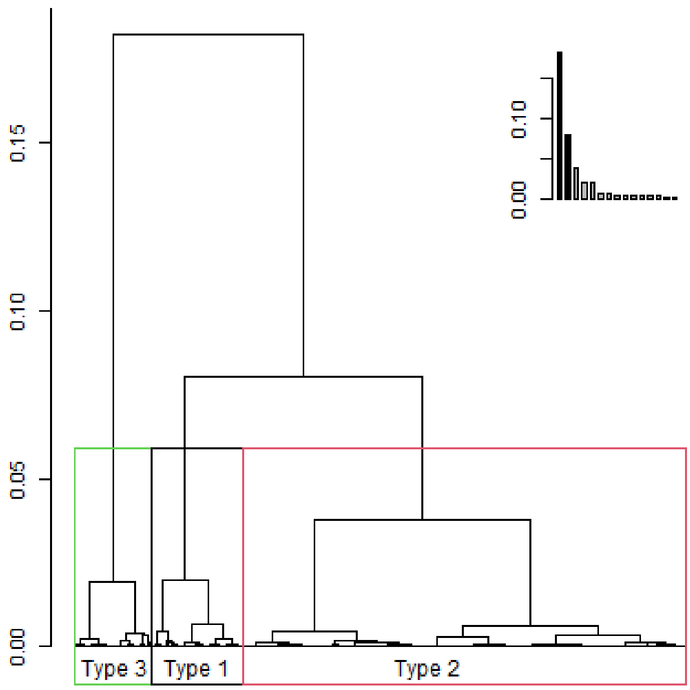

Figure 1. Dendrogram showing population clustering based on their practices and behavior from hierarchical clustering on principal components. The dashed line shows selected cut-off points

The results in figure 2 show that the first main component allows a better separation of Type 3 individuals from those of two other types (Type 1 and Type 2). Individuals are those with no information on their comorbidity diagnoses, while those of the other types (Type 1 and Type 2) are those who are informed of their health status with respect to the different comorbidities. The second main component (PC2) allows us to clearly separate individuals according to the symptoms they have presented. Type 1 individuals take positive values on the second main component. This means that these are the individuals who have presented the most characteristic symptoms of COVID-19 and who were tested positive. Type 2 individuals tended not to exhibit the symptoms characteristic of COVID-19. Finally, the third major component (PC3) does not allow for any separation of the three types (Type 1, Type 2, and Type 3). All individuals tend to take the same coordinates on this axis, regardless of the type to which they belong. This means that the conditions of exposure to COVID-19 are the same for all individuals. Thus, Type 1 individuals tend to present the characteristic symptoms of COVID-19 with obesity as a comorbidity characteristic. Type 2 is the most predominant in the population. These are the individuals who presented less symptoms characteristic of COVID-19 and who have no particular comorbidity. Type 3 individuals are those who have not presented any particular symptoms of COVID-19 but are unaware of any comorbidities they may have (Figure 2).

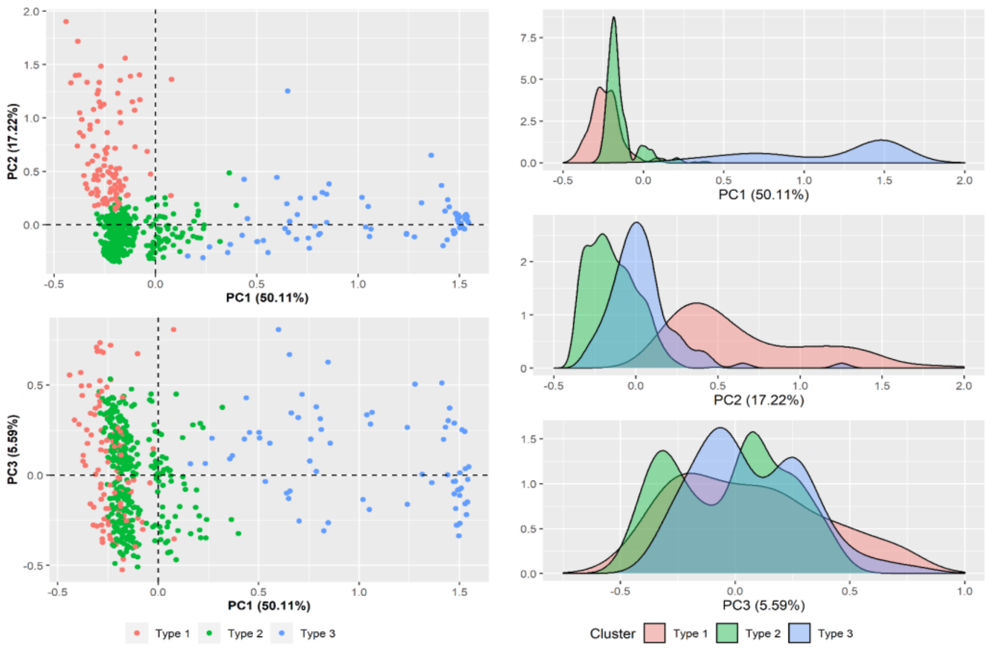

Figure 2. Characterization of types on the main components from multiple correspondence factorial analysis

The results in this table 3 show that individuals of all three types (Type 1, Type 2, and Type 3) have the same gender and religious profile. On the other hand, it was observed that the age distribution is not the same in the three types, although the age range most represented in the three types is between 30 and 49 years of age. In types 2 and 3, people under 30 years of age occupy larger proportions (over 35%) than in type 1 (no more than 24%). This could also explain the fact that it is still in these two categories (Types 2 and 3) that we find the highest proportions of single (unmarried persons). In terms of education level, persons with higher levels of education (university and post-graduate) occupy large proportions in type 1 compared to the other two types, which could also explain the predominance in type 1 of persons with higher levels of monthly income compared to persons in the other two types. Spatially, people living in the municipality of Ibanda are more predominant in all three categories. However, it can be seen that people living in Bagira are much more represented in Types 2 and 3, 11% and 18% respectively, whereas they occupy no more than 3 in Type 1 (Table 3).

Table 3. Socioeconomic profile of people considering the three types

Variables	Type1	Type2	Type3	Total	p
Sex					0.878
Female	31.48	30.84	33.71	31.29	
Male	68.52	69.16	66.29	68.71	
Age					0.049
Under 30 years old	23.15	35.82	38.20	34.21	
30 to 49 years old	63.89	51.72	47.19	52.99	
50 years old and over	12.96	12.45	14.61	12.78	
Religion					0.927
Catholic	49.07	51.53	56.18	51.74	
Protestant	43.52	40.99	40.45	41.31	
Muslim	2.78	2.87	1.12	2.64	
Other	4.63	4.59	2.25	4.30	
Level of education					<0.001
None	0.00	3.64	0.00	2.64	
Primary	0.93	4.02	7.86	4.03	
Secondary	27.78	40.99	55.05	40.75	
Academic	51.85	40.99	37.08	42.14	
Academic Post	19.44	10.34	0.00	10.43	
Marital status					0.007
Single	21.29	37.74	31.46	34.49	
Married	72.22	58.62	65.17	61.47	
Divorced	0.93	1.53	2.25	1.53	
Widow(er)	5.56	2.11	1.12	2.50	
Monthly income					<0.001
Less than 100	5.56	16.67	29.21	16.55	
100 to 299	21.29	28.93	23.59	27.12	
300 to 499	20.37	29.31	31.46	28.23	
500 to 699	16.67	11.30	3.37	11.12	
700 to 999	19.44	7.66	7. 87	9.46	
1000 and more	16.67	6.13	4.49	7.51	
Household size					0.063
Less than 3	6.48	7.66	3.37	6.95	
3 to 7	66.67	56.51	47.19	56.89	
8 to 12	24.07	32.76	46.07	33.10	
More than 12	2.78	3.06	3.37	3.06	
Municipalities					0.011
Bagira	2.78	10.92	17.98	10.57	
Ibanda	81.48	73.18	69.66	73.99	
Kadutu	14.81	15.33	12.36	14.88	
Outside Bukavu	0.93	0.57	0.00	0.55	

More than 2 out of 5 Type 1 individuals have one or more comorbidities (Table 4), which is less the case in the other two categories. The most predominant comorbidities are obesity, high blood pressure or cardiovascular disease, and diabetes. Type 1 individuals also develop the most characteristic symptoms of COVID-19. More than 9 out of 10 people of type 1 had two or more symptoms, mainly cough, asthenia, fever, and/or headache. This prompted them to take certain actions to prevent and/or treat COVID-19. Given this, comorbidities and symptom development, self-medication, lifestyle change, and self-isolation are the main behaviors adopted by Type 1 individuals, along with wearing masks and regular hand washing. Types 2 and 3 individuals have been much less likely to engage in any of the behaviors associated with COVID-19 because they have fewer comorbidities and have developed fewer of the symptoms characteristic of COVID-19.

Table 4. Characteristics of the three people considering the studied parameters

	Type1	Type2	Type3	Total	p
Blood Type					
A-	0.00	0.95	1.12	0.83	0.052
A+	12.03	11.30	8.98	11.12	
AB-	0.00	0.95	0.00	0.69	
AB+	6.48	5.93	12.36	6.81	
B-	0.92	0.76	0.00	0.69	
B+	24.07	12.64	8.98	13.90	
O-	4.63	1.72	0.00	1.94	
O+	21.29	27.96	25.84	26.70	
NSP	30.55	37.73	42.69	37.27	
Presence of comorbidity	40.74	12.26	5.61	15.71	<0.001
Comorbidities					
Heart Disease	8.33	1.14	0.00	2.08	0.001
HPA or Cardiovascular Pathology	17.59	5.17	2.24	6.67	<0.001
Chronic Respiratory Pathology	9.25	1.53	1.12	2.64	0.001
Obesity	21.29	3.06	2.24	5.70	<0.001
Chronic Kidney Disease	0.00	0.19	0.00	0.13	1.000
Diabetes	9.25	4.78	2.24	5.14	0.145
Immunosuppressive treatment	0.92	0.38	0.00	0.41	0.533
Other immunosuppression	0.92	0.38	0.00	0.41	0.533
Development of clinical signs	88.88	2.49	10.11	16.41	<0.001
Clinical signs developed					
Fever	39.81	0.19	2.24	6.39	<0.001
Febrile non-febrile syndrome	7.40	0.00	2.24	1.39	<0.001
Shivers	21.29	0.00	0.00	3.19	<0.001
Cough	50.00	0.76	2.24	8.34	<0.001
Sweaters	12.03	0.00	1.12	1.94	<0.001
Dyspnea	7.40	0.19	1.14	1.39	<0.001
Asthenia	45.37	0.95	4.49	8.06	<0.001
Myalgia/curvatures	11.11	0.00	2.24	1.94	<0.001
Diarrhoea	4.63	0.00	2.24	0.97	<0.001
Headache	37.03	0.57	1.12	6.12	<0.001
Alcohol consumption	50.00	46.55	44.94	46.87	0.806
Cigarette consumption	6.48	4.78	1.12	4.59	0.208
Conditions of exposure to COVID-19					
Travel outside the DRC	60.18	39.65	30.33	41.58	<0.001
Staying in a high-risk area	63.88	42.33	53.93	47.01	<0.001
Positive Person Contact at COVID-19	29.63	23.75	13.48	23.36	0.053
Symptomatic person contact	25.00	9.77	41.57	15.99	<0.001
Personal contact of a hospital treating COVID-19	12.03	8.81	3.37	8.62	0.219
Types of places most frequented					
Church	55.55	46.93	33.70	46.59	0.016
Hospital	13.88	6.32	1.12	6.81	0.004
Bar	24.07	20.30	10.11	19.61	0.075
Place of work	79.63	62.06	69.66	65.64	0.006
Crossroads / Walk	12.03	9.96	7.86	10.01	0.761
Stadium / Playground	7.40	4.21	3.37	4.59	0.510
School / University	5.55	4.21	5.61	4.59	0.699
Behaviour in the face of COVID-19					
None	8.33	35.05	61.79	34.35	<0.001
Prayer	37.96	31.99	24.71	31.98	0.209

Self-medication	77.77	21.45	15.73	29.20	<0.001
Self-isolation	44.44	27.20	15.73	28.37	<0.001
Lifestyle change	53.70	19.92	8.98	23.64	<0.001
Changing the feed mode	33.33	9.19	3.37	12.1	<0.001
Wearing a mask	97.22	95.59	92.13	95.41	0.221
Regular hand washing	95.37	94.25	92.04	94.15	0.647

People in both three types were alcohol consumers. More people in Type 1 traveled outside DRC and stayed in a high-risk area of COVID-19 than those in Type 2 and 3. Type 3 were in contact with symptomatic people (Table 4).

DISCUSSION

Our results indicate three categories of people depending on their behavior and practices during the COVID-19 pandemic. They can be categorized into those who contracted the disease and knew their serological status, the ones who were negative to the disease, and those who have not their serological status. The behavior of these categories vary with age, education level, income, and geographical location. It was observed that the population of South Kivu adopted variable behaviors in relation to COVID-19. These behaviors include lack of action, prayer, self-medication, lifestyle and nutritional changes. In fact, we note that the adopted measures by the large population of our respondent are related to hygiene as it had been recommended by the government. In a study conducted in Australia on public perception of the COVID-19 pandemic, over 52% of respondents indicated the inefficacity of social distancing measures to prevent the COVID-19 spread mostly the travel bans and self-isolation (Seale et al., 2020). In Germany, on the other hand, an association between the level of education and adoption of protective behaviors were very weak, and the perception of risk was particularly high among the elderly (Azlan et al., 2020). In Malaysia, results similar to this study reported a high proportion of respondents observing precautions such as crowd avoidance (83.4%) and hand hygiene practice (87.8%) during the outbreak. In this study, the mask-wearing score remains high compared to observations made in Malaysia (95% vs 51.2%) (Geldsetzer et al., 2020). This could probably be due to the type of respondents who were from contact persons as well as those who developed symptoms and therefore applied some protective measures.

Social distancing remains an unobserved measure in the population in spite of popularization. Indeed, the poor observation of social distancing is not surprising as the rationale behind these strategies are not captured nor were they explained to the public. Considering the socioeconomic dynamics of the population, individuals may be unable to get capacity or resources to apply physical distancing measures as (1) the size of their household is large enough with additional family members; (2) they often have the task of caring for someone outside their home; (3) they have shared accommodation facilities; (4) they do not have indoor access to electricity, television, etc.; or (5) they cannot simply stay at home because the family lives on daily earnings have.

In the COVID-19 infected category, 8.33%, 17.5%, 9%, 21%, and 9% had comorbid heart disease, cardiovascular disease, chronic respiratory disease were obese, or had diabetes respectively. In fact, several pathologies are qualified as comorbidity and linked with the severity of COVID-19 disease. Indeed, in a cohort study, it was shown that patients with diabetes were more likely to contract the virus and develop more severe forms of the symptoms (Cowling et al., 2009). Their mortality was also shown to be the highest (Lau et al., 2010). Nine percent of our patients had chronic respiratory diseases and this places them at risk of developing acute respiratory distress syndrome and respiratory failure if they were infected with the new coronavirus. In the literature and research, comorbidities increase the mortality rate in patients who have acquired COVID-19, especially with heart disease and diabetes (Nachega et al., 2020).

The result indicates three categories of people depending on their behavior and practices during the COVID-19 pandemic. The multivariate statistical analysis presented the gender and religion profile with the age range most being between 30 and 49 years of age. This is consistent with the previous findings (WHO, 2007) which consisted of people with the same gender profile, although the age range most represented was quite different from ours (between 40 and 59 years old). In socio-demographic characteristics, gender differences may lead to various perceptions and induce several behaviors (Boniol et al., 2019, Howard (2021). For example, an older, poorer and economically active woman who has a higher risk of contagion may be more compliant with the rules for protection against COVID-19. Household size may also affect the costs of compliance, forcing people to stay at home. Religion may as well influence the view as well as compliance with associated management strategies against the virus.

Regarding the level of education, our results are in line with recent study (Kuhangana et al., 2020) in which a cross-national (Germany, Netherlands, France, United Kingdom, Belgium, United States Italy, Spain) Facebook survey on behaviors and attitudes in response to the COVID-19 pandemic. Similar to our study, most respondents involved in their survey attained university education level except in Italy (50%), Germany (62%), and the Netherlands (58%), where most of the interviews attained secondary-level education. From our study, a direct relationship could be established between the level of education of respondents and their monthly income (persons with higher levels of education occupied large proportions in type 1 compared to the other two types, which could also explain the predominance in type 1 of persons with higher levels of monthly income compared to persons in the other two types). Our findings are similar to those from Liu et al (2020) study whose survey participants differed across four main locations (Kolwezi, Lwambo, Likasi, and Lubumbashi) with regards to age and socioeconomic position.

In this study, people in Type 1 presented some symptoms (cough, asthenia, fever, and headache) related to COVID-19. 50% of people in that group were alcohol consumers, and only 6.48% cigarette consumers. Although the time and volume of alcohol consumption were not considered in their study, Liu et al. (2020) demonstrated the absence of a link between drinking and the severity of COVID-19. Therefore, it has been mentioned that smoking was being considered a risk factor in elderly male patients for the disease progression (Leask, 2020). Indeed, in a study on the analysis of patients smoking status and severity of COVID-19, the results showed that there was no link between smoking and severity at COVID-19 (Ortiz et al., 2020). Regarding the findings from this study on the alcohol and cigarettes consumptions and the symptoms related to COVID-19 in type 1, there was no link between them. However, this has to be clarified since we recognize the deterioration of the lungs by smoking and the link with COVID-19 regarding respiratory depression induced. In South Kivu the proportion of smokers remain very low as close contact with people suffering from acute respiratory infections and staying in the high risk of COVID-19 area are one of the risks factors of disseminating SARS-CoV-2. In this study, type 1 (63.88%) and type 3 (53.93%) had a stay in the high-risk area of COVID-19 and had close contact with positive person contact at COVID-19 (23.36% of the total population considered in this study).

Symptoms may range from mild to severe in patients infected with COVID-19. In this study, the main symptoms developed by the participants were fever, asthenia, chills, cough, and headache. These flu-like symptoms have been described as mild and may disappear after a few days with or without self-medication at home or hospitalization but may also go unnoticed (Jutzeler et al., 2020). Fever, cough, and fatigue are the main clinical signs reported in a systematic review (Wang et al., 2020) and in a study conducted on the Wuhan population, as being the most common clinical manifestations at the onset of the disease35. Other accompanying symptoms such as diarrhea, odynophagia, rhinorrhea are rarely described (Latz et al., 2020).

The description of the clinical manifestations related to COVID-19 to date shows that more than 80% of cases are mild infections, and only about 15% of patients develop severe infections, and less than 5% progress to the very critical forms (Zhao et al., 2020). These manifestations can evolve towards a severe form with respiratory difficulty, especially in some patients with chronic diseases such as diabetes mellitus but also in older subjects, which increases mortality related to COVID-19 (Jutzeler et al., 2020).

Most of the people with SARS-COV-2 symptoms were from blood B+ and group A+. Less COVID-19 positive patients were blood type O+. Many patients do not know their blood type in DRC, as highlighted in this study. A study aimed to determine the independent effect of blood type on intubation or death, and positive testing in COVID-19 patients with a known blood type revealed no link between blood type and risk of intubation or death. Patients with blood type O were less likely to be tested positive, while those with blood type AB and B had a high probability of testing positive. Rh+ patients had a high probability of testing positive (Zhao et al., 2020). Different conclusions have been made in a previous study38 in the evaluation of blood type and mortality association in Wuhan.

Although data on ABO blood types show defined roles in disease transmission and severity in other infections, several previous works on severe disease did not confirm this observation in COVID-19 (Liumbruno et al., 2013; Harris et al., 2016; Zietz et al., 2020). However, a slight increase in the prevalence of the disease in non-O patients was observed in a study conducted in New York City (Hulstrom et al., 2020). This risk decreased in type A patients, and interestingly, increased in type AB and B patients compared to O patients. In contrast, mortality risk increased for AB and decreased for A and B, leading to the argument that the Rh-negative blood group would have a protective effect (Hulstrom et al., 2020). A recent study showed a dichotomized distribution from A/AB 47% to B/O 53%

and found that blood group A had a risk of admission to intensive care and death within 30 days of infection41. This is attributed to terminal galactosamine saccharide, a sugar contained in blood group with a potential mechanism to increase the risk. Blood group B, on the other hand, has galactose and fucose sugar in blood group O, also found in the other two types, which could explain the difference between the blood groups. The SARS-COV-2 peak protein then binds to carbohydrates, and a high affinity between antigen A and the virus could facilitate the absorption of the virus into cells (Chiodo et al., 2020). The limitation of several available data sets on the effects of blood group on COVID-19 positivity and death is a relatively small num-ber of patients, which in this case is associated with a difference in age and sex. Based on the results of this study and all previously published articles, blood group A can be considered a risk factor for severity and death from COVID-19 disease, regardless of genetic background.

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AUTHOR CONTRIBUTION

ARB: Conceptualization, data collection, Formal analysis; Methodology; Writing original draft; Writing review and editing. BB: Formal analysis; Writing original draft; Writing review and editing. CB: Data curation; Formal analysis; Methodology; Writing original draft; Writing review and editing. BP: Data collection; data curation; Methodology; Writing original draft. TH: Validation; Writing-original draft; Writing review and editing. BBP: Data curation; Formal analysis; Methodology; Writing original draft. YM: Data curation; Formal analysis; Writing original draft; Writing review and editing. MV: Methodology; Software; Writing original draft; Writing review and editing. BBJ: Data curation; Formal analysis; Methodology; Writing original draft. BNP: Methodology; Software; Writing original draft; Writing review and editing. MD: Conceptualization; Methodology; Supervision; Writing original draft; Writing review and editing. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST

None declared.

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