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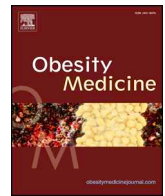
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The mutual effects of COVID-19 and obesity



December 31st, 2020, is the day on which the World Health Organization (WHO) was informed about the birth of a new virus belongs to CORONA viruses family causing coronavirus disease 2019 (COVID-19) (Zhu et al., 2020). On March 11th, 2020, the WHO announced to the world the confirmation of COVID-19 as pandemic after causing 1,776,867 confirmed cases and 111,828 confirmed deaths (Zhu et al., 2020). COVID-19 is known to cause lung injury and acute respiratory distress syndrome. However, does it cause overweight or obesity? Is it dangerous to be obese and get COVID-19?

Overweight and obesity are defined as excessive fat accumulation, so they represent a risk to health. Most of the world's populations live in countries where overweight and obesity kill more people than underweight. But will the world notice an increase in obesity during this era of the COVID-19 epidemic?

One gets obese due to the consumption of too many calories to be used by the body. This occurs due to eating energy-dense foods that are rich in fat and sugar and decrease in physical activity (Smethers and Rolls, 2018). Changes in diet and lifestyle are usually due to environmental changes, which are evident during this period of the pandemic, curfew, and quarantine. All governments that got COVID-19 in their countries have started a curfew until further notice. This leads to a change in lifestyle and a decrease in exercise practice in their populations. So, in addition to work stops, the people in these countries stopped working and going to gyms or parks to do exercise or even doing at home. Many people may become stressed, depressed, or unable to do any form of exercise and others eating more foods without any kind of activities as a result of bad news of COVID-19 spread, which may result in weight gain and becoming obese (Rodríguez et al., 2020).

As COVID-19 pandemic continues sweeping the world, it looks like that it doesn't have effects on physical health only. Still, also it has its burdens on psychological health through fear of catching the virus, worrying about family, social isolation, financial pressure, rumors everywhere, and information overload. These all can lead to increased stress & anxiety levels, which will lead to more physical health issues, including obesity. Previous study reported an association between chronic stress with obesity, higher energy intake & lower diet quality (Isasi et al., 2015). Stress can affect body weight through biological behavioral & psychological mechanisms.

Biological mechanisms:

- Activation of the hypothalamo-adrenal-pituitary axis, that leads to releasing cortisol, which can affect body weight by promoting eating by stimulating eating on its own, decreasing brain sensitivity to Leptin potentiating reward pathway (Schulte et al., 2015).
- Activating reward centers in brain such as nucleus accumbens and dorsal striatum, which increase the tendency to consume highly palatable food with a high content of sugar, fat & sodium (Isasi et al., 2015).

- Stress effect on brain areas responsible for self-regulation which is essential to control one's own behaviors as eating & physical activity which are important to control weight

Behavioral mechanisms:

- Stress can lead individuals to eat higher quantities of food with a higher tendency to highly palatable food.
- Stress decreases the tendency for physical activity.
- Stress can disrupt sleeping & lead to shorter times of sleep accompanied with higher odds of obesity.

With COVID-19 pandemic continuation, there's a real fear of food supplements decrease with an increased tendency for food storing and higher use of canned foods & ultra-processed products due to their secure storage and preparation and the probability of eating while doing other activities. That contributes significantly to increasing the global burden of obesity, especially with decreased activity & stay-at-home measures. This can be explained by:

- High content of sugar, sodium, and fat.
- High content of calories which may exceed calories consumption of an individual.
- The ultra-processed food high content of refined carbohydrates which can lead to a change in insulin response, causing excess nutrients storage in adipose tissue (Hall, 2017).
- Changes in the brain reward system by ultra-processed food leading to addictive-like behaviors and overconsumption (Schulte et al., 2015).

Unfortunately, obesity in a patient with COVID-19 infection is not a good sign. Obesity, in this case, can cause more severe symptoms and complications. Obese patients have difficulties to be intubated. It can be more difficult to obtain diagnostic imaging (as on imaging machines, there are weight limits). It is harder for the nursing staff to transport obese patients or position them. So, special beds and equipment should be available.

Moreover, studies show that obesity disrupts the immune system through different mechanisms. Some of these mechanisms are decreased cytokine production, altered monocyte, and lymphocyte function, natural killer cell dysfunction, reduced macrophage and dendritic cell function and decreased response to antigen/mitogen stimulation (Milner and Beck, 2012). Low levels of immunity are not accepted in defending a new virus-like COVID-19. It's noticed that in 50% of patients with COVID-19 are associated with hypercytokinemia. Severe cases tend to have lymphopenia; especially T cells, leucocytosis and increase in neutrophil-lymphocyte ratio (NLR), as well as lower percentages of monocytes, eosinophils, and basophils. Inflammatory

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cytokines were also elevated in severe cases, including IL-2R, IL-6, IL-10, and TNF- α . The overproduction of those proinflammatory cytokines results in what has been described as a cytokine storm, leading to an increased risk of vascular hyperpermeability and multiorgan failure with COVID-19 (Jose and Manuel, 2020).

Furthermore, obesity is associated with other co-morbidities that are no less dangerous than obesity itself like essential hypertension, atherosclerosis, coronary artery diseases, type 2 diabetes mellitus, cerebrovascular strokes, and osteoarthritis (Afolabi et al., 2019, 2020). These diseases, by themselves or their treatment, affect body well-being. So, they make the patient more susceptible to get COVID-19 infection. However, fortunately, these co-morbidities need a long time to occur, that long time we do not expect for COVID-19 to exist owing to the scientific and medical development.

After all that, we can say it is better to avoid obesity as possible as you can, especially in this era of COVID-19 pandemic. Try to maintain healthy eating behavior by increasing eating different salads and green foods. Daily moderate-intensity physical activity at home is advisable (Rahmati-Ahmadabad and Hosseini, 2020). You don't have to go to the gym. Watching YouTube exercise channels can help. It's better to begin reducing hours of using mobile phones and increase doing other activities like reading. Getting enough sleep is crucial for the immune system and the circadian rhythm of hormones. Try having a normal sleep schedule by going to bed early and wake up early around the same time every day and not reversing sleep hours not to increase snacks.

Eventually, obese people need special care in their normal life and in this special period of pandemic. Future studies about the relation between body mass index and COVID-19 infection are needed to declare if obese people are at a higher risk of getting the virus or not. Additionally, a study evaluates if obesity increased the burden on hospitals during the pandemic is needed to take future precautions.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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