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Body mass index, eating habits, and various lifestyle changes in young adults during the two years of the coronavirus disease 2019 (COVID-19) pandemic

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Abstract:

BACKGROUND: The aim of this study was to find out the perceived impact of 2 years of coronavirus disease 2019 (COVID-19) pandemic on various lifestyle behaviors (LSBs) and changes and their effect on body mass index (BMI) of young Saudi adults.

MATERIALS AND METHODS: This was a descriptive exploratory study conducted in January 2022 on 1724 students (aged 16–21 years) from multiple colleges of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia. The main tools of the study were: BMI and an online 30-item LSB and changes structured questionnaire, which assessed LSB and perceived changes, 1 month immediately preceding and 2 years after the COVID-19 outbreak.

RESULTS: Our study results showed that 48% of the subjects gained weight after the pandemic. Screen time (ST) increased from 6.8 h before pandemic to 9.2 h/24 h after pandemic outbreak ($P < 0.0001$). However, no significant association was observed between excessive ST and increased BMI. A significant decrease in physical activity was seen after the outbreak ($P < 0.001$), which was positively but insignificantly associated with increased BMI ($P = 0.3$). A significant increase in the frequency of food intake was observed; 18.7% of the subjects reported taking ≥ 4 meals/day before the epidemic compared to 32.1% during the pandemic ($P = 0.001$). Decreased intake of homemade food, increased intake of junk food, and increased number of the meals/day were significantly related with increased BMI ($P < 0.05$). The strongest risk factor for increased BMI after the outbreak of the pandemic was ≥4 meals/day (OR=1.6; $P = 0.048$).

CONCLUSION: After 2 years of the pandemic, 48% of the young adults perceived they had gained weight, which was strongly associated with self-reported increase in the number of meals/day (≥4). These observations could aid the development of nutritional recommendations to maintain the health of young adults during and after the COVID-19 pandemic.

Keywords:

Body mass index, coronavirus disease 2019 pandemic, eating behaviors, physical activity, screen usage time

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Introduction

Coronavirus is a highly contagious positive single-strand RNA virus that causes severe respiratory symptoms that could lead to death.[1] The virus was named coronavirus disease 2019 (COVID-19) by the WHO on February 11, 2020, and was declared a pandemic on March 13, 2020.[2] The first case of COVID-19 was detected in Saudi Arabia on March 2, 2020.[3] The Saudi government took several quick stringent

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measures to control the spread of the virus. All schools and universities were closed, and online teaching began for all students; workplace attendance was suspended; shopping centers were closed, and a ban was imposed on traveling and on all mass gatherings in the entire kingdom.[4-7] On March 23, 2020, a curfew commencing from 7 pm to 6 am was enforced in all the cities in Saudi Arabia. On June 21, 2020, the curfew was fully lifted, but schools and universities were directed to continue online education.[8,9]

Almost half of the world's population has been under "off and on" "full or partial lockdowns" work from home and quarantines since March 2020.[10,11] Although these worldwide strict preventative regulations helped to control the spread of virus,[12] they adversely affected lifestyle behaviors (LSB) of people worldwide. LSB of student populations has been the most affected as COVID-19 resulted in school closure worldwide.[13] While COVID-19 infection rates in countries differ, currently, more than 186 countries are affected by school closures and have shifted to online teaching.[14] Two of the most recent reviews have raised the serious concerns about the increased screen time (ST), decreased physical activity (PA), negative changes in eating habits, and weight gain in the general population as well as in youngsters after the outbreak of the pandemic.[15,16]

The WHO has advised people to stay healthy by eating homemade healthy balanced diet. Moreover, it endorsed staying physically active, minimizing SUT, managing stress, and getting enough sleep to improve immune functions.[17,18]

During the pandemic, young students were expected to experience a maximum change in their LSB and body mass index (BMI), because the pandemic caused most educational sectors all over the world to change from physical to online/hybrid teaching.[19] Most existing studies on young adults have pinned the short-duration effects of the pandemic (4–5 months) on LSB and BMI. Therefore, our aim was to "find out the perceived impact of long duration (2 years) of COVID-19 pandemic on ST, PA, eating habits and BMI of young Saudi adults." Although an increase in the BMI in young populations after 2 years of the pandemic has been reported in various studies,[20] the factors accounting for this change represent a research gap. Therefore, our aim was also to "identify the factors responsible for increased BMI in young adults in the pandemic."

Materials and Methods

This descriptive exploratory study was conducted in January 2022 on 1815 students from various health colleges of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (College of Medicine, College of Clinical Pharmacy, College of Nursing, College of Dentistry, and College of Applied Medical sciences).

The calculation of sample size was done by epidemiologic statistics for public health tools software (accessed at: http://epitools.ausvet.com.au/content.php?page = 1ProportionandProportion). The estimated minimum sample size was 1039 (we recruited 1815 participants, more than the minimum calculated sample size)." This calculation was based on the estimated prevalence of increased BMI after COVID-19 pandemic and a target adult population of 1519 in an Italian survey with: Proportion (increased BMI after pandemic) 58%; precision (d) 3%; confidence level 95%.[21]

Ethical approval was obtained from the Institutional Review Board (IRB) vide Letter No. 2022-01-011 dated 10/01/2022, and informed written consent was taken from all participants.

The main tools of this study were: (1) BMI and a 30-item LSB and changes (LSBC) self-administrated structured online questionnaire, which assessed the perceived LSBC "one month immediately before the pandemic" and " the present time, almost 2 years after the COVID-19 outbreak." This questionnaire was designed by the authors based on various previous studies.[1-4] The reliability and validity of the questionnaire were confirmed by a retest technique done on 35 students ($P = 0.003$; $r = 0.80$). The component of LSBC, including 7-item International physical activity questionnaire (IPAQ), was not included in the test retest analysis as the reliability and validity of this questionnaire are already established at international level.[21]

The LSBCs questionnaire (LSBCQ) was divided into three different sections assessing screen time (ST), physical activity (PA), and dietary intake as follows: ST was divided into four main categories: Total ST (including the time spent on a mobile, iPad, Laptop, computer, television, and video games); ST for mobile use only; ST for educational purpose only (including the time spent on mobile, iPad, laptop, and computer); ST for entertainment purpose only (including the time spent on mobile, iPad, laptop, computer, television, and video games). The subjects were divided into four categories based on their ST: Low ST ≤2 h/24 h; Medium ST = 3–5 h/24 h; high ST = 6–8 h/24 h; and very high ST ≥9 h/24 h.[22]

PA was assessed by a seven-item IPAQ. Based on IPAQ, the subjects were divided into three main categories [Table 1].[23]

Participants with low PA were categorized as inactive. Subjects with medium and high activity were categorized as active.

Information on food intake included data about the frequency and quality of food taken. The frequency of food was assessed by the number of meals per day, which determined the three main categories the subjects were divided into decreased frequency of food intake = 1 meal/day; Normal frequency of food intake = 2 or 3 meals/day; Increased frequency of food intake ≥4 meals/day. The quality of food was assessed by the following eating habits: Intake of junk food (including packaged sweets and baked products, sweet beverages, savory snacks, dressings, sauces, fast food, sugary drinks, and deep-fried food); Intake of homemade food; and Intake of healthy food (including fruits, vegetables, milk, nuts, fish, lean meat, and pulses). Increased intake= ≥5 days/week. Decreased intake = <4 days/week.[21]

The response rate was 43.2%, as 1815/4200 students volunteered to participate in the study. The online LSBCQ was shared with the willing students who completed the LSBCQ and were then called to the physiology laboratory for anthropometric measurements. BMI was calculated by the formula = weight in kg/height in m^2. Weight was measured in kilograms and height in centimeters. The anthropometric measurements were done by using standard procedures (light clothing, bare feet, empty bowel and bladder, and a minimum of 3 h of fasting). Subjects were categorized into four main groups based on their BMI: underweight (BMI ≤18.5); normal weight (BMI ≤24.9); overweight (BMI >25–29.9); and obese (BMI >30).[24]

Criterion for inclusion was: students between 16 and 21 years willing to participate in the study. Students with any chronic physical or mental illness were excluded from the study. In total, 91 students were excluded, and 1724 selected.

Table 1: Categorization of physical activity according to IPAQ

Physical activity	Cut-off value
Low	No activity is reported or
	Some activity is reported, but not enough to meet category 2 or 3
Moderate	3 or more days of vigorous activity for at least 30 min/day or
	5 or more days of moderate activity or walking for at least 30 min/day or
	5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of 600 MET min a week
High	3 or more days of vigorous activity accumulating at least 1500 MET min a week or
	7 days of any combination of walking, moderate- or vigorous-intensity activities achieving a minimum of 3000 MET min a week

Data analysis was done by Statistical Package for Social Sciences (SPSS) for Windows, Version 20.0 (IBM, Armonk, Newyork, USA). Demographic data were determined by descriptive statistics. All categorical variables including BMI categories, screen usage time categories, PA, and variables related to food were presented as frequencies and percentages. All continuous data, including BMI and screen usage time were presented as mean and standard deviation. Chi-square test or Fisher's exact test was used to check the association between variables, *t*-test or ANOVA was used to compare the mean BMI between different variables. Odds ratios (ORs) with their 95% confidence intervals were measured in multivariate analysis. Statistical significance was set at $P < 0.05$.

Results

The mean age of the study participants was 18 ± 2 years. A comparison of BMI before and after 2 years of the pandemic showed a statistically significant increase after the onset of the pandemic ($P = 0.002$). There was an increase in the number of overweight (15.7%–16.1%) and obese participants (11.2%–12.9%) and a decrease in the number of underweight participants (16%–14.85%) during the pandemic [Table 2].

Table 2 shows that perceived weight gain was seen in 48%, weight loss in 38%, but only 17.9% participants maintained their weight after 2 years of the pandemic [Figure 1].

Table 3 shows the comparison of ST of the participants before and after 2 years of the COVID-19 pandemic. The average total perceived ST before and during the pandemic was 6.8 ± 2.6 and 9.2 ± 2.2 h/24, respectively. Before pandemic, only 22.7% of the subjects perceived that they had very high ST (≥9). This increased to 68.6% during the pandemic ($P = 0.0001$).

A comparison of different categories of ST before and after 2 years of the COVID-19 pandemic is also shown in Table 3.

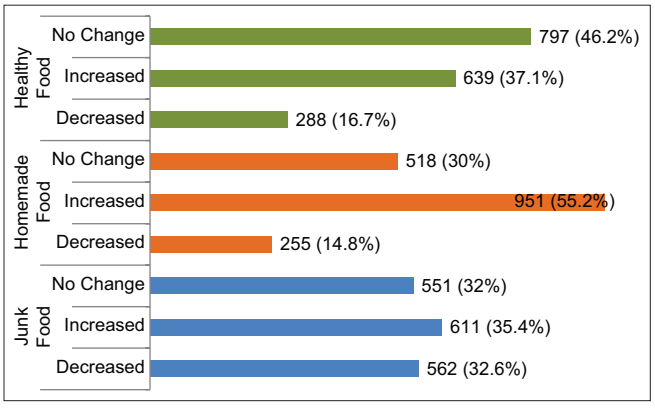

Figure 1: Food quality taken by subjects during the COVID-19 pandemic

A perceived change (decrease) in the PA was seen after the 2 years ($P \leq 0.001$) [Table 4]. The number of inactive subjects increased from 22.6% before pandemic to 37.9% in the pandemic ($P < 0.001$), while the number of active subjects decreased from 20.7% before pandemic to 11.9% during pandemic (<0.001).

A comparison of the frequency of food intake before and after the outbreak of the pandemic is highlighted in Table 4. Normal food intake (1–3 meals/day) was documented by 81.3% of the subjects before and 67.9% of subjects after the outbreak. There was a perceived significant increase in the frequency of food intake, as before pandemic only 18.7% of the subjects took ≥4 meals/day. This increased to 32.1% in the pandemic ($P = 0.001$).

Figure 1 provides the information about the quality of food taken by the subjects during the COVID-19 pandemic. There was perceived increase in homemade food (55.2%) and healthy food (37%), whereas no significant change was perceived in the intake of junk food.

Table 2: Comparison of body mass index of study participants before and during the COVID-19 epidemic (*n*=1724)

BMI	1 month immediately before pandemic *N* (%)	2 years after the pandemic *N* (%)	*P-value**
Mean BMI	23.3±5.9	23.6±5.9	0.002*
Underweight	276 (16.0)	256 (14.8)	0.32
Normal weight	984 (57.1)	968 (56.1)	0.55
Overweight	271 (15.7)	278 (16.1)	0.7
Obese	193 (11.2)	222 (12.9)	0.12

*$P \leq 0.05$ is statistically significant. Underweight=BMI ≤18.5 kg/m², Normal weight=BMI ≤24.9 kg/m², Overweight=BMI 25-29.9 kg/m², Obese=BMI ≥30 kg/m². BMI=Body mass index

Univariate analysis [Table 5] showed that increased BMI was significantly related to increased frequency of food intake ($P < 0.001$), decreased intake of homemade food ($P = 0.023$), and decreased intake of healthy food ($P = 0.044$) (perceived changes).

Multivariate logistic regression analysis [Table 6] revealed that subjects whose PA decreased, whose frequency of food intake rose, intake of junk food increased, and intake of homemade food reduced (perceived changes) had 1.3 times, 1.6 times, 1.2 times, and 1.5 times increased OR of having increased BMI. However, the only factor which showed a significant *P* value was perceived increased frequency of food intake ($P = 0.048$). This indicates that increased frequency of food intake is the strongest factor responsible for increased BMI 2 years after the pandemic outbreak in our study population.

Discussion

This study identified the impact of 2 years of COVID-19 pandemic on various LSB and their effects on BMI of young Saudi adults. There was weight gain in 48% of our young adults. Similar findings were reported by the pooled results of two meta-analysis (including almost 100 studies worldwide), COVID-19 pandemic lockdowns led to body weight gain ($P < 0.00001$) in a significant number of children and young adults (11.1%–72.4%).[25,26] The major contributor for increased BMI in young populations was a shift from physical to online education, resulting in increased: ST, sleeping hours, sitting hours, and the number of meals/day, resulting in the increasing trend of overweight and obesity.[25,26]

This study also aimed to identify the factors responsible for increased BMI in our study population. Almost all

Table 3: Comparison of screen time among study participants before and during the COVID-19 epidemic (*n*=1724)

Screen time	1 month immediately before pandemic *N* (%)	2 years of the pandemic *N* (%)	*P-value**
Total mean ST hours/24 h	6.8±2.6	9.2±2.2	<0.0001*
Low ST	60 (3.5)	27 (1.6)	0.0004*
Medium ST	389 (22.6)	69 (4.0)	<0.0001*
High ST	883 (51.2)	445 (25.8)	<0.0001*
Very high ST	392 (22.7)	1183 (68.6)	<0.0001*
Comparison of different categories of screen usage time, before and during the COVID-19 pandemic			
ST for mobile use only			
Low + medium ST	984 (57.1)	515 (29.8)	<0.0001**
High ST	535 (31.0)	622 (36.1)	0.002*
Very high ST	205 (11.9)	587 (34.0)	<0.0001
ST for study purpose only			
Low + medium ST	1093 (63.4)	397 (23.0)	<0.0001*
High ST	431 (25.0)	531 (30.8)	0.0001*
Very high ST	200 (11.6)	796 (46.2)	<0.0001*

$P \leq 0.05$ is statistically significant. Low ST=<2 h/24 h, Medium ST=3-5 h/24 h, High ST=6-8 h/24 h, Very high ST=≥9 h/24 h. ST=Screen time, COVID-19=Coronavirus disease 2019. * in all the values which have a significance below 0.05, ** in all the values which have a significance below 0.01

Table 4: Comparison of physical activity and frequency of meals per day among study participants before and during COVID-19 disease (*n*=1724)

	1 month immediately before pandemic *N* (%)	2 years of the pandemic *N* (%)	*P-value**
PA			
Low	390 (22.6)	653 (37.9)	<0.001*
Moderate	288 (16.7)	157 (9.1)	<0.001*
High	69 (4.0)	49 (2.8)	0.052*
Food frequency			
Normal	1402 (81.3)	1171 (67.9)	<0.001*
High	322 (18.7)	553 (32.1)	<0.001*

P≤0.05 is statistically significant. PA was categorized based on IPAQ. Decreased food intake=1 meal/day, Normal food intake=2 or 3 meals/day, Increased food intake=≥4 meals/day. IPAQ=International Physical Activity Questionnaire, PA=Physical activity. * in all the values which have a significance below 0.05

Table 5: Comparison of mean body mass index of the study participants before and during the COVID-19 epidemic by various lifestyle behaviors (*n*=1724)

Lifestyle behaviors	*N*	BMI Mean±SD	*P-value*
SUT			
Normal	96	23.72±4.24	0.8
High	1628	23.53±5.99	
PA			
Active	206	23.13±4.68	0.9
Inactive	653	23.18±6.26	
Frequency of food intake			
Normal	1171	23.13±5.71	<0.001*
High	553	24.39±6.21	
Junk food			
Increased	611	23.98±6.27	0.11
Decreased	562	23.42±5.39	
Homemade food			
Increased	951	23.57±5.49	0.023*
Decreased	255	24.53±7.29	
Healthy food			
Increased	639	23.45±5.06	0.044*
Decreased	288	24.27±7.01	

P≤0.05 is statistically significant. SUT=Normal SUT ≤5 h/24 h, High SUT=≥6-8 h/24 h, PA was categorized based on IPAQ. Low activity was categorized as inactive, whereas medium and high activity was categorized as active group. Frequency of food intake: Normal food intake=2 or 3 meals/day. Increased food intake=≥4 meals/day. IPAQ=International physical activity questionnaire, SUT=Screen usage time, SD=Standard deviation, BMI=Body mass index, LSBs=Lifestyle behaviors, PA=Physical activity. * in all the values which have a significance below 0.05

educational sectors in KSA shifted from physical to online teaching after the pandemic outbreak,[19] leading to an increase in the ST. Our data also showed an increase in the ST from 6.8 to 9.2 h/24. The highest increase in ST (≥9 h) was for education, i.e., (11.65% vs. 46.2%) before and after the outbreak. Moreover, our participants also indicated a significant increase in their use of the mobile phone ≥9 h after the pandemic (11.9% vs. 34%, respectively). Despite all these results, we were not able to find any relation or association between excessive ST and weight gain. Because of the expected negative effects of excessive ST on physical and mental health of the students, some governments have ordered a restriction on the number of online classes/day. However, educators appreciate the enormous educational benefits that technology can offer to students at this difficult time of pandemic.[27,28] Moreover, a systematic review of "the screen time literature and educational policy and practice during COVID-19" concluded that the strengths and benefits of ST should be utilized in a purposeful way ensuring that any associated risks are minimized during these exceptional pandemic times.[29] Negative effects of ST on BMI are usually mediated when ST displaces the time for PA, sleep, and social interaction. Therefore, these effects could be avoided when educational ST during the pandemic is not allowed to displace these important activities.[30]

The results of this study also showed a significant reduction in the PA of the students, which was positively but insignificantly associated with increased BMI. Similar findings were reported in a study done in the initial months of COVID 19 lockdown (March–May 2020) on 10 121 participants from 67 countries, in which 31.25% of the young inactive population reported weight gain.[31] Although our study was conducted almost 2 years after the onset of the pandemic, the number of inactive young adults had risen to 37.9%, while the number of active subjects had fallen to 11.9%, indicating that the unhealthy lifestyles adopted during the initial months of pandemic, were still in practice resulting in weight gain and obesity in the young adults.

This study also documented the changes in the eating habits of the young adults and their effects on BMI. It was observed that during the pandemic, there was an increase in homemade food (55.2%). The study results of Randah and Husain *et al*., also revealed a rise in home cooking during the pandemic. This may be due to the increase in the time spent at home as most people worked from home during the pandemic.[32,33] Moreover, 37% of our study participants reported an increased intake of healthy food (including fruits, vegetables, milk, nuts, fish, lean meat, and pulses), during the pandemic. Our results contradict the findings of most other studies in which more fast food, sweet beverages, savory snacks, sugary drinks, and deep-fried food were reported to have been consumed during the pandemic.[33-36] This dissimilarity may be because our study population included students from the health science colleges who appreciated the fact that eating healthy food during the pandemic could boost their immune systems and provide protection against the COVID-19 infection.[37] The univariate analysis of this study indicated that

Table 6: Multiple logistic regression analysis: Association between body mass index and various lifestyle behaviors

Lifestyle behavior	Model β	SE (β)	Overweight/obese OR (95% CI)	*P-value*
Screen time high (>6 h/24 h)	−0.422	0.500	0.656 (0.3–1.7)	0.4
PA: Inactive (low)	0.294	0.284	1.342 (0.8–2.4)	0.3
Food frequency: High (≥4 meals/day)	0.471	0.253	1.601 (1.0–2.6)	0.048*
Intake of junk food: Frequently (≥5 days/week)	0.243	0.271	1.275 (0.8–2.1)	0.4
Intake of homemade food: Infrequently (≤4 days/week)	0.466	0.305	1.593 (0.9–2.9)	0.12
Intake of healthy food: Infrequently (≤4 days/week)	−0.503	0.274	0.605 (0.4–1.0)	0.4

P≤0.05 is statistically significant. Normal weight category was taken as a reference value. OR=Odds ratio, SE=Standard error, CI=Confidence interval, PA=Physical activity. * in all the values which have a significance below 0.05

those subjects whose intake of homemade and healthy food fell showed weight gain and had 1.2 and 1.5 times increased OR of having increased BMI. This is in accord with the fact that a high intake of fats, sugars, and junk food can lead to weight gain and various other health issues.[38]

The most important finding of the current study was that the increased number of meals/day (≥4), the strongest risk factor associated with increased BMI, could lead to 1.6 times increased OR of weight gain. There was a significant rise in the frequency of food intake. Before pandemic only 18.7% of our subjects had ≥4 meals/day, but this increased to 32.1% after pandemic outbreak. Increased consumption of food during the pandemic has also been reported by various other studies.[34] Randha pointed out that during the pandemic, 58% of their study participants reported eating more; 86.0% of the respondents of the Ismail *et al.,* study reported that they were unable to control their diet during the pandemic. This could be the result of the increased period of stay time at home, enhanced exposure to food because of boredom, having more time available to cook and eat, emotional eating, and negative moods that result in comfort eating.[35,36] Increased frequency of food intake, together with decreased PA might have affected the energy balance in our young adults because when energy intake exceeds energy expenditure, a state of positive energy balance occurs resulting in increased BMI.[38] Wang *et al*., estimated that excessive weight gain can be prevented in children and adolescents by reducing positive energy balance by about 150 kcal/day.[39] Consequently, young adults should be motivated to increase their PA, adopt healthy eating habits, and keep a check on their daily caloric intake. These measures can help to minimize the impact of COVID-19 pandemic on BMI and LSB of young adults.

The data shows that stricter measures/lockdowns and curfews imposed in the first 4 months of the pandemic (March 2020–June 2020) compelled people to remain at home. During this period, there was a drastic negative shift in the LSB and eating habits in populations worldwide. However, when most of the restrictions were lifted after June 2020, and parks and shopping malls reopened, and most business and office activities resumed, physical classes for students did not resume. Most educational institutions continued online teaching, as a result of which the unhealthy lifestyles adopted during the initial periods of pandemic remained and ultimately turned into habits for young adults, and still remain 2 years on in the pandemic.

Conclusion

There was a perceived significant change in the lifestyle and behavior of young Saudi students during the pandemic. This included weight gain (48% of the population), increased screen usage time, decreased PA, and increased food intake (≥4 meals/day). Although there was a perceived increase in the consumption of homemade and healthy food during the pandemic, no significant change was seen in the intake of junk food before and in the pandemic. Reduced intake of homemade food, increased intake of junk food, and increased number of the meals/day were significantly related with increased BMI. However, perceived rise in the number of meals/day (≥4) was the strongest risk factor associated with increased BMI, that could lead to 1.6 times increased OR of weight gain.

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Conflicts of interest
There are no conflicts of interest.

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