*Original Research Article*

# Evaluation of risk factors in COVID- 19 patients presenting in a Nigerian Teaching Hospital


## ABSTRACT

**Aim**: The study's goal was to look into the relationship between disease incidence, clinical symptoms, and comorbidities in COVID patients at the Delta State University Teaching Hospital Isolation Centre in Delta State, Nigeria, to see if they were COVID risk factors.

**Study Design:** The study relied on case notes and clinical records of 80 study participants

**Place and Duration of Study:** The study was conducted at the COVID-19 Isolation Centre affiliated to Delta State University Teaching Hospital (DELSUTH), Oghara, Delta State, Nigeria. It was a one-off sampling study.

**Methodology:** COVID-positive patients at the Isolation Centre were separated from the Control group. In this study, the control group refered to those who tested negative or unconfirmed. Participants were people in the community who appeared to be of a similar age and appeared to be in good health. Both groups of participants' clinical records were acquired. A total of 80 participants were thus recruited for the study. The clinical records of both groups were compiled and examined after due authorization.

**Results:** The results showed that 51 of the 80 participants tested positive for COVID-19 at the designated study center. The majority of COVID patients were between the ages of 30 and 59, which is human active age. The majority of COVID patients had diabetes miletus, accounting for more than 25% of the total. The majority of the participants had normal blood pressure: 34.6% of unconfirmed cases, 52.9% of COVID patients, and 100% of those who were COVID negative.

**Conclusion:** Respiratory failure, AKI, cardiac arrest, hypoxic brain injury, UTI, and Gastritis were among the most common complications identified by study participants.



*Keywords: COVID-19, SARS-CoV-2, risk factors, pathogenesis, disease, virus*


## 1. INTRODUCTION

Coronaviruses have a crown-like viral particles (virions) that gives them their name.This family of viruses infects a wide range of vertebrates, most notably mammals and birds, and are considered to be a major cause of viral respiratory infections worldwide.[1] With the recent detection of the 2019 novel coronavirus (SARS-CoV-2), and the resultant disease that has been given the name, coronavirus disease 2019 (COVID-19), there are now a total of 7 coronaviruses known to infect humans (Human coronavirus 229E (HCoV-229E), Human coronavirus OC43 (HCoV-OC43), Human coronavirus NL63 (HCoV-NL63), Human

coronavirus HKU1, Severe acute respiratory syndrome-related coronavirus (SARS-CoV-1), Middle East respiratory syndrome-related coronavirus (MERS-CoV), Novel coronavirus SARS-CoV-2). On January 30, 2020, the World Health Organization (WHO) announced the novel human coronavirus disease (COVID-19) outbreak, which began on December 8, 2019, in Wuhan, China, a Public Health Emergency of International Concern (PHEIC).

HCoV-OC43 and HCoV-229E were the corona viruses that infected humans first. This was followed by SARS-CoV-1 that occurred in 2003. After the SARS-CoV-1 occurrence, there has been five more coronaviruses discovered in humans. The most recently discovered is SARS-CoV-2. This is taken to have been recognized first in Wuhan, China. SARS-CoV-1 and MERS-CoV occurrence caused high morbidity and mortality in humans.[2]

As of date, SARS-Cov-2 responsible for corona virus disease 2019 (COVID-19) has caused worldwide morbidity and mortality, making the World Health Organization (WHO) to declare it a pandemic disease with high fatal outcome. It is becoming clearer that a lot of persons having comorbid infections like diabetes mellitus, asthma, hypertension, chronic obstructive pulmonary disease (COPD), advanced age, obesity, transplant patients , cancer patients, a compromised immune system, present with severe disease and poorer outcomes.[3,4,5]

The proportions of patients who die from respiratory symptoms occur mainly from hypoxia before patients develop dyspnea. [6] The illness makes some patients struggle through the first week of the SARS-Cov-2 infection. They may begin to feel a little better, but suddenly some develop a strange and tragic pattern, especially of respiratory distress syndrome, usually thought to be from cytokines storm, but now being proposed to be from pulmonary oxidative stress arising from dysfunctional hemoglobin that cannot take up oxygen from the lungs. This is because like methemoglobin, SARS- Cov -2 viruses stick to heme through their proteins-MENS (Membrane, Envelope, Nucleocapsid, Spike) to displace oxygen with release of iron-free ion, that cause inflammation of alveolar macrophages.[7]

This leads to lung inflammation with failure of oxygen and carbon dioxide exchange. Lack of oxygen delivery to tissues causes hypoxia and organs damage (multi-organ failure) with high mortality. Both lungs are affected at the same time. This rarely happens in pneumonia.[5] The liver gets overwhelmed in clearing iron radicals and hepatic enzymes like alanine transaminase (ALT) was elevated. COVID-19 manifestation usually presents with lymphopenia, thrombocytopenia, but neutrophilia, elevated lactate dehydrogenase (LDH) and increased cytokines levels(IL-1,IL-6, IL-18, Tumor necrosis factor alpha).[5] Other raised inflammatory molecules include nuclear factor kappa-B and monocyte chemo-attractant protein-1[5,8]

The management of COVID-19 is in two phases: The first starting in the first week involves use of antiviral drugs which include hydroxy-chloroquine, monoclonal antibodies like ritonavir and zinc. The second phase involves use of oxygen, steroids, fresh packed red blood cells transfusion, plasmapheresis, immunosuppresants, iron chelators and use of ventilators.[7]Most importantly however is the fact that management of the disease relies heavily on the initial health status of patients. COVID-19 severity has been related to age, sex, and underlying comorbidities, and there is some evidence that other factors, such as ethnicity, are also independent risk factors. With the impact of age, gender and ethnicity, the effects of comorbidities on the severity of COVID-19 is expected to vary. The aim of the present study therefore was to examine the relation between diseased incidence, clinical symptoms and comorbidities in COVID-19 patients admitted into the isolation Centre of a tertiary health facility in Delta State, Nigeria.

## 2. MATERIAL AND METHODS

Ethical Clearance for this study was obtained from the Health Research Ethics Committee [HREC] of the Delta State University Teaching Hospital, Oghara on folio: HREC/PAN/2020/023/0368

The study was conducted at the COVID-19 Isolation Centre affiliated to Delta State University Teaching Hospital (DELSUTH), Oghara, Delta State, Nigeria. DELSUTH is a renowned and accredited university teaching hospital to the Delta State University (DELSU), Abraka. The institution is located in Oghara, Ethiope West Local Government Area of Delta State. The hospital, a 180-bed ultra-modern specialist hospital was built to provide quaternary services to the indigenes of Delta State and its neigbours. An inaugural management board was sworn in June 2009 to manage the affairs of the hospital when it kicked-off. The earliest staff of DELSUTH consisted of a team of qualified Nigerian medical professionals drawn from the United Kingdom and the United States. The hospital was officially commissioned on the 19th of June, 2010.

The Isolation Centre is located in a serene environment of Ijomi Primary Health Centre along Otefe road, Oghara, a few miles away from the teaching hospital (DELSUTH). It was built and donated by Nigeria Gas Company and designated for the Teaching Hospital Psychiatric Center before the advent of Covid-19. It is a 20-bed facility with two wards (male and female medical wards), three nursing stations, an obstetric delivery room, one pharmacy, a waiting area, two consulting rooms, one on-call room, a store, a laboratory section having diagnostic equipment that include a chemistry analyzer and a haematology Full Blood Count/differential analyzer. It is manned by frontline health care workers drawn from the Teaching Hospital.
A total of 80 participants were recruited for the study. All COVID subjects whose case notes in the Isolation centre were included in the study. The case notes were obtained in batches from the isolation centre, after an approved request letter from the hospital management. Moreover, a group of individuals in the population (among the 80 selected participants who either tested negative to COVID-19 or were unconfirmed) but with similar basic demographics and obviously in good health were used as controls groups in this research. The clinical records of both groups were compiled and examined.

Data obtained were subjected to chi-squared analyses for assessment of categorical data, and as mean and standard deviation for measurable data like glucose levels.

## 3. RESULTS

The anthropogenic information of recruited participants showed that of the 80 participants studied at the designated study centre, 51 (or 63.8%) were positive for COVID-19, 3 (or 3.75%) were negative while the remaining 32.5% were unconfirmed. Of the COVID patients, 11.8% were within the 70 – 79yrs age category, compared to 3.9% in the 20 – 29 yrs age category. Majority of the COVID patients were between 30 and 59 yrs old. More than 60 % of patients with COVID- 19 had tertiary level of education (Table 1).

**Table 1: Anthropogenic distribution based on COVID-19 status of participants**

| Status | COVID status (%) | | | Total (n) | Pearson Chi-Square | Likelihood Ratio | Linear-by-Linear Association |
|---|---|---|---|---|---|---|---|
| | Unconfirmed (n=26) | Positive (n=51) | Negative (n=3) | | | | |
| ***Age category*** | | | | | | | |
| 20 - 29 yrs | 7.7 | 3.9 | 33.3 | 5 | 9.237 | 8.784 | 0.116 |
| 30 - 39 yrs | 30.8 | 23.5 | 33.3 | 21 | -0.511 | -0.553 | -0.733 |
| 40 -49 yrs | 11.5 | 23.5 | 0 | 15 | | | |
| 50 - 59 yrs | 23.1 | 27.5 | 0 | 20 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60 - 69 yrs | 11.5 | 9.8 | 33.3 | 9 | | | |
| 70 - 79 yrs | 15.4 | 11.8 | 0 | 10 | | | |
| ***Level of edu.*** | | | | | | | |
| Primary level | 15.4 | 3.9 | 0 | 6 | 4.955 | 4.736 | 1.35 |
| Secondary level | 34.6 | 33.3 | 66.7 | 28 | -0.292 | -0.315 | -0.245 |
| Tertiary level | 50 | 62.7 | 33.3 | 46 | | | |
| ***Gender*** | | | | | | | |
| Male | 53.8 | 62.7 | 0 | 46 | 4.775 | 5.856 | 0.108 |
| Female | 46.2 | 37.3 | 100 | 34 | -0.092 | -0.053 | -0.745 |
| ***Occupation*** | | | | | | | |
| Government employee | 7.7 | 37.3 | 33.3 | 22 | 18.569 | 16.778 | 1.491 |
| Private employee | 15.4 | 9.8 | 0 | 9 | -0.017 | -0.033 | -0.222 |
| Self employed | 73.1 | 41.2 | 33.3 | 41 | | | |
| Unemployed | 0 | 3.9 | 33.3 | 3 | | | |
| Retiree | 3.8 | 7.8 | 0 | 5 | | | |

The values in parentheses are p-values /asymptotic significance (2-sides)

The clinical information of the study participants have been documented in Table 2a and Table 2b. Majority of participants with unconfirmed COVID status were not hypertensive (61.5%), whereas most of the COVID patients has hypertension (52.9%). Among the total 80 study participants, 62.7% had Diabetes Miletus (Table 2a). Blood pressure was normal for most of the participants; 34.6% for unconfirmed casesand 100% for those that were negative for COVID. Participants with elevated blood pressure were more likely to become COVID-19 patients than the control groups. A total of 69.6% of the COVID patients had an elevated blood pressure. No marked differences in body temperature were reported between cases and control groups respectively (Table 2b). Glucose concentration averaged 128 mg/dl in participants with unconfirmed COVID status, compared with 143.0 mg/dl in COVID patients ($p<0.05$) (Table 3). For COVID patients, glucoselevels were determined and distributed on the basis of occurrence of Diabetes Miletus or hypertension (Table 4). For diabetic patients who had COVID-19, glucose levels averaged 210.6 mg/dl compared to those who were never diabetic (102.9 mg/dl). There were no significant differences in glucose levels (141.7 – 144.1 mg/dl) in both hypertensive and non-hypertensive COVID patients ($p>0.05$).

A number of common complications reported among the study participants were presented (Table 5). Results showed that majority of these complications were associated with COVID-19. Majority of the patients with COVID-19 (79.3%) had a respiratory failure, compared to only 3.4% in the control group; thus pointing to its being a major risk factor, or associated comorbidity or clinical presentation. Within this same group, at least one in every ten COVID patient had acute kidney injury, cardiac arrest, hypoxic brain injury, urinary tract infection and Gastritis at one time or the other.

**Table 2a: Clinical history of participants in the study**

| Parameter | COVID Status (%) | | | Total | Pearson Chi-Square | Likelihood Ratio | Linear-by-Linear Association |
|---|---|---|---|---|---|---|---|
| | Unconfirmed (n=26) | Positive (n=51) | Negative (n=3) | | | | |
| ***Hypertension*** | | | | | | | |
| Yes | 38.5 | 52.9 | 33.3 | 38 | 1.699 | 1.713 | .655 |
| No | 61.5 | 47.1 | 66.7 | 42 | (0.428) | (0.425) | (0.418) |
| ***Diabetes Miletus*** | | | | | | | |
| Yes | 19.2 | 62.7 | 0.0 | 40 | 4.000 | 4.931 | 0.758 |
| No | 80.8 | 37.3 | 100.0 | 40 | (0.135) | (0.085) | (0.384) |
| ***Airway Distress*** | | | | | | | |
| Yes | 7.7 | 9.8 | 0.0 | 7 | 0.395 | 0.656 | 0.000 |
| No | 92.3 | 90.2 | 100.0 | 73 | (0.821) | (0.720) | (0.993) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***FBC*** | | | | | | | |
| Not determined | 7.7 | 0.0 | 0.0 | 2 | 20.844 | 22.956 | 0.038 |
| Normal | 19.2 | 51.0 | 66.7 | 33 | (0.106) | (0.061) | (0.846) |
| Leucocytosis | 38.5 | 29.4 | 0.0 | 25 | | | |
| Anaemia | 19.2 | 2.0 | 33.3 | 7 | | | |
| Neutrophilia | 0.0 | 2.0 | 0.0 | 1 | | | |
| Thrombocytosis | 0.0 | 2.0 | 0.0 | 1 | | | |
| Leucopenia | 3.8 | 9.8 | 0.0 | 6 | | | |
| Lymphocytosis | 3.8 | 3.9 | 0.0 | 3 | | | |
| ***Urinalysis*** | | | | | | | |
| Normal | 53.8 | 51.0 | 100.0 | 43 | 7.783 | 9.236 | 0.086 |
| Proteinuria | 26.9 | 27.5 | 0.0 | 21 | (0.650) | (0.510) | (0.769) |
| Ketonuria | 7.7 | 13.7 | 0.0 | 9 | | | |
| Hematuria | 3.8 | 0.0 | 0.0 | 1 | | | |
| Glycosuria | 3.8 | 0.0 | 0.0 | 1 | | | |
| Leucocyte | 3.8 | 7.8 | 0.0 | 5 | | | |
| ***Chest Xray*** | | | | | | | |
| Not determined | 73.1 | 84.3 | 100.0 | 65 | 12.057 | 13.331 | 2.463 |
| Normal | 3.8 | 7.8 | 0.0 | 5 | (0.441) | (0.345) | (0.117) |
| Multilobal pneumonia | 3.8 | 0.0 | 0.0 | 1 | | | |
| Incipient cardiac failure | 3.8 | 0.0 | 0.0 | 1 | | | |
| Heart failure | 7.7 | 0.0 | 0.0 | 2 | | | |
| Atypical pneumonia | 3.8 | 7.8 | 0.0 | 5 | | | |
| Wide spread infiltrates | 3.8 | 0.0 | 0.0 | 1 | | | |

**Table 2b: Clinical history of participants in the study**

| Parameter | COVID Status | | | Total | Pearson Chi-Square | Likelihood Ratio | Linear-by-Linear Association |
|---|---|---|---|---|---|---|---|
| | Unconfirmed (n=26) | Positive (n=51) | Negative (n=3) | | | | |
| ***ECG*** | | | | | | | |
| Not determined | 80.8 | 84.3 | 100.0 | 67 | 8.089 | 9.564 | 1.416 |
| Normal | 7.7 | 11.8 | 0.0 | 8 | (0.778) | (0.654) | (0.234) |
| Prolong QTC | 0.0 | 2.0 | 0.0 | 1 | | | |
| LDDD LAB | 3.8 | 0.0 | 0.0 | 1 | | | |
| LAD, ST abnormality | 3.8 | 0.0 | 0.0 | 1 | | | |
| Altrial flutter, IVH | 3.8 | 0.0 | 0.0 | 1 | | | |
| Atypical pneumonia | 0.0 | 2.0 | 0.0 | 1 | | | |
| ***HIV status*** | | | | | | | |
| Not determined | 69.2 | 70.6 | 100.0 | 56 | 1.273 | 2.096 | 0.415 |
| Negative | 30.8 | 29.4 | 0.0 | 24 | (0.529) | (0.351) | (0.520) |
| ***BP*** | | | | | | | |
| Normal | 34.6 | 30.4 | 100.0 | 28 | 12.781 | 14.435 | 2.196 |
| Low | 15.4 | 0.0 | 0.0 | 4 | (0.047) | (0.025) | (0.138) |
| Stage 1 | 38.5 | 41.2 | 0.0 | 31 | | | |
| Stage 2 | 7.7 | 28.4 | 0.0 | 17 | | | |
| ***Body Temperature*** | | | | | | | |
| Normal | 42.3 | 66.7 | 100.0 | 48 | 7.563 | 8.304 | 5.043 |
| Low | 7.7 | 2.0 | 0.0 | 3 | (0.272) | (0.217) | (0.025) |
| Hypothermia | 11.5 | 13.7 | 0.0 | 10 | | | |
| High grade | 34.6 | 17.6 | 0.0 | 18 | | | |

The values in parentheses are p-values /asymptotic significance (2-sides); ECG- Electrocardiography, LDDD LAB- Lumbar Degenerative Disc Disease Laboratory, LAD- Left Axis Deviation in ECG, IVH- Intra Ventricular Hypertrophy

**Table 3: Glucoselevels in participants in the study**

| Status | (n) | Mean | Std. Dev. | F-statistics | Sig. |
|---|---|---|---|---|---|
| Unconfirmed | 26 | 128.0 | 11.6 | 0.618 | ***0.042**** |
| Positive | 51 | 143.0 | 9.3 | | |
| Negative | 3 | 103.7 | 18.1 | | |

**Table 4: Glucoselevels of diabetic and hypertensive participants who were positive for COID-19 (n=51)**

| Status | Status | (n) | Mean | Std. Deviation | T-test | p-value |
|---|---|---|---|---|---|---|
| DM status | Yes | 32 | 210.6 | 94.9 | 6.203 | ***<0.001**** |
| | No | 19 | 102.9 | 21.1 | | |
| HTN status | Yes | 36 | 144.1 | 55.4 | 0.109 | 0.914 |
| | No | 15 | 119.7 | 24.0 | | |

DM – Diabetes Mellitus, HTN- Hypertension

**Table 5: Complications of study participants who were positive for COID-19 compared to those who were not.**

| | COVID cases (N=51) | | No COVID (N=29) | | Df | $X^2$ | p-value |
|---|---|---|---|---|---|---|---|
| | (n) | % | (n) | % | | | |
| Respiratory failure | 23 | 79.3 | 1 | 3.4 | | | |
| AKI | 5 | 17.2 | 2 | 6.9 | | | |
| Cardiac arrest | 4 | 13.8 | 3 | 10.3 | | | |
| Hypoxic brain injury | 3 | 10.3 | 2 | 6.9 | | | |
| Seizures | 2 | 6.9 | 3 | 10.3 | 10 | 10.754 | 0.377 |
| UTI | 4 | 13.8 | 12 | 41.4 | | | |
| Gastritis | 3 | 10.3 | 0 | 0 | | | |
| Elevated BP | 1 | 3.4 | 2 | 6.9 | | | |
| Myalgia | 2 | 6.9 | 1 | 3.4 | | | |
| Septic shock | 2 | 6.9 | 2 | 6.9 | | | |
| Decompesated CLD | 2 | 6.9 | 1 | 3.4 | | | |
| Total | 51 | 100 | 29 | 100 | | | |

UTI- Urinary Tract infection, BP- Blood Pressure, CLD- Chronic Liver Disease

## 4. DISCUSSION

The current study focused on the clinical manifestations of study participants that could be used as COVID-19 risk factors. A number of clinical presentations of study participants were reviewed, with more incidences reported in patients with COVID-19. Important to note was the association of age with severity of infection. Majority of the COVID patients were between 30 and 59 yrs old. This is the active age in humans. When the COVID-19 pandemic first broke out, reports indicated that the disease mainly afflicted older adults, with younger individuals suffering from milder cases. However, the Centers for Disease Control and Prevention in the United States found that people under the age of 30 were responsible for more than 20% of COVID-19 cases reported in the country, and that people in this age group were more likely to transmit the virus than those in other age groups.[9] Several individuals in their twenties and thirties work in a variety of fields, such as health care, food service, and public transportation. These are positions that put them at risk of contracting the COVID virus. Young people often work in high-coronavirus-risk settings, such as bars and restaurants, schools, child care centers, and retail stores. Campus outbreaks may affect college students, who may then spread the coronavirus back home.

Examining the full blood count of the COVID patients, it was observed that majority of the anomalies were more of Leucocytosis. COVID-19 affects the hematopoietic system and hemostasis as a systemic infection. Peripheral blood leukocyte and lymphocyte counts are normal or slightly decreased during the virus's incubation period, which typically lasts 1 to 14 days, and during the early stages of the disease, when non-specific symptoms are present. SARS-CoV-2 mainly affects tissues with high ACE2 levels, such as the lungs, heart, and gastrointestinal tract, after viremia. COVID-19 has been linked to Leucocytosis and lymphopenia. [10] Fan *et al*. [11] discovered that patients who required ICU support had significantly lower lymphocyte levels at baseline in Singapore.

According to reports, a percentage of patients with Coronavirus Disease 2019 (COVID-19) had an elevated leukocyte count. In a cohort of 619 patients with confirmed COVID-19 who had pneumonia with abnormal features on chest CT scan, lymphopenia was found to be the most common laboratory abnormal finding [4,12,13]

Proteinuria was the most common urinalysis risk factor, accounting for over a quarter of the COVID population. Ketonuria was mentioned as well (17 %). In patients with coronavirus disease 2019 (COVID-19), kidney involvement is widespread, and AKI is related to a higher death rate in this group. According to a study, proteinuria is common among COVID-19 patients and may precede AKI.[14] Low albuminuria points to a tubular cause, which is backed up by elevated retinol binding protein levels in the urine. A urine protein-creatinine ratio of less than 1 g/g at the time of admission is highly associated with poor kidney and patient outcomes.

Diabetes is common among COVID-19 patients, and it is linked to poor outcomes. It was discovered to be a major risk factor for COVID in the current study. Diabetic (DM) disease is one of the leading causes of morbidity worldwide, and it is expected to skyrocket in the coming decades.[15] People with diabetes are more susceptible to infectious diseases caused by immune system malfunctions.[16,17,18] Diabetes has also been linked to a poor prognosis and an increased risk of pneumonia-related mortality [19] and diabetic COVID-19 patients have higher nonsurvival rates (22 percent to 31 percent) than nondiabetic subgroups.[20] In the face of uncertainty about clinical characteristics and risk factors, clinicians face a major challenge in improving outcomes for COVID-19 patients with preexisting diabetes mellitus.

## 5. CONCLUSION

Occurrence and prognosis of diseased conditions have been linked to certain risk factors such as those identified in this study. To ensure significant reductions in infection levels in endemic countries, it is critical to develop and reinforce communicable disease control, which necessitates a major and long-term commitment of human and material resources. This typically starts with a systematic assessment of national priorities in terms of disease burden, and then progresses to national strategies and plans for communicable disease prevention and control. Activities related to prevention and control can be carried out on their own, but they must first improve the population's well-being. Given the link between common clinical manifestations in the study population and COVID severity, it's critical to make concerted efforts to reduce these clinical conditions. Healthy living should be a part of your daily routine. Chronic diseases and long-term illnesses can be avoided by leading a healthy lifestyle. In conclusion, COVID-19 patients have identifiable comorbidities which could serve as risk factors in contracting the disease and contributing to some identifiable complications or outcomes.

## CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this study.

## ETHICAL APPROVAL

Ethical Clearance for this study was obtained from the Health Research Ethics Committee [HREC] of the Delta State University Teaching Hospital, Oghara on folio: HREC/PAN/2020/023/0368

## REFERENCES


1. Giwa GL, Desai A. Novel Coronavirus COVID-19: An Overview for Emergency Clinicians. Emergency Medicine Practice EXTRA. 2020
2. Russell B, Moss C, George G, Santaolalla A, Cope A, Papa S. Associations between immune-suppressive and stimulating drugs and novel COVID-19—a systematic review of current evidence ecancer.2020; 14 (1022).
3. Chihrin S, Loutfy MR. Overview of antiviral and anti-inflammatory treatment for severe acute respiratory syndrome Expert Rev Anti Infect Ther 2005; 3(2) 251–262 https://doi.org/10.1586/14787210.3.2.251 PMID: 15918782
4. Chen L, Liu HG, Liu W, *et al*. [Analysis of clinical features of 29 patients with 2019 novel coronavirus pneumonia] Zhonghuajie he hehu xi zazhi = Zhonghuajiehe he huxizazhi = Chin J TubercRespir Dis., 2020; 43(3) 203–208
5. Chen N, Zhou M, Dong X, *et al*. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study Lancet. 2020; 395(10223) 507–513 https://doi.org/10.1016/S0140-6736(20)307 PMID: 32007143
6. Cascella M, Rajnik M, Cuomo A, *et al*. Features, Evaluation and Treatment Coronavirus (COVID-19) [Updated 2020 Mar 20]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK554776/
7. Liu, W, Li, H. COVID-19: Attacks the 1-Beta Chain of Hemoglobin and Captures the Porphyrin to Inhibit Human Heme Metabolism. ChemRxiv. Preprint. 2020; https://doi.org/10.26434/chemrxiv.11938173.v7
9. Maragakis LL. Coronavirus and COVID-19: Younger Adults Are at Risk, Too. John Hopkins Medicine. 2020; Available at: https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-and-covid-19-younger-adults-are-at-risk-too
10. Young BE, Ong SWX, Kalimuddin S, *et al*. Epidemiologic Features and Clinical Course of Patients Infected With SARS-CoV-2 in Singapore. JAMA, 2020; 323(15):1488-1494.
11. Fan BE, Chong VCL, Chan SSW, et al. Hematologic parameters in patients with COVID-19 infection. Am J Hematol 2020; 95(6):E131-E134.
12. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J, Cao B. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet (London, England) 2020; 395(10223):497–506. https://doi.org/10.1016/s0140-6736(20)30183-5

13. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA, 2020; 323(11):1061–1069. https://doi.org/10.1001/jama.2020.1585
14. Karras A, Livrozet M, Lazareth H, Benichou N, Hulot J-S, Fayol A, Chauvet S, Jannot A-S, Penet M-A, Diehl J-L, Godier A, Sanchez O, Mirault T, Thervet E. and Pallet N. Clinical Journal of the American Society of Nephrology, CJASN February 2021, CJN.09130620; DOI: https://doi.org/10.2215/CJN.09130620
15. Knapp S. Diabetes and infection: is there a link?--A mini-review, Gerontology, 2013; 59 (2): 99–104,
16. Shah BR and Hux JE. Quantifying the risk of infectious diseases for people with diabetes, Diabetes Care, 2003; 26(2) 510–513.
17. Muller LMAJ, Gorter KJ., Hak E, *et al*. Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus, Clinical infectious diseases: an official publication of the Infectious Diseases Society of America, 2005; 41(3): 281–288,
18. Hodgson K, Morris J, Bridson T, Govan B, Rush C, and Ketheesan N. Immunological mechanisms contributing to the double burden of diabetes and intracellular bacterial infections, Immunology, 2015;144(2): 171–185
19. Falguera M, Pifarre R, Martin A, Sheikh A, and Moreno A. Etiology and outcome of community-acquired pneumonia in patients with diabetes mellitus, Chest. 2005; 128(5): 3233–3239,
20. Singh, A. K. Gupta, R., Ghosh, A. and Misra, A. Diabetes in COVID-19: prevalence, pathophysiology, prognosis and practical considerations. Diabetes and Metabolic Syndrome: Clinical Research & Reviews, 2020; 14(4) 303–310.