



# Effect of COVID-19 Quarantine on the Sleep Quality and the Depressive Symptom Levels of University Students in Jordan During the Spring of 2020

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**Objectives:** This study was designed to assess the effect of COVID-19 home quarantine and its lifestyle challenges on the sleep quality and mental health of a large sample of undergraduate University students in Jordan. It is the first study applied to the Jordanian population. The aim was to investigate how quarantine for several weeks changed the students' habits and affected their mental health.

**Methods:** A cross-sectional study was conducted using a random representative sample of 6,157 undergraduate students (mean age  $19.79 \pm 1.67$  years, males 28.7%) from the University of Jordan through voluntarily filling an online questionnaire. The Pittsburgh Sleep Quality Index (PSQI) and the Center for Epidemiologic Studies-Depression Scale (CES-D) were used to assess sleep quality and depressive symptoms, respectively.

**Results:** The PSQI mean score for the study participants was  $8.1 \pm 3.6$ . The sleep quality of three-quarters of the participants was negatively affected by the extended quarantine. Nearly half of the participants reported poor sleep quality. The prevalence of poor sleep quality among participants was 76% (males: 71.5% and females: 77.8%). Similarly, the prevalence of the depressive symptoms was 71% (34% for moderate and 37% for high depressive symptoms), with females showing higher prevalence than males. The overall mean CES-D score for the group with low depressive symptoms is 9.3, for the moderate group is 19.8, while it is 34.3 for the high depressive symptoms group. More than half of the students (62.5%) reported that the quarantine had a negative effect on their mental health. Finally, females, smokers, and students with decreased income levels during the extended quarantine were the common exposures

that are significantly associated with a higher risk of developing sleep disturbances and depressive symptoms.

**Conclusions:** Mass and extended quarantine succeeded in controlling the spread of the COVID-19 virus; however, it comes with a high cost of potential psychological impacts. Most of the students reported that they suffer from sleeping disorders and had a degree of depressive symptoms. Officials should provide psychological support and clear guidance to help the general public to reduce these potential effects and overcome the quarantine period with minimum negative impacts.

**Keywords:** University students, mental health, COVID-19 quarantine, PSQI, CES-D

## INTRODUCTION

In early December of 2019, the novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), known later as COVID-19, emerged in Wuhan city of China (1). As of 20th of December 2020, COVID-19 affected more than 200 countries, with more than 77 million cases and a death toll that is nearly two million globally (2). This respiratory pandemic is highly contagious, and containment strategies include quarantine, lockdown, isolation, travel bans, country-wide closure, social distancing, personal hygiene, and face-mask mandating were applied by many countries (3). These stringent measures helped in controlling the virus spread. Many countries had applied quarantine or stay at home procedures from the detection of early cases; it aims to restrict people's movement and reduce their social mixing (4). Even though quarantine limits the spread of COVID-19 and other infectious diseases (5–9), its psychological effect, along with its social, economic, and physiological impacts, should not be neglected (10–14).

Having sufficient sleep at night plays an essential role in the efficiency of accomplishing everyday tasks and having good mental abilities (15). Globally, inadequate sleep is considered a public health epidemic, being linked to 7 of the 15 leading causes of death in the U.S. (16). A study among Canadians reported that poor sleep quality with short sleep duration was prevalent, as 43% of men and 55% of women had a disturbance in sleeping or staying asleep (17). Another study in Ethiopia reported poor sleep quality among 65.4% of the participants (18). Furthermore, in Saudi Arabia, a study conducted on a sample of health care workers revealed that 42.3% suffer from poor sleep quality (19).

Several studies assess the sleep quality amid the COVID-19 pandemic. In France, deteriorated sleep quality during the current quarantine was reported by 47% of the study sample (20). 57.1% of Italians who participated in an online questionnaire suffered from decreased sleep quality (21). Moreover, during the 2 weeks of quarantine in February in China, the sleeping disorders were significantly increased in the age group of 18–24 years (22). Likewise, a study in Greece showed that although the quantity of sleeping hours increased in 66.3% of the study participants, the sleep quality decreases to 43% (23). Furthermore, more than half of the Spanish participants in a study reported a change in their sleeping habits due to quarantine (24).

Depression is a widespread mental disorder that affects millions of people worldwide, and it is the leading cause of disability (25). Persistent negative thoughts, feeling down, lack of energy, losing interest in joyful activities, sleep disturbance, and many more are among the common symptoms of depression (25). This long-lasting pessimistic mood may lead to suicidal thoughts (26, 27). Many people suffering from depressive symptoms tend to escape real-life and dealing with surrounding family, friends, and colleagues into social media looking for comforts and relief in positive comments and news, which is reflected in their high usage of their smart devices; like smartphones, tablets, iPad, and other devices (28–32). Globally, 40.5% (31.7–49.2%) of the disability-adjusted years of life caused by depressive disorders, with a 4.7% (4.4–5.0%) global prevalence of major depressive disorders and an annual incidence of 3.0% (2.4–3.8%) (33, 34). Regionally, researchers in the Middle East and North Africa regions had evaluated depressive symptoms rates ranging from around 13 to 29%, with women and University students having higher rates, among others (35). Another study reported depressive symptoms among University students in Oman and Egypt as 27.7 and 60.8%, respectively (36, 37). In Jordan, around 74% showed a degree of depressive symptoms among school and University students (38, 39).

The fear of the current pandemic and its consequences, especially on the economy, caused a depression that sometimes leads to suicidal incidents (40–42). The extended quarantine and disturbance of everyday life routine increase the anxiety and depression levels. In Southwestern China, Lei et al. reported significant differences in the prevalence of anxiety and depressive symptoms among the public affected by quarantine (12.9 and 22.4%, respectively) and those unaffected (6.7 and 11.9%, respectively) during the COVID-19 pandemic (43). Similarly, after the stay-at-home order was issued, Spanish researchers identified higher levels of depressive symptoms in northern Spain, specifically among younger individuals with chronic diseases (44). These results are in line with the 2003 SARS outbreak findings in which the sample group that showed the highest levels of depression symptoms were quarantined during the outbreak (45).

Treating and taking care of COVID-19 infected patients, in addition to protecting others from catching the virus, are the priority for most countries worldwide. However, COVID-19 has psychological stress impact on non-infected members, which

may last longer than the pandemic's actual time. Understanding the level and prevalence of these impacts on the current situation can improve the population's health and reduce its consequences during COVID-19 and future similar pandemics. Therefore, this is the first study that aims to assess the impact of the extended COVID-19 quarantine on the mental health, especially depressive symptom levels, and the sleep quality of a large sample of undergraduate University students in Jordan. This is assessed by collecting many exposures to cover the demographic, economic, and quarantine-related factors that might worsen the effect of quarantine on both the students' sleep quality and mental health.

## METHOD

### Participants

The online questionnaire participants were undergraduate students at the University of Jordan (UJ, located in Amman) who voluntarily completed its questions. The total number of collected responses had reached 7,146. Six thousand one hundred fifty-seven unique participants remained after cleaning the data by removing all the duplicated submissions. All the questions were obligatory; hence there was no missing data. At any time, any participant could have ignored answering any of the questions to withdraw from the study. The Institutional Review Board / the Research Ethics Committee at UJ had approved the study objectives and procedures. The age of the participants ranged between 17 and 30, with a mean of  $19.79 \pm 1.67$ . Nearly half of the students were in their first year. 28.7% of participants were males (1,769), and 71.3% were females (4,388), with a male to female ratio of 1:2.48. Half of the students were studying humanities-related majors, and 36.2% were studying scientific majors, while 13.6% were from the medical schools (medicine, dentistry, nursing, pharmacy, and rehabilitation sciences).

### Measurements of Clinical Symptoms

The questionnaire collects an extensive list of general socio-demographic, socio-economic, and quarantine-related information (as a measure of exposures) in addition to the questions in the PSQI and CES-D measures to assess the primary outcomes: sleep quality and depressive symptom levels. The reason for collecting this extensive list of exposures was to cover the main confounding factors and assess how these many different exposures may affect/associate with the two primary outcomes.

### Socio-Economic and Socio-Demographic Factors

Socio-economic factors regarding the household income, parents' education levels ranging from "did not reach high school" to "postgraduate," and parents' employment status during the quarantine were collected. Furthermore, gender, age, year level, academic major/performance, and students' smoking practices were measured.

**TABLE 1 |** Items of Pittsburgh Sleep Quality Index (PSQI).

Component	Description
1 Sleep quality	Perceived overall sleep quality
2 Sleep latency	Measures how long it took to fall asleep
3 Sleep duration	The actual length of sleep
4 Sleep efficiency	The total number of hours slept divided by and the number of hours spent in bed
5 Sleep disturbances	Behaviors that negatively affect sleep, such as waking up at late night or early in the morning, getting up at night to use the bathroom, uncomfortable breathing, coughing or snoring loudly, feeling too hot or too cold, having nightmares, or pain
6 Sleep medication	Whether there is a need to use them to go to sleep
7 Daytime dysfunction	Troubles staying awake while driving, eating meals or engaging in social activity, or keep enough enthusiasm to get thing done

*This scale was proposed by Buysse et al. (46).*

### Quarantine Variables

To assess the effect of home quarantine on student's mental health, more information related to the stay at home period, including the number of members (and children) quarantined with each student, place of quarantine (rural or urban), house specifications (apartment/independent house with/without a garden), household income during the quarantine, communication with family members, and practiced hobbies were gathered.

### Clinical Assessment of Sleep Quality

The sleep quality of the undergraduate University students during the several weeks of COVID-19 home quarantine was assessed using Pittsburgh's Sleep Quality Index (PSQI) (46). This index is a validated self-reported questionnaire that measures the quality of sleep subjectively from different perspectives. It contains 19 items grouped into seven components, each measures one aspect (Table 1). The components are subjective sleep quality (very good, fairly good, fairly bad, and very bad), sleep latency (time between lying down in bed and falling asleep), duration (<5 h, 5–6 h, 6–7 h, >7 h), efficiency (<65%, 65–74%, 75–84%, >85%), disturbance, the need to use sleep medication (yes, no), and daytime dysfunction. Each component is scored on a four-point scale from 0 (no difficulty) to 3 (severe difficulty). The global score is calculated by adding each component's score and can range from 0 to 21, with higher scores indicating lower sleep quality (46).

### Clinical Assessment of Depressive Symptoms

Depressive symptoms were assessed using the Center for Epidemiologic Studies-Depression Scale (CES-D) (47). It is a validated self-reporting scale that contains 20 items, each ranged between 0 and 3 (Table 2). The global score is calculated by

**TABLE 2 |** Items of Center for Epidemiologic Studies-Depression Scale (CES-D).

Items	Items
1 I was bothered by things that usually don't bother me	11 My sleep was restless
2 I did not feel like eating; my appetite was poor	12 I was happy
3 I felt that I could not shake off the blues even with help from my family or friends	13 I talked less than usual
4 I felt I was just as good as other people	14 I felt lonely
5 I had trouble keeping my mind on what I was doing	15 People were unfriendly
6 I felt depressed	16 I enjoyed life
7 I felt that everything I did was an effort	17 I had crying spells
8 I felt hopeful about the future	18 I felt sad
9 I thought my life had been a failure	19 I felt that people dislike me
10 I felt fearful	20 I could not get "going"

This scale was proposed by Radloff et al. (47).

adding all items' scores, which ranged from 0 to 60. The four-point scale is: rarely or less than once a day (scores 0 points), some of the time or 1-2 days (scores one point), occasionally or moderate amount of time or 3-4 days (scores two points), and most of the time or 5-7 days (scores three points). The higher the global score is, the higher levels of depressive symptoms there are (47).

## Statistical Analysis

Frequencies and percentages were used to analyze the categorical demographic, economic, and quarantine variables, while mean and standard deviation were used for continuous variables. A two-sample *t*-test was used to test for significance for the binary variables, while multi-values variables were tested using a one-way analysis of variance (ANOVA). As a *post-hoc* analysis, Tukey Honestly Significance Difference (TukeyHSD) was used to follow up on the significant factors that resulted from the ANOVA to identify the pair of values that had a significant mean difference. The significant factors were further investigated using logistic regression, and the significant associations between the exposures and the primary outcomes were identified using the Backward selection method. While binary logistic regression was used for the sleep quality state (1: poor, 0: normal), the multinomial logistic regression was used for the depressive symptoms state (1: low, 2: moderate, and 3: high). A *p*-value of  $\leq 0.05$  was considered to be statistically significant. All statistical analyses were performed using R version 4.0.0 and RStudio version 1.2.5042.

## RESULTS

### Demographic and Economic Characteristics of the Study Participants

Nearly half of the participants ( $n = 3,003$ ) were fresh students, with most ( $n = 3,092$ ) studying humanities-related majors.

Around three-quarters were females ( $n = 4,388$ ), and only 16.3% were smokers ( $n = 1,006$ ). The average mean age was 19.79, and the standard deviation was 1.67. Only 3.5% of the students are about to graduate ( $n = 217$ ) (Table 3; the first two columns).

Furthermore, around 45% ( $n = 2,798$ ) and 34% ( $n = 2,087$ ) of the students' fathers and mothers had a University degree (bachelor or postgraduate). The household income level ranged from <200 JD (\$ 282) to more than 1,500 JD (\$ 2,115), which mainly fall into three categories; very low to low income (<600 JD: 45%,  $n = 2,807$ ), medium income (600-1,000 JD: 30%,  $n = 1,906$ ), and high income (more than a 1,000 JD: 25%,  $n = 1,444$ ) (Table 3; the first two columns).

### Quarantine Characteristics of the Study Participants

Only 4.5% ( $n = 275$ ) of the students had their household income increased during the quarantine, whereas nearly 50% had either a decreased or a completely stopped income ( $n = 2,467$  and  $n = 775$ , respectively). A low proportion of 13.7% ( $n = 842$ ) of the students were quarantined in rural areas. 55% ( $n = 3,350$ ) lived in an apartment; one-third of these apartments had a garden. The majority (~80%,  $n = 2,210$ ) of the students who lived in an independent house had a garden (Table 4; the first two columns). Watching movies and/or TV series in addition to sleeping were the most common activities (70%,  $n = 4,310$ ) among the students during the quarantine, and then eating or cooking with a percentage of nearly 50% ( $n = 3,079$ ). More than half of the students (68%,  $n = 4,187$ ) start practicing new hobbies like board games (25%,  $n = 1,539$ ), drawing (11%,  $n = 677$ ), cooking (42%,  $n = 2,586$ ), meditation (16%,  $n = 985$ ) and watching movies/series (51%,  $n = 3,140$ ). Despite the different demographics for the students, the majority of them (89.7%,  $n = 5,523$ ) communicated more with their families and reported that they are spending more time with their families during the quarantine, and around 70% ( $n = 4,310$ ) increased their communication with the members living apart. Furthermore, students were asked about the health of the family members and friends that they were quarantined with; more than half of the students reported that they were quarantined with a smoker ( $n = 3,386$ ), around 20% ( $n = 1,416$ ) with a diabetic patient, about 8% ( $n = 493$ ) with a cardiac patient, and 17% ( $n = 1,047$ ) with an elderly member (>65 years). Finally, during the quarantine, 77% ( $n = 4,741$ ) of the students lived with 3-7 family members, and 43% ( $n = 2,648$ ) were not quarantined with children.

### Psychological Findings of the Study Participants (Sleep Quality)

Students' sleeping behaviors were assessed through the PSQI. It revealed an evident abnormal and unhealthy sleeping habits, which might affect sleep quality. For instance, more than three-quarters of the students (77%,  $n = 4,764$ ) went to bed after midnight during the quarantine, more than half of them ( $n = 2,711$ ) went to bed after 3 a.m. About half of the students ( $n = 3,003$ ) needed more than 30 min to fall asleep after going to bed, and 30% ( $n = 1,847$ ) needed more than 40 min. Sixty percentage of the students ( $n = 3,669$ ) woke up after midday and 33% ( $n =$

**TABLE 3 |** Socio-demographic and socio-economic characteristics, PSQI and CES-D scores of study participants.

Variable	Mean $\pm$ SD or N (N%)	PSQI Score Mean $\pm$ SD or (p-value)	CES-D Score Mean $\pm$ SD or (p-value)
Age	19.79 $\pm$ 1.67	8.1 $\pm$ 3.6	22.2 $\pm$ 11.7
Gender		(8.34e-04 <sup>a*</sup> )	(4.02e-07 <sup>a*</sup> )
Male	1,769 (28.7%)	7.9 $\pm$ 3.7	21.0 $\pm$ 11.7
Female	4,388 (71.3%)	8.2 $\pm$ 3.5	22.6 $\pm$ 11.7
Major		(6.28e-06 <sup>b*</sup> )	(0.941 <sup>b</sup> )
Humanities	3,092 (50.2%)	8.4 $\pm$ 3.6	22.1 $\pm$ 11.9
Medical	840 (13.6%)	7.9 $\pm$ 3.6	22.3 $\pm$ 11.7
Scientific	2,235 (36.2%)	7.9 $\pm$ 3.5	22.2 $\pm$ 11.6
Class		(2.69e-05 <sup>b*</sup> )	(0.472 <sup>b</sup> )
Year 1	3,003 (48.8%)	7.9 $\pm$ 3.5	21.9 $\pm$ 11.7
Year 2	1,757 (28.5%)	8.2 $\pm$ 3.6	22.6 $\pm$ 11.5
Year 3	793 (12.9%)	8.4 $\pm$ 3.7	21.9 $\pm$ 12.3
Year 4	481 (7.8%)	8.5 $\pm$ 3.7	22.3 $\pm$ 11.5
> Year 4 (Year 5, Year 6, and more)	123 (2.0%)	9.1 $\pm$ 4.0	22.0 $\pm$ 12.4
About to graduate		(8.09e-04 <sup>a*</sup> )	(0.168 <sup>a</sup> )
Yes	217 (3.5%)	9.0 $\pm$ 3.8	23.3 $\pm$ 12.0
No	5,940 (96.5%)	8.1 $\pm$ 3.6	22.1 $\pm$ 11.7
Smoking		(3.85-03 <sup>a*</sup> )	(0.285 <sup>a</sup> )
Yes	1,006 (16.3%)	8.4 $\pm$ 3.6	22.5 $\pm$ 11.9
No	5,151 (83.7%)	8.1 $\pm$ 3.6	22.1 $\pm$ 11.7
Household Income Level (1 JD = ~1.4 USD)		(8.30e-13 <sup>b*</sup> )	(0.181 <sup>b</sup> )
Less than 200 JD	375 (6.2%)	9.1 $\pm$ 3.7	22.7 $\pm$ 13.9
200–400 JD	1,225 (19.9%)	8.5 $\pm$ 3.6	22.5 $\pm$ 12.1
400–600 JD	1,207 (19.6%)	8.2 $\pm$ 3.6	22.4 $\pm$ 11.6
600–800 JD	951 (15.4%)	8.1 $\pm$ 3.4	22.2 $\pm$ 11.7
800–1,000 JD	955 (15.5%)	7.9 $\pm$ 3.4	22.2 $\pm$ 11.3
1,000–1,200 JD	493 (8.0%)	7.8 $\pm$ 3.5	22.2 $\pm$ 11.2
1,200–1,500 JD	341 (5.5%)	7.5 $\pm$ 3.6	20.9 $\pm$ 11.1
More than 1,500 JD	610 (9.9%)	7.7 $\pm$ 3.8	21.2 $\pm$ 11.2
Education level (Father)		(0.011 <sup>b*</sup> )	(0.031 <sup>b*</sup> )
Post graduates	732 (11.9%)	8.0 $\pm$ 3.6	21.5 $\pm$ 11.8
Bachelor	2,066 (33.6%)	8.0 $\pm$ 3.6	21.7 $\pm$ 11.4
Diploma	1,126 (18.3%)	8.2 $\pm$ 3.5	22.8 $\pm$ 11.6
High School	1,485 (24.1%)	8.3 $\pm$ 3.5	22.5 $\pm$ 12.0
Others (did not reach high school)	748 (12.1)	8.4 $\pm$ 3.6	22.4 $\pm$ 12.1
Education level (Mother)		(6.72e-03 <sup>b*</sup> )	(0.502 <sup>b</sup> )
Post graduates	308 (5.0%)	7.9 $\pm$ 3.8	21.3 $\pm$ 12.0
Bachelor	1,779 (28.8%)	8.0 $\pm$ 3.7	22.0 $\pm$ 11.5
Diploma	1,543 (25.1%)	8.2 $\pm$ 3.5	22.4 $\pm$ 11.9
High school	1,900 (30.9%)	8.2 $\pm$ 3.5	22.1 $\pm$ 11.7
others (did not reach high school)	627 (10.2%)	8.5 $\pm$ 3.7	22.6 $\pm$ 12.2

Total number of participants: 6,157 students, —SD, Standard Deviation.

Numerical variables were summarized as mean and standard deviation, while the categorical variables were summarized using percentages.

PSQI, Pittsburgh's Sleep Quality Index (46).

CES-D, Center for Epidemiologic Studies Depression Scale (47).

<sup>a</sup>p-value is obtained using t-test; <sup>b</sup>p-value is obtained using one-way-ANOVA.

\*Statistically significant p-value ( $\leq 0.05$ ).

2,031) woke up after 2 p.m. Forty percentage of the students ( $n = 2,463$ ) slept for more than 9 h and around 8% ( $n = 493$ ) slept more than 12 h a day.

More than one-fifth ( $n = 1,416$ ) of the students had to take medications to help them sleep during the quarantine. Around half of the students ( $n = 3,196$ ) experienced difficulties staying

**TABLE 4 |** Study participants statistics of quarantine factors, and their corresponding PSQI and CES-D scores.

Variable	N (N%)	PSQI Score Mean ± SD	CES-D Score Mean ± SD
Location of house during quarantine		(0.205 <sup>a</sup> )	(0.806 <sup>a</sup> )
Urban areas	5,315 (86.3%)	8.1 ± 3.5	22.2 ± 11.6
Rural areas	842 (13.7%)	8.3 ± 3.7	22.1 ± 12.4
Home specification		(1.36e-07 <sup>b</sup> )	(0.572 <sup>b</sup> )
Apartment with garden	1,176 (19.1%)	8.0 ± 3.5	22.0 ± 11.3
Apartment without a garden	2,174 (35.3%)	8.0 ± 3.5	22.4 ± 11.6
House with garden	2,210 (35.9%)	8.1 ± 3.6	22.0 ± 11.9
House without a garden	597 (9.7%)	9.0 ± 3.7	22.2 ± 12.3
Household income during quarantine		(4.37e-10 <sup>b</sup> )	(2.21e-07 <sup>b</sup> )
Increased	275 (4.5%)	8.6 ± 3.9	21.2 ± 11.2
Stay the same	2,640 (42.9%)	7.8 ± 3.5	21.2 ± 11.4
Decreased	2,467 (40.1%)	8.3 ± 3.5	23.0 ± 11.8
Stopped completely	775 (12.5%)	8.6 ± 3.7	23.0 ± 12.3
Number of people quarantined with		(1.49e-03 <sup>b</sup> )	(0.093 <sup>b</sup> )
Less than 4	941 (15.3%)	8.1 ± 3.7	21.6 ± 11.2
4–7	4,248 (69.0%)	8.1 ± 3.5	22.1 ± 11.7
8–10	845 (13.7%)	8.5 ± 3.6	22.7 ± 12.4
More than 10	123 (2.0%)	8.7 ± 3.8	23.8 ± 13.4
Number of children quarantined with		(5.58e-15 <sup>b</sup> )	(2.26e-06 <sup>b</sup> )
None	2,624 (42.6%)	7.9 ± 3.6	21.5 ± 11.4
1	1,447 (23.5%)	8.1 ± 3.4	22.0 ± 11.1
2	1,120 (18.2%)	8.3 ± 3.5	22.3 ± 12.2
3	513 (8.3%)	8.3 ± 3.5	23.9 ± 12.0
4–6	395 (6.4%)	9.1 ± 4.1	24.4 ± 12.9
More than 6	58 (1.0%)	10.8 ± 4.4	22.6 ± 16.7

Total number of participants: 6,157 students.

SD, Standard Deviation.

Numerical variables were summarized as mean and standard deviation, while the categorical variables were summarized using percentages.

PSQI, Pittsburgh's Sleep Quality Index (46).

CES-D, Center for Epidemiologic Studies Depression Scale (47).

<sup>a</sup>p-value is obtained using t-test.

<sup>b</sup>p-value is obtained using one-way-ANOVA.

\*Statistically significant p-value ( $\leq 0.05$ ).

awake while doing a daytime activity. Furthermore, around 80% ( $n = 4,870$ ) of the students found it challenging to stay enthusiastic in order to complete tasks during the quarantine (30%;  $n = 1,866$ , reported that this had been a minor problem, another 30%;  $n = 1,865$ , found this somewhat of a problem, and about 20%;  $n = 1,139$ , stated that this was a big problem they suffer from). According to self-reporting, nearly half of the students ( $n = 3,060$ ) had poor sleep quality (12.1%;  $n = 745$  very good, 38.2%;  $n = 2,352$  good, 27%;  $n = 1,662$  bad, and 22.7%;  $n = 1,398$  very bad).

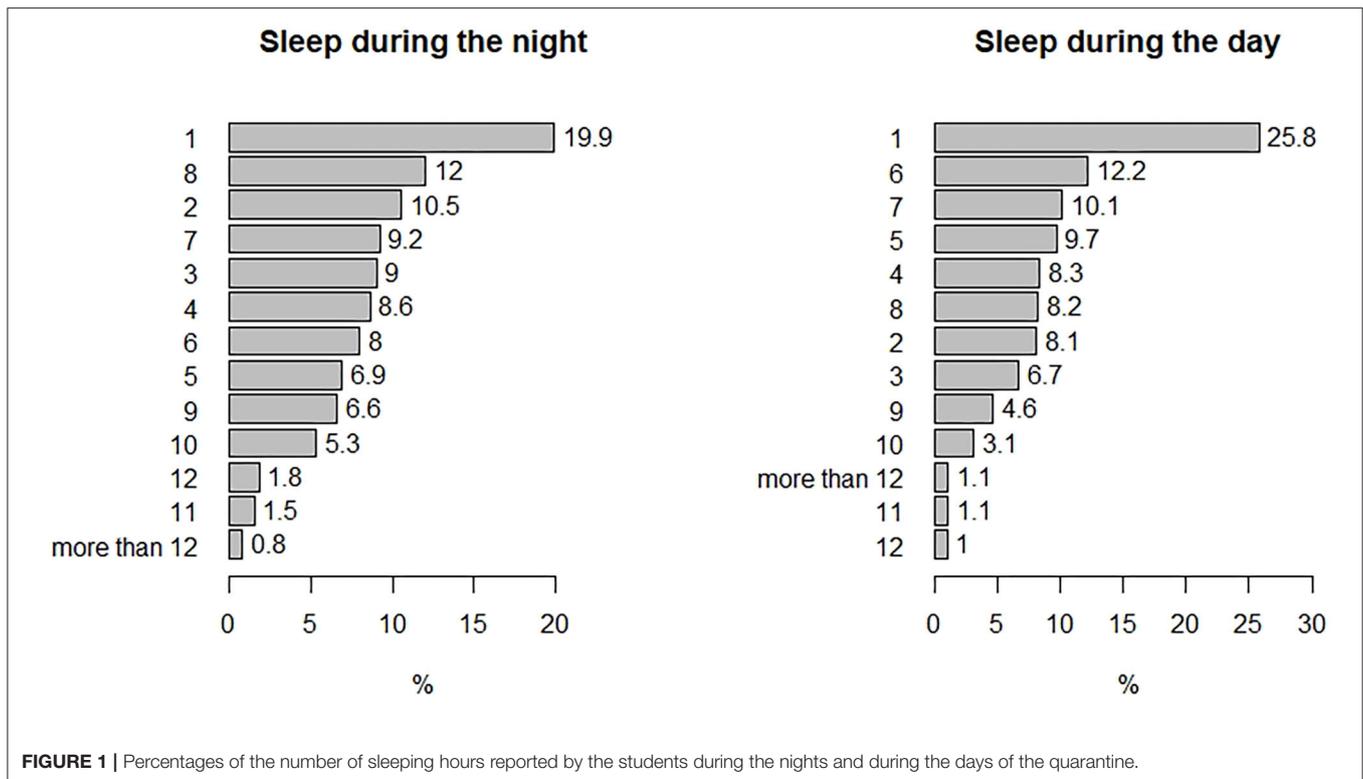
Other than the PSQI 19 items, the students were asked a few more questions regarding their sleeping habits during the quarantine. Almost all students (94.9%,  $n = 5,843$ ) reported that the quarantine affected their sleeping times (greatly: 72.5%;  $n = 4,464$ , slightly: 22.5%;  $n = 1,380$ ), only 5.1% ( $n = 316$ ) were not

affected. Around 65% ( $n = 4,002$ ) reverse their sleeping habits as they used to sleep most of the day and woke up most of the night during the quarantine. About 40% ( $n = 2,421$ ) of the students slept 3 h or less, around 10% ( $n = 584$ ) slept more than 10 h, and around 30% ( $n = 1,803$ ) slept more than 7 h during the day (**Figure 1**). Finally, only 10% ( $n = 611$ ) reported that quarantine affected their sleeping habits positively, whereas 74% ( $n = 4,539$ ) were negatively affected, while the rest ( $n = 1,010$ ) were not affected.

The PSQI mean scores for the different socio-demographic, socio-economic, and quarantine variables are presented in **Tables 3, 4**, with an overall mean score of  $8.1 \pm 3.6$ . The lowest PSQI score was  $7.5 \pm 3.6$  reported by the students with a household income level of 1,200–1,500 JD (**Table 3**), while the highest score was  $10.8 \pm 4.4$  reported by the students who were quarantined with more than six children (**Table 4**). A global PSQI score higher than 5 points indicates poor sleep quality (46). Thus, the prevalence of poor sleep quality among participants was 76% ( $n = 4,680$ ), with a mean PSQI score of 9.5 and a standard deviation of 2.9. The prevalence of poor sleep quality in male students was 71.5% ( $n = 1,264$ ) and in females was 77.8% ( $n = 3,416$ ) with very close PSQI scores of  $9.6 \pm 3.0$  and  $9.5 \pm 2.9$  for males and females, respectively (**Table 5**).

The only non-significant binary exposure was the quarantine's house location (*t*-test *p*-value: 0.2: **Table 4**). Other binary exposures, like gender, graduation status, and smoking habit, were significant (*t*-test *p*-value  $< 0.05$ ). Females, students in their final University semester, and smokers had a significant association with poor sleep quality than their inverse (**Table 3**). Students' field of study was also significantly associated with poor sleep quality (ANOVA *p*-value: 6.28e-06), where the mean difference between the humanities and each of the scientific and medical majors were significant (TukeyHSD *p*-values: 2.9e-05 and 2.5e-3, respectively). The humanities-related majors had a larger PSQI mean score than the scientific and medical majors (**Table 3**).

Besides, students' year of study was significantly associated with poor sleep quality (ANOVA *p*-value: 2.69e-05: **Table 3**), with the most significant difference between fresh students and those in their third, fourth, and fifth years. The economic status was significantly negatively associated with poor sleep quality (ANOVA *p*-value: 8.30e-13: **Table 3**), where the most significant mean difference was between lower and higher incomes. Similarly, the parents' education level was inversely associated with the PSQI scores (**Table 3**), with the significant difference between University degrees and school degrees. Furthermore, house specifications were found significantly associated with sleep quality (ANOVA *p*-value: 1.36e-07: **Table 4**); the highest PSQI scores were for those living in a house without a garden ( $9.0 \pm 3.7$ ). The income status during the quarantine had a significant association with the PSQI (ANOVA *p*-value: 4.37e-10: **Table 4**); when income stayed the same, the PSQI was the lowest ( $7.8 \pm 3.5$ ). Finally, the number of people and children quarantined with the student affected the poor sleep quality directly, such that the larger the number of the quarantined members, the higher the PSQI scores and thus the lower sleep quality (**Table 4**).



**FIGURE 1** | Percentages of the number of sleeping hours reported by the students during the nights and during the days of the quarantine.

All significant exposures (resulting from the pair-wise *t*-test/ANOVA) were combined into one model and analyzed using logistic regression (Table 6) to assess each factor's association with the poor sleep quality after controlling other factors. Females, students in their final semester, smokers, lower household income, living in a house without a garden, decreased income during the quarantine, and being quarantined with more than four children all have a significant association and a potentially higher risk of suffering from poor sleep quality (Table 6). The model was evaluated using the Backward selection method with an Akaike Information Criterion (AIC) of 6692.8 and a difference of 127.6 between residual and null deviance with 17 degrees of freedom.

## Psychological Findings of the Study Participants (Depressive Symptoms)

The CES-D mean scores for the different socio-demographic, socio-economic, and quarantine variables are presented in Tables 3, 4, with an overall mean score of  $22.2 \pm 11.7$ . However, students were divided into three groups based on their CES-D scores as suggested by a study on depression levels for hospital employees after the 2003 SARS epidemic (45); low level of depressive symptoms group with a CES-D score of  $<16$ , moderate level of depressive symptoms group with CES-D score between 16 and 24, and high level of depressive symptoms group with a CES-D score of  $>24$ . The prevalence of moderate and high depressive symptoms was higher in female students (34.3 and 38.4%, respectively) than the male students. Similarly, the CES-D

mean scores were higher in females in all groups than their male colleagues (Table 5). The overall mean CES-D score for the low depressive symptoms group is 9.3, for the moderate group is 19.8, while it is 34.3 for the high symptoms group (Table 5).

More than half of the students (62.5%,  $n = 3,851$ ) reported that the quarantine had a negative effect on their mental health, and only 10.4% ( $n = 640$ ) reported the opposite, whereas the rest (27.1%,  $n = 1,666$ ) were not affected. Around one-fifth ( $n = 1,285$ ) of the students reported a change in their attitude by becoming more anxious with hard-tempered than they used to be, while about one-tenth ( $n = 596$ ) reported a change in the opposite direction.

Using pair-wise *t*-test/ANOVA, only four factors were significantly associated with high depressive symptom levels; the gender (*t*-test *p*-value:  $4.02e-07$ : Table 3), father's education level (ANOVA *p*-value: 0.031: Table 3), household income during quarantine, and number of children quarantined with (ANOVA *p*-values:  $2.21e-07$  and  $2.26e-06$ , respectively: Table 4). However, the multinomial logistic regression results used to control for confounding factors and study the combined effect of the different exposures on the depressive symptoms state show a different pattern. Female students are more likely to suffer from moderate (Wald test *p*-value:  $6.08e-03$ ) and high (Wald test *p*-value:  $4.55e-07$ ) depressive symptoms than male students. Furthermore, smokers and students with decreased income during quarantine have higher risks for developing high depressive symptoms than their counterparts with Wald test *p*-values of  $7.78e-04$  and  $5.58e-07$ , respectively.

**TABLE 5 |** Sleep quality and depressive symptoms prevalence among the study participants based on PSQI and CES-D scores, respectively.

Participant groups	Factor	Prevalence as N (N%)	PSQI or CES-D Score as mean $\pm$ SD
Poor sleep quality	Male	1,264 (71.5%)	9.6 $\pm$ 3.0
	Female	3,416 (77.8%)	9.5 $\pm$ 2.9
	Total	4,680 (76.0%)	9.5 $\pm$ 2.9
Good sleep quality	Male	505 (28.5%)	3.7 $\pm$ 1.3
	Female	972 (22.2%)	3.8 $\pm$ 1.1
	Total	1,477 (24.0%)	3.8 $\pm$ 1.2
Low depressive symptoms (CES-D score < 16)	Male	569 (32.2%)	8.9 $\pm$ 5.3
	Female	1,201 (27.3%)	9.5 $\pm$ 5.2
	Total	1,770 (28.7%)	9.3 $\pm$ 5.2
Moderate depressive symptoms (16 $\leq$ CES-D score $\leq$ 24)	Male	597 (33.7%)	19.6 $\pm$ 2.5
	Female	1,503 (34.3%)	19.9 $\pm$ 2.4
	Total	2,100 (34.1%)	19.8 $\pm$ 2.5
High depressive symptoms (CES-D score > 24)	Male	603 (34.1%)	33.7 $\pm$ 8.1
	Female	1,684 (38.4%)	34.5 $\pm$ 7.9
	Total	2,287 (37.2%)	34.3 $\pm$ 8.0

Total number of participants: 6,157 students: 1,769 males, and 4,388 females.

SD, Standard Deviation.

PSQI, Pittsburgh's Sleep Quality Index (46).

Sleep quality cut-off value (poor quality: PSQI score > 5) is based on what was reported in Buysse et al. (46).

CES-D, Center for Epidemiologic Studies Depression Scale in Radloff (47).

Participant groups division is based on what was reported in Liu et al. (45).

## DISCUSSION

This study's participants were students from the University of Jordan, the largest public University in Jordan, Amman. UJ hosts about 35,000 students studying undergraduate and postgraduate degrees in humanities, science, and health disciplines. Seventy-six percent of the UJ students are females, and about half of the students (50.3%) study humanities-related majors. The total number of participants in this study was 6,157 students (represent 18% of the whole University students) who filled the online questionnaire. The questionnaire link was uploaded as part of several University compulsory courses which are mainly covered during the first 2 years of the majors, thus, explaining why around 77% of the participants were in year 1 and year 2, with a mean age of 20 years, whereas only 3.5% of the students were in their final semester (Table 3). This sample of participants is a good representative of the University demographics as 71.3% of the study participants are females, and 50.2% are studying humanities.

Moreover, this sample is representative of the Jordanian population. According to the national survey conducted by the National Council for Family Affairs (NCF) in 2017 (48), about 78% of the families that participated had 3–7 members, which is comparable to sample study demographics (Table 4). Furthermore, according to the NCF survey, about 57 and

42% of the families that participated lived in apartments and separate houses. This is consistent with the current study in which the students reported percentages of 54.4 and 45.6% correspondingly (Table 4). Regarding chronic diseases, non-communicable chronic diseases (NCCD) prevail in the society, as 14.5 and 7.2% suffer from diabetes and cardiovascular diseases, respectively. In this sample, 23 and 8% of the students were quarantined with a family member suffering from diabetes and cardiovascular diseases, respectively. Additionally, as reported by WHO (49), tobacco smoking is more prevalent in Jordanian males, where 70% of males aged more than 14 years are smokers (50). This explains the high percentage of nearly half of the students who were quarantined with a smoker. The preponderance of females who participated might account for the 16.3% reported smoker status (Table 3). Nevertheless, around 70% of the student participants were females. Although this represents the UJ community (public universities tend to admit students with high grades, which is more achievable by females than males in Jordan), it is not representative of the University student population in Jordan. This potential selection bias was controlled by logistic regression.

The impact of the extended quarantine on students' sleeping behavior is tremendously apparent. 94.9% of the students reported that their sleeping habits were affected; 74% in a negative way, especially in reversing the day-night activities (65%) and highly increasing or decreasing the quantity of sleeping hours, which resulted in reducing the quality of their sleep (~50%). These results can be explained by the staying-at-home order, distance-learning/working, banning outdoor activities, COVID-19 updates news all over the media, the broad and unprecedented closure, and many more different forced lifestyles, which affected the well-being of most if not all the Jordanians. All these factors contributed to the high prevalence of sleeping disorders among the participants, reaching 76% of the sample. The gender was significantly associated with lower sleep quality (Table 6; logistic regression coefficient  $p$ -value: 2.33e-09) and had significantly higher PSQI scores (Table 3;  $t$ -test  $p$ -value: 8.34e-04), with a clear difference in the prevalence between male (71.5%) and female (77.8%) students, which is aligned with the reported literature (51–54). However, a few studies reported the opposite (55, 56).

Furthermore, this study revealed that smokers had significantly lower sleep quality than non-smokers (Table 6; logistic regression coefficient  $p$ -value: 8.01e-05). A cross-sectional study from central China's general population reported that smokers demonstrated lower sleep quality and more sleeping disturbances, a finding supported by a plethora of other studies (57–60). One plausible explanation would be tobacco's effect and the changes it induces to the core circadian clock gene expression, which affects sleeping habits (61, 62). Likewise, the significant correlation between lower incomes and poor sleep quality (Table 6) is consistent with previous studies (53, 63, 64).

The parameters related to the University-study variables, including the effect of the study major, and year of study, impacted the sleep quality. The pair-wise significant association between studying in humanities and poor sleep quality when compared to medical and scientific students (Table 3; ANOVA  $p$ -value: 6.28e-06) as reported in this study contradicts what

**TABLE 6** | Association between poor sleep quality state and each of the identified significant exposures, as assessed by logistic regression<sup>†</sup>.

Coefficients	Estimate	p-value	Odds ratio	CI lower	CI upper
(Intercept)	0.827	5.41e-15*	2.287	0.621	1.036
Sex (Male)	-0.426	2.22e-09*	0.653	-0.565	-0.286
Graduation semester (yes)	0.404	0.027*	1.498	0.057	0.776
Smoking (yes)	0.360	8.01e-05*	1.434	0.183	0.541
Household income (0-200 JD)	0.726	2.74e-05*	2.068	0.392	1.072
Household income (200-400 JD)	0.371	0.002*	1.449	0.141	0.600
Household income (400-600 JD)	0.267	0.019*	1.307	0.043	0.491
Household income (600-800 JD)	0.237	0.045*	1.268	0.004	0.469
Household income (800-1,000 JD)	0.299	0.012*	1.348	0.066	0.530
Household income (1,000-1,200 JD)	0.134	0.328	1.143	-0.133	0.402
Household income (1,200-1,500 JD)	-0.180	0.218	0.835	-0.467	0.108
Home specification (Apart. without a garden)	-0.054	0.449	0.947	-0.194	0.086
Home specification (Apart. with a garden)	-0.001	0.989	0.999	-0.168	0.167
Home specification (House without a garden)	0.325	0.007*	1.383	0.092	0.564
Income during quarantine (Stopped)	0.097	0.341	1.101	-0.101	0.297
Income during quarantine (Increased)	0.175	0.253	1.191	-0.118	0.481
Income during quarantine (Decreased)	0.255	0.0001*	1.290	0.124	0.386
Quarantine with more than four children	0.516	0.009*	1.675	0.145	0.917

CI: Confidence Interval.

\*Statistically significant p-value ( $\leq 0.05$ ).

<sup>†</sup>Dependent variable: poor sleep quality state; calculated based on the suggested PSQI scores threshold of  $> 5$ , reported in Buysse et al. (46).

Baseline for Household Income is "more than 1,500 JD".

Baseline for Home specification is "House with a garden".

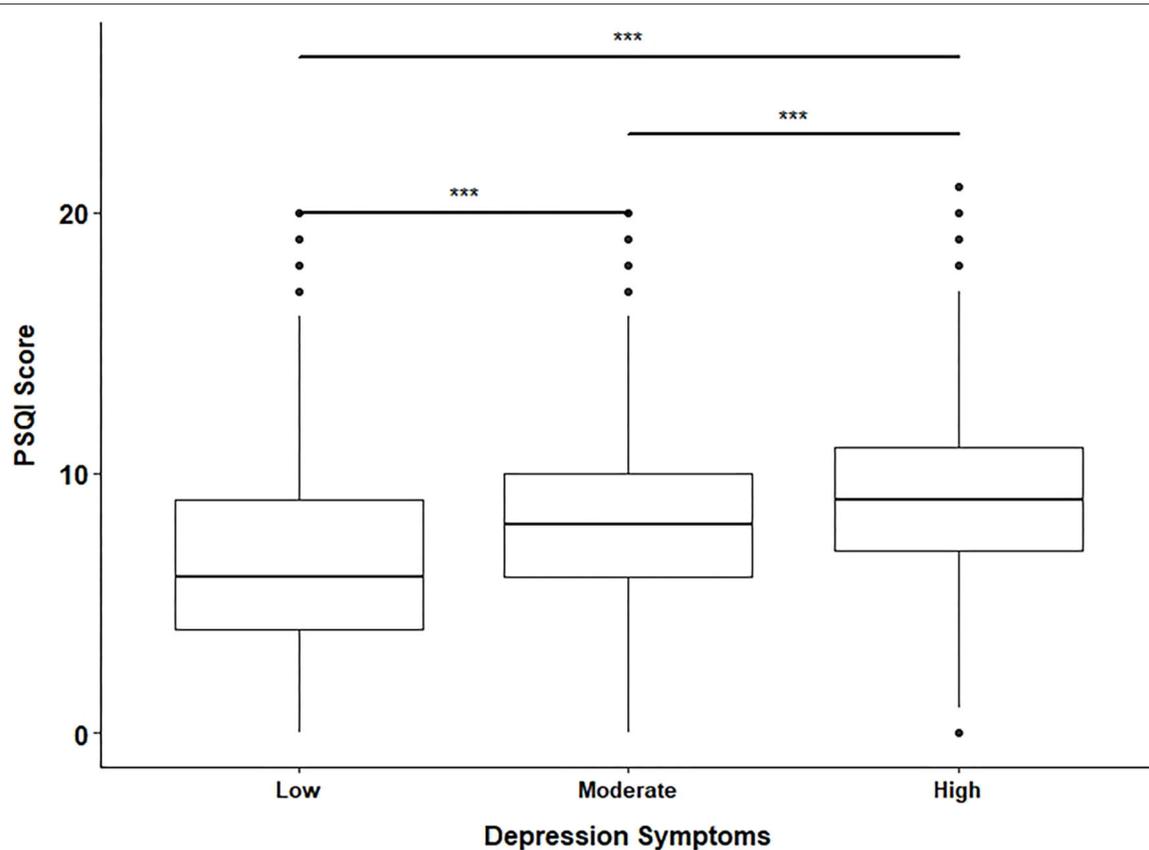
Baseline for Income during quarantine is "Stayed the same".

was reported in an abstract presented in SLEEP 2007; the 21st Annual Meeting of the Associated Professional Sleep Societies (APSS). It revealed that medical students suffer more from poor sleep quality than their peers in humanities majors (65). More-so, the pair-wise significant difference in respect to students' year of study (with the most significant difference between fresh students who had relatively better sleep and those in their third, fourth, and fifth years) is also consistent with a study of 860 medical students from 49 medical colleges in the United States, which revealed higher rates of sleeping disorders in first- and third-year students relative to second- and fourth-year students (66). It is not surprising that students in their final semester, or with low household income or decreased income during the unprecedented closure, significantly suffer from sleeping disturbances more than their peers (Table 6). Likewise, when the number of children the student quarantined with increase, their sleep quality decrease (Tables 4, 6). Interestingly, living in a house without a garden resulted in lower sleep quality (Table 6: logistic regression coefficient p-value: 0.009).

The assessment of the depressive symptoms among the Jordanian students is alarming as the prevalence of the high/and potentially-high risk group that showed high/and moderate depressive symptoms was 37.2 and 34.1%, respectively, with a total risk percentage of 71.3%. This is comparable to the 74.3% prevalence reported in Greece (23). Uncertainty and unclear plans for the academic semester and the grades probably left the students anxious and stressed. Besides, social distancing and lack

of social communication may have affected the students with loneliness and isolation, ultimately leading to more depressive symptoms and sad feelings. The female gender is considered a significant risk factor for high depressive symptoms (logistic regression coefficient p-value: 4.55e-07). The susceptibility of females to develop depressive symptoms was also reported in previous studies (67, 68). Female sensitivity to stress might be explained by the role sex steroids play in mood regulation (69). Depressive symptoms in low-income families were prevalent, regardless of quarantine (70, 71). During the quarantine, the effect of the sudden closure and losing the source of income with a lack of savings can lead to an unstable and stressful financial state. So, decreased income during quarantine is also significantly linked with higher depressive symptoms (logistic regression coefficient p-value: 5.58e-07). In addition, two previous studies conducted in Southwestern China and Canada showed similar findings; high levels of anxiety and depressive symptoms were correlated with low average household income (43, 72). Students in their final semester did not show significantly higher depressive symptoms than their colleagues (both categories had high CES-D scores; Table 3), albeit a study of home-quarantined students in China reported the opposite (73).

Finally, poor sleep quality is a risk factor for many chronic diseases' incidence and progression and psychological problems, including depression, anxiety, and suicidal behavior (64, 74-80). According to Celik et al. the risk of depressive symptoms in students with poor sleep quality was 3.28 times higher (81). This is consistent with this study's finding, as there



**FIGURE 2** | Box plot for PSQI scores of the three groups of depressive symptoms levels. The low depressive symptoms group was determined by a CES-D score <16, the moderate had a CES-D score between 16 and 24, while the high group had a score >24. The pair-wise comparisons between the three groups were significant. The  $p$ -values from the  $t$ -test were all < 0.001 (\*\*\*).

was a positive correlation between the PSQI scores and the severity of the depressive symptoms (**Figure 2**). In addition, non-pharmacological sleep interventions were found to be effective in reducing the severity of clinical depressive symptoms (82). Thus, engagement in healthy life patterns, including exercise, might help tackle these serious issues.

We acknowledge the limitations of this study. The sample was drawn from one University in the capital city of Amman. The quarantine effects, including sleep quality and depressive symptoms, could differ in other cities in Jordan. Also, the preponderance of earlier University year's students could have skewed the results. One significant limitation is the potential selection bias resulted from having around 70% of female participants. More balanced selection criteria would be better to apply. However, this factor was controlled in the logistic regression model. Another significant limitation is related to the deficiency of literature on the sleep quality and depressive symptoms scales before the quarantine on the Jordanian population, thus hindering any comparison outside the quarantine period. We recommend that this study be repeated outside the quarantine period, in other areas outside Amman, and to target older University students. Nevertheless, a recent pre-quarantine study reported moderate depressive

symptom levels for 600 University students in Jordan using the Depression, Anxiety, and Stress Scale (DASS-21) (83).

## CONCLUSION

In conclusion, this is the first study that evaluated the effect of the COVID-19 pandemic and the resultant quarantine among University students in Jordan. Poor sleep quality and depressive symptoms were prevalent among this group of participants. The results of this study should be taken seriously to address and guide policy-makers and authorities when planning for extended closures and lock-down. Repeating the study outside the COVID-19 pandemic might help to quantify these issues among University students better. The COVID-19 pandemic has infringed on many aspects of our lives. This has gone beyond the economic into the mental and psychological reverberation.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board and the Research Ethics Committee at UJ. The ethics committee waived the requirement of written informed consent for participation.

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## AUTHOR CONTRIBUTIONS

HS and MS conceived the idea, performed the analysis, and wrote the manuscript. MA-H co-wrote the manuscript and helped in design the study. WA, AA, NS, RA, HK, and SA-S contributed to collect the data and to the literature search. All authors contributed to the article and approved the submitted version.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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