



Comparing the BMI and Some Physical Parameters Before and One Year After the COVID-19 Pandemic among High School Students in Rafsanjan City, Iran

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Abstract

Background: Obesity has many side effects and deadly risks. During the COVID-19 pandemic, school closures have been affecting the lifestyle of students worldwide. This study aims to assess changes in the BMI and some physical parameters among students before and one year after the COVID-19 pandemic in Rafsanjan City, Iran.

Materials and Methods: In this descriptive study, the sample included 793 high school students (422 males and 371 females) within the age range of 11 to 19. The sampling method was multistage clustering. Accordingly, we compared pre-pandemic data on the BMI and the circumference of the waist, hip, neck, and wrist with the data collected one year after the COVID-19 pandemic.

Results: Our findings demonstrated that the BMI and the circumference of the waist, hip, and wrist were significantly higher in males one year after the outbreak of the disease. However, except for the neck circumference, a comparison of other variables before and after the COVID-19 pandemic in females showed no significant difference. Moreover, the results showed that the average BMI of all participants, regardless of their gender, increased significantly from 20.55 to 22.00 kg/m².

Conclusion: The data obtained from this survey would serve as an important evidence necessitating future planning for controlling overweight and obesity in order to reduce the probability of chronic diseases incidence in future. . Additionally, it is recommended that more comprehensive studies and extracurricular physical activity programs be designed to counteract the negative effects of sedentary behavior.

Keywords: COVID-19, Lockdown, BMI, Waist Circumference, Obesity, Lifestyle

Introduction

Obesity is the abnormal accumulation of excess fat in the body, which in addition to making a person look disproportionate, it brings about many side effects and deadly risks [1]. The prevention of obesity in children and adolescents reduces the

risks of several chronic diseases, such as coronary artery disease and type 2 diabetes [2].

With the outbreak of the COVID-19 pandemic, many governments advised their citizens to stay at home to prevent the spread of the disease. This disease has changed many aspects of human life

[3]. Accordingly, it has led to various medical, political, socioeconomic, religious, cultural, and civilizational consequences [4].

During the COVID-19 pandemic, lockdown measures and school closures affected millions of teenagers and students worldwide [5]. A student who was present in the school environment for at least 6 to 8 hours took all of their lessons online at home. A great portion of student behavior in the school and classroom environment, at the presence of the principal, supervisor, and teachers, changed with online education [6]. Students in school had to display some personal behaviors, including wearing formal dress, sitting in a chair, doing physical activity, and interacting with classmates. However, with the outbreak of this disease and the holding of online classes, all these behaviors were either eliminated or greatly reduced [7]. Many studies have been conducted on psychological and economic effects of the COVID-19 pandemic in different societies [8]. However, less attention has been paid to the physical effects exerted after this disease, especially on students.

Pietrobelli et al reported that screen time and sleep time increased significantly among obese persons, whereas sports activities decreased during COVID-19 lockdowns [9]. A recent study in China explored lifestyle changes before and during the COVID-19 pandemic and stated that all young participants' activity pattern changed significantly [10]. Besides, it revealed that the prevalence of overweight and obesity increased significantly among the general young population. However, it is possible that some students may have lost weight due to economic problems caused by the COVID-19 pandemic.

Since there is a relationship between weight and the amount of physical activity, we evaluated changes in the BMI and some physical parameters before and one year after the COVID-19 pandemic among students in Rafsanjan City, Iran.

Materials and Methods

This study was approved by the Ethics Committee of Rafsanjan University of Medical Sciences (IR.RUMS.REC.1400.003). Informed written consent was obtained from all participants. A total of 793 high school students (422 males and 371 females within the age range of 11 to 19) were included in this community-based study, Rafsanjan, Iran. For this purpose, their demographic information, including age and gender, was recorded.

The sampling method was four-stage clustering. The first stage was associated with gender. At the

second stage, 6 male and 6 female high schools were randomly selected from all high schools in Rafsanjan City. Next, grades 7 to 12 students were considered as clusters in schools. At the fourth stage, in each school, one class was randomly selected from each grade (cluster). The number of students in the pre-COVID-19 and post-COVID-19 groups was 393 and 400, respectively. In fact, the sampling method was the same for both groups.

In epidemiology, there is a type of study that evaluates the effect of natural phenomena, such as the occurrence of a pandemic, and compares conditions before and after such phenomena. Similarly, the present study was of the same type. Accordingly, in this study, the data obtained in June 2021 were compared with previously unpublished ones (before the COVID-19 pandemic and school closures, October 2019), which were related to another research project of the authors of the present study (IR.RUMS.REC.1397.039). This project aimed to evaluate anthropometric indices and the prevalence of cardiovascular disease risk factors in children and adolescents (10-18 years old) in Rafsanjan City.

All measurement steps were taken with informed consent obtained from the students. The inclusion criteria included physically healthy students (aged 11 to 19) and willingness to give informed consent. On the other side, the exclusion criterion was very obese students.

Anthropometric measurements: Height was measured against a wall-fixed tape (Ficko K70, with 1mm accuracy), and weight was measured on a platform scale (PH-2015A) with 100gr accuracy. In fact, both measurements were performed without shoes in the morning [11]. The metric formula of the students' weight in kilograms divided by their height in meters squared was used to calculate the BMI. In this study, we compared the pre-outbreak data on the BMI and the circumference of the waist, hip, neck, and wrist with similar data obtained one year after the COVID-19 pandemic. The aforementioned variables were measured as follows: (1) Waist circumference was measured at the midpoint between the iliac crest and the rib margin (after gentle expiration). (2) Hip circumference was considered the largest circumference at the gluteal region (in the standing position) [12]. (3) Neck circumference was measured at the superior border of the thyroid cartilage. (4) Wrist circumference was measured at the level of the styloid processes of the radius and ulna (the right wrist was measured) [13]. Next, all of the aforementioned measurements, which were recorded before the COVID-19 pandemic, were

compared with the data from one year after the pandemic. Data were presented as the mean \pm SD. In addition, an independent t-test was used for the statistical analysis of the BMI and other physical parameters in each gender group before and one year after the COVID-19 pandemic. Besides, the Kolmogorov-Smirnov test was used to evaluate normal distribution of the data. Furthermore, a p-

value less than 0.05 was considered statistically significant.

Results

In the present study, a total of 793 high school students of Rafsanjan City, southeastern Iran, with an average height of 165.64 ± 10.25 cm and a mean weight of 59.18 ± 15.58 kg were included in the final analysis (Table 1).

Table 1. Participants' baseline characteristics

	Males (n = 422)		Females (n = 371)		Total (n = 793)	
	Mean \pm SD	Range	Mean \pm SD	Range	Mean \pm SD	Range
Age (y)	16.07 \pm 1.31	12-19	15.51 \pm 1.40	11-19	15.77 \pm 1.38	11 \pm 19
Height (cm)	169.73 \pm 11.27	120-203	160.99 \pm 6.31	130-180	165.64 \pm 10.25	120-203
Weight (kg)	62.70 \pm 18.26	30-135	55.16 \pm 10.48	24.5-94.00	59.18 \pm 15.58	24.50- 135

The males' average BMI before and after the COVID-19 pandemic was 20.11 ± 4.48 and 22.48 ± 4.98 kg/m², respectively, which showed a significant difference (P < 0.001). On the other side, the average BMI in the females before the COVID-19 pandemic was 21.05 ± 3.82 kg/m², which did not change significantly one year after the outbreak of the disease (P = 0.339) (Table 2).

Furthermore, the neck circumference in the males and females before the pandemic was 32.21 ± 3.84 and 32.01 ± 3.12 cm, respectively, which reached 36.76 ± 3.69 and 32.91 ± 3.02 cm, respectively, one year after the COVID-19 pandemic, respectively. Accordingly, the difference was significant in both genders (males: P < 0.001; females: P = 0.006).

Table 2. The BMI and some physical parameters among high school students in Rafsanjan City before and after COVID-19 lockdowns

Variables	Male		P-value*	Female		P-value*
	Before (222)	After (200)		Before (183)	After (188)	
	Mean \pm SD	Mean \pm SD		Mean \pm SD	Mean \pm SD	
BMI (kg/m ²)	20.11 \pm 4.48	22.48 \pm 4.98	< 0.001	21.05 \pm 3.82	21.44 \pm 3.76	0.339
Waist circumference (cm)	73.31 \pm 12.58	83.32 \pm 13.90	< 0.001	72.88 \pm 8.48	72.90 \pm 9.52	0.982
Hip circumference (cm)	82.17 \pm 16.02	89.67 \pm 20.20	< 0.001	93.16 \pm 8.85	91.40 \pm 14.40	0.148
Waist-hip ratio (cm)	0.92 \pm 0.25	0.98 \pm 0.28	0.056	0.78 \pm 0.07	0.82 \pm 0.17	0.99
Neck circumference (cm)	32.21 \pm 3.84	36.76 \pm 3.69	< 0.001	32.01 \pm 3.12	32.91 \pm 3.02	0.006
Wrist circumference (cm)	16.03 \pm 1.68	17.28 \pm 1.76	< 0.001	15.51 \pm 1.23	15.58 \pm 1.54	0.649

* Independent t-test

Our findings revealed that the circumference of the waist, hip, and wrist was significantly higher in males one year after the outbreak of the disease than before. However, the comparison of the three aforementioned variables did not show a significant difference before and after the COVID-19 pandemic in females. In addition, changes in

the waist-hip ratio were greater in males than in females, but no significant difference was observed in either gender (Table 2).

Additionally, after the evaluation of data on all participants, regardless of their gender, a significant increase was observed in the BMI and circumference of the waist, hip, neck, and wrist (Fig. 1).

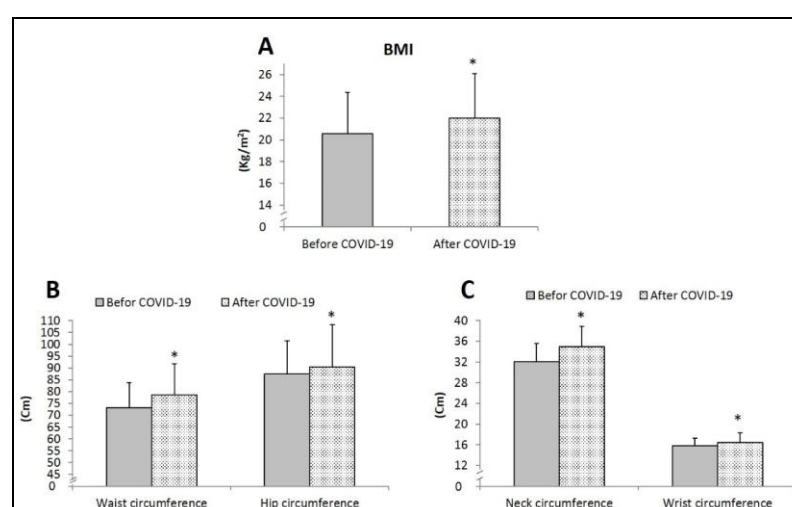


Fig. 1. Data analysis of the BMI (A), circumference of the waist and hip (B), and circumference of the neck and wrist (C) in all students regardless of their gender; the results also showed that the numerical value of all variables was significantly higher after the outbreak than before it ($P = 0.007$ for the hip circumference and $P < 0.001$ for other variables).

Moreover, data assessment for periods before and after the COVID-19 outbreak revealed that the waist circumference in males underwent most changes among other variables.

Discussion

Few studies have assessed the way the COVID-19 pandemic changes lifestyle and activity patterns [14]. The COVID-19 pandemic has affected the lives of different groups, among whom students have been experiencing completely new conditions. After the COVID-19 pandemic and due to the prolonged social distancing, closure of public places, and home seclusion, students' regular school activities were halted, and their dietary behaviors changed [15].

Findings from the present study showed some changes in the BMI as well as the circumference of the waist, hip, neck, and wrist. Accordingly, this supports the hypothesis of the increase in the obesity prevalence after one year from the beginning of the COVID-19 outbreak. Additionally, our results verifies a Chinese study that reported increased overweight and obesity in the youths during COVID-19 lockdowns [10]. In fact, it reported that all youths had about a 30% increase in their sleep time and a 36% increase in their screen time. Moreover, about 42% of the participants in this survey had increased sedentary time during weekdays.

Lissak reported that excessive screen time was associated with eating junk food, snacking, and sedentary behavior, which was associated with high blood pressure, insulin resistance, and obesity in children and adolescents [16]. An elevated BMI caused by the increased consumption of junk food was reported in an Italian study by Di Renzo et al [17].

Ghosh et al reported that home quarantine caused greater psychological suffering for children than physical problems [18]. Besides, they reported that the closure of schools as well as aberrant sleep and dietary habits could disrupt students' regular lifestyle, having been likely to trigger neuropsychiatric symptoms, including monotony, impatience, and distress.

Dutta assessed physical activities and socioeconomic factors in the US states. Accordingly, he reported a higher obesity rate (more than 15%) in students during the COVID-19 pandemic [19]. A meta-analysis reported that the mortality rate among patients with a BMI greater than 25 kg/m² was 21.66%, while this rate was 7.07% in patients with a BMI less than 25 kg/m² [20]. Since the risk of deaths from COVID-19 contraction is higher among obese people, it is important to identify factors affecting weight gain, especially during the pandemic [21].

The assessment of the UK Biobank's data revealed that a higher BMI was associated with a greater risk of deaths from COVID-19 [22]. Additionally, other anthropometric measures, such as the waist-to-height ratio, waist-to-hip ratio, and waist circumference, were associated with a higher rate of deaths from COVID-19 in both genders. Furthermore, the risk of deaths from COVID-19 associated with a larger BMI was higher in women than in men.

Restrictions associated with the COVID-19 pandemic have been disrupting the everyday routine life of all people, making changes to their eating habits, sleep time, and physical activity [23]. Among the major changes, one can refer to changes in dietary behaviors and unhealthy food choices, including sweets, sugary drinks, fried food, and potatoes, as well as food intake during

the COVID-19 pandemic. Furthermore, another concern during this pandemic is the rising food insecurity for financial reasons. In fact, children and adolescents are the groups most affected by these conditions [24].

As a matter of fact, reduced physical activity and restrictions on outdoor activities are other risk factors for obesity and weight gain. Furthermore, in recent years, the prevalence of obesity has been increasing in low- and middle-income countries in addition to high-income countries [25].

In this study, the students' dietary behaviors and physical activity were not investigated, having been among the limitations of the present study. However, among the strengths of this study, one can refer to the comparison of the BMI and other physical parameters before and one year after the COVID-19 pandemic. To conduct more comprehensive studies, it is recommended that the effects of factors, such as psychological parameters, physical activity, dietary habits, economic status, and livelihood status of students be investigated.

Conclusion

In sum, the data from this survey can be used to plan for the prevention of the prevalence of obesity to decrease the number of young people with diabetes and high blood pressure. Moreover, school administrators and teachers should be informed of this important issue and design extracurricular physical activity programs to counteract negative effects of sedentary behavior and inactive lifestyles during COVID-19 lockdowns.

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Conflict of interest: None declared.

References

1. Fruh SM. Obesity: Risk factors, complications, and strategies for sustainable long-term weight management. *J Am Assoc Nurse Pract.* 2017;29(S1):S3-14
2. Stefan N, Birkenfeld AL, Schulze MB, Ludwig DS. Obesity and impaired metabolic health in patients with COVID-19. *Nat Rev Endocrinol.* 2020;16(7):341-2.
3. Hemmingsson E. Early Childhood Obesity Risk Factors: Socioeconomic Adversity, Family

- Dysfunction, Offspring Distress, and Junk Food Self-Medication. *Curr Obes Rep.* 2018;7(2):204-9.
4. Zhou Y, Chi J, Lv W, Wang Y. Obesity and diabetes as high-risk factors for severe coronavirus disease 2019 (Covid-19). *Diabetes Metab Res Rev.* 2021;37(2):e3377
5. Balanzá-Martínez V, Kapczinski F, de Azevedo Cardoso T, Atienza-Carbonell B, Rosa AR, Mota JC, et al. The assessment of lifestyle changes during the COVID-19 pandemic using a multidimensional scale. *Rev Psiquiatr Salud Ment (Engl Ed).* 2021;14(1):16-26.
6. Weems CF, Carrion V, McCurdy B, Scozzafava MD. Increased risk of suicide due to economic and social impacts of social distancing measures to address the Covid-19 pandemic: a forecast. *Res Prepr.* 2020. doi:10.13140/RG.2.2.21601.45926
7. Toquero CM. Emergency remote education experiment amid COVID-19 pandemic. *Int J Educ Res Innov.* 2021;(15):162-76.
8. Mishra L, Gupta T, Shree A. Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *Int J Educ Res Open.* 2020;1:100012.
9. Radha R, Mahalakshmi K, Kumar VS, Saravanakumar A. E-Learning during lockdown of Covid-19 pandemic: A global perspective. *Int J Control Autom.* 2020;13(4):1088-99
10. Atalan A. Is the lockdown important to prevent the COVID-19 pandemic? Effects on psychology, environment and economy-perspective. *Ann Med Surg (Lond).* 2020;56:38-42.
11. Mucci F, Mucci N, Diolaiuti F. Lockdown and Isolation: Psychological Aspects of Covid-19 Pandemic in the General Population. *Clin Neuropsychiatry.* 2020;17(2):63-4.
12. 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
13. Yang S, Guo B, Ao L, Yang C, Zhang L, Zhou J, et al. Obesity and activity patterns before and during COVID-19 lockdown among youths in China. *Clin Obes.* 2020;10(6):e12416
14. Shahabi-Rabori M, Eftekhari-Vaghefi S, Babaee A, Seyed F. Anthropometric assessment of classroom chairs and determination of classroom chairs' standard dimensions for 3rd and 6th grade students in Kerman. *Iran Occup Health.* 2018;15(2):42-53.
15. Ndagire CT, Muyonga JH, Odur B, Nakimbugwe D. Prediction equations for body composition of children and adolescents aged 8-19 years in Uganda using deuterium dilution as the reference technique. *Clin Nutr ESPEN.* 2018;28:103-9.
16. Kelishadi R, Heidari-Beni M, Qorbani M, Motamed-Gorji N, Motlagh ME, Ziaodini H, et al.

- Association between neck and wrist circumferences and cardiometabolic risk in children and adolescents: The CASPIAN-V study. *Nutrition*. 2017;43-44:32-8
17. Pérez-Rodrigo C, Gianzo Citores M, Hervás Bárbara G, Ruiz-Litago F, Casis Sáenz L, Arija V, et al. Patterns of Change in Dietary Habits and Physical Activity during Lockdown in Spain Due to the COVID-19 Pandemic. *Nutrients*. 2021;13(2):300
 18. Curtis RG, Olds T, Ferguson T, Fraysse F, Dumuid D, Esterman A, et al. Changes in diet, activity, weight, and wellbeing of parents during COVID-19 lockdown. *PLoS One*. 2021;16(3):e0248008.
 19. Wang X, Lei SM, Le S, Yang Y, Zhang B, Yao W, et al. Bidirectional Influence of the COVID-19 Pandemic Lockdowns on Health Behaviors and Quality of Life among Chinese Adults. *Int J Environ Res Public Health*. 2020;17(15):5575.
 20. Lissak G. Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environ Res*. 2018;164:149-57
 21. 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.
 22. Ghosh R, Dubey MJ, Chatterjee S, Dubey S. Impact of COVID-19 on children: special focus on the psychosocial aspect. *Minerva Pediatrica*. 2020;72(3):226-35.
 23. Dutta M. COVID-19 and Impact of School Closures on the Children of the United States; a Point of View with an Empirical Analysis. *Soc Sci Humanit Open*. 2020. doi:10.2139/ssrn.3596096
 24. Hussain A, Mahawar K, Xia Z, Yang W, Elhasani S. Obesity and mortality of COVID-19. Meta-analysis. *Obes Res Clin Pract*. 2020;14(4):295-300.
 25. Dietz W, Santos-Burgoa C. Obesity and its Implications for COVID-19 Mortality. *Obesity (Silver Spring)*. 2020;28(6):1005
 26. Peters SA, MacMahon S, Woodward M. Obesity as a risk factor for COVID-19 mortality in women and men in the UK biobank: Comparisons with influenza/pneumonia and coronary heart disease. *Diabetes Obes Metab*. 2021;23(1):258-62
 27. Sidor A, Rzymiski P. Dietary Choices and Habits during COVID-19 Lockdown: Experience from Poland. *Nutrients*. 2020;12(6):1657
 28. Jansen E, Thapaliya G, Aghababian A, Sadler J, Smith K, Carnell S. Parental stress, food parenting practices and child snack intake during the COVID-19 pandemic. *Appetite*. 2021;161:105119.
 29. 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.
 30. 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.