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## **Collateral Damage of the COVID-19 Pandemic on Nutritional Quality and Physical Activity: Perspective from South Korea**

Running title: Lifestyle changes during COVID-19 pandemic

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## Introduction

A novel coronavirus (SARS-CoV-2), that emerged in the city of Wuhan, China in December 2019, has now spread worldwide. As of June 2, 2020, more than 6,200,000 people had been infected with this virus and its mortality is around 6% (see <https://coronavirus.jhu.edu/map.html> for real-time tracking of cases).

According to initial reports, old age, obesity, hypertension, and preexisting cardiovascular diseases, as well as diabetes mellitus are considered as risk factors for the severity of the coronavirus disease 2019 (COVID-19). During the COVID-19 pandemic, the potential reduction in physical activity in general and an increase in sedentary time caused by many social distancing protocols and government lockdowns and regulations present in many countries should be a source of concern. Access to a healthy diet for all is also an issue, and these factors in turn are likely to contribute to weight gain and related cardiometabolic consequences. Here, we provide a South Korean perspective which may provide some explanations for these behavioral changes and related health consequences. Some solutions are also proposed.

## Changes in dietary patterns toward unhealthy foods and increase in sedentary time

Under the COVID-19 pandemic, dietary patterns have been changing and access to healthy food options has diminished (1). In countries such as South Korea and other Asian countries, where the food delivery network is highly developed, dependence on such services has seen a substantial increase. According to Statistics Korea data, online food shopping has increased by 66.1% from 1,292,900,000,000 Korean won (KRW) or 1,047,306,601 USD in March 2019 to 2,147,200,000,000 KRW or 1,739,327,663 USD in March 2020 (Supplementary Table 1; <http://kostat.go.kr/portal/eng/pressReleases/1/index.board?bmode=read&aSeq=382257>). Of note, based on the data derived from the leading food delivery apps in Korea (Baemin® [<https://www.baemin.com>] and Yogiyo® [[www.yogiyo.co.kr](http://www.yogiyo.co.kr)]), the number of deliveries has increased by 9% during January 31 to February 17 compared with January 3–20, 2020, and by 11% during February 1–16 compared with January 6–21, 2020 when the virus had spread across the country (<https://pulsenews.co.kr/view.php?sc=30800022&year=2020&no=176494>).

Delivered foods are mostly fast foods, such as pizza, hamburgers, fried chicken, and carbonated soda or sugar-sweetened beverages (2), and are probably more obesogenic than home-cooked foods (3, 4). The increased consumption of fast food has been shown to be associated with increase in energy density (5), excessive portion sizes, high glycemic load (6), and low intakes of vegetables, fruits, and milk (7). Some previous studies have shown that increased consumption of fast food and sugar-sweetened beverages is associated with increased risk of obesity (6, 8), fatty liver (9), metabolic syndrome, and type 2 diabetes (6, 10, 11).

Among the many types of fast foods being delivered in South Korea, Korean-style fast foods are much more popular because they are less expensive and easier to access across various income levels and residence regions (12). Of particular concern in the Korean-style fast foods are high-carbohydrate foods such as white flour, white rice, and corn starch. In addition, due to the recent COVID-19 economic disruption, many households are likely to be suffering from financial difficulties, limiting their ability to buy and consume more expensive, healthier, and fresh foods. In addition, a decrease in outdoor activities and an increase in time spent on smartphones, online games, and TV viewing may have also contributed to have a negative impact on eating behaviors. During such sedentary screen times, people habitually tend to consume energy dense snacks and alcohol or sugar-sweetened beverages (13, 14). Thus, increased screen time may not only have contributed to increase sedentary behaviors, but it may have also indirectly influenced overall nutritional quality in a negative way during these confinement times. Studies are currently underway in some countries to document these phenomena and results are expected to be reported in the near future.

Another important issue is nutrition in students. Schools in many countries, including South Korea, have been closed for several months and the future is uncertain regarding their re-opening in some countries. In this context, children confined at home will be more dependent upon the family environment. Whereas some popular surveys have suggested that some families may cook more at home (which could contribute to increase their nutritional quality), socio-economic status may be an important factor explaining why some other families may rather be more likely to choose unhealthy fast foods, instead of the healthier and more balanced school lunches provided by school. Lack of supervision from teachers and parents (who are often working) for their food choices and dietary

habits is another factor to consider (15). Food security is another issue for children from low-income families who may get their best meal daily from school programs.

Many authorities such as the Centers for Diseases Control and Prevention and the World Health Organization are recommending general quarantine principles, such as wearing a mask, washing hands thoroughly, and keeping a social distance. Based on social distancing, people are recommended not to get together at work and public places as well as in restaurants. Naturally, the likelihood of eating alone is increasing during this COVID-19 pandemic and this is also likely to affect dietary habits in a negative way. According to a previous study using Korean national data, diet quality and eating behaviors of people who eat alone were poor (16). The social aspect of eating together helps us control or limit how much and what we eat because of socially determined norms, expectations, and even judgments. In the absence of these, people are more likely to overindulge. The psychological stress of dealing with the pandemic may also contribute to the overconsumption of low nutritional quality/energy dense “comfort food”. Again, data on these issues are forthcoming.

One of the most important strategies to stop the spread of SARS-CoV-2 is to reduce close interpersonal contacts. On the basis of this strategy, public as well as private facilities such as community health centers, gyms, swimming pools, and parks have been closed by law in many countries. In many cases, people who have come in contact with infected people or have spent time at locations that were visited by infected individuals, have been requested to stay at home for 2 weeks as a form of “self-quarantine.” Many countries have put in place confinement policies, and economic activities have been shut down for several weeks. In these aspects, South Korea is similar to the rest of the world.

Persons with obesity or who are overweight are reported to be less active, and sedentary behaviors are relatively prevalent among these individuals all over the world (17, 18). Thus, developing solutions to increase physical activity is a challenge, particularly when individuals are confined. For example, for people with obesity, group exercise with peers or exercise under supervision (for people with obesity) have been reported to be effective compared to absence of support (19, 20). But policies prohibiting public gatherings in confined spaces or going to a local gym leave persons living with obesity with limited options. This situation could be an obstacle for some individuals to exercise, not only among people with obesity but also for the general public. In a study

of more than 400,000 middle-aged adults, a lower density of physical activity facilities was associated with higher adiposity levels (21). Overcoming such hurdles and trying to navigate across government policies in order to remain physically active or to exercise for 150 min per week takes commitment and may require some creativity, even for the most motivated and health-conscious person.

In addition, most school systems have been shut down, which poses the problem of lack of physical activity that children would generally undertake on a daily basis from interaction with friends and —more importantly— from physical education classes and academic sport programs. For these reasons, adults or children with obesity may be deprived of opportunities to engage in physical activity as well as become demotivated. Overall, the impact of the South Korea's pandemic response on sedentary behaviors and level of physical activity may mirror the rest of the world. Again, data to document these phenomena are needed and expected to come in the coming months.

## **Recommendations**

It is well documented that the development of chronic societal diseases such as diabetes mellitus and obesity is affected by behaviors such as lack of physical activity and an energy-dense diet of poor nutritional quality ([https://www.who.int/health-topics/noncommunicable-diseases#tab=tab\\_1](https://www.who.int/health-topics/noncommunicable-diseases#tab=tab_1)). It is proposed that the COVID-19 pandemic is likely to have a negative influence on behaviors associated with obesity and cardiometabolic health.

Here, we propose that the COVID-19 pandemic has produced negative influences on behaviors associated with obesity and cardiometabolic health and we suggest some actions to limit the impact on health during the current viral crisis (Table 1). Social network services and internet platforms such as YouTube could be used to create a sense of community between people during times of lockdown such as this (22). Social media or web-based programs could create some ludic and friendly physical activity challenges among users, and good examples of this are the many exercise challenges that have “gone viral” (23, 24). Indeed, YouTube could be a useful tool for home training if the educational videos are provided by trained health professionals or kinesiologists, who adjust their “educational products” to the user (e.g., a young, active mother who wants to stay fit has different goals compared to a frail, elderly person who needs to move and reduce his/her sitting time). Thus, the credibility and quality of the tools provided on the web are important. We also propose that

medical societies could take more leadership in this area. Of note, several medical societies have started several actions to help people at high risk of COVID-19. The American diabetes association has asked Congress to help people living with diabetes mellitus by keeping insurance coverage going, eliminating co-pays for antidiabetic medications, and getting testing into underserved communities (<https://www.diabetes.org/advocacy/platform>). The American society for nutrition has released 3 steps to stay healthy during the COVID-19 pandemic; 1) minimize trips to the supermarket during the pandemic and eat healthy, 2) eat out safely during the COVID-19 pandemic with restaurant curfews, 3) think positive!. Mindset is vital to getting through this pandemic physically and mentally healthy (<https://nutrition.org/making-health-and-nutrition-a-priority-during-the-coronavirus-covid-19-pandemic/>). The Korean Endocrine Society has also released a special report, recommending sharing scientific knowledge with patients and educating them to fight this crisis together (25). They suggest several actions, such as strict self-hygiene, self-monitoring, and lifestyle modifications in patients with chronic societal diseases to protect them from COVID-19. Of particular, they suggest using telemedicine and digital health, because many comorbid patients, such as people with obesity, have difficulties in visiting clinics during the COVID-19 pandemic.

Concerning nutritional quality, there are several possibilities to be explored. First, a public health campaign could be developed to encourage providers to produce and deliver healthier foods (with a reward system). Fortunately, in South Korea, many companies are now offering precooked, balanced, and nutritional meals, which are a good alternative to fast food. An electronic commerce firm (Coupang®, South Korea) has launched a same-day delivery service for fresh food, allowing customers to order in the morning and receive their products in the evening ([https://www.koreatimes.co.kr/www/tech/2020/05/694\\_288830.html](https://www.koreatimes.co.kr/www/tech/2020/05/694_288830.html)). The same-day fresh food delivery service is an innovation which can change the whole paradigm of eating pattern. However, the establishment of infrastructure like transportations as well information technology is required for this. Second, being confined is an opportunity to promote family cooking at home provided that, once again, credible public health educational material become available on the web. This is particularly important for children with weight issues, to help them learn how to cook healthy foods from a young age. As families share food habits, these programs should also be attractive for low socio-economic

class families. For instance, public health authorities could offer meal coupons redeemable with preapproved healthy food suppliers.

Finally, we would like to propose that all international medical societies should get involved in developing a list of recommended open sources for the promotion of physical activity/exercise and healthy eating during the COVID-19 pandemic. More active counseling to help people with obesity address their issues and deal with their barriers from adopting a healthier lifestyle is needed (26). It is the responsibility of health providers to promote healthy living in these challenging times.

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## References

1. Naja F, Hamadeh R. Nutrition amid the COVID-19 pandemic: a multi-level framework for action. *Eur J Clin Nutr* 2020.
2. Kim TH, Park Y, Myung J, Han E. Food price trends in South Korea through time series analysis. *Public Health* 2018;**165**: 67-73.
3. Fleischhacker SE, Evenson KR, Rodriguez DA, Ammerman AS. A systematic review of fast food access studies. *Obes Rev* 2011;**12**: e460-471.
4. Anderson B, Rafferty AP, Lyon-Callo S, Fussman C, Imes G. Fast-food consumption and obesity among Michigan adults. *Prev Chronic Dis* 2011;**8**: A71.
5. Prentice AM, Jebb SA. Fast foods, energy density and obesity: a possible mechanistic link. *Obes Rev* 2003;**4**: 187-194.
6. Pereira MA, Kartashov AI, Ebbeling CB, Van Horn L, Slattery ML, Jacobs DR, Jr., *et al.* Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet* 2005;**365**: 36-42.
7. Poti JM, Duffey KJ, Popkin BM. The association of fast food consumption with poor dietary outcomes and obesity among children: is it the fast food or the remainder of the diet? *Am J Clin Nutr* 2014;**99**: 162-171.
8. Duffey KJ, Gordon-Larsen P, Jacobs DR, Jr., Williams OD, Popkin BM. Differential associations of fast food and restaurant food consumption with 3-y change in body mass index: the Coronary Artery Risk Development in Young Adults Study. *Am J Clin Nutr* 2007;**85**: 201-208.



9. Lee G, Han JH, Maeng HJ, Lim S. Three-Month Daily Consumption of Sugar-Sweetened Beverages Affects the Liver, Adipose Tissue, and Glucose Metabolism. *J Obes Metab Syndr* 2020;**29**: 26-38.
10. Malik VS, Popkin BM, Bray GA, Despres JP, Willett WC, Hu FB. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. *Diabetes Care* 2010;**33**: 2477-2483.
11. Devaraj S, Wang-Polagruto J, Polagruto J, Keen CL, Jialal I. High-fat, energy-dense, fast-food-style breakfast results in an increase in oxidative stress in metabolic syndrome. *Metabolism* 2008;**57**: 867-870.
12. Lim H, Lee HJ, Choue R, Wang Y. Trends in Fast-Food and Sugar-Sweetened Beverage Consumption and Their Association with Social Environmental Status in South Korea. *J Acad Nutr Diet* 2018;**118**: 1228-1236 e1221.
13. Pearson N, Biddle SJ. Sedentary behavior and dietary intake in children, adolescents, and adults. A systematic review. *Am J Prev Med* 2011;**41**: 178-188.
14. Hobbs M, Pearson N, Foster PJ, Biddle SJ. Sedentary behaviour and diet across the lifespan: an updated systematic review. *Br J Sports Med* 2015;**49**: 1179-1188.
15. Bogl LH, Mehlig K, Ahrens W, Gwozdz W, de Henauw S, Molnar D, *et al.* Like me, like you - relative importance of peers and siblings on children's fast food consumption and screen time but not sports club participation depends on age. *Int J Behav Nutr Phys Act* 2020;**17**: 50.
16. Chae W, Ju YJ, Shin J, Jang SI, Park EC. Association between eating behaviour and diet quality: eating alone vs. eating with others. *Nutr J* 2018;**17**: 117.

17. Barone Gibbs B, Pettee Gabriel K, Carnethon MR, Gary-Webb T, Jakicic JM, Rana JS, *et al.* Sedentary Time, Physical Activity, and Adiposity: Cross-sectional and Longitudinal Associations in CARDIA. *Am J Prev Med* 2017;**53**: 764-771.
18. Nightingale CM, Rudnicka AR, Donin AS, Sattar N, Cook DG, Whincup PH, *et al.* Screen time is associated with adiposity and insulin resistance in children. *Arch Dis Child* 2017;**102**: 612-616.
19. Barkley JE, Salvy SJ, Sanders GJ, Dey S, Von Carlowitz KP, Williamson ML. Peer influence and physical activity behavior in young children: an experimental study. *J Phys Act Health* 2014;**11**: 404-409.
20. Fitzgerald A, Fitzgerald N, Aherne C. Do peers matter? A review of peer and/or friends' influence on physical activity among American adolescents. *J Adolesc* 2012;**35**: 941-958.
21. Mason KE, Pearce N, Cummins S. Associations between fast food and physical activity environments and adiposity in mid-life: cross-sectional, observational evidence from UK Biobank. *Lancet Public Health* 2018;**3**: e24-e33.
22. Macdonald-Wallis K, Jago R, Sterne JA. Social network analysis of childhood and youth physical activity: a systematic review. *Am J Prev Med* 2012;**43**: 636-642.
23. Antwi F, Fazylova N, Garcon MC, Lopez L, Rubiano R, Slyer JT. The effectiveness of web-based programs on the reduction of childhood obesity in school-aged children: A systematic review. *JBIS Libr Syst Rev* 2012;**10**: 1-14.
24. Ainscough KM, O'Brien EC, Lindsay KL, Kennelly MA, O'Sullivan EJ, O'Brien OA, *et al.* Nutrition, Behavior Change and Physical Activity Outcomes From the PEARS RCT-An mHealth-Supported, Lifestyle Intervention Among Pregnant Women With Overweight and Obesity. *Front Endocrinol (Lausanne)* 2019;**10**: 938.

25. Rhee EJ, Kim JH, Moon SJ, Lee WY. Encountering COVID-19 as Endocrinologists. *Endocrinol Metab (Seoul)* 2020.
26. Patnode CD, Evans CV, Senger CA, Redmond N, Lin JS. *Behavioral Counseling to Promote a Healthful Diet and Physical Activity for Cardiovascular Disease Prevention in Adults Without Known Cardiovascular Disease Risk Factors: Updated Systematic Review for the U.S. Preventive Services Task Force*: Rockville (MD), 2017.

**Table 1. Factors promoting unhealthy lifestyles and possible recommendations to overcome these barriers during the COVID-19 pandemic**

	<b>Current situation</b>	<b>Recommendations</b>
<b>Decreased physical activity</b>	<ul style="list-style-type: none"> <li>• Closing of community health centers, gyms, swimming pools, and parks</li> <li>• Increase in smartphone use, online games, and TV watching</li> <li>• Less opportunity for group exercise in children due to absence of physical education classes and interruption of academic sport activities</li> </ul>	<ul style="list-style-type: none"> <li>• Walking or jogging in open spaces or using an indoor ergocycle or treadmill</li> <li>• Home training using Youtube or joining online exercise classes</li> <li>• Exercise with family members or partners (e.g., jump rope in the parking lot, badminton in backyard, and indoor table tennis)</li> </ul>
<b>Poor dietary habits</b>	<ul style="list-style-type: none"> <li>• Increase in consumption of delivered fast food</li> <li>• Increase in consumption of snacks or drinking sugar-sweetened beverages while staying at home</li> <li>• No access to school lunch and lack of supervision from teachers for children's food choices and dietary habits</li> <li>• Eating alone due to quarantine principles and closing of public places and restaurants</li> </ul>	<ul style="list-style-type: none"> <li>• Cook healthy foods at home – take cooking lessons from validated sources on the internet</li> <li>• Order healthy, semi-cooked food</li> <li>• Change from unhealthy snacks to fresh vegetables or fruits</li> <li>• Make sure that parents are involved in the selection of foods consumed by children</li> <li>• Have structured meals with a social aspect – eating together physically or virtually</li> </ul>