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Research Article

Sleep Quality and its Relationship to Snack Consumption during the Quarantine Period in Saudi Arabia

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Abstract

Background: Poor sleeping is linked to obesity and hormonal changes factors might lead to poor sleep include stress, poor lifestyle and noise pollution. During COVID-19 stress levels were high and this might lead to poor sleep. To investigate the effects of home confinement on sleeping patterns and snacking behaviour in the Saudi population.

Methodology: This a cross-sectional study. Participants were asked to complete an online questionnaire regarding their snacking habits and the Sleep Quality using Pittsburgh Sleep Quality Index.

Results: A total of 413 (78.5%) of the participants had poor sleep quality. Sleep quality was significantly associated with age ($P = 0.005$), having hypertension ($P = 0.003$), feeling depressed or frustrated during the quarantine ($P < 0.001$), the timing of the first meal was at noon ($P = 0.003$), the desire to snack after dinner and before going to sleep ($P = 0.049$), the proportion of a participant's daily snacks that were eaten after dinner and before going to sleep ($P = 0.013$), waking up to eat due to insomnia ($P < 0.001$) and having or not having an emotional trigger for eating and type of food.

Conclusions: Poor sleep quality, short sleep duration and late bedtimes are all associated with poor diet quality and excess food intake. Poor nutrition affects quality of life; therefore, educational programmes should be established to assess sleep quality and educate the general population about its importance.

Keywords: Dietary Habits; Obesity; Weight Management; Pandemic; COVID-19; Eating Behaviors

Introduction

In December 2019, the World Health Organization (WHO) announced the outbreak of a severe acute respiratory syndrome coronavirus 2 (SARS- CoV-2) [1]. The 2019 coronavirus (COVID-19) outbreak led to social distancing requirements and stay-at-home orders in most countries of the world to limit the spread of the disease. The pandemic has affected many aspects of human life [2], including sleep, nutrition and physical activity [3]. Decreases in the rate and quality of sleep, increased anxiety and stress, weight gain, and decreased physical activity have occurred due to COVID-19 restrictions and the resulting physical isolation; isolation may also cause sleep disturbances such as insomnia, disturbances in the biological clock and physiological changes [4]. There is a significant relationship between sleep and eating, and both are impacted by physical isolation [5]. Recent evidence indicates that there is a significant relationship between decreased sleep quality, increased mental stress, anxiety, weight gain and decreased physical activity associated with the COVID-19 quarantine period, which may also cause physiological alterations and even result in sleep disorders and circadian rhythm disturbances [1]. Studies in sleep laboratories, as well as epidemiological studies, indicate that short sleep duration is a risk factor that contributes to obesity and its complications [6,7]. Altered hormonal regulation of appetite (feelings of satiety and hunger) is the mechanism for the association of insufficient sleep and higher body mass as it leads to a change in food intake and energy expenditure (EE) [8]. These factors can lead to an increase in body weight that is associated with increased food intake in response to mental stress, extended time spent at home, increased opportunities for food intake and increased visual and olfactory stimuli that stimulate increased food intake [8]. Sleep duration affects the length of available eating time [9]. Also, it affects the time of awakening, leading to changes in the digestion, absorption and metabolism of nutrients [10]. Leptin and ghrelin have a role in sleep as sleep deprivation alters the concentration of these hormones in the plasma [11]. Ghrelin is one of the most important

appetite-regulating peptides and is involved in regulating energy balance [11]. The major physiological function of leptin is to signal states of negative energy balance and decreased energy stores [12]. Therefore, sleep restriction, by affecting ghrelin and leptin production, is a factor that contributes to weight gain [13]. A change in the circadian rhythm can disrupt a range of biological processes. People who sleep fewer hours than they need to feel refreshed consume large amounts of fat and carbohydrates [14]. They have more irregular meal patterns, with snacks replacing meals [15,16] lower vegetable and fruit intake [17,18] and reduced desire to consume healthy foods compared to energy-rich foods [6]. Night-time food consumption during the COVID-19 pandemic may have decreased reference energy expenditure and increased energy intake as a consequence of the disruption in the patterns of secretion of leptin and ghrelin. These changes in eating and sleeping behaviours can be expected to translate into long-term physical and psychological effects after the end of the pandemic [19].

Despite the interruption of public life during the quarantine period, some people had more flexibility in scheduling as they were working from home offices. This led to an improvement in the timing of sleep and waking for some individuals; others suffered from sleep restriction and circadian misalignment [20]. Sleep restriction is linked to health and mental problems [20]. A significant relationship has been demonstrated between sleep, biological rhythms and the COVID-19 pandemic [4]. However, no study has investigated the relationship between home confinement and sleeping patterns and food consumption in Saudi Arabia. Therefore, the aim of this study is to investigate the effect of home confinement on sleeping patterns and snacking in the Saudi population.

Materials and Methods

This is a cross-sectional study. A self-administered online questionnaire was distributed electronically via social media tsuch as It was distributed online via different socil media platform, such as Email invitations, LinkedIn®,Twitter®, Instagram®, WhatsApp from June 3rd to August 18th, 2020. articipants aged ≥18 years who were under homerestriction were included. Participants who were notunder home restriction were excluded.

The questionnaire was divided into three parts. The first part focused on socio-demographic data, anthropometric measurements, physical activity levels and history of chronic disease. The second part measured the quality of sleep during the quarantine period using the Pittsburgh Sleep Quality Index (PSQI). The questions in the last part were designed to assess the consumption of snacks during the quarantine period. The questionnaire was available in Arabic and English.

A pilot study on 30 participants was conducted to validate the questionnaire and test the questionnaire under survey conditions, in addition to determining the duration of the interview.

The Raosoft sample size calculator (http://www.raosoft.com/samplesize.html) was used to calculate the sample size needed for this study. The total population of Saudi Arabia is approximately 30 million citizens. The predetermined margin of error was 5%, and the confidence level was 95%. The target sample size was 385 to minimize erroneous results and increase study reliability.

A written informed consent was collected from participants electronically. The study was ethically approved by the Biomedical Ethics Committee at Um Al-Qura University, Makkah City (HAPO-02-K-012-2020-06-408).

Statistical analysis

The data analysis was performed using Statistical Package for the Social Sciences (SPSS) (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp). Frequency and percentages were used to display categorical variables. Minimum, maximum, mean and standard deviation were used to display continuous variables. The Chi-square test was used to test for the presence of associations between categorical variables. The level of significance was set at $P < 0.05$.

Results and Discussion

By 18th of June 2020. A total of 526 (75 men and 451 women) participated. Participants characteristics are shown in table 1.

Variables	N(%)
Gender	
Male	75 (14.3)
Female	451 (85.7)
Age	
18-39	372 (70.70)
40-50	109 (20.70)
51-65	45 (8.60)
Nationality	
Saudi	458 (87.1)
Non-Saudi	68 (12.9)
Pregnancy and breastfeeding	
Yes	25 (4.8)
No	426 (81)
Educational level	
Intermediate school or less	14 (2.70)
High school	94 (17.90)
Diploma	43 (8.20)
Bachelor's degree	285 (54.20)
Master's degree / PhD	90 (17.10)
BMI	
Underweight	45 (8.60)
Normal weight	217 (41.30)

Overweight	138 (26.20)
Obesity class 1	70 (13.30)
Obesity class 2	36 (6.80)
Obesity class 3	20 (3.80)
Exercise / day	
I don't exercise	269 (51.10)
Half an hour	156 (29.70)
An hour	82 (15.60)
Two hours	19 (3.60)
Smoking	
Yes	28 (5.3)
Occasionally	50 (9.5)
No	448 (85.2)

Table 1: Participants Characteristics.

The nature of work has been influenced by the pandemic, as shown in table 2. Participants worked a mean 5.30 ± 2.58 hours, with a maximum of 10 working hours and a minimum of 2 working hours.

Job	N (%)
In public sector	113 (21.50)
In the health sector	45 (8.60))
I work in the health sector, but I am not a health practitioner	46 (8.70)
Private sector employee	6 (1.10)
An employee in the military sector	186 (35.40)
Self-employed	130 (24.70)
During the quarantine period (month of April), how did the nature of your work change?	
I stopped working	104 (19.80)
I spent less time working outside the home	39 (7.40)
I spent more time working outside the home	23 (4.40)
I worked from home	160 (30.40)
I already worked from home before the quarantine period and the nature of my work has not changed	13 (2.50)
Refrained from answering this question	13 (2.50)

Table 2: Working during COVID-19 Pandemic (n = 526).

Data are presented as n (%).

Eating habits among participants during the lockdown

Table 3 details the participants' eating habits. Roughly 38% said they sometimes felt hungry in the morning, 25% felt hungry most mornings, 19.2% always felt hungry in the morning and only 17.5% rarely felt hungry in the morning. Majority of participants had their meal between 12-3 PM.

During the quarantine period (month of April):	n	%
How often do you feel hungry in the morning?		
Always	101	19.2
Most of the time	135	25.7
Sometimes	198	37.6
Rarely	92	17.5
When did you usually have your first meal?		
Before 9 AM	109	20.7
Between 9 AM and 12 PM	183	34.8
Between 12 PM and 3 PM	234	44.5
During the quarantine period (month of April), what level of control did you have over the desire to eat a snack after dinner and before going to sleep?		
Very strong	105	20
Strong	165	31.4
Weak	177	33.7
Very weak	79	15
During the quarantine period (month of April), what proportion of your daily snacks did you eat after dinner and before going to sleep (from 0 to 100%)?		
0-25%	343	65.2
26 -50%	117	22.2
51-75%	46	8.7
76-100%	20	3.8
During the quarantine period (month of April), did you wake up at night to eat or eat at night because of insomnia?		
Yes	64	12.2
Sometimes	108	20.5
No	354	67.3

Table 3: Eating Habits Among the Participants (n = 526).

Data are presented as n (%).

Figure 1 shows the participants' activities while snacking. More than half, 69.2% (364), followed social media while snacking; 51.7% (272) watched TV; 27.2% (143) were at family gatherings; 20.2% (106) ate while working on a laptop and 20.9% (110) indicated that they did not do any activities while snacking.

The emotions that triggered snacking among participants are presented in figure 2. Around 38.2% (201) reported that feelings did not influence their snacking. On the other hand, 47.1% (248) of participants ate out of boredom, 17.9% (94) out of stress and anxiety, 13.1% (69) out of anger and 18.6% (98) out of happiness.

Table 4 illustrates the most common snacks eaten during the lockdown. Traditional desserts such as basbousa, konafah, and maamoul were followed in popularity by chips and crisps, nuts, fruits, other sweets, dairy and cheese products, ice cream, instant noodles (Indomie), dried fruits, protein supplements, coffee or tea, pasta, rice, pastry and popcorn.

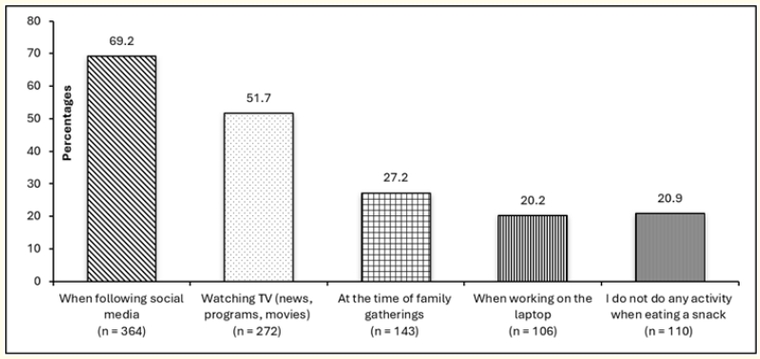

Figure 1: Activities Engaged in While Snacking.

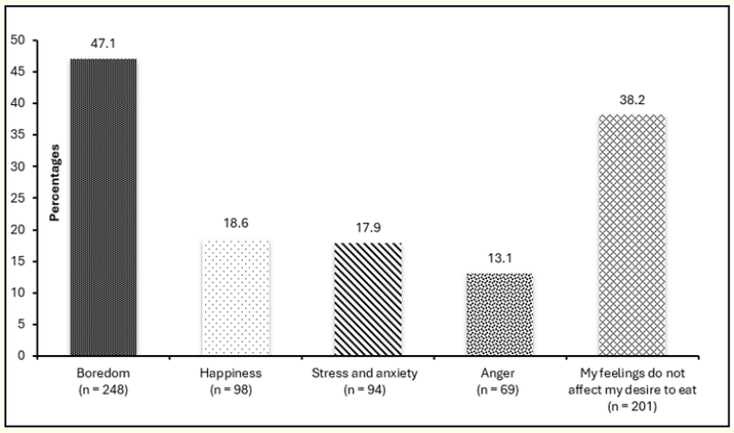

Figure 2: Emotions that Triggered Snacking.

Food item	n (%)
Basbousa (100g/520Kcal), konafah (100g/420 Kcal), maamoul (date biscuits) (180 Kcal), cookies (502 Kcal), brownie (466 Kcal), sweet or salt biscuit (421 Kcal)	211 (40.1)
Bag of chips such, as Lays (41g/233 Kcal) or Doritos (41g/200 Kcal) or others	185 (35.2)
1 oz =28.4 g of nuts, such as hazelnuts (178 Kcal), cashew (157 Kcal) and others	162 (30.8)
A large serving of fruit such as an apple (52 Kcal), orange (47 Kcal), pear (57 Kcal), mango (60 Kcal) or a half cup of fruit juice (56 Kcal)	158 (30)
Sweets such as chocolate (1oz/28.4g/155 Kcal), jelly (100g/62 Kcal), 1 cup of miniature marshmallows (50g/159 Kcal) or other sweets	149 (28.3)
Dairy and cheese products such as a cup of buttermilk (99 Kcal) or milk (148 Kcal) or a piece of cheese (28g/114Kcal)	128 (24.3)
Half cup of ice cream (137 Kcal)	104 (19.8)
Instant noodle (Indomie) (380 Kcal)	86 (19.8)
Dried fruits (1 oz/28.4g/102 Kcal)	31 (5.9)
One serving of a protein supplement such as a protein bar (331 Kcal) or protein ml (100 Kcal)	22 (4.2)
Coffee or tea	6 (1.1)
Pasta (2 oz/57g/75 Kcal)	3 (0.6)
Rice (100 g/130 Kcal)	3 (0.6)
Pastries (47 g/259 Kcal)	2 (0.4)
Popcorn (1 oz/28.4g/106 Kcal)	1 (0.2)

Table 4: Most Frequently Consumed Snacks During the Quarantine (n = 526).

Data are presented as n (%).

Majority of participants preferred to drink coffee, followed by tea, energy drinks, soft drinks and sugar-free soft drinks (Table 5).

Drinks	n (%)
Coffee (1-3 cups)	311 (59.1)
Coffee (more than 3 cups)	67 (12.7)
Tea (1-3 cups)	182 (34.6)
Tea (more than 3 cups)	35 (6.7)
Energy drinks (1 can, 8.4 fl oz/258 ml/117 Kcal)	18 (3.4)
Energy drinks (more than 1 can)	4 (0.8)
Soft drinks (1 can, 12 fl oz/360ml/150 Kcal)	74 (14.1)
Soft drinks (more than 1 can)	17 (3.2)
Sugar-free soft drinks (1 can)	10 (1.9)
Sugar-free soft drinks (more than 1 can)	5 (1)

Table 5: Most Frequently Consumed Beverages During the Quarantine (n = 526).

Data are presented as n (%).

Participants quality of sleep during the quarantine

During the strict lockdown period, 78.5% (413) of the participants slept poorly and 21.5% (113) had good sleep quality. The changes in the participants' sleeping patterns are shown in table 6. More than one-third of the participants (37.3%) slept worse than before the lockdown.

During the quarantine period (month of April)	n	%
Do you think that the quality of your sleep changed in terms of sleep duration and the ability to fall asleep at night?		
Yes, became better	137	26
Yes, became worse	196	37.3
No, it did not change	193	36.7
Did you feel depressed or frustrated, and if so, when did you feel most depressed?		
Yes, in the morning	38	7.2
Yes, in the evening	144	27.4
Yes, at night	175	33.3
I did not feel any depression or frustration	169	32.1

Table 6: Changes in Sleep and Mental Health During the Quarantine Period (n = 526).

Data are presented as n (%).

Factors Associated with Sleep Quality

Table 7 shows the responses relating to sleep quality. There was no significant association between the sleep quality score and gender, smoking, BMI, exercise or most of the diseases. However, age was significantly associated with sleep quality. The highest rate of poor sleep (82.3%) was found in participants aged 18 to 39 years. Having hypertension was also significantly associated with poor sleep (P = 0.003). Participants with hypertension were more likely to report poor sleep than those without hypertension (54.2% vs 45.8%). Feeling depressed or frustrated during the quarantine was also significantly associated with poor sleep (P < 0.001). The highest rate of poor sleep was reported by participants who felt depressed at night (92.6%).

Factor	Poor sleep quality	Good sleep quality	P-value
Gender			0.238
Male	358 (79.4%)	93 (20.6%)	
Female	55 (73.3%)	20 (26.7%)	
Age			0.005*
18–39	306 (82.3%)	66 (17.7%)	
40–50	75 (68.8%)	34 (31.2%)	
51–64	32 (71.1%)	12 (28.9%)	
Smoking			0.81
Yes	22 (78.6%)	6 (21.4%)	
Occasionally	41 (82%)	9 (18%)	
No	350 (78.1%)	98 (21.9%)	
BMI			0.570
Underweight	36 (80%)	9 (20%)	
Normal weight	167 (77%)	50 (23%)	
Overweight	111 (80.4%)	27 (19.6%)	
Obesity class 1	52 (74.3%)	18 (25.7%)	
Obesity class 2	32 (88.9%)	4 (11.1%)	
Obesity class 3	15 (75%)	5 (25%)	
Exercise			0.40
I don't do sports	214 (79.6%)	55 (20.4%)	
Half an hour	122 (78.2%)	34 (21.8%)	
An hour	60 (73.2%)	22 (26.8%)	
Two hours	17 (89.5%)	2 (10.5%)	
Medical History			
I do not have any diseases	326 (79.5%)	84 (20.5%)	0.29
Thyroid disorders	26 (76.5%)	8 (23.5%)	0.76
Gastrointestinal diseases	23 (74.2%)	8 (25.8%)	0.54
Hypertension	13 (54.2%)	11 (45.8%)	0.003**
Diabetes	16 (72.7%)	6 (27.3%)	0.49
Bone diseases	16 (84.2%)	3 (15.8%)	0.53
Psychological diseases	11 (100%)	0.00	0.08
Immunological diseases	7 (77.8%)	2 (22.2%)	0.95
Neurological diseases	6 (100%)	0.00	0.19
Kidney disease	6 (100%)	0.00	0.19
Cardiovascular diseases	5 (100%)	0.00	0.24
Time of day when depression was experienced			< 0.001**
In the morning	29 (76.3%)	9 (23.7%)	
In the evening	128 (88.9%)	16 (11.1%)	
At night	162 (92.6%)	13 (7.4%)	
I did not feel any depression	94 (55.6%)	75 (4.44%)	

Table 7: Factors Associated with Sleep Quality.

*Significant at the P ≤ 0.05 level, ** Significant at the P ≤ 0.005 level.

Snacking and Sleep Quality During Lockdown

The time at which the first meal of the day was eaten was significantly associated with sleep quality (P = 0.003), the more delayed the first meal, the higher the rate of poor sleep. The following snacks were significantly associated with sleep quality: a bag of chips, such as Lays, Doritos or others (P= 0.017); a large piece of fruit, such as an apple, orange, pear, mango or half a cup of fruit juice (P < 0.001) and other sweets, such as chocolate, jelly and marshmallows (P = 0.009) and ice cream (P = 0.006). Those who favoured fruits were less likely to report experiencing poor sleep quality, whereas those who favoured chips, sweets and ice cream reported a higher rate of poor sleep quality. Participants' abilities to control their desires to snack after dinner and before going to bed were also significantly associated with sleep quality (P = 0.04). Those who had very weak control over their desire to snack had the lowest rate of poor sleep quality (68.4%). The highest rate of poor sleep quality was reported by those who had strong control (82.4%).

The proportion of daily snacks eaten after dinner and before going to sleep was also significantly linked to sleep quality (P = 0.01). The rate of poor sleep in those who ate 25% or fewer of their snacks during the time between finishing dinner and going to sleep was notably lower than the rate in those who ate more of their snacks during this period (74.3% vs > 80% for all of the other groups). Waking up to eat or getting up to eat due to insomnia was also significantly linked to sleep quality (P < 0.001). Those who indicated that they woke up to eat or got up to eat because of insomnia had the highest rate of poor sleep (93.8%), compared to the rate of poor sleep (88.9%) in those who said they sometimes woke or got up to eat and the rate in those who did not wake or get up to eat (72.6%). Two emotional triggers were also significantly linked to sleep quality, boredom (P < 0.001) and stress and anxiety (P = 0.002). Participants who craved food when they were bored or happy had higher rates of poor sleep quality. Not having an emotional trigger for eating was also significantly associated with sleep quality (P < 0.001); those who reported that boredom and happiness did not lead them to eat had a lower rate of poor sleep quality. Gender, smoking, BMI, exercise and drinks consumed daily were not significantly correlated with sleep quality (Table 8).

	Poor sleep quality	Good sleep quality	P-value
During the quarantine (month of April), what were your favourite snacks?			
A piece of basbousa, konafa, or maamoul; cookies, a brownie or a sweet or salt biscuit	173 (82%)	38 (18%)	0.11
A bag of chips, such as Lays or Doritos	156 (84.3%)	29 (15.7%)	0.0*
A handful of nuts, such as almonds or cashew nuts	135 (83.3%)	27 (16.7%)	0.07
A large piece of fruit such as an apple, orange, pear, mango or a half cup of fruit juice	109 (69%)	49 (31%)	< 0.001**
Sweets such as chocolate, jelly, or marshmallows	128 85.9%)	21 (14.1%)	0.009**
Dairy and cheese products such as a cup of buttermilk or milk or a 30 g piece of cheese	102 (79.7%)	26 (20.3%)	0.71
Ice cream	92 (88.5%)	12 (11.5%)	0.006**
Indomie (noodles)	74 (86%)	12 (14%)	0.06
A handful of dried fruit	22 (71%)	9 (29%)	0.29
One serving of a protein supplement, such as a protein bar or milkshake	18 (81.8%)	4 (18.2%)	0.70
Coffee or Tea	5 (83.3%)	1 (16.7%)	0.77
Pasta	3 (100%)	0.00	0.36
Rice	1 (33.3%)	2 (66.7%)	0.05
Pastries	2 (100%)	0.00	0.45
Popcorn	1 (100%)	0.00	0.60
During the quarantine period (month of April), did you drink any of the following beverages daily?			
Coffee (1-3 cups)	242 (77.8%)	69 (22.2%)	0.63
Coffee (more than 3 cups)	57 (85.1%)	10 (14.9%)	0.16
Tea (1-3 cups)	144 (79.1%)	38 (20.9%)	0.80
Tea (more than 3 cups)	27 (77.1%)	8 (22.9%)	0.83
Energy drinks (1 can)	15 (83.3%)	3 (16.7%)	0.61
Energy drinks (more than 1 can)	4 (100%)	0.00	0.29
Soft drinks (1 can)	63 (85.1%)	11 (14.9%)	0.13
Soft drinks (more than 1 can)	14 (82.4%)	3 (17.6%)	0.69
Sugar-free soft drinks (1 can)	8 (80%)	2 (20%)	0.90
Sugar-free soft drinks (more than 1 can)	4 (80%)	1 (20%)	0.93

During the quarantine (month of April), when did you usually have your first meal?			0.003**
Before 9 AM	76 (69.7%)	33 (30.3%)	
9 AM-12 PM	138 (75.4%)	45 (24.6%)	
12 PM-3 PM	199 (85%)	35 (15%)	
During the quarantine (month of April), how great was your control over the desire to snack after dinner and before going to sleep?			0.04*
Very strong	79 (75.2%)	26 (24.8%)	
Strong	136 (82.4%)	29 (17.6%)	
Weak	144 (81.4%)	33 (18.6%)	
Very weak	54 (68.4%)	25 (31.6%)	
During the quarantine period (month of April), what proportion of your daily snacks did you eat after dinner and before going to sleep (from 0 to 100%)?			0.013*
0%-25%	255 (74.3%)	88 (25.7%)	
26%-50%	103 (88%)	14 (12%)	
51%-75%	38 (82.6%)	8 (17.4%)	
76%–100%	17 (85%)	3 (15%)	
During the quarantine period (month of April) did you wake up at night to eat or eat at night because of insomnia?			< 0.001**
Yes	60 (93.8%)	4 (6.3%)	
Sometimes	96 (88.9%)	12 (11.1%)	
No	257 (72.6%)	97 (27.4%)	
Did you feel the desire to eat when you experienced any of these states?			
Boredom	212 (85.5%)	36 (14.5%)	< 0.001**
Happiness	82 (83.7%)	16 (16.3%)	0.168
Stress and anxiety	85 (90.4%)	9 (9.6%)	0.002**
Anger	60 (87%)	9 (13%)	0.06
My feelings do not affect my desire to eat	140 (69.7%)	61 (30.3%)	< 0.001**

Table 8: Associations Between Sleep Quality and Snack Type.

*Significant at the P ≤ 0.05 level, **Significant at the P ≤ 0.005 level.

Relationship between change in work during the quarantine and change in the quality of sleep during the quarantine

No significant association was found between these two factors (P = 0.09) (Table 9).

Discussion

We looked into the effect of sleep quality on snack consumption during COVID-19 lockdown. High number (78.5%) of the partici-

During the quarantine period (month of April), did the nature of your work change and if so, how?				
	Yes, become better	**Yes, become worse**	**No, did not change**	
I stopped working	35 (33.7%)	42 (40.4%)	27 (26%)	0.09
I spent less time working outside the home	8 (20.5%)	11 (28.2%)	20 (51.3%)	
I spent more time working outside the home	6 (26.1%)	8 (34.8%)	9 (39.1%)	
I worked from home	41 (25.6%)	71 (44.4%)	48 (30%)	
I already worked from home before the quarantine period and the nature of my work has not changed	1 (7.7%)	6 (46.2%)	6 (46.2%)	

Table 9: Relationships between Changes in Work During Quarantine and Quality of Sleep.

pants suffered from poor sleep quality during the lockdown. Similar findings rereported in Germany during home quarantine [4]. Similarly, university students in Jordan suffered from decrease in the sleep efficiency. Almost half of the participants said that they didn't get enough sleep. Body temperature, cortisol, melatonin, and the sleep-wake cycle are all regulated by rhythmic oscillations with a periodicity of about 24 hours. Light is the primary synchronizer of circadian cycles, but diet and consistent sleep patterns affect them also. Diminished exposure to light, decreased physical exercise and psychological distress were among the many factors that could have affected sleeping habits during the complete COVID-19 lockdown. Also, a lack of social cues, such as daily work hours and social interactions, can have a significant impact on sleep habits.

There was no significant association in our study between sleep quality scores and gender, smoking, BMI, exercise and most diseases. Conversely, several studies have reported that women had a higher incidence of sleep quality problems than men during the pandemic. Moreover, age was associated with sleep quality. The highest rate of poor sleep was found in participants aged 18 to 39 years. This is consistent with previous study that found strong associations between quality of sleep and age. The mean age for subjects with poor sleep quality was observed at 56.38 years.

We also found that hypertension was significantly associated with poor sleep. This agrees with the findings of several studies. Recently, a meta-analysis of observational studies observed a positive association between poor sleep quality and the presence of hypertension. A study conducted in China found that a higher PSQI score in both men and women was linked to an increased risk of prevalent hypertension. In addition, people who sleep poorly had a greater likelihood of developing hypertension. A recent meta-analysis conducted in China reported that the prevalence of poor sleep quality was 52.5% among 13,920 hypertensive patients in 24 studies. Additionally, a recent study that evaluated sleep quality in patients with hypertension reported poor sleep quality scores in patients with grade I and II hypertension. The elevated incidence of poor sleep quality in hypertensive patients may have several causes. Pain and headache, which can be symptoms of hypertension, can also result from low sleep quality. Also, low sleep quality has been shown to counteract the benefits of blood pressure regulation in some trials. Furthermore, in patients with hypertension, low sleep quality is commonly associated with decreased physical functioning and poor mental health. Hormones that control the sleep/wake cycle can lower systolic and diastolic blood pressure as well as increase nocturnal systolic and diastolic blood pressure dipping in hypertensive patients. Low sleep quality over time can disrupt the body clock and affect catecholamine secretion, potentially leading to high blood pressure. Additionally, bad sleep quality is linked to higher sympathetic nervous system activity and is an independent indicator of the absence of nocturnal blood pressure dipping. This potential correlation may be because sleep affects autonomic nervous system activity and other physiologic activities that influence blood pressure.

Sleep disturbance has been linked with poor sleep quality and emotional eating. It has been found that women with higher degrees of emotional eating showed a positive and significant association between short sleep duration and increases in BMI. According to a recent study in Saudi Arabia, emotional eating has been very common among young women during the pandemic, with almost one in two women identifying as emotional eaters.

Changes in sleeping hours affect the timing of first food consumption; 45% of the participants in our study reported eating their first meal at noon. A possible reason was that working and performing other activities from the place of confinement changed participants' rising times and mealtimes. We found a significant association between the timing of the first meal of the day and sleep quality. The more delayed the first meal was, the higher rate of poor sleep was reported. Meals are an essential biological cue, especially affecting the liver and adipose tissue. Changes in mealtimes uncouple the central and peripheral body clocks, resulting in circadian misalignment and disruptions in metabolic functions [3]. Meal timing plays a role in synchronizing peripheral circadian rhythms in humans and may have particular relevance for patients with circadian rhythm disorders, shift workers, and trans-meridian travellers. In our study, we observed a significant correlation between emotional triggers for eating and sleep quality. Boredom, and stress and anxiety were significantly linked to sleep quality. Participants whose appetite was triggered by these emotions had higher rates of poor sleep quality. Poor sleep quality was significantly associated with unhealthy snacks and less likely in those who consumed fruits. This is consistent with a meta-analysis in which short sleep time was linked to increased intake of soda and sweets and decreased intake of fruits in children and adolescents. Sleep deprivation can influence food consumption by affecting circadian rhythms, appetite and satiety hormone levels and blood glucose levels. It appears to increase food consumption by increasing the production of the appetite-stimulating hormone ghrelin and decreasing the release of the appetite-suppressing hormone leptin. Furthermore, sleep-deprived people have more time to eat. Consequently, short sleep can result in disordered consumption of meals as well as an increase in the intake of junk foods and unhealthy snacks. More time and opportunity for feeding, psychological anxiety, the need for more calories to support long periods of wakefulness, and changes in the production of appetite hormones are all mechanisms by which insufficient sleep increases energy consumption. Moreover, coping processes and hedonic stimuli production in the brain are likely to drive unhealthy habits, such as choosing unhealthy foods and eating heavily after a sleepless night. Thus, snacking on unhealthy foods is done to compensate for sleep disruptions and improve mood rather than to satisfy hunger or thirst.

According to our results, feelings of depression or frustration during the quarantine were significantly associated with poor sleep ($P < 0.001$). The highest rate of poor sleep (92.6%) was reported by participants who felt depressed at night, followed by the

rate among those who felt depressed in the evening (88.9%), in the morning (76.3%) or not at all (55.6%). This is consistent with the findings of a study conducted in Italy during the pandemic in which decreases in sleep quality (PSQI global score) were greatest in participants with higher symptoms of depression, anxiety and stress. Some studies have found that daytime sleepiness, general sleep quality, and insomnia severity are consistently poorer in subjects with both depression and anxiety. Circadian misalignment is common in people with a variety of psychiatric conditions, including depression [4]. Moreover, there is an association between unhealthy eating and depressive symptoms that is also linked to poor sleep quality. After controlling for sleep issues, snacking on food and/or drinks was linked to an increased odds ratio for depression in 24,697 Japanese adults.

In our study, we observed more than half of our participants (69.2%) followed social media while snacking and 51.7% watched TV. Some studies indicate that eating while watching TV is related to more TV viewing, greater overall intake of unhealthy snacks, more daytime napping and decreased overnight sleep.

Conclusions

The COVID-19 pandemic quarantine negatively affected sleep quality, which led to unhealthy eating habits and increased snacking. Sleep deprivation, reduced sleep duration, and late bedtimes are all linked to low diet quality and high food consumption. The implications of the findings for public health include understanding the possible mechanisms by which poor sleep quality increases food consumption include more time and opportunity for eating, psychological anxiety, the need for more calories to survive long periods of wakefulness, and changes in the production of appetite hormones.

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Conflict of Interest

The authors declare no conflict of interest.

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