



Obesity as a risk factor for severe COVID-19 outcomes

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Since the COVID-19 pandemic exploded in Canada over a year ago, perhaps the most vital question for Canadians looking to gauge their personal health risk is this: why do most COVID-19 patients experience relatively innocuous symptoms like fatigue, dry cough and fever while approximately 10% of affected individuals develop severe conditions like pneumonia and respiratory failure that require hospitalization (1,2)? What determines whether an individual is likely to be infected by the SARS-CoV-2 virus, and what factors increase their risk of death from the disease? Answering these questions begins with an understanding of the virus that causes COVID-19, which is classified as a severe acute respiratory syndrome coronavirus (2). Coronaviruses like SARS-CoV-2 belong to a group of viruses that are responsible for a spectrum of upper-respiratory tract infections, including some as mild as the common cold (2). However, there is little that is mild about COVID-19; since the virus be-

gan spreading in Canada, 930,500 people have been infected and at least 22,643 people have died (3).

Among those most severely affected are adults over 80 years of age; this age demographic has by far the highest proportion of both hospitalizations and deaths (approximately 32.6% and 69.0%, respectively) (4). The likelihood of a COVID-19 patient being admitted to the ICU also increases dramatically with age; adults in the 60-69 age group are over 5 times more likely to be admitted than adults half that age (4). Unsurprisingly then, a great number of global studies have found age to be the greatest risk factor for a severe COVID-19 outcome (2). While aging is unavoidable, an alarming number of studies have found obesity, which is preventable, to be a major risk factor associated with the severity of a patient's COVID-19 symptoms (2). Obesity is the second strongest, independent predictor for COVID-19-related hospitalization worldwide. A recent study of

383 patients found that obese individuals are 140% more likely to develop severe pneumonia (2). In addition, obese individuals of any age are more likely to test positive for SARS-CoV-2 than individuals with a lower Body Mass Index (1). This correlation is likely a direct result of the fact that obese individuals have more adipose (or fat) tissue and therefore more receptors that facilitate SARS-CoV-2 infection than individuals of a healthy weight (5). The internalization of the SARS-CoV-2 virus happens via the integral membrane protein angiotensin-converting enzyme 2 (ACE2), which is more highly expressed in adipose tissue than in other COVID-19-targeted tissues like the lungs and heart (5,6,7,8,9). Thus, the excess fat which characterizes obesity makes obese individuals more likely to be infected by COVID-19 (9).

Interestingly, high-fat diets are thought to increase the expression of ACE2 in adipose tissue (6). A dietary study involving mice found

that one week of consuming a 60% fat diet significantly increased the expression of ACE2 in adipose tissue by nearly three-fold as compared to mice fed a low-fat diet (6). This robust difference was maintained over the extended study period, during which time the expression of ACE2 in the heart did not change (6). This data suggests that individuals consuming high fat diets are also more likely to be infected by COVID-19 due to the increased number of SARS-CoV-2-receptors in their cells (9). Beyond increasing the chances of initial infection, the excess of highly ACE2-expressing adipose tissue in obese individuals is also likely to serve as a reservoir for SARS-CoV-2 viral particles during the period when the patient is contagious (1,5,9). In this respect, COVID-19 is similar to the Influenza A (IAV), H1N1 and Human Immunodeficiency (HIV) viruses, wherein (the latter are just two have been found in the adipose tissue of obese individuals and have been demonstrated to shed the viral particles causing person-to-person transmission for 42% longer than individuals of healthy weights (5).

Once infected, obese individuals are also more vulnerable to severe COVID-19 symptoms and death due to the excess weight on their lungs, which are then additionally stressed by the SARS-CoV-2 virus (7). As a respiratory virus, SARS-CoV-2 primarily attacks the lungs, causing air sacs to fill with fluid and airways to become inflamed and narrowed (5,7,10). As such, COVID-19 patients need increased oxygen intake, which

many hospital staff achieve by placing the patient in the prone position (7,10). Multiple observational studies have suggested that the prone position improves oxygenation, or the amount of oxygen in the lungs, as well as the amount of circulating oxygen in the blood by opening parts of the lungs that would otherwise be compressed by the weight of the chest (11).

However, the benefits of the prone position have been found to be significantly challenged when caring for COVID-19 patients suffering from obesity (7,11). These patients, therefore, carry a greater respiratory burden that may have lethal consequences (7). Unfortunately, this correlation between obesity and COVID-19-related death is particularly high in the 20-39-year age group, which also has the highest rate of viral infection in Canada (4,12). In fact, a cohort study in Italy found a significant inverse correlation between increasing age and body mass index (BMI); in other words, younger COVID-19 patients who are obese are more likely to develop severe symptoms and die than older obese patients (1). Although the precise reason for this correlation is unclear, it is likely that the effect of obesity in older COVID-19 patients is eclipsed by the effect of



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Obese individuals are more vulnerable to COVID-19 symptoms than others

tions that become more prevalent with age (7). Nevertheless, the fact that obese 20-39-year-old adults are at increased risk of death by coronaviruses like SARS-CoV-2 is extremely concerning, especially given that 20-39-year-old Canadians account for nearly 35% of the country's total case count (4,12).

In light of this growing body of knowledge, greater emphasis should be placed on informing younger Canadians about the COVID-19-related dangers of obesity. Increased social discourse surrounding improved public health messaging on obesity prevention and management in Canada has the potential to positively propel knowledge transfer. Internationally, similar initiatives in Norway, Denmark and Japan have worked to encourage and improve healthy eating habits in younger children (13). While these measures would have direct public health benefits, additional initiatives in Canada should also be focused on supplementary training for health care providers. Indeed,

this was identified as the greatest barrier to obesity treatment by the World Obesity Federation (14). At a workshop in 2018, the National Academies of Sciences, Engineering and Medicine identified “lack of knowledge and awareness” as the second most important barrier to obesity prevention worldwide (14). Therefore, by going beyond its current measures of listing obesity as a COVID-19 risk factor, Canadian leaders and policy makers in public health should consider implementing the online COVID-19 weight management program Drop 5 Mission (15,16).

Direct advertising campaigns that outline the health risks and

“Obesity is a modifiable risk factor of COVID-19 and one goal of public health bodies should be to achieve a healthy weight at the population level that might reduce adverse outcomes of COVID-19.”

prevalence of obesity, as well as those which provide specific examples of what Canadians can do to maintain a healthy lifestyle, such as maintaining a Body Mass Index of 18-25, eating more than 5 servings of fruits and vegetables per day and exercising for 30 minutes five times a week, are tangible examples of what the Canadian government can do to increase knowledge and awareness (17). By helping increase social discourse around obesity and COVID-19 risk in this way, individuals and communities can be better protected from adverse ancillary health outcomes in future pandemics. Indeed, as the

number of Canadians suffering from obesity is set to increase to approximately 8.54 million by 2023-2024, Canada needs to prepare for the potential ancillary health consequences of future viral pandemics by addressing obesity as another ongoing health crisis (18). After all, history has set a grim precedent; obese individuals have a higher risk of death from COVID-19, just as they did during the 1918, 1957, 1968 and the 2009 Influenza pandemics (1). As such, Canadians should consider maintaining a healthy weight as a means of reducing their risk of death from the next viral pandemic.

References:

1. Huang Y, Lu Y, Huang Y-M, Wang M, Ling W, Sui Y, Zhao H-L. Obesity in patients with COVID-19: a systematic review and meta-analysis. *Metabolism Clinical and Experimental*. 2020;113:154378
2. Dugail I, Amri E-Z, Vitale N. High prevalence for obesity in severe COVID-19: Possible links and perspectives towards patient stratification. *Biochimie*. 2020;179:257e265
3. Canada Coronavirus Map and Case Count. *The New York Times*. <https://www.nytimes.com/interactive/2020/world/canada/canada-coronavirus-cases.html>
4. Coronavirus disease 2019 (COVID-19): Epidemiology update. Government of Canada. <https://health-infobase.canada.ca/src/data/COVIDLive/Epidemiological-summary-of-COVID-19-cases-in-Canada-Canada.ca.pdf>
5. Kassir R. Editorial: Risk of COVID-19 for patients with obesity. *Obesity Reviews*. 2020;21:e13034
6. Gupte M, Boustany-Kari CM, Bhargava K, Police S, Thatcher S, Gong MC, English VL, Cassis LA. ACE2 is expressed in mouse adipocytes and regulated by a high-fat diet. *American journal of physiology. Regulatory, integrative and comparative physiology*. 2008;295:R781–R788
7. Kass D. Editorial: COVID-19 and Severe Obesity: A Big Problem? *Annals of Internal Medicine*. 2020; doi:10.7326/M20-5677
8. Couselo-Seijas M, Almengló C, Agra-Bermejo RM, Fernandez AL, Alvarez E, González-Juanatey JR, Eiras S. Higher ACE2 expression levels in epicardial cells than subcutaneous stromal cells from patients with cardiovascular disease: Diabetes and obesity as possible enhancer. *Eur J Clin Invest*. 2020;00:e13463
9. Fang L, Karakiulakis G, Roth M. Correspondence: Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *The Lancet Respiratory Medicine Journal*. 2020;8:e21
10. Galiatsatos P. What Coronavirus Does to the Lungs. *Johns Hopkins Medicine*. [https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/what-coronavirus-does-to-the-lungs#:~:text=Acute%20Respiratory%20Distress%20Syndrome%20\(ARDS,a%20form%20of%20lung%20failure](https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/what-coronavirus-does-to-the-lungs#:~:text=Acute%20Respiratory%20Distress%20Syndrome%20(ARDS,a%20form%20of%20lung%20failure)
11. Venus K, Munshi L, Fralick M. Prone positioning for patients with hypoxic respiratory failure related to COVID-19. *CMAJ*.

2020;192:E1532-E537

12. Goodman KE, Magder LS, Baghdadi JD, Pineles L, Levine AR, Perencevich EN, Harris AD. Impact of Sex and Metabolic Comorbidities on COVID-19 Mortality Risk Across Age Groups: 66,646 Inpatients Across 613 U.S. Hospitals. *Clin Infect Dis*. 2020:ciaa1787

13. Curley C. 6 Things We Can Learn from Other Countries About Obesity. Healthline.

<https://www>

[.healthline.com/health-news/5-things-we-can-learn-from-other-countries-about-obesity#5.-Provide-healthier-school-lunches](https://www.healthline.com/health-news/5-things-we-can-learn-from-other-countries-about-obesity#5.-Provide-healthier-school-lunches)

14. Current Status and Response to the Global Obesity Pandemic: Proceedings of a Workshop. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Food and Nutrition Board; Roundtable on Obesity Solutions; Callahan EA, editor. Washington (DC): National Academies Press (US); 2019 Jun 25. <https://www.ncbi.nlm.nih.gov/books/NBK544136/>

15. People who are at risk of more severe disease or outcomes from COVID-19. Government of Canada.

<https://www.canada.ca/en/public-health/services/publications/diseases-conditions/people-high-risk-for-severe-illness-COVID-19.html>

16. During the COVID 19 Pandemic, Canadians Who Maintain a Healthy Body Weight Enjoy Better Physical and Mental Health. CIS-ION. <https://www.newswire.ca/news-releases/during-the-COVID-19-pandemic-canadians-who-maintain-a-healthy-body-weight-enjoy-better-physical-and-mental-health-844163460.html>

17. Zelman KM. 4 Steps to a Healthy Lifestyle. WebMD. <https://www.webmd.com/diet/features/4-steps-healthy-lifestyle#1>

18. O'Neill M, Kornas K, Rosella L. The future burden of obesity in Canada: a modelling study. *Canadian Journal of Public Health*. 2019;110:768–778