

COVID-19 Pandemic and Lifestyle Changes: Impact on School Students

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Abstract. *Background:* Due to COVID-19, a pandemic of acute respiratory syndrome in humans (SARS-CoV-2) led to the social isolation globally as a precautionary step to save humans. There is concern regarding the impact of COVID-19 pandemic lockdown on dietary habits, screen time, sleep duration and physical activity of young children and adolescents. Accordingly, the present study analyzed the lifestyle behaviors of school going children residing in Saudi Arabia. *Methods:* The present study was conducted using an online survey platform and its designated link was distributed through social media. The study sample was composed of 432 (166 males and 266 females) school students. The questionnaire was divided into three sections. The first section included general and anthropometric characteristics of the participants. The second section included the information related to dietary pattern and the third section included the information related to changes in the activity pattern among participants. *Results:* Some good habits such as slight increase in physical activity and sleep duration, increase in the number of meals, increased consumption of fruit, vegetables and red meat has been observed among all age groups, but at the same time increased consumption of unhealthy food, too much increased screen time has also been observed among all. *Conclusion:* Public health officials are suggested to increase their focus on lifestyle management of school students especially in tragic times like COVID-19 to enhance the wellbeing of population.

Key words: COVID-19, dietary; physical activity, screen time, pandemic

Introduction

In December 2019, pneumonia cases of unknown origin were reported in Wuhan, China, which later was identified as coronavirus-19 (COVID-19) (1) and by January, 2020, the first instance of COVID-19 was reported outside China: two in Thailand and one in Japan (2). COVID-19 is a severe acute respiratory syndrome caused by SARS corona virus 2 (SARS-CoV-2). SARS-CoV-2 is a single stranded positive sense RNA virus (+) ssRNA belonging to β -coronavirus lineage B (3). Its clinical symptoms consist of a wide-range of

symptoms, such as fever, dry cough, shortness of breath i.e. dyspnea, headache, myalgia, cytopenia, hemoptysis, fatigue, diarrhea, nausea, vomiting, abdominal pain, and loss taste and smell (4-6). It causes acute respiratory distress syndrome (ARDS) and even affected multiple organ in elderly, and peoples were affected with multi morbidities such as diabetes, obesity, cardiovascular disease, blood pressure, lung and kidney diseases (7-9). The patients may need noninvasive ventilation, continuous positive airway pressure (CPAP) or non-invasive ventilation (NIV), or endotracheal intubation during the acute phase of pneumonia (10). Infected person can

transmit the coronavirus through saliva droplets, sneezing and aerosols (11). Due to its seriousness and high transmissibility rate the World Health Organization declared COVID-19 as global pandemic on 11th March 2020 (12).

In many countries, social distancing and isolation have been used as major methods of prevention against COVID-19 infection. The Kingdom of Saudi Arabia reported its first confirmed case on March 2, 2020 and the lockdown was enacted within a week (March 9, 2020) of the first instance of confirmation (13). In order to control the spread of COVID-19 infection, the Kingdom of Saudi Arabia suspended prayers at mosques, Umrah and Hajj and implemented strict curfew even during holy month of Ramadan. There were penalties and arrests for violators of lockdown measures. All public gatherings were banned, and schools, universities, and other activity centers were closed down and due to unprecedented lifestyle changes, such as decreased physical activity and an increase in stress, home confinement has been demonstrated to impact children's wellbeing (14). In school going children, the impact of radical reduction on any form of socialization depends on many factors, such as their developmental stage, their education level, their special needs, their family financial situation, and whether any of their family members are infected (15). As a result of pandemic massive changes was observed in education system, i.e. shifting from in campus education to online education system, smart working system, restrictions on outdoor activities and stockpiling of food. Apart from this, prolonged home confinement and school closure drastically impacted the lifestyle behavior such as sleep, eating habits and physical activities of students.

Sedentary behavior along with poor diet and physical activity lead to the development of various health problems (16). According to researchers, obesity and sleep disturbances are associated with an increase in pro inflammatory cytokines secreted by visceral adipose, which can alter sleep-wake rhythms (17-18). Maintaining the correct nutrition status is essential, especially during period of stress when the immune system have to fight back. Food also influences the gene expression levels of all cytokines and modulates the process of inflammation and oxidative stress (19). Studies have

shown that COVID -19 lockdown influenced dietary profiles (20-21). Apart from education, schools also provide the chance to interact and communicate with friends and teachers for psychological comfort and disciplined the life. Studies have shown that the impact of lockdown was greater in young children and adolescents than grown-ups (22-23). Jiao et al. (24) in their study has mentioned that children experienced fear, disturbed sleep, poor appetite, anxiety and uncertainty during COVID-19 pandemic. In a study on children in Spain and Italy, the researchers reported changes in emotional states and behavior of children (25). An increase in food purchased and storage has also been reported during pandemic due to restriction in movement which in turn increased the availability of foods especially energy rich and processed food (26) and studies have reported that various factors such as insufficient sleep (27), food availability (28), physical activity (29) influence the eating behavior of children. It is very important for everyone to maintain balanced dietary pattern and healthy lifestyles. There is concern regarding the impact of COVID-19 pandemic on dietary habits, screen time, sleep duration and physical activity of young children and adolescents. Accordingly, the present study analyzed the lifestyle behaviors of school students during COVID-19 pandemic lockdown, residing in Saudi Arabia.

Material and methods

Participants

The study sample was composed of 432 children. One hundred sixty-six (38.43%) were males and 266 (61.57%) were females. The sample size of 385 participants was calculated using Survey Monkey sample size calculator (<https://www.surveymonkey.com/mp/sample-size-calculator/>) keeping a 5% margin of error and a 95% confidence interval. However, more subjects were included in the study in order to minimize the errors.

Inclusion criteria

Inclusion criteria were school students aged between 6 and 18 years living in Saudi Arabia.

Exclusion criteria

The exclusion criteria included school students lesser than 6 years and more than 18 years, and participants with incomplete responses.

Ethical consideration

All participants (guardians of very small children and adolescents by themselves under the supervision of their guardians) voluntarily responded to the survey and indicated their informed consent within the survey. The study was conducted according to the guidelines of the Declaration of Helsinki and the study was approved by the institutional review board and ethical committee of King Saud University, Riyadh, KSA (Approval no. KSU-HE-21-72). Participants were assured that the information given was solely for scientific purpose and would be kept confidential.

Study design

A cross-sectional approach was used to assess the effect of COVID-19 pandemic lockdown on the eating habits and lifestyle behaviors of children and adolescents in Saudi Arabia.

Data collection

For validation, a self-administered questionnaire was used, which was compiled by the authors. To ensure that the content of the questionnaire was valid and reliable, the researcher sent it to nutrition experts who gave their opinion related to the clarity of questionnaires. The questionnaire was published on an online survey platform and its designated link was distributed through social media (Twitter, Instagram, Telegram and WhatsApp), in order to reach required number of participants. The purpose of the study was provided as an introductory paragraph along with questionnaire. Participants were allowed to quit the survey at any point without explanation. The questionnaire was divided into three sections as follows:

- The first section included general and anthropometric characteristics of the participants.

- The second section included the information's related to changes in dietary pattern.
- The third section included the information's related to changes in the activity pattern.

General information and anthropometric characteristics

The first segment of the study involved socio-demographic information, such as age group, gender, height, weight, and waist circumference. Body mass index (BMI) was calculated based on information (height and weight) given by the participants using the formula $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$.

Healthy and unhealthy food habits among participants before and during COVID- 19

Food habit was categorized into healthy eating habits and unhealthy eating habits. Changes in the healthy food habits included questions such as the number of meals consumed in a day, number of time fruit and vegetables consumed in a day, frequency of red meat consumption per day, and changes in the unhealthy food habits included questions such as frequency of fast food consumption in a week, number of chips packets, soda drinks and energy drinks consumed daily before and during pandemic.

Activity pattern (screen time, physical activity and sleep pattern) among participants before and during COVID- 19

Screen time

Screen time included the total time spent on television, mobiles, laptops, I pad and video games. Screen time was classified as follows: Low screen time (<2 hours/day), High screen time (2-4 hours/day), Very high screen time (≥ 4 hours)

Physical activity

It was assessed by time spent in exercises and leisure activities per week.

Sleep duration

Regarding their sleeping duration, the respondents reported the time spent in sleeping on daily basis. Following the National sleeping Foundation recommendation (30), an average of less than 8 hours of sleeping daily during night was considered inadequate.

Data analysis

The data obtained from the survey were organized, coded, and analyzed using Statistical Package for Social Sciences (SPSS) package SPSS ver. 22.0 (IBM, Chicago, IL, USA). Data are represented as percentage for categorical variables. The Chi-Square independence test was used to indicate differences as all variables are nominal. Results were considered to be significant at $p \leq 0.05$. The effect size (d) is calculated as follows

$$d = \sqrt{\frac{C^2}{1 - C^2}}$$

Where C is the coefficient of contingency and is calculated from the relationship

$$C = \sqrt{\frac{\chi^2}{\chi^2 + n}}$$

This effect is categorized according to its value into d (.01) = very small, d (.2) = small, d (.5) = medium, d (.8) = large, d (1.2) = very large, and d (2.0) = huge.

Results

General and anthropometric characteristics of the participants

The sample size of the survey included 432 students (166 males and 266 females). The general and anthropometric characteristics of the participants are presented in Table 1.

The study participants comprised of children aged 6-12 years (93 males and 71 females) and adolescents ages 13-18 years (73 males and 195 females). Highest ($n=51$) number of the males that participated in this

study belonged to the age group of 10-12 years and the maximum ($n=172$) number of females that participated in the study belonged to the age group 16-18 years. Statistically significant ($p \leq 0.05$) difference has been observed between males and females in terms of age, height, weight and circumference. It can be predicted from the table that only 23 males (13.85%) and 38 females (14.28%) were underweight. More than 50% females [$n = 157$ (59%)] and 70 (42.18%) males had normal BMI. As compared to female participants (9.39%) more male participants (22.29%) were either overweight or obese. During COVID-19 pandemic lockdown even though statistically significant difference has been observed in the BMI of males and females but the effect size (ES) was only 0.22 which is considered as quite small.

Determinants of the lifestyle changes during COVID-19 pandemic in the school students

Dietary changes

The eating habit of subjects has been divided into two categories as healthy eating habits and unhealthy eating habits (Table 2).

A significant rise in the consumption of most of the foods has been revealed during COVID-19 lockdown. Regarding the participants healthy eating habit a significant increase in the number of meals [from 10.9% to 27.8% for 4 meals a day (155.046% increase) and from 2.3% to 10.9% (373.913% increase) for >4 meals a day; $p=0.000$, ES= 0.54], consumption of fruits and vegetables [from 6.3% to 15.5% (146.032% increase) for 3 times a day and from 1.4% to 2.6% (85.71% increase) for >3 a day; $p=0.000$, ES= 1.03], red meat [from 3% to 8.1% (170% increase) for 3 times a day and from 1.4% to 2.5% (78.57% increase) for more than 3 times a day; $p=0.000$, ES= 01.36] has been observed. Similar pattern of healthy eating habits has been observed when the subjects were categorized on the basis of gender and age for number of meals, fruits and vegetable consumption and meat consumption per day. Although a decrease in the consumption of fast food for more than 4 times in a week [from 6.51% to 4.4% (32.4117% decrease;

Table 1. General and anthropometric characteristics of the participants

	Males	Females	Total	p-value	Effect Size
Age (years)					
6-9	42	45	87	0.000**	0.47
10-12	51	26	77		
13-15	42	23	65		
16-18	31	172	203		
Height (cm)					
100-110	15	14	29	0.000**	0.33
111-120	29	18	47		
121-130	24	28	52		
131-140	24	12	36		
141-150	19	27	46		
151-160	27	106	133		
≥160	28	60	88		
Weight (kg)					
≤30	35	30	65	0.000**	0.30
31-40	47	43	90		
41-50	25	52	77		
51-60	16	67	83		
61-70	17	40	57		
71-80	4	17	21		
81-90	14	9	23		
91-100	4	4	8		
≥101	4	4	8		
WC (cm)					
50-55	67	75	142	0.033*	0.18
56-60	35	63	98		
61-65	21	32	53		
66-70	20	39	59		
71-75	9	31	40		
76-80	10	10	20		
≥81	4	16	20		
BMI (kg/m ²)					
<18.5	23	38	61	0.001**	0.22
18.5-24.9	69	157	226		
25.0-29.9	36	45	81		
30-34.9	22	17	39		
35-39.9	10	7	17		
≥40	5	1	6		

Data represented as N (%)

Table 2. Food habit of the participant's before and during COVID-19 pandemic

	Frequency	Overall		Based on Gender				Based on Age			
				Males		Females		Childhood		Adolescence	
		BP	DP	BP	DP	BP	DP	BP	DP	BP	DP
Healthy Eating Habits											
How many meals do you eat in a day	2	33.1	25.2	21.7	19.9	40.2	28.6	26.8	17.1	36.9	30.2
	3	53.7	36.1	62.0	33.1	48.5	38.0	59.1	39.0	50.4	34.3
	4	10.9	27.8	13.9	34.3	9.0	23.7	12.8	32.3	9.7	25.0
	>4	2.3	10.9	2.4	12.7	2.3	9.8	1.2	11.6	3.0	10.4
P value (Effect size)		0.000 (0.54)		0.000 (0.57)		0.000 (0.53)		0.000 (0.67)		0.000 (0.55)	
How many times do you eat fruits and vegetables in a day	None	13.9	12.0	12.7	7.8	14.7	14.7	9.1	7.9	16.8	14.6
	1	48.8	40.0	47.0	41.6	50.0	39.1	51.8	40.2	47.0	39.9
	2	29.6	29.9	31.3	29.5	28.6	30.1	32.9	32.9	27.6	28.0
	3	6.3	15.5	7.8	18.7	5.3	13.5	6.1	15.9	6.3	15.3
	>3	1.4	2.6	1.2	2.4	1.5	2.6	-	3.0	2.2	2.2
P value (Effect size)		0.000 (1.03)		0.000 (0.98)		0.000 (1.08)		0.000 (0.92)		0.000 (1.11)	
How many times do you eat red meat in a day	None	15.5	14.4	12.0	12.7	17.7	15.4	14.0	12.8	16.4	15.3
	1	60.6	56.0	59.7	53.6	61.3	57.5	62.2	57.3	59.7	55.2
	2	19.4	19.0	22.9	19.9	17.3	18.4	18.9	19.5	19.8	18.7
	3	3.0	8.1	3.6	10.8	2.6	6.4	4.9	7.9	1.9	8.2
	More	1.4	2.5	1.8	3.0	1.1	2.3	-	2.4	2.2	2.6
P value (Effect size)		0.000 (1.36)		0.000 (1.4)		0.000 (1.37)		0.000 (1.26)		0.000 (1.46)	
Unhealthy Eating habits											
How many times do you eat fast food in a week	None	37.89	25.7	4.2	21.7	6.4	28.2	6.1	20.1	5.2	29.1
	1	29.82	38.7	41.6	38.6	36.5	38.7	42.1	40.2	36.2	37.7
	2	20.40	19.4	30.1	22.8	29.7	17.3	26.8	23.2	31.7	17.2
	3-4	5.38	11.8	18.1	13.9	22.2	10.5	20.7	14.0	20.5	10.4
	More	6.51	4.4	6.0	3.0	5.3	5.3	4.3	2.4	6.3	5.6
P value (Effect size)		0.000 (0.47)		0.000 (0.57)		0.000 (0.45)		0.000 (0.57)		0.000 (0.47)	
How many pack of chips do you eat daily	None	15.5	19.4	13.3	16.3	16.9	21.4	7.3	10.4	20.5	25.0
	1	49.6	34.2	48.8	34.9	50.0	33.8	54.9	37.2	46.3	32.5
	2	19.9	17.4	19.8	17.5	19.9	17.3	18.3	20.7	20.9	15.3
	3	10.5	17.4	12.7	19.9	9.0	15.8	14.6	17.1	7.8	17.5
	More	4.5	11.6	5.4	11.4	4.1	11.7	4.9	14.6	4.5	9.7
P value (Effect size)		0.000 (0.92)		0.000 (0.88)		0.000 (0.97)		0.000 (0.90)		0.000 (0.95)	
How many times do you drink soda and energy drinks daily?	None	40.5	39.8	36.7	31.9	42.9	44.7	43.9	37.8	38.4	41.0
	1	39.8	39.1	37.3	39.8	41.4	38.7	37.8	43.3	41.0	36.6
	2	10.5	13.0	13.4	17.5	8.6	10.2	9.8	10.4	10.8	14.6
	3	6.0	4.4	7.8	6.0	4.9	3.4	6.1	6.7	6.0	3.0
	More	3.2	3.7	4.8	4.8	2.3	3.0	2.4	1.8	3.7	4.9
P value (Effect size)		0.000 (1.01)		0.000 (0.96)		0.000 (1.04)		0.000 (0.91)		0.000 (1.11)	

BP- before pandemic; DP- during pandemic

The Chi-Square independence test was used to indicate differences as all variables are nominal. Results were considered to be significant at $p \leq 0.05$.

$p=0.000$, $ES= 0.47$] has been reported, but at the same time an increase in the consumption of chips from 10.5% to 17.4% (65.7143% increase) for 3 times a day and from 4.5% to 11.6% (157.778% increase) for more than 3 times a day; $p=0.000$, $ES=0.92$), and soda and energy drink (from 3.2% to 3.7% (15.625% increase) for more than 3 times/day; $p=0.000$, $ES=1.01$) has also been reported. Simultaneously, it can be observed from the table that almost 25% students didn't consume any kind of fast food and 19.4% of them didn't consume any chips. It is interesting to note that almost 40% of students didn't drink any energy or soda drinks. Almost similar pattern has been observed for unhealthy eating habits when the subjects were categorized on the basis of gender and age.

Screen use

Students' pattern of screen use has been presented in Table 3.

According to the report, the students spent significantly more time on mobile phones, computers, I pad, television and video games. A significant ($p \leq 0.05$) effect of COVID-19 lockdown has been observed in time spent on screen with effect size (ES) of 0.63. For example during COVID-19 pandemic lockdown the time spent on screen for 4-6 hours (very high screen time) has increased from 27.4% to 31.7% (15.69% increase) and daily rate of screen use for more than 6 hours (excessive screen time) increased from 20.1% to 51.9% (158.21% increase) which is more than double of the screen time used before pandemic and the use of screen for 1-2 hours (low screen time) decreased from 16.9% to 4.4% (73.96% decrease). Similar trend was observed when the subjects were categorized on the basis of gender [(males, $p=0.000$, $ES=0.60$ and females, $p=0.000$, $ES=0.66$)] and age (children, $p= 0.000$, $ES=0.52$ and adolescence, $p=0.000$, $ES=0.70$). The time of screen use for more than 6 hours (excessive screen time) increased from 17.5% to 46.4% (165.14% increase) and 21.8% to

Table 3. Students pattern of screen use before and during COVID-19 pandemic

Activities	Time spent (hours)	Overall		Based on Gender				Based on Age			
		BP	DP	Males		Females		Children		Adolescence	
				BP	DP	BP	DP	BP	DP	BP	DP
How many hours do you spend on screen* / day	1-2	16.9	4.4	19.3	6.0	15.4	3.4	31.1	6.7	8.2	3.0
	2-4	35.6	12.0	39.8	14.5	33.1	10.5	37.8	19.5	34.3	7.5
	4-6	27.4	31.7	23.4	33.1	29.7	30.8	20.1	34.1	31.7	30.2
	More	20.1	51.9	17.5	46.4	21.8	55.3	11.0	39.6	25.7	59.3
P value (Effect size)		0.000 (0.63)		0.000 (0.60)		0.000 (0.66)		0.000 (0.52)		0.000 (0.70)	
How many hours do you spend on physical activity/ week	≤ 1	47.0	48.8	45.2	52.4	48.1	46.6	50.0	62.8	45.1	40.3
	1-2	24.3	23.6	24.7	26.5	24.1	21.8	27.4	20.7	22.4	25.4
	2-4	9.0	6.3	15.7	4.2	4.9	7.5	7.9	3.0	9.7	8.2
	4-6	16.7	16.7	10.2	12.7	20.7	19.2	13.4	12.2	18.7	19.4
	More	3.0	4.6	4.2	4.2	2.3	4.9	1.2	1.2	4.1	6.7
P value (Effect size)		0.000 (0.76)		0.000 (0.99)		0.000 (0.71)		0.000 (1.06)		0.000 (0.69)	
How many hours do you sleep/day	≤ 6	24.8	8.6	10.8	7.2	33.5	9.4	9.8	6.7	34.0	9.7
	6-8	45.5	34.3	51.2	34.9	42.1	33.8	45.7	32.3	45.5	35.4
	8-10	21.1	36.3	30.2	36.2	15.4	36.5	34.8	39.0	12.7	34.7
	≥ 10	8.6	20.8	7.8	21.7	9.0	20.3	9.8	22.0	7.8	20.1
P value (Effect size)		0.000 (0.63)		0.000 (0.67)		0.000 (0.62)		0.000 (0.76)		(0.57)	

*Screen –mobiles, laptop, ipad, televisions, videogames etc; BP- before pandemic; DP- during pandemic

The Chi-Square independence test was used to indicate differences as all variables are nominal. Results were considered to be significant at $p \leq 0.05$.

55.3% (153.67% increases) for males and females respectively and this is more than double of the screen time used before. The screen time of 1-2 hours (low screen time) decreased from 19.3% to 6.3% (67.36% decrease) and 15.5% to 3.4% (78.06% decreases) in males and females respectively. Similarly, the excessive screen time (more than 6 hours) increased from 11% to 39.6% (260% increase) and 25.7% to 59.3% (130.739% increases) in children and adolescents respectively. It has been observed that males and children spent more time on screen during home isolation.

Physical activity

Students' pattern of physical activity before and during COVID-19 pandemic lockdown has been presented in Table 3. The percentage of the students with low physical activity (less than an hour) increased from 47.0% to 48.8% (3.83% increase) and the percentage of students engaged in physical activity for more than 6 hours per week also increase from 3% to 4.6% (53.33% increase). A significant ($p \leq 0.05$) effect of COVID-19 pandemic has been observed on time spent on physical activity between before and during COVID-19 pandemic with overall effect size (ES) of 0.76. When the subjects were categorized on the basis of gender and age than a slight increase has been observed only among males [from 45.2% to 52.4% (15.93% increase)] and children ≥ 12 years [from 50% to 62.8% (25.6% increase)] for less than an hour activity, while females [from 48.1% to 46.6% (3.12% decrease)] and adolescents [45.1% to 40.3% (10.64% decrease)] reported decrease in physical activity for less than an hour time physical activity. But at the same time, they reported an increase in physical activity in females [2.3% to 4.9% (113.043% increases)] and adolescents [from 4.1% to 6.7% for (63.41% increase)] for more than 6 hours.

Sleep duration

Students' pattern of sleep duration before and during COVID-19 pandemic lockdown has been presented in Table 3. The percentage of students on the time spent on sleeping during COVID-19 pandemic lockdown increased from 21.1% to 36.3% (72.04% increase) for 8-10 hours and from 8.6% to 20.8%

(141.86% increase) for more than 10 hours ($p=0.000$, $ES=0.63$). Simultaneously a decrease in percentage [from 24.8% to 8.6% (65.32% decreases)] has been observed in sleeping for less than 6 hours. Similar trend was observed when the subjects were categorized on the basis of gender and a significant effect of pandemic has been observed in each category (males- $p=0.000$, $ES=0.67$; females- $p=0.000$, $ES=0.62$ and children- $p=0.000$, $ES=0.76$; adolescents- $p=0.000$, $ES=0.57$). Specifically, during pandemic time an increase in the duration of sleeping hours has been observed.

Figure 1 depicts the determinants of lifestyle changes during COVID-19 pandemic, the risk involved and management.

Discussion

This study was designed to determine extent of changes in food habits, sleep pattern and physical activity of school going students before and during COVID-19 pandemic lockdown. Social distancing and lockdown were the strategy adopted globally to reduce the spread of COVID-19. Various studies have focused on difficulties faced by peoples to the new standards during quarantine. Small children face more difficulties in understanding the complexity of pandemic and schools' closures have confined them to their home, limiting their social and peer interactions which affect their overall development. One more challenge for them was to encourage them not to take the mask off. Both, the health associated conditions caused by COVID-19 outbreak itself and actions taken to reduce the spread of the outbreak have resulted in lifestyle changes in the majority of the society. Due to COVID-19 pandemic lockdown various habits such as eating, sleeps, daily physical activities have been circumscribed due to enforcement of social distancing, curfews and lockdowns. The global shutting of academic institutions has negatively affected over 91% of world's student population (31).

The main findings of the present study showed that during pandemic the school students increased the frequency of meal, increased the fruits, vegetable and meat consumption, increased the chips, cold

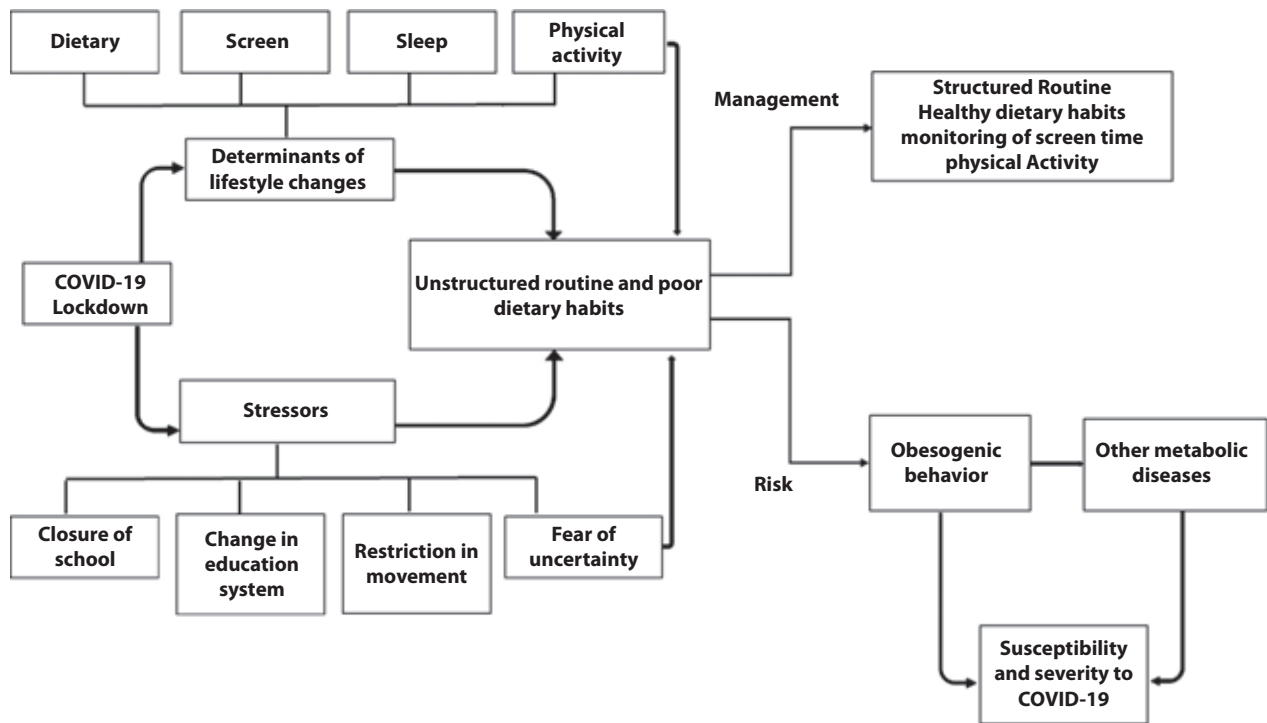


Figure 1. Determinants of lifestyle changes and stressors during COVID-19 pandemic in school students

drinks and slightly increased the intake of fast food, increased the screen time, sleep duration and slight increased physical activity. Even though the parents and caregiver's consideration to children's nutrition was high, but at the same time unhealthy nutrition has also been reported. Various studies have shown that healthy diet and physical activity can lead to better mental health (16,32) and observational studies have reported that COVID-19 lockdown influenced dietary profile (20,33). Staying at home due to pandemic resulted in boredom and news related to pandemic was very stressful. The central nervous system is in a susceptible developmental stage during infancy and even in adolescence and incidence of any stressful condition during these times can cause short or long term cognitive, behavioral or physiological damages (34-35). According to Lampert et al. (36) even a short period of social isolation can induce long term effect on dopaminergic pathway. Boredom is a feeling perceived due to dissatisfaction in the present life which was as a result of pandemic situation. Boredom and stress have been found to be associated with increased energy intake (37) and carbohydrate rich

food encourages the production of serotonin and in turn decreases the stress. In a study on animal model high fat diet reduced the stress, depression and anxiety caused due to social isolation (38). Stockpiling of convenient foods rich in sugar, salt and fat as a safety measure to avoid excess exposure and preparation of new recipes as a recreational activity due to availability of increased unstructured time in turn increases the availability of fried and sweet snacks. In respond to the undesirable experience of self-isolation, individuals will be more susceptible to look for reward and satisfaction physiologically linked with food consumption, even superseding other signs of satiety and hunger (39). Several studies reported unhealthier dietary pattern during confinement with an increase in sugary and fatty foods such as chocolates, chips and confectionaries (40, 41) which was associated with mood and anxiety level and these unhealthy foods was a suppressor of boredom.

The results reveal that the students increased the number of meals consumed per day. Similar result was obtained in a study on adults in Saudi Arabia (42). Pietrobelli et al. (40) reported an increase in fruit

consumption in children, whereas Ruiz Roso et al. (33) found an increase in both fruits and vegetables consumption among children. Studies have stated that family meals are connected with strong family bonding and the positive role of parents regarding their children nutrition (43-44). But at the same time, it also increases the possibility that they consume unhealthy sweet and fried snacks in between the main meals so, it is necessary that the parents and caregivers should be aware about basic principles of healthy meal preparation. Similar findings have been reported by Androutos et al. (45) in a study on children's and adolescents in Greece. Balanced nutrition maintains immunity and plays significant role in the prevention and management of viral infection. In an Italian survey on subjects ≥ 12 years, it has been noted that 13.4% respondents reported increased appetite and the increased hunger and appetite could justified the perception of weight gain observed in 48.6% of the population. Hashem et al. (46) also reported increased appetite, increased sweet and unhealthy food consumption frequent snacking between meals. Cross sectional studies on children between 6-18 years (40) and 0-19 years (47) also reported increased food intake during lockdown. Another survey from Poland also reported similar findings (48).

Beside the increase in healthy food habit, an increase in the consumption of chips and cold drinks for 3 times and more has also been observed in this study. Although a decrease in the consumption of fast food for more than 4 times in a week has been noted but at the same time increase in the percentage in its consumption for 3-4 times per week has also been observed. Slight decrease in the consumption of the fast food might be due to the fear of being affected by virus that could be transmitted through delivery person. Despite the fact that it was expected that availability of fresh fruits and vegetables would decrease due to movement restrictions, the parents made sure that their children receive the best nutrition, which was a priority to deal with pandemics. Fresh fruits and vegetables are rich source of various vitamins and minerals such as vitamin C, vitamin E, zinc, selenium etc. and these nutrients boosts the immunity which is the prerequisite to fight against infection. Studies have shown that deficiency of these nutrients are

associated with impaired immune responses and even obesity thus making more susceptible to viral infections (49-50) and weaker immune system results in lesser response to drugs and vaccination (51). In a study by Ruiz-Roso et al. (33) in multinational samples of adolescents showed that family cooked and provided nutritious and healthy food due to availability of sufficient times and reduced the intake of fast food but then also the overall quality of the food was not up to the mark due to increased consumption of sweet and fried food which is quite similar to the results obtained in this study. Similarly, an Italian survey also reported increased consumption of unhealthy food and attributed it to the psychological state of anxiety toward pandemic (52).

In a survey on Kingdom of Saudi Arabia; gain in weight among children and adolescents has been reported and the increased appetite and low physical activity was the contributed factor behind this situation (53). Almost similar results have been reported in this study, but the duration of physical activity mentioned in this study has increased slightly during pandemic. A study conducted by Jia et al. (54) on high schools, colleges and graduate students reported that BMIs, sleeping time and screen time increased when compared with physical activity.

Sedentary lifestyle and inactivity are associated with various metabolic disorders and screen time and video games is considered as another factor of inactivity. Although various studies found decrease in physical activity (53, 55) but as contrast to those reports a slight increase has been observed in physical activity. It has been observed that students utilized some time constructively in physical activity which provides a sense of relief to the parents. However, despite the decline in outdoor activities, several indoor activities such as cleaning, gardening and washing cars along with exercises at home provided students an opportunity to burn calories. Similarly, in an Italian survey on adults' sports and training frequency has increased among subjects who already took part previously (20). During lockdown even though the gyms were closed but people have more time to do exercise at home. Low physical activity has been suggested to interact both with body fat and appetite dysregulation (56).

Studies have reported that due to protracted internment at home, increased use of social media influences them to use internet impulsively, which even led them to access objectionable content and also upsurges their susceptibility for getting bullied or abuse (57). The inception of COVID-19 pandemic was in the mid of the academic year, which increased the fear of year loss or delays in students' studies. Online studying and electronic distant learning were adopted globally to assure the needs of students learning, although the students and staffs in the remote areas complained about the system due to poor network. Like this study, another study reported 29.58% respondents spent more than 5 hours per day online (58). Alshehri et al. (53) also reported an increase in screen time. In this study also 33.10 % of school students (43.97% males and 26.31% females) were reported to be obese. Spending excessive time on screen could be potential menace factor for addiction to the smartphones and internet and associated with decrease in physical activity which in turn is responsible for increase in weight and higher BMI. Hashem et al. (59) in his study on Egyptian children and adolescents reported 94.6% have increased usage of screen time and they found highly significant correlation between increased appetite and screen (television, laptop, mobile, video games) time. Studies have shown that overuse of smartphone and internet may lead to mental or behavioral problems, causing poor performance in study, decreased real life social interaction, neglecting personnel life, relationship disorders and mood dysfunction (60-61).

The increase in sleep time may be associated with the fact that the children don't have to go to school in the morning so they can spend more time in sleeping. Study suggests that decreased sleep duration lessens the quality of sleep and functionality at daytime (62). An association between circadian and biological rhythm and psychosomatic complaints has been found among University students (63-64). In a study by Androutsos et al. (45) maximum children sleep more than 10 hours which is almost similar to the present study. Intolerance of uncertainty encompasses the belief that certain events are deplorable, threatening and discriminating and studies shows that it is related with sleep disorder (65-66). Due to

high secretion of pro inflammatory cytokines by the increased visceral adipose, an association between sleep disturbances and obesity has been reported which could contribute to change the sleep-wake rhythm (67). The COVID-19 pandemic has shown various psychological manifestations and obesogenic behavior in children which might aggravates the epidemic of childhood obesity, so this issue has to be considered seriously as it could have severe consequences which cannot be reversed.

Limitations

The study has numerous limitations. Firstly, the data obtained in this study was limited to availability of internet and social media usage. Secondly the data obtained was self-reported as direct contact with the subjects was matter of concern due to pandemic, so this is an unavoidable limitation in terms of data reliability. Thirdly there is possibility of recall bias in the study.

Conclusion

The unanticipated serious situation, like COVID-19 pandemic has threat extending beyond those of direct viral infection. It unfavorably affected the lifestyle of children and adolescents. Although some good habits such as slight increase in physical activity and sleep duration, increase in the number of meals, increased consumption of fruit, vegetables and red meat has been observed among all age groups, but at the same time increased consumption of unhealthy food, too much increased screen time has also been observed among all. Therefore, public health officials are suggested to increase their focus on lifestyle management of school students especially in tragic times like COVID-19 to enhance the wellbeing of population.

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