JOURNAL OF NUTRITION FASTING AND HEALTH

The Effects of Quarantine and Corona Virus on Dietary Habits, Physical Activity, and Anthropometric Indices

Ameneh Ghorbani[1], Zinat Kamali[2], Pouyan Ebrahimi[3], Zahra Abodollahi[4], Mina Minaei[4], Ariyo Movahedi[1*]

1. Department of Nutrition, Faculty of Medical Sciences and Technologies, Science and Research Branch, Islamic Azad University, Tehran, Iran.
2. Deputy of Research of National Nutrition and Food Technology Research Institute, Shaheed Beheshti University of Medical Sciences and Health Services, Tehran, Iran.
3. Student Research Committee, Babol University of Medical Sciences, Babol, Iran.
4. PhD in Nutritional Sciences, Department of Community Nutrition, Deputy of Health, Ministry of Health and Medical Education, Tehran, Iran.

ARTICLEINFO

Article type:
Research Paper

Article History:
Received: 21 Aug 2023
Accepted: 24 Dec 2023
Published: 15 Jan 2024

Keywords:
COVID-19
Dietary habits
Physical activity
Anthropometric

ABSTRACT

Introduction: Numerous changes occurred in economic, social, and medical fields following the onset of Coronavirus (COVID-19), including lifestyle and dietary habits. This study examined dietary habits, physical activity, and individuals' anthropometric indices during quarantine due to the lack of research on quarantine's effects on lifestyle changes.

Methods: This cross-sectional study was conducted on adults based on inclusion and exclusion criteria during the COVID-19 quarantine period. Participants were asked to complete a 10- to 15-minute online survey regarding their experiences during the COVID-19 pandemic. Demographic variables and surveys related to eating habits, lifestyle behaviors, and the impact of COVID-19 on physical activity and health were investigated. SPSS 22.0 was used to analyze all data, and the significance level was less than 0.05.

Results: A total of 630 participants were enrolled in this study, of whom 537 (85.2%) were women, and their mean age was 38.12 + 3.25 years (range: 19-58). The average of all anthropometric profiles, in general and gender-specific, was significantly higher during quarantine than before (P<0.001 for all). Moderate and high levels of activity were significantly higher before quarantine than during quarantine, while low levels of activity increased significantly during quarantine (P<0.001 for all). The most consumed food groups included fruits (72.9%) and meat (63.8%). Carbonated drinks (16.7%) and fats and oils (21%) were less consumed than other food groups. The most critical factors affecting BMI during quarantine included fat-free body weight before quarantine (importance coefficient (IC) = 0.4097), weight before quarantine (IC = 0.2398), and gender (IC = 0.4097).

Conclusions: Based on the results, quarantine probably increased obesity prevalence, altered diet habits, and decreased physical activity levels among individuals. Expanding health development programs is essential to promote healthy lifestyles in communities during quarantine.

► Please cite this paper as:
Ghorbani A, Kamali Z, Ebrahimi P, Abodollahi Z, Minaei M, Movahedi A. The Effects of Quarantine and Corona Virus on Dietary Habits, Physical Activity, and Anthropometric Indices. J Nutr Fast Health. 2024; 12(1): 42-50. DOI: 10.22038/JNFH.2023.74524.1462.

Introduction

The new Coronavirus disease (COVID-19), which originated from SARS-CoV-2 and was first reported in December 2019 in Wuhan, China, resulted in a newfound and quickly evolving situation and inevitably extended outside of China and Asia and a pandemic was announced in March 2020 (1, 2). Meanwhile, the countries that reported their first cases began to enforce strict hygiene rules and eventually national quarantine (3).

Quarantine and isolation are two actions to minimize the spread of infectious diseases (4). Quarantine in public health is defined as separating individuals or populations susceptible to an infectious disease from infected individuals (4). According to SARS experiences, mandatory quarantine could cause high levels of psychological distress, which usually appears as low mood and agitation, emotional disturbances and exhaustion, anger, insomnia, post-traumatic stress disorder, and depression symptoms (5). Therefore, quarantine during pandemic diseases

* *Corresponding authors:* Ariyo Movahedi; Assistant Professor in Clinical Nutrition, Department of Nutrition, Faculty of Medical Sciences and Technologies, Science and Research Branch, Islamic Azad University, Tehran, Iran. Tel: +989390282157, E-mail: amm35@mail.aub.edu.

could be categorized as a stressful event, and generally, such events affect diet patterns (6). Concerning acute or chronic stress, hypophagia or hyperphagia could occur, leading to significant weight changes. Meanwhile, total quarantine due to a pandemic could alter dietary habits because of forcing most people to stay in their houses longer. The result is usually fewer food options and less physical activity, which is very worrying in people with prior dietary problems.

There is a lack of information regarding the effects of quarantine on obesity. However, there is agreement that it is similar to a period of severe stress, and stress could increase obesity risk. An outcome of quarantine stress is a change in lifestyle and dietary habits. Stress-related eating (defined as an effort to feel better by drinking or eating in stressful situations) is related to obesity, especially in women (7). There may be a sex-specific response to stress, where women usually use food to overcome stress. In contrast, men mostly use other oral behaviors, such as alcohol consumption and smoking, as strategies against stress (8, 9). These factors, along with obesity, were considered public health issues before the pandemic, and COVID-19 could make them worse (10). In addition, studies have shown the negative effects of low physical activity on physical and mental health (11). Therefore, fear related to COVID-19 is having an indirect impact and increases obesity by affecting sleep quality and negative emotions (12).

Social distance and lifestyle changes have also affected the Iranian population. All activities in sports centers, gyms, and swimming pools were suspended (13). A worrying matter is the long-term effects of the pandemic on body weight management in adults. Dietary habits could protect health and weight gain (14). In the last decade, obesity prevalence among adults has increased and affected 650 million people (39% of the population) around the world. In general, the percentage of obese women (40%) is higher than that of obese men (7.33%) (15). However, a study recently showed that weight gain and obesity are related to COVID-19 risk and its consequences (16). As a result, obese individuals are identified as a high-risk group in need of actions and social isolation (17). There may be a great deal of importance to population health, and physical activity, stress, hygiene, and diet quality could differ in countries (18). However, the effects of restricted activities on body weight remain unknown, with studies showing results from around the globe (19).

There is a need for further investigation regarding obesity-related risks, especially since obesity management treatments have been reduced in many parts of the world due to quarantines. In addition, conflicting findings regarding quarantine's effects on COVID-19 have been reported. According to Cicero et al., quarantine did not significantly impact body mass index in 359 patients (20). Meanwhile, Al-Domi et al. showed that quarantine led to weight gain among participants (21). Therefore, this study aimed to evaluate how quarantine and COVID-19 affected people's eating habits, physical activity, and anthropometric indicators despite the dangers associated with obesity, the contradictions in the studies, and the limited number of studies investigating this issue in Iranians.

Materials & Methods

The present study is a cross-sectional study that was performed using an online questionnaire to gain information on the effects of the COVID-19 pandemic on people over 18. This study has an ethical code with the number IR.IAU.TMU.REC.1400.123 approved in Islamic Azad University, Science and Research branch.

The participants were asked to complete a 10-to-15-minute questionnaire about their experiences during the COVID-19 pandemic related to their hygiene behaviors and lifestyle. The people who agreed to participate signed a consent form that enabled the researchers to call them to obtain their information. Participants answered questions about dietary habits, lifestyle behaviors, and COVID-19's effects on physical activity and mental health. This study was performed using the survey method with an online questionnaire. The participants were chosen using convenience sampling. The inclusion criteria were consent to participate, age over 18, Iranian nationality, not having special diets during the pandemic and quarantine, and not suffering from endocrine disorders or disorders leading to loss or gain of weight. Participants who did not fully cooperate (filed less than 70% of the questions) were excluded from the study.

This study was performed using convenience sampling, and the sample size was calculated using the Cochrane formula with a 95%

confidence interval. Participants were asked about their gender, ethnicity, age, marital status, and primary anthropometric information (height and weight before quarantine and current). Information about their families, including the number of children, educational level, and whether the participants or other family members or relatives were affected. Nutritional intake, food consumption, and diversity in their diet were evaluated through a questionnaire.

Besides demographic variables, the COVID-19 pandemic significantly changed people's everyday lives. The participants were asked about these changes (Do you feel like your size has grown compared with before the quarantine?) (Did you have a special diet during the quarantine?) (Which food group have you consumed most during the quarantine?) (Has diversity in your foods been increased during the quarantine?) (Have the consumption of herbal essences and teas been increased during the quarantine?) (Do you take weight loss drugs?) (Have your mealtimes changed during the quarantine?) (Did you experience microphagier during the quarantine?) And how they acted in response to the orders to stay at home and the amount of their food waste during the weeks. The James formula calculates the participants' lean body mass (LBM). The daily physical activity of the individuals was assessed using the online questionnaire. Questions consisted of pre-quarantine physical activity (low, moderate, and high), current physical activity, types of physical activity (including hula hoop, rope skipping, pull-ups, morning exercises, and others), and the site of physical activity (gym, park, home or neither) and were reported as self-declaration.

All data were analyzed using SPSS software version 22. The Kolmogorov-Smirnov test was used to assess the normality of the variables. The histogram diagram was drawn, and the Chai-squared test was used to determine the relation between the dependent qualitative variables. Additionally, the Independent T-test and the Mann-Whitney test were used to compare quantitative variables with qualitative variables based on the normality of the data. The effects of the confounding factors of age, gender, history of illnesses, consumption of supplements, and energy intake were modulated in modeling and the regression test. In this study, a P-value less than 0.05 was considered significant.

Table1. General characteristics of the participants in the study

variable		Frequency N (%) =630
gender	female	537 (85.2)
	male	93 (14.8)
marital status	single	321 (51)
	married	309 (49)
infected with Corona virus	no	618 (98.1)
	yes	12 (1.9)
Follow a special diet	no	555 (88.1)
	yes	75 (11.9)
number of children	0	362 (57.6)
	1	96 (15.2)
	2	147 (23.3)
	>2	24 (3.8)
level of education	diploma and lower	246 (39)
	diploma	30 (4.8)
	bachelor or master's degree	312 (49.6)
	doctorates degree or higher	42 (6.7)

Results

In this study, an overall of 630 individuals with a mean age of 38.12 + 3.25 years (range of 19-58) were assessed, of whom 537 were women (85.2%), and 93 were men (14.8%). About 51% of the participants were single, and 49% were married. Table 1 demonstrates the frequency and percentage of the participants' general features. In addition, 39% of the total population's educational level was diploma and lower, 4.8% of the participants had a diploma, 49.6% had a bachelor's or master's degree, and 6.7% had a doctorate or higher. Further, 11.9% of the

participants followed a specific diet, and only 1.9% were infected with Coronavirus.

Table 2 shows the anthropometric indices of the studied population before and after the quarantine. Mean±standard deviation of the participants' weight was 65.77±15.75kg before the quarantine and increased to 67.43±15.75kg. During the quarantine, weight, body mass index (BMI), lean body mass, and percent of body fat significantly increased (P=0.001).

Table 2. Comparison of anthropometric indices before and after quarantine

Variable	Quarantine		P-value
	after (Mean±SD)	before (Mean±SD)	
weight	65.77 ± 15.75	67.43 ± 15.75	<0.001
body mass index	24.60 ± 5.96	25.22 ± 5.98	<0.001
lean body mass	49.71 ± 7.23	50.45 ± 7.13	<0.001
percent of body fat	22.66 ± 10.37	23.41 ± 10.31	<0.001

Table 3. Comparison of the anthropometric indices before and after the quarantine separated by gender

variable	female		P-value	male		P-value
	after quarantine (Mean±SD)	before quarantine (Mean±SD)		after quarantine (Mean±SD)	before quarantine (Mean±SD)	
weight	63.31 ± 12.64	65.04 ± 12.81	<0.001	80.15 ± 22.97	81.44 ± 22.65	<0.001
body mass index	24.36 ± 5.89	25.01 ± 5.93	<0.001	25.98 ± 6.18	26.42 ± 6.16	<0.001
lean body mass	49.15 ± 6.92	49.96 ± 6.89	<0.001	52.95 ± 8.13	53.34 ± 7.85	<0.001
percent of body fat	20.63 ± 9.22	21.42 ± 9.21	<0.001	34.49 ± 8.74	35.02 ± 8.63	<0.001

Table 3 shows the anthropometric indices before and after quarantine, separated by gender. Results showed that weight, body mass index, lean body weight, and percent of body fat significantly increased in both genders (O=0.001), and weight gain after quarantine was more in women than men.

High and moderate physical activity levels before quarantine were significantly higher than during quarantine (high activity: 18.6% before quarantine compared to 9.7% during quarantine and moderate activity: 55.2% before quarantine compared to 34.8% during quarantine). In comparison, low levels of activity showed a more significant increase during quarantine (55.6% during quarantine and 26.2% before quarantine) (P<0.001 for all).

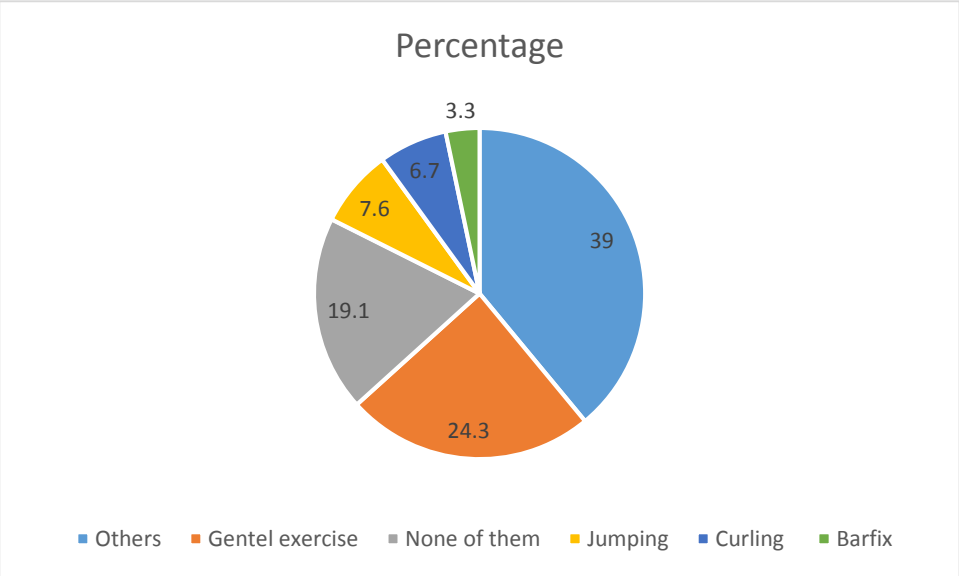

Figure 1. Percentage of frequency of pre-covid-19 physical activity in participants in the study

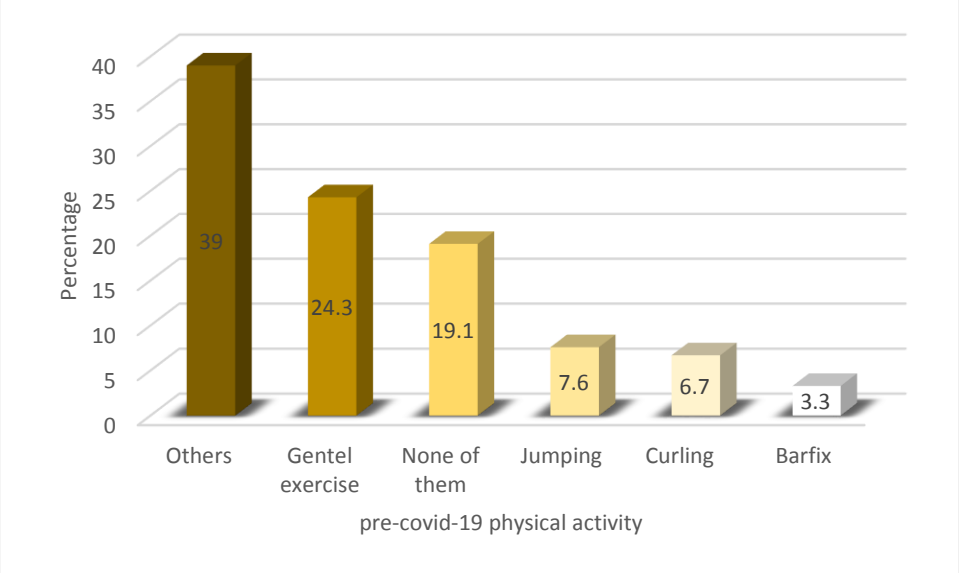

Figure 2. Prevalence of pre-covid-19 physical activity type in participants in the study (Unit: Percentage)

Figures 1 and 2 show the percent frequency of physical activity and the type of physical activity before Coronavirus in participants, respectively. According to these diagrams, 44.4% exercised at home, 22.9% at the gym, and 17.6% in parks. Among different types of physical activity, 24.3% of the participants did morning exercises.

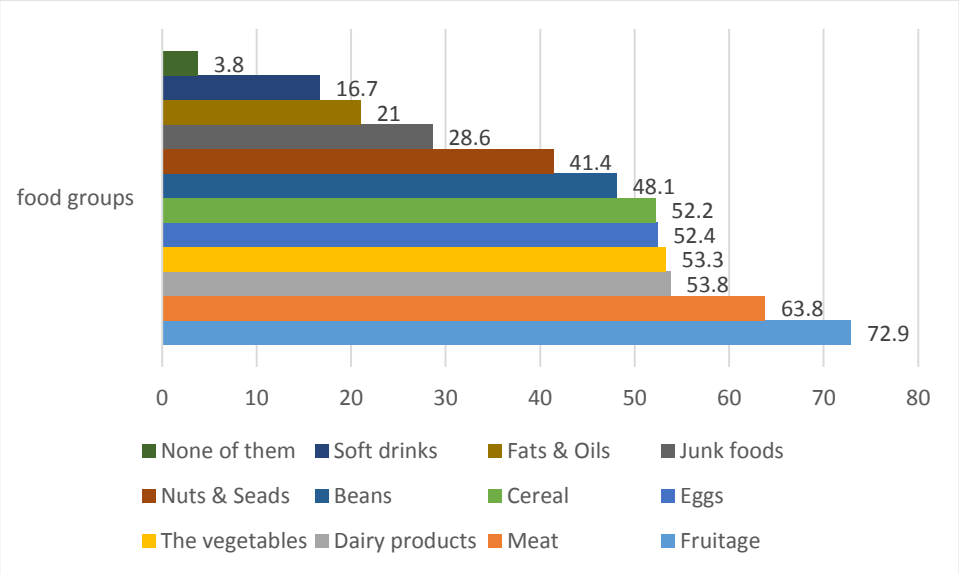

Figure 3. The frequency of the type of food groups consumed during quarantine in the participants in the study (Unit: Percentage)

Figure 3 shows the frequency percent of food groups consumed during quarantine in this study population. According to this diagram, the most popular food group among individuals was fruits (72.9%), meat (63.8%), dairy products (53.8%), vegetables (53.3%), eggs (52.4%), and grains (52.2%) were eating more than others. Carbonated drinks (16.7%) and fats and oils (21%) were consumed less than other food groups during the quarantine.

The effects of different factors on body mass index (BMI) after quarantine are indicated in Figure 4. Results show that lean body mass before the quarantine had the most significant

impact on BMI during the quarantine (Importance coefficient= 0.4097). Then, weight before the quarantine (Importance coefficient= 0.2398) and gender (Importance coefficient= 0.1751) were the most critical factors, respectively. Among the factors, grains and red meat had the least effect on BMI after quarantine.

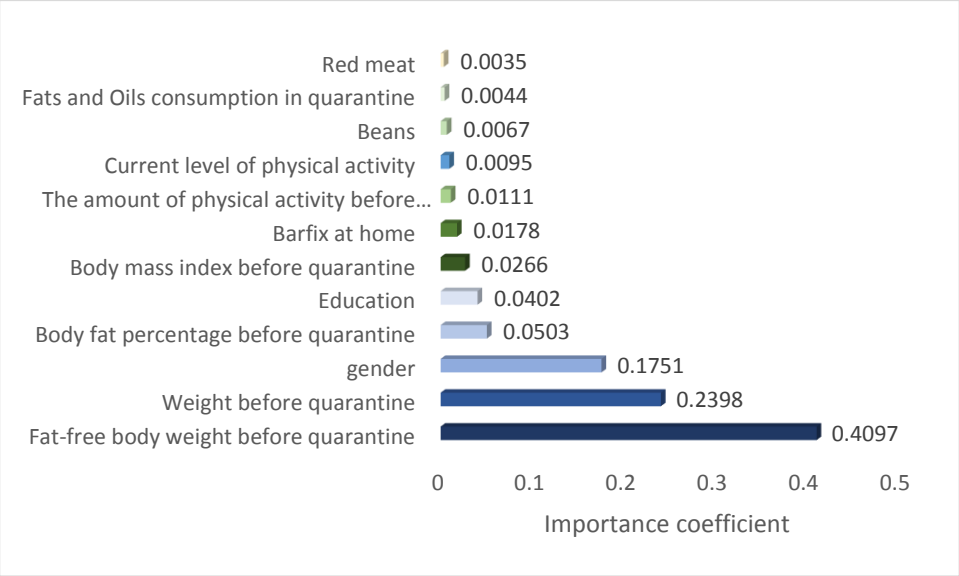

Figure 4. Comparison of the effect of different factors on body mass index after quarantine (Units: BMI= Kg/m^2; physical activity variables= low, moderate, and high; weight variables= Kg)

Discussion

A cross-sectional study evaluated quarantine and Coronavirus's effects on dietary habits, physical activity, and anthropometric indices. According to the present study, weight, body mass index, lean body mass, and percent of body fat significantly increased in both genders during the quarantine compared with before the quarantine. Precision and fast physical distances were key to fighting the COVID-19 pandemic worldwide. Various social interventions, including quarantines in public and private areas, were implemented to facilitate these actions. Companies faced bankruptcy, and the unemployment rate rapidly increased due to the economic crisis, even though the wanted outcomes were isolation and inhibiting virus transmission. Socioeconomic challenges exacerbate social and economic inequality and polarization of the population in countries with liberal markets and no cohesion-based welfare programs (22).

Obesity is a chronic, non-infectious disease and might seem unlikely to be related to COVID-19. Instructions to stay at home, as well as efforts to isolate high-risk populations and those infected or suspected of being infected with COVID-19, had a severe effect on obesity patients' hygiene behaviors and welfare (23). Combining forced isolation with economic hardships and worsening mental and social status could lead to long-term metabolic effects (24). Increasing social inequality as a result of political interventions against COVID-19 could worsen socioeconomic status, contributing to obesity and metabolic disorders in different populations (25). A possible explanation for this increase is the abundance of processed foods, which are high in energy, tasty, cheap, and easily available.

Global pandemics may cause mental stress, but socioeconomic conditions may exacerbate anxiety. Feeding patterns are generally affected by such events. Stress, sleep disturbances, and increased snack consumption could lead to weight gain (25). Food-related behaviors may be negatively affected by social-mental disorders. Food hoarding is a cultural example that is temporary. Social-mental stress increases energy consumption (26). In addition, obesity is more likely to occur in people with a low level of social interaction. Quarantine changed food exposure, which may have challenged cognitive limitations and caused binge eating behaviors to increase (27). Staying at home for long periods could also

increase the consumption of diverse food, meals, and snacks (27, 28). In addition, emotional eating, which usually helps to alleviate negative feelings, could increase in these situations (23). Patients usually choose cheaper foods with poor energy and nutritional content due to recent economic challenges. Although more patients cook at home, processed foods are mostly stored because of their longer shelf life, leading to more fat, carbohydrates, calorie consumption, and weight gain than moderate diets (29). Obesity affects pulmonary functionality and inflammation, and COVID-19's effects on obese patients are not much. Obesity leads to decreased exhalatory reserve volume, functional capacity, and adaptability of the respiratory system. Lying down may compromise pulmonary function and complicate ventilation in patients with high abdominal obesity. In addition, increased inflammatory cytokines related to obesity could increase COVID-19 infection risks (30, 31).

The results showed intense and moderate physical activity was significantly more before than during quarantine. Individuals mostly did mild activities during quarantine. Other studies have also confirmed the present results (32, 33). A lack of fitness centers, limited organized sports, and the need for physical distance may make it difficult to maintain an active lifestyle. Keeping weight in check requires more than 300 minutes of physical activity each week. Thus, disturbances in physical activity could have negative outcomes for individuals trying to lose or gain weight (32, 33).

Obesity is the abnormal or excessive fat accumulation that endangers human health. While obesity threats are increasingly recognized, worldwide obesity prevalence continues to increase, possibly because of low activity in our living environments after modern industrialization and the increase in alternatives (34, 35), which may have been intensified due to the quarantine because of COVID-19. Additionally, schools play an important role because they provide physical education classes and extracurricular activities that reduce adolescent obesity. School closures may have inappropriate effects on adolescents' activity patterns and weight during the quarantine. For example, an Italian study found that obesity affected children's exercise time and how much time they spent sleeping and using monitors after the COVID-19 quarantine (36, 37), which could probably remain after quarantine. A study by Jia et al. (35) demonstrated that all three educational levels saw increases in young people's weight during the COVID-19 quarantine and spent more time sedentary and less active. Young Chinese people were wary of being outside after the quarantine despite most cities being designated low-risk areas in May. Additionally, most universities and high schools began teaching online between March and April, resulting in more idle time.

According to many studies, children, teenagers, and adolescents changed their eating habits during COVID-19 and gained weight (38, 39). More specifically, 41.7% of teenagers in Palestine stated that their weight gain during the quarantine was due to the consumption of more fried foods, sweets, sugary beverages, and dairy products (40). A meta-analysis showed that the COVID-19 pandemic has altered daily life and eating habits. The number of meals increased during the quarantine, with men eating more potatoes, meat, and sugary beverages than women (41). Women and teenagers in Spain, Brazil, and Chile ate more vegetables and fruits compared with the week before the quarantine. Teenagers whose mothers had higher educational levels consumed even more vegetables and fruits (42). During the quarantine, 20.7% of teens consumed fried foods and sweets, which is related to a higher BMI and a younger age. A moderate increase in high-calorie or salty food consumption was observed (24%) in younger women who were married, had a history of psychiatric disorders, and were related to their living location. Parents were more worried about their children's food intake and tried to control it by limiting some foods and pressuring their children to take healthier and more nutritious foods (42, 43).

According to our knowledge, the present study is the first in Iran to investigate the effects of quarantine and Coronavirus on eating habits, physical activity, and anthropometric indices. This study collected important information to increase awareness regarding future comprehensive healthcare for obese patients. Access to healthcare services should continue during these times, especially if the pandemic leads to more quarantine regulation, as staying at home has consequences for long-term health. This cross-sectional study limited our ability to determine cause and effect. A self-administered

questionnaire was another study limitation, which could lead to measurement errors. Another limitation was that behavioral changes were based on the patient's perception when completing the questionnaire, which was not according to the quantification of these behaviors.

Conclusion

Based on the results, quarantine probably increases the prevalence of obesity, changes dietary habits, and lowers individuals' physical activity. The development of health programs to promote healthy lifestyles in societies during quarantine is being supported. However, more studies are required to confirm these findings.

Acknowledgments

The authors would like to thank the assistance and cooperation of the Health Deputy at the Islamic Azad University, Science and Research Branch, Tehran. This study was financially approved by the Islamic Azad University, Science and Research Branch, Tehran.

Conflicts of Interest

The authors declare no competing interests.

References

1. Li G, Hu R, Gu X. A close-up on COVID-19 and cardiovascular diseases. Nutr Metab Cardiovasc Dis. 2020;30(7):1057-60.
2. Yadav M. Understanding the epidemiology of COVID-19. Eur J Biol Res. 2020;10(2):105-17.
3. Javanian M, Masrour-Roudsari J, Bayani M, Ebrahimpour S. Coronavirus disease 2019 (COVID-19): What we need to know. Caspian J Intern Med. 2020;11(2):235-6.
4. Parmet W, Sinha M. Covid-19-La ley y los límites de la cuarentena. N Engl J Med. 2020;18.
5. Anderson RM, Heesterbeek H, Klinkenberg D, Hollingsworth TD. How will country-based mitigation measures influence the course of the COVID-19 epidemic?. Lancet. 2020;395(10228):931-4.
6. Caulfield T. Pseudoscience and COVID-19 - we've had enough already. Nature. 2020.
7. Mattioli AV, Ballerini Puviani M. Lifestyle at Time of COVID-19: How Could Quarantine Affect Cardiovascular Risk. Am J Lifestyle Med. 2020;14(3):240-2.
8. Conway TL, Vickers RR, Jr., Ward HW, Rahe RH. Occupational stress and variation in cigarette, coffee, and alcohol consumption. J Health Soc Behav. 1981;22(2):155-65.
9. Sciomer S, Moscucci F, Maffei S, Gallina S, Mattioli AV. Prevention of cardiovascular risk factors in women: The lifestyle paradox and stereotypes we need to defeat. Eur J Prev Cardiol. 2019;26(6):609-10.
10. Najera H, Nandy S, Carrillo-Larco RM, Miranda JJ. Within-country migration and obesity dynamics: analysis of 94,783 women from the Peruvian demographic and health surveys. BMC Public Health. 2019;19(1):263.
11. Di Renzo L, Gualtieri P, Cinelli G, Bigioni G, Soldati L, Attinà A, et al. Psychological Aspects and Eating Habits during COVID-19 Home Confinement: Results of EHLC-COVID-19 Italian Online Survey. Nutrients. 2020;12(7).
12. Chaput JP, Dutil C. Lack of sleep as a contributor to obesity in adolescents: impacts on eating and activity behaviors. Int J Behav Nutr Phys Act. 2016;13(1):103.
13. Shahriarirad R, Khodamoradi Z, Erfani A, Hosseinpour H, Ranjbar K, Emami Y, et al. Epidemiological and clinical features of 2019 novel coronavirus diseases (COVID-19) in the South of Iran. BMC Infect Dis. 2020;20(1):427.
14. Sanders JM, Monogue ML, Jodlowski TZ, Cutrell JB. Pharmacologic Treatments for Coronavirus Disease 2019 (COVID-19): A Review. JAMA. 2020;323(18):1824-36.
15. Al-Rubeaan K, Bawazeer N, Al Farsi Y, Youssef AM, Al-Yahya AA, AlQumaidi H, et al. Prevalence of metabolic syndrome in Saudi Arabia - a cross sectional study. BMC Endocr Disord. 2018;18(1):16.
16. Palaiodimos L, Kokkinidis DG, Li W, Karamanis D, Ognibene J, Arora S, et al. Severe obesity, increasing age and male sex are independently associated with worse in-hospital outcomes, and higher in-hospital mortality, in a cohort of patients with COVID-19 in the Bronx, New York. Metabolism. 2020;108:154262.
17. Flint SW, Tahrani AA. COVID-19 and obesity-lack of clarity, guidance, and implications for care. Lancet Diabetes Endocrinol. 2020;8(6):474-5.
18. Scarmozzino F, Visioli F. Covid-19 and the Subsequent Lockdown Modified Dietary Habits of Almost Half the Population in an Italian Sample. Foods. 2020;9(5):675.
19. Popkin BM, Du S, Green WD, Beck MA, Algaith T, Herbst CH, et al. Individuals with obesity and COVID-19: A global perspective on the epidemiology and biological relationships. Obes Rev. 2020;21(11):e13128.
20. Cicero AFG, Fogacci F, Giovannini M, Mezzadri M, Grandi E, Borghi C, et al. COVID-19-Related Quarantine Effect on Dietary Habits in a Northern Italian Rural Population: Data from the Brisighella Heart Study. Nutrients. 2021;13(2).
21. Al-Domi H, Al-Dalaeen A, Al-Rosan S, Batarseh N, Nawaiseh H. Healthy nutritional behavior during COVID-19 lockdown: A cross-sectional study. Clinical Nutrition ESPEN. 2021;42:132-7.
22. Clemmensen C, Petersen MB, Sørensen TIA. Will the COVID-19 pandemic worsen the obesity epidemic? Nat Rev Endocrinol. 2020;16(9):469-70.

23. Almandoz JP, Xie L, Schellinger JN, Mathew MS, Gazda C, Ofori A, et al. Impact of COVID-19 stay-at-home orders on weight-related behaviours among patients with obesity. Clin Obes. 2020;10(5):e12386.
24. Iversen T, Soskice D. 5. The politics of the knowledge economy and the rise of populism. democracy and prosperity. Princeton University Press; 2019; 216-56.
25. Petrou P, Gothelf Y, Argov Z, Gotkine M, Levy YS, Kassis I, et al. Safety and Clinical Effects of Mesenchymal Stem Cells Secreting Neurotrophic Factor Transplantation in Patients With Amyotrophic Lateral Sclerosis: Results of Phase 1/2 and 2a Clinical Trials. JAMA Neurol. 2016;73(3):337-44.
26. Kim D, Subramanian SV, Gortmaker SL, Kawachi I. US state- and county-level social capital in relation to obesity and physical inactivity: a multilevel, multivariable analysis. Soc Sci Med. 2006;63(4):1045-59.
27. Maniscalco JW, Kreisler AD, Rinaman L. Satiation and stress-induced hypophagia: examining the role of hindbrain neurons expressing prolactin-releasing Peptide or glucagon-like Peptide 1. Front Neurosci. 2012;6:199.
28. Razzoli M, Bartolomucci A. The Dichotomous Effect of Chronic Stress on Obesity. Trends Endocrinol Metab. 2016;27(7):504-15.
29. Finer N, Garnett S, Bruun J. COVID 19 e obesidade. Obesidade Clínica. 2020;10(3).
30. Yu J, Lv Y, Di W, Liu J, Kong X, Sheng Y, et al. MiR-27b-3p Regulation in Browning of Human Visceral Adipose Related to Central Obesity. Obesity (Silver Spring). 2018;26(2):387-96.
31. Parameswaran K, Todd DC, Soth M. Altered respiratory physiology in obesity. Can Respir J. 2006;13(4):203-10.
32. Liu J, Rehm CD, Micha R, Mozaffarian D. Quality of meals consumed by us adults at full-service and fast-food restaurants, 2003-2016: persistent low quality and widening disparities. J Nutr. 2020;150(4):873-83.
33. Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. Perspect Psychol Sci. 2015;10(2):227-37.
34. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet. 2017;390(10113):2627-42.
35. Jia P, Cao X, Yang H, Dai S, He P, Huang G, et al. Green space access in the neighbourhood and childhood obesity. Obes Rev. 2021;22 Suppl 1(Suppl 1):e13100.
36. Jia P. A changed research landscape of youth's obesogenic behaviours and environments in the post-COVID-19 era. Obes Rev. 2021;22 Suppl 1(Suppl 1):e13162.
37. Rundle AG, Park Y, Herbstman JB, Kinsey EW, Wang YC. COVID-19-Related School Closings and Risk of Weight Gain Among Children. Obesity (Silver Spring). 2020;28(6):1008-9.
38. Adams EL, Caccavale LJ, Smith D, Bean MK. Food Insecurity, the Home Food Environment, and Parent Feeding Practices in the Era of COVID-19. Obesity (Silver Spring). 2020;28(11):2056-63.
39. An R. Projecting the impact of the coronavirus disease-2019 pandemic on childhood obesity in the United States: A microsimulation model. J Sport Health Sci. 2020;9(4):302-12.
40. Allabadi H, Dabis J, Aghabekian V, Khader A, Khammash U. Impact of COVID-19 lockdown on dietary and lifestyle behaviours among adolescents in Palestine. Dynam Human Health. 2020;7:2170.
41. Pietrobelli A, Pecoraro L, Ferruzzi A, Heo M, Faith M, Zoller T, et al. Effects of COVID-19 Lockdown on Lifestyle Behaviors in Children with Obesity Living in Verona, Italy: A Longitudinal Study. Obesity (Silver Spring). 2020;28(8):1382-5.
42. Ruiz-Roso MB, de Carvalho Padilha P, Mantilla-Escalante DC, Ulloa N, Brun P, Acevedo-Correa D, et al. Covid-19 Confinement and Changes of Adolescent's Dietary Trends in Italy, Spain, Chile, Colombia and Brazil. Nutrients. 2020;12(6).
43. Di Renzo L, Gualtieri P, Pivari F, Soldati L, Attinà A, Cinelli G, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. J Transl Med. 2020;18(1):229.