Effect of Obesity on Immune System

Khadeejah Alsolami

Abstract: Purpose of review to identify the relation between obesity and immune system. This review summarizes the recent information regarding the effect of obesity on system. Recent Findings reported that there is direct relationship between obesity and several infections. Obese patients have increased hospitalized length of stay and mortality rate. Obesity was significantly related to susceptibility to respiratory infections because of a state of hypercoagulability and a decrease in respiratory capacity, leading to a risk of severe COVID-19 with cardiovascular complications, acute respiratory distress syndrome, and disseminated intravascular coagulation, which can lead to multiple organ failure and even death. Summary: More national and international efforts are required to dealing with associated factors of obesity.

Keywords: Obesity, Immune system, Infection

1. Introduction

Obesity is defined as abnormal or excessive fat accumulation that presents a risk to health. Body mass index provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. World Health Organization (WHO, 2019) defines overweight and obesity overweight is a body mass index (BMI) greater than or equal to 25; and obesity is a BMI greater than or equal to 30. Obesity and its associated health problems have a significant impact on obese patient and health care system.

Incidence of obesity

Rates of overweight and obesity continue to grow in adults and children. Worldwide 39% of adults aged 18 years and over were overweight in 2016, and 13% were obese. According to World Health Organization (WHO, 2019) the overall prevalence of obesity in Kingdom of Saudi Arabia (KSA) was estimated to be 35.4% compared with 31.7%, 30.4%, and 27% in the neighboring United Arab Emirates, Iraq, and Oman, respectively, 27.8% in Syria, and 8.6% in Sudan. Al - Raddadi et al (2019) also reported that the prevalence of overweight and obesity in Saudi Arab was 35.1 and 34.8%, respectively, in men, and 30.1% and 35.6%, respectively, in women. Both overweight and obesity increased in prevalence to 60 years of age and decreased in the oldest age group in both sexes.

Causes obesity

The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. Globally, three causes increase rate of obesity include an increased intake of energy - dense foods that are high in fat and sugars, an increase in physical inactivity due to the increasingly sedentary nature of many forms of work, changing modes of transportation and finally increasing urbanization. Changes in dietary and physical activity patterns are often the result of environmental and societal changes associated with development and lack of supportive policies in sectors such as health, agriculture, transport, urban planning, environment, food processing, distribution, marketing, and education. Some illnesses also lead to obesity. These may include Cushing’s disease, and polycystic ovary syndrome and other factors in energy balance and weight gain such as chemical exposures and the role of the microbiome (Omer, 2020).

Health, Economic and Societal Consequences of obesity

People who have obesity, compared to those with a healthy weight, are at increased risk for noncommunicable diseases such as cardiovascular diseases mainly heart disease and stroke, which were the leading cause of death in 2012, diabetes, musculoskeletal disorders especially osteoarthritis—a highly disabling degenerative disease of the joints, sleep apnea, breathing problems, low quality of life, mental illness such as clinical depression, anxiety and some cancers including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon (Center Disease Prevention and control, 2020). Obesity and its associated health problems have a significant economic impact on the US health care system, including direct and indirect costs. Direct medical costs may include preventive, diagnostic, and treatment services. Indirect costs relate to sickness and death and include lost productivity. Productivity measures include employees being absent from work for obesity-related health reasons, decreased productivity while at work, and premature death and disability (Center Disease Prevention and control, 2020).

Immune system

The immune system is a network of biological processes that protects an organism from diseases. It detects and responds to a wide variety of pathogens, from viruses to parasitic worms, as well as cancer cells that distinguishing them from the organism's own healthy tissue. There are two major subsystems of the immune system. The innate immune system provides a preconfigured response to broad groups of situations and stimuli. The adaptive immune system provides a tailored response to each stimulus by learning to recognize molecules it has previously encountered (Amano et al., 2014).

The immune system uses two sequential responses to react to disturbances in homeostasis, as seen in tissues under physiological or infectious stress. An initial rapid innate immune response, which has only broad specificity for the trigger is followed by a delayed, highly specific adaptive immune response. Both types of responses require specialized white blood cell types, such as granulocytes, macrophages, and natural killer cells that are innate immune populations, while different types of T - and B - lymphocytes constitute the adaptive immune cells. Although often designated distinct immune responses it should be realized that innate and adaptive responses are highly interdependent (Agrawal etal., 2017).
Relationship between obesity and immunity system

Obesity is associated with a state of chronic, low-grade inflammation both in white adipose tissue and systemically. It is characterized by altered levels of circulating hormones and nutrients such as glucose and lipids. Circulating immune cells and those resident in peripheral tissues are thus exposed to an energy-rich environment in the context of altered concentrations of metabolic hormones. In adipose tissue, the anti-inflammatory/immune regulatory primed immune cells (e.g., M2 - type macrophages, regulatory T cells (Treg), T - helper (Th) 2, type 2 innate lymphoid cells (ILC2)) normally present in lean adipose tissue are replaced by increased numbers of pro-inflammatory primed immune cells (e.g., M1 macrophages, Th1, Th17, CD8+ T - cells) that secrete pro-inflammatory cytokines such as IL - 1β, IL - 6, IL - 17, and IFN - γ. This may even be further enhanced by obesity - associated gut inflammation (Agrawal et al., 2017).

In addition to local adipose tissue immune alterations, systemic immune adaptations are observed in obesity as well, including increased numbers of circulating (inflammatory) monocytes, neutrophils, Th1, Th17, Th22, decreased circulating Treg and elevated pro-inflammatory cytokine levels. These changes lead to a pro-inflammatory state of the immune system in individuals with obesity, characterized by elevated cytokine levels, both locally in the adipose tissue as well as systemically. This chronically elevated inflammatory state is thought to stimulate regulatory pathways, which in turn limit the response to an acute trigger such as SARS - CoV - 2 (Pascal et al., 2021).

Obesity Associated Hospitalized Patients

Many studies reported that obese patients have increased intensive care unit (ICU) length of stay and mortality rate in the hospital. In a recent secondary analysis of a large prospective observational study including critically ill and injured patients remaining in the ICU for 48 h or more, obesity was reported to be an independent risk factor for catheter and blood stream infections (Bercault, 2014; Bochicchio, 2016). A study in critically injured blunt trauma patients stated that morbid obesity (BMI ≥ 40) was associated with increased risk of pneumonia and urinary tract infection but not with increased mortality. Further, several epidemiological investigations have reported that obesity increases infection susceptibility in clinical settings. In fact, numerous studies have reported obesity to be an independent risk factor for post-operative infections and post-operative complications (Dossett, 2019).

Obesity Associated Respiratory Infections

Several studies highlighting a connection between influenza severity and obesity. A recent study by Akiyama et al. suggests that obesity may impact the response to respiratory syncytial virus infection in children. A study from Poland reported that BMI was significantly related to susceptibility to respiratory infections. In critically ill trauma patients, obesity or morbid obesity was associated with respiratory infections (Akiyama et al.2011). However, it is important to consider that obesity can complicate lung mechanics, such as restricting lung which could potentially increase risk for pneumonia or other infections. Although the mechanisms contributing to increased susceptibility may include impaired immunity, there may be non-immune factors to consider (Milner & Beck, 2021; McClean et al.2018).

Obesity Associated with COVID - 19

United state (2019) reported that, 68% of the COVID - 19 patients possessed at least one comorbidity, among which obesity is the second most common (48.3%) in hospitalized patients. Several reports have confirmed the correlation between obesity and worse outcome of COVID - 19. The percentage of obesity in the COVID - 19 patients admitted to intensive care units (ICU) or receiving invasive mechanical ventilation (IMV) is much higher than those who did not. Patients with obesity are prone to have symptoms of cough and fever (Christopher et al., 2019). The collaborated study reported from the Saudi Health Council, the University of North Carolina at Chapel Hill and the World Bank, found that obesity increases the risk of death from the virus by 48%, the risk of hospitalization by 13%, and of needing intensive care by 74%. The study also highlights the concern that a coronavirus vaccine may not be as effective in obese people, given that flu vaccines don’t work as well in those with a body mass index (BMI) of over 30 (Zhu et al., 2020).

Management of obesity

Overweight and obesity, as well as their related noncommunicable diseases, are largely preventable. Supportive environments and communities are fundamental in shaping people’s choices, by making the choice of healthier foods and regular physical activity the easiest choice (the choice that is the most accessible, available and affordable), and therefore preventing overweight and obesity.

At the individual level, people can limit energy intake from total fats and sugars, increase consumption of fruit and vegetables, as well as legumes, whole grains and nuts; and engage in regular physical activity 60 minutes a day for children and 150 minutes spread through the week for adults (CDC, 2020).

Individual responsibility can only have its full effect where people have access to a healthy lifestyle. Therefore, at the societal level it is important to support individuals in following the recommendations above, through sustained implementation of evidence based and population - based policies that make regular physical activity and healthier dietary choices available, affordable, and easily accessible to everyone, particularly to the poorest individuals. An example of such a policy is a tax on sugar sweetened beverages (CDC, 2020).

The food industry can play a significant role in promoting healthy diets by reducing the fat, sugar, and salt content of processed foods; ensuring that healthy and nutritious choices are available and affordable to all consumers, restricting marketing of foods high in sugars, salt and fats, especially those foods aimed at children and teenagers; and ensuring the availability of healthy food choices and supporting regular physical activity practice in the workplace (CDC, 2020).
WHO response
World Health Organization response adopted by the World Health Assembly in 2004 and recognized again in a 2011 political declaration on noncommunicable disease (NCDs), the "WHO Global Strategy on Diet, Physical Activity and Health" describes the actions needed to support healthy diets and regular physical activity. The Strategy calls upon all stakeholders to take action at global, regional and local levels to improve diets and physical activity patterns at the population level (WHO, 2021).

The "Global action plan on physical activity 2018–2030: more active people for a healthier world" provides effective and feasible policy actions to increase physical activity globally. WHO published ACTIVE a technical package to assist countries in planning and delivery of their responses. New WHO guidelines on physical activity, sedentary behavior, and sleep in children under five years of age were launched in 2019 (WHO, 2021).

The World Health Assembly welcomed the report of the Commission on Ending Childhood Obesity (2016) and its 6 recommendations to address the obesogenic environment and critical periods in the life course to tackle childhood obesity. The implementation plan to guide countries in taking action to implement the recommendations of the Commission was welcomed by the World Health Assembly in 2017 (WHO, 2021).

Behavior modification
- Healthy behaviors include regular physical activity and healthy eating. Balancing the number of calories consumed from foods and beverages with the number of calories the body uses for activity plays a role in preventing excess weight gain. The Physical Activity Guidelines for Americans external icon recommends adults do at least 150 minutes a week of moderate intensity activity such as brisk walking. In addition, adults need to do activities that strengthen muscles at least 2 days a week.
- A healthy diet pattern follows the Dietary Guidelines for Americans external icon which emphasizes eating whole grains, fruits, vegetables, lean protein, low - fat and fat - free dairy products, and drinking water.
- A pattern of healthy eating and regular physical activity is also important for long - term health benefits and prevention of chronic diseases such as type 2 diabetes and heart disease (CDC, 2020).

Enhance immune system
Several factors like sleep, diet, stress and hygiene can affect the immune system’s performance, and any offsets in these behaviors impact on immune function. Centers for Disease Control (2021) recommends 15 seconds of scrubbing hands with soap decrease risk of exposure to microbes. American Microbiology Society (2010) reported that smaller percentage of people report washing their hands after participating in other activities that significantly increase risk of exposure to microbes like petting a dog or cat (42% of people), handling money (27% of people), and coughing or sneezing (39% of people).

Sleep Cycles
Beresovsky et al (2012) stated that sleeping decreased levels of the stress hormone cortisol, which can suppress immune function, and increased signals that activate the immune system. Studies also show that vitamins C, A, E, B6 and B12 and minerals like iron and zinc are important for the maintenance of immune function. Increased cortisol level (stress hormone) makes it difficult for the immune system to function properly. The American Psychological Association reports that 75% of Americans experience moderate to high levels of stress.8, 9 In addition to the direct impact of stress on immune function, unmanaged stress can influence our sleep patterns, mood, dietary intake, and physical activity levels. All of these factors are associated with immune system function (Wiegner et al, 2015).

References


