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Mini Review

Obesity and Diabetes as the Predisposing Medical Risk Factors for the COVID-19 Severity

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Abstract

The COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is now striking the global public health to the deadliest point. Besides the research on the viral genome, the corresponding virulence factors associated with the pathogenesis, and the host immune-biology, the underlying medical conditions or the risk factors need be examined in order to achieve accurate knowledge on the clinical course of illness as well as effective treatment. Among the common pre-clinical conditions including the older age or lung disease or the lymphocyte count, obesity and diabetes may play a major role to render a COVID-19 patient to the extreme fatality.

Keywords: COVID-19 pandemic; Acute respiratory syndrome coronavirus (SARS-CoV-2); Obesity; Diabetes

Introduction

Existing COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) originated from Wuhan, China, is steadfastly making the global public health to the highest health threat; so far accounting for 716075 deaths with 19187943 infected cases all over the world [1]. The starting outbreak was associated with the live wild animals followed by the person-to-person transmission by sneezing/ coughing resulting in the entry of the virus into the nasopharyngeal tract (with the onset of mild symptoms) followed by its travel along the bronchial tubes to the lungs, ultimately leading to the acute respiratory syndrome (ARDS) [2-4]. The genomic analysis of SARS-CoV-2 revealed that the viral S (Spike protein) facilitates the viral entry directly through the host surface receptor binding site (RBD); and the human angiotensin-converting enzyme 2 (ACE 2) acts as the cell entry receptor [5,6]. The Antibody-Dependent Enhancement (ADE) of entry is also known [2,7]. The E (Envelope) protein mediates the assembly and viral release while the M (Membrane) protein confers the shape, and the N (Nucleocapsid) protein detects the Transcriptional Regulatory Sequences (TRSs) and the genomic packaging signal.

The pathogenesis of SARS-CoV-2 depends on the imbalanced immune responses triggered by the hyperactivation of the innate immune cells and due to the increase in the pro-inflammatory cytokines and chemokines known as the cytokine storm [3,7]. As the host protective immunity, several innate immune sensors are activated with the concomitant activation of the B-lymphocytes (production of immunoglobulins IgM and IgG) [8]. However, since the SARS-CoV-2 evolved unique strategies to escape the host immunity, it's imperative to examine the underlying medical conditions which make the COVID-19 patient more prone to the severity of the disease leading to death [2,3]. An array of predisposing risk factors like the older age and comorbidities, lymphocytopenia, increased levels of Alanine Aminotransferase (ALT) and the creatine kinase levels, d-dimer levels, high-sensitivity cardiac troponin I, lymphocyte count, the Sequential Organ Failure Assessment (SOFA) score, coronary heart disease, asthma, Body Mass Index (BMI) and obesity, diabetes, organ malfunction (mainly liver and kidney), severe Chronic Obstructive Pulmonary Disease (COPD), the immunocompromised condition, and some other risk factors have been studied so far [4,9]. Present review emphasized mainly on the obesity and diabetes as the common underlying factors for an individual to be vulnerable towards COVID-19.

Obesity as the Risk Factor for COVID-19

The excess fat mass or obesity is known to be related to coronary heart disease, atrial fibrillation, hypertension, heart failure, diabetes, metabolic dysregulation, and even to the renal disease [10,11]. Lots of reports stated about the linkage between the obesity and the vulnerability towards SARS-CoV-2 infection [10-12]. One exemplary study showed that the risk for invasive mechanical ventilation for the COVID-19 patients with the Body Mass Index (BMI) >35 Kg/m^2 was more than 7-fold higher compared to the infected individuals with a BMI less than 25 kg/m^2 [11]. Another data consistently showed that COVID-19 patients with a BMI >35 Kg/m^2 were approximately 2.7 times more likely to undergo fatality compared to the patients with a BMI less than 30 kg/m^2 [12].

Indeed, SARS-CoV-2 may directly interrupt the pancreatic β-cell function by interacting with the host ACE2 receptor [13]. Additionally, obesity may also enhance the blood clot (thrombosis) that is critical for the COVID-19 severity as evident by a recent Dutch study whereby 184 patients with covid-19 admitted to an Intensive Care Unit (ICU) were diagnosed with 49% cumulative incidence of thrombotic complications [14]. Entry of SARS-CoV-2 triggers massive inflammation by boosting the cytokines and chemokines (i.e., the cytokine storm), which may also increase the production of clotting factors from liver as seen in a case whereby the fibrinogen levels in a severely ill covid-19 patient were 10-14 g/L compared to the normal level of 2-4 g/L [14]. Indeed, earlier statistics showed that the rates of H1N1 affected patients' hospitalizations were significantly greater among the obsess American Indians, African Americans, and Hispanics than non-Hispanic whites with low BMI [15]. It was also

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noticed that 66% of the patients with obesity also had the underlying conditions including chronic lung disease, including asthma, cardiac problems, or diabetes [15]. Moreover, patients having diabetes may suffer from the deficiency of insulin resistance due to obesity; and thus both obesity and diabetes together can make a COVID-19 patient to commit the extreme lethality of the disease [12].

Diabetes as the Risk Factor for COVID-19

Both obesity and diabetes should be in consideration in the clinical course of COVID-19 illness for the sake of maintain the sound public health globally. Besides understanding the SARS-CoV-2 epidemiology and pathogenesis, the regulation or prevention of these risk factors are also important [10,16]. As stated elsewhere, due to the impaired immune system, diabetes mellitus may predispose to the SARS-CoV-2 infection and even may double the mortality risk as well as increases the comorbidities associated with pulmonary complications and the cardiac injury as revealed by the elevation of troponin I in blood; and due to hyperglycemia induced by stress and infection [9]. Several statistical data showed that diabetes, hypertension, cardiovascular diseases, respiratory diseases and kidney diseases (usually noticed in the racial groups of African Americans and in the Asians) may render to the worse outcome of the COVID-19 complications [10]. Poorly controlled diabetes inhibits the lymphocyte proliferation, decrease the activation of complement cascade; and more importantly the onset of hyperglycemia causes the deterioration of production of cytokines, dysfunction of phagocytosis and T-lymphocytes, and the infiltration of macrophage which in turn facilitates the viral replication [10,16,17]. A study in Hong Kong showed that persons (aged 75) with diabetes suffering from pneumonia were more prone to death compare in the same age group even from Cardiovascular Disease (CVD) and from cancer [17]. Similar evidence of diabetes risk was also noticed in case of the earlier severe acute respiratory syndrome coronavirus (SARS-CoV) in 2002 and in the Middle East respiratory syndrome coronavirus (MERS-CoV) infections in 2012 [17].

Conclusion

Among the underlying risk factors for COVID-19 severity, obesity is a major risk factor decreasing both the cardiorespiratory homeostasis the regulation of the protective immunity; and even triggering the development of organ malfunction in the COVID-19 patients. Another vital underlying factor is the diabetes whereby the immune dysfunction may enhance the severity of the infection. Knowing about such underlying factors is thus crucial for the appropriate treatment of the COVID-19 patients.

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