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Anxiety and Depressive Symptoms are Associated with Poor Sleep Health During a Period of COVID-19 Induced Nation-wide Lockdown: A Cross-Sectional Analysis of Adults in The Middle East

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Abstract

Background: Previous research demonstrated increased prevalence of negative mental health outcomes during epidemics, and it is suggested that extended states of lock-down further heighten mental health outcomes. Jordan, a Middle Eastern country, declared a state of national emergency due to the novel coronavirus (COVID-19) and a strict nation-wide lockdown on March 17, 2020, banning all travel and movement around the country, potentially impacting mental health. This study sought to investigate the association between mental health (i.e., anxiety and depressive symptoms) and sleep health among a sample of Jordanians living through a state of COVID-19 induced nation-wide lockdown.

Methods: Using Facebook, participants in Jordan in March 2020 were recruited and direct to a web-based survey measuring anxiety, depressive symptoms, sleep health, and demographics. A modified Poisson regression model with robust error variance Adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were estimated to examine how anxiety and depressive symptoms may affect different dimensions of sleep health: 1) poor sleep quality, 2) short sleep duration, 3) encountering sleep problems.

Results: Anxiety was associated with poor sleep health outcomes. For example, corresponding to the dose-response relationship between anxiety and sleep health outcomes, those reporting severe anxiety were the most likely to experience poor sleep quality (aPR = 9.24; 95% CI =6.35–13.46), short sleep duration (aPR =2.25; 95% CI = 1.93–2.63), and at least one problem sleep problem (aPR = 1.76; 95% CI = 1.56–1.98). Moreover, depressive symptoms were also associated with poor sleep health outcomes. As compared to scoring in the first quartile, scoring in the second, third, and fourth quartile was associated with poor sleep quality (aPRs = 2.24, 5.44, and 12.38, respectively), short sleep duration (aPRs = 1.22, 1.42, and 1.90, respectively), and experiencing at least one sleep problem (aPRs = 1.41, 1.64, and 1.95, respectively).

Conclusions: Increased levels of anxiety and depressive symptoms can negatively influence sleep health among a sample of Jordanian adults living in a state of COVID-19 induced nation-wide lockdown.

Strengths and Limitations of this study

- This study utilized a relatively large sample for a population that is heavily understudied in public health research.
- To the best of our knowledge, this is the first study to examine this association among a Middle Eastern population and one of the first to investigate the impact of an extremely strict extended lockdown on health outcomes.
- The reliance of subjective measures for both the exposure and the outcome may have introduced bias.
- The generalizability of the results is an acknowledged concern given that participants were Jordanian using the social media platform, Facebook

Keywords: Coronavirus; COVID-19; Lockdown; Outbreak Control; Mental Health; Sleep Health

Introduction

On December 31, 2019, a pneumonia of unknown cause was first detected in Wuhan, the largest metropolitan area in China's Hubei province, and was reported to the World Health Organization (WHO) Country Office in China. A month later, the coronavirus (COVID-19) outbreak was declared as a public health emergency of international concern by the WHO. On March 2, 2020, Jordan detected its first COVID-19 case in the country. On March 11, 2020, as the number of COVID-19 cases outside China continued to increase, resulting in over 4,000 deaths at the time, WHO declared the COVID-19 a pandemic[1,2].

As the COVID-19 pandemic continued to unfold across the world, Jordan began detecting tens of cases, and decided to impose some of the strictest measures to combat an outbreak. On March 14, 2020, a travel ban was issued, and all borders in Jordan were blocked. Few days after, a strict nation-wide lockdown was implemented, and residents were not allowed on the streets[3]. Although lockdown ended in Wuhan, China on April 8, 2020 after 76 days of being implemented[4], Jordanians continued to live under some of the strictest measures of a lockdown for nearly two months until early May 2020. This included allowing some movement outside households for some days of the week while completely disallowing such movement on other days. Additionally, all parks, restaurant, cafes, and any public open spaces were shut down indefinitely. Groceries were only available through delivery to households, and no cars could be driven on the streets in all regions of the country.

While a lockdown is considered a recommended measure in combating an outbreak, an extended lockdown may have severe effects on people's social lives, mobility, and the overall economy[5]. This includes influencing a set of health outcomes among the general population and could be an activator of stressors, such as anxiety, and several other symptoms of poor mental health[6-9]. In the context of a prolonged strict lockdown measures, large-scale social isolation is also induced among the population. In Jordan, a large proportion of the population is employed in working-class jobs, such as those in the industrial or agricultural sectors, which require manual labor and typically offer low pay. The lockdown has left many Jordanians unemployed and without the daily income they depend on, imposing significant financial stress. For instance, in a report demonstrating the impact of lockdown in Jordan on households across the country, three-quarters of respondents (72.5%), among a sample of 12,084 Jordanian adults, indicated having difficulties covering basic needs (rent, food, heating and medicine) due to the lockdown measures[3]. Additionally, 63.3% indicated that they did not have a source of support in case they run out of food and basic amenities required for survival[3].

In general, previous research has consistently demonstrated that poor mental health is associated with multiple negative health outcomes, including poor sleep health[6-9]. The *Diagnostic and Statistical Manual of Mental Disorders* 5th *Edition*, widely used by psychiatrists across the globe, lists sleep disturbance as one of the possible symptoms required for the diagnosis of both major depressive disorder and generalized anxiety disorder. Negative mental health outcomes may be heightened in epidemics, such as during the COVID-19 pandemic[10]. For instance, Wang et al. demonstrated that the

COVID-19 pandemic and the restriction of freedom during lockdowns has been shown to have a significant psychological impact related to stress, depression and anxiety[11]. Additionally, Brooks et al., reported that such psychosocial health outcomes (e.g., stress, anger, and fear) could be further increased during the state epidemic-induced lockdowns[12].

Despite there being an abundance of literature on the prevalence of mental health issues during the times of epidemics, as well as its relationship with sleep health among various populations[6-10,13-15], few studies have investigated such an association during times of nation-wide lockdowns, especially in the Middle East. While lockdown measures could be effective in controlling the transmission of infection, such measures could influence other health outcomes unrelated to their current outbreak. Research has shown that sleep and the circadian system exert a strong regulatory influence on immune functions[16]. Sleep and the circadian system cooperate bidirectionally at the systemic and cellular level to organize immune functions intime and space via neuroendocrine and sympathetic effector mechanisms[17-20]. The relationship between sleep health and the immune system is particularly of importance during times of epidemics. For example, Prather et al. showed that among a sample of 164 healthy men and women, shorter sleep duration, measured behaviorally using actigraphy prior to viral exposure, was associated with increased susceptibility to the common cold[21].

In this study, we sought to investigate the associations between mental health issues, including anxiety and depressive symptoms, with poor sleep health among a sample of individuals residing in Jordan during a period of COVID-19 pandemic induced lockdown. This study is one of the first to examine associations between mental health and sleep health in The Middle East. We hypothesized that anxiety and depressive symptoms are associated with a higher risk of poor sleep health among a sample of Jordanians, after controlling for demographic covariates.

Methodology

Data and Study Sample

Facebook, a social media platform, was utilized to recruit a sample of individuals across Jordan during a period of nation-wide lockdown put in place due to the COVID-19 pandemic outbreak in March 2020. A post was placed on Facebook targeting Jordanians between the ages of 18 – 65 years old who were in Jordan for the duration of the last two weeks of March 2020. The survey was administered through Qualtrics, a platform for survey administration previously used in health research[22]. The survey was available to participants in both English and Arabic languages. The survey was originally written in English, and then translated independently by three bilingual researchers to Arabic. The survey was then piloted for readability and clarity among both English and Arabic speakers. The post was advertised for a period of four consecutive days and included assessment of eligibility and a total of 30 items including demographics and measures for various constructs. These included anxiety, depressive symptoms, and sleep health. Measures were taken to avoid duplicate answers by utilizing the “prevent ballot box stuffing” feature on Qualtrics. Additionally, internal protocol (IP) addresses associated

with responses were reviewed manually to ensure no duplicates were recorded. On average, the survey took 7 minutes for completion.

Overall, 3,462 participants clicked on the link and were redirected to the survey, of which 2,202 participants were eligible to participant. A total of 1,240 full responses were recorded, corresponding to a completion rate of 56.4% among those deemed eligible. Approximately, 67.4% of the respondents completed the survey in Arabic. Overall, the completion rate of those who clicked the linked to the survey was 36.5%. All protocols and procedures were approved by the University of Jordan Hospital Institutional Review Board prior to data collection.

Measures

Demographics

Four items were included to measure demographic variables among participants. Participants were asked to report their age (in years), gender (male or female), employment status (employed, self-employed, unemployed, student, or retired), and the city they currently reside in within Jordan. Cities were grouped into the following regions: Northern region (Irbid, Jerash, Balqa'a, Zarqa, Ajloun, and Mafraq), Central Region (Amman, Madaba, and Salt), Southern Region (Tafila, Karak, Ma'an, Aqaba, and Petra)

Anxiety

The General Anxiety Disorder 7-item (GAD-7) scale was used to measure anxiety among participants. The GAD-7 was developed to diagnose generalized anxiety disorders and has been validated in 2,740 primary-care patients[23]. Seven items were included in the survey, and participants' anxiety was determined according to their scoring on the item. A 7-item questionnaire was utilized where each item asked participants how often, during the last 2 weeks, they were bothered by a given symptom. Response options were "not at all," "several days," "more than half the days," and "nearly every day," scored as 0, 1, 2, and 3, respectively. Scores range from 0 to 21, with four categorizations of anxiety severity according to the score. Those who score between 0 to 4 were considered to have minimal anxiety, while those scoring between 5-9, 10-14, and 15-21 were noted to have mild, moderate, and severe anxiety, respectively. Cronbach's alpha was 0.87, indicating good internal consistency.

Depressive Symptoms

Ten (10) items were adopted from the Center for Epidemiologic Studies Depression Scale (CES-D). Those items were chosen to be consistent with cultural concerns regarding the topic of depression and to be appropriate when translated to the Arabic language. Response options were "rarely or none of the time (<1 day)", "some or a little of the time (1-2 days)", "occasionally or a moderate amount of time (3-4 days)", and "most or all of the time (5-7 days)", scored as 0,1,2, and 3, respectively. Three items worded in the positive direction were reverse coded and all items were summed for a total score, with

a possible range of 0-30. During data analysis, the total scores were divided in quartiles: the first quartile (Q1:0-3), the second quartile (Q2:4-6), the third quartile (Q3: 7-11), and the fourth quartile (Q4:12-27). Cronbach's alpha was 0.8145, indicating good internal consistency.

Sleep Health

Three items were adopted from the Pittsburgh Sleep Quality Index (PSQI), a reliable and validated tool [24], and included in the survey to measure for sleep health outcomes: sleep quality, sleep duration, and experiencing sleep problems. Sleep quality was measured using the item "During the past month, how would you rate your sleep quality overall?"[25]. Participants were asked to choose one of four options, including "Very good", "Fairly good", "Fairly bad", and "Very bad". Consistent with previous research on sleep health[26-29], the four response options were dichotomized in statistical analysis good sleep quality (e.g., includes "very good" and "fairly good") and poor sleep quality (e.g., includes "very bad" and "fairly bad"). To measure sleep duration, we used the question asking, "During the past month, how many h of actual sleep did you get each night? (This may be different from the number of hours you spent in bed.)"[25]. Participants then reported their response in hours as integers with one decimal place allowed (e.g., halves). Short sleep duration was defined as 7 hours or less[26,30,31]. Finally, sleep problems were assessed by asking the participants if they experienced any of three sleep-related problems in the past two weeks (e.g., the period of lock-down). Three statements were presented, and participants were given a "Yes" or "No" response options. These statements were "1) "I had trouble sleeping because I could not get to sleep within 30 min." (i.e., problems falling asleep) 2). "I had trouble staying awake while driving, eating meals, or engaging in social activity." (i.e., problems staying awake in the daytime also known as daytime sleepiness) 3) "I took medicine (prescribed or "over the counter") to help me sleep"[27]

Statistical Analysis

The study population included individuals aged 18 years and older (n = 1,240). Descriptive statistics (frequencies, percentages) were calculated for demographic characteristics, anxiety, and depression according to sleep health outcomes (poor sleep quality, short sleep duration, and experiencing sleep problems). Chi-square or Fisher's exact tests were used to examine the differences in demographic characteristics, anxiety, and depression between those with and without each sleep health outcome.

The association between anxiety, depression, and each poor sleep outcome was assessed using a modified Poisson regression model with robust error variance. The multivariable analysis adjusted for age, gender, employment status, and region. Adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were estimated. P-values for trend were calculated using logistic regression. Two-sided $p < 0.05$ was considered statistically significant. Data were analyzed using Stata 16.0 (StataCorp, College Station, TX, USA).

Results

Table 1 presents the participants sociodemographic characteristics, anxiety, and depressive symptoms according to sleep health outcomes. The mean age was 37.35 (SD = 11.01), with over 60% of our sample aged less than 40 years old. Approximately half of the sample (52.9%) were males. Additionally, more than three quarters of the participants reported residing in the Central region (78.2%), followed by the Northern region (19.1%). Most of the participants were either employed (54.3%) or self-employed (16.5%), while 17.6% reported being unemployed or 4.6% were retired at the current time. In terms of anxiety, 53% of the participants reported symptoms for mild (33.8%), moderate (12.9%), or severe anxiety (6.3%) during the period of national lockdown. Furthermore, approximately a quarter of our sample scored in each of the four quartiles for the depressive symptoms measures (e.g., 26.9% in the lowest quartile, 24.8% in the second quartile, 26.8% in the third quartile, and 21.5% in the highest quartile. Finally, and when measuring for sleep health outcomes, 17.9% of the participants reported poor sleep quality, 46.8% reported short sleep duration (equal or less than 7 hours of sleep on average for every night over the past week), while 63.7% reported experiencing at least one sleep problem over the past week.

Multivariable regressions with 95% confidence intervals were calculated to investigate the relationship between anxiety, depressive symptoms, and sleep health outcomes. The results, after adjusting for sociodemographic covariates, are presented in Table 2. Anxiety was associated with poor sleep health outcomes. Results demonstrated a dose-response relationship, as the aPRs for poor sleep health increased with increasing levels of both anxiety and depressive symptoms. Compared to those who reported minimal anxiety, participants reporting mild anxiety were more likely to experience poor sleep quality (aPR = 3.10; 95% CI = 2.15–4.49), short sleep duration (aPR = 1.36; 95% CI = 1.18–1.57), and at least one problem sleep problem (aPR = 1.43; 95% CI = 1.29–1.58). Similarly, those reporting moderate anxiety were more likely to experience poor sleep quality (aPR = 6.06; 95% CI = 4.17 – 8.82), short sleep duration (aPR = 1.75; 95% CI = 1.49–2.06), and at least one problem sleep problem (aPR = 1.59; 95% CI = 1.42–1.78) compared to those reporting minimal anxiety. Similarly, and corresponding to the dose-response relationship between anxiety and sleep health outcomes, those reporting severe anxiety were the most likely to experience poor sleep quality (aPR = 9.24; 95% CI = 6.35–13.46), short sleep duration (aPR = 2.25; 95% CI = 1.93–2.63), and at least one problem sleep problem (aPR = 1.76; 95% CI = 1.56-1.98). P-trend <0.001 for all sleep outcomes.

Depressive symptoms were also associated with poor sleep health outcomes. This association also demonstrated dose-response relationship. As compared to scoring in the first quartile, scoring in the second, third, and fourth quartile was significantly associated with poor sleep quality (aPRs = 2.24, 5.44, and 12.38, respectively), short sleep duration (aPRs = 1.22, 1.42, and 1.90, respectively), and experiencing at least one sleep problem (aPRs =1.42, 1.64, and 1.95, respectively).

Discussion

This study is the first to empirically explore both mental health and sleep health measures during nationwide lockdown in response to the COVID-19 pandemic. It is also the first study to evaluate associations between mental health and sleep health in Jordan, and one of few studies to address the relationship between these measures among a severely understudied population; Middle Eastern adults. To the best of our knowledge, there is only one other study that has assessed sleep health in Jordan, which reported that poor sleep health, including a high risk of obstructive sleep apnea, snoring, and daytime sleepiness, was common among Jordanians attending primary care clinics[32].

In our study, the majority of participants reported having experienced mild (33.8%), moderate (12.9%), or severe (6.3%) levels of anxiety during lockdown, and nearly half of respondents reported depressive symptoms during lockdown. Similarly, over 60 percent of participants reported having experienced at least one sleep problem in the last week, and nearly half reported having had short sleep duration. In addition, we found that increased levels of reported anxiety or depression were both significantly associated with an increase in poor sleep health outcomes among Jordanians during lockdown in response to the COVID-19 pandemic.

These findings suggest the possible impact that economic, social, or health-related circumstances caused by nation-wide lockdown can have in exacerbating anxiety, depressive symptoms, and poor sleep health among respondents in Jordan. Particular to the context of lockdown in response to the COVID-19 pandemic, the Jordanian government did not provide economic support, financial incentives (e.g., stimulus), or loan forgiveness schemes to support individuals who may have lost significant portions of their income or faced additional financial obligations as a result of lockdown and their inability to engage with their given occupations consistently[3]. As a result, these economic circumstances may have contributed to increased anxiety, reported depressive symptoms, and poor sleep health. While it is expected that these economic circumstances would affect adult men in particular because they are typically considered financial providers for their families in the context of Jordanian culture[33], reported rates of anxiety, depressive symptoms, and poor sleep health were comparable between male and female respondents. This is the case despite that within Jordan, a larger proportion of men work outside the home than women. That being said, because childcare, elderly care, and housework are typically women's responsibilities in this context, the lockdown restrictions would be expected to disproportionately affect women's economic resilience, mental well-being, and sleep health, especially given rising levels of domestic violence and reduced access to sexual and reproductive health services during lockdown[34,35]. It should be noted that studies have shown that men tend to have a higher prevalence of sleep disorders such as obstructive sleep apnea, other studies have found that women are more likely than men to report an increased burden of depressive symptoms as a result of poor sleep health[36].

Other factors that have been found to affect sleep health and mental health outcomes that are also expected to be relevant or exacerbated during lockdown situations include tobacco or khat use, daytime sleepiness, atypical work schedules, low levels of physical

activity, and violent or poor familial environments in households[37-41]. The increased recreational screen time during lockdown spent watching television, using a computer, or utilizing smartphones and the reality of isolation with limited social contact would also be expected to contribute to poor mental health outcomes, including anxiety and depressive symptoms, found in our study[41-43]. In addition, unemployment has been noted to be associated with diminished mental health and is negatively correlated with sleep health measures[44]. Approximately 25% of unemployed or retired respondents in our study reported having experienced at least one sleep problem in the last week and short sleep duration. These risk factors are not only expected to work in tandem but are also expected to expose underlying vulnerabilities that also contribute to poor mental health and sleep health.

Our findings that increased levels of self-reported anxiety or depression were significantly associated with an increase in poor sleep health outcomes can potentially be explained by the relationship between mental health and sleep health. The pathway by which depression alters sleep is thought to be through the loss of deep, slow-wave sleep and an increase in nocturnal arousal. The combination of these two effects contributes to a decrease in non-REM sleep, which may subsequently result in reduced REM sleep latency[45]. Several studies have shown the association between depression and the disruption of REM sleep[46,47]. Furthermore, the cause of depression is most commonly attributed to the dysregulation of monoamines, such as serotonin, dopamine, norepinephrine, and dopamine. An individual's transition to REM sleep is typically accompanied by a rapid decrease in these monoamines[48], and such dysregulation may be associated with the disruption of REM sleep and the subsequent onset of depressive symptoms . Research has also demonstrated that depression is correlated with increased inflammatory markers and that depressive symptoms can be reduced by decreasing that inflammation[49]. As such, sleep loss has been associated with the increased production of inflammatory markers, such as C-reactive protein and interleukins[50]. Though the exact mechanism is not fully understood, there appears to be a relationship between sleep disturbance, inflammation, and depression [49,51]. Another potential pathway by which sleep disturbances and depression interact is through alternations in one's circadian rhythm. An individual's circadian rhythm is crucial to maintaining the sleep-wake cycle, and it has been observed that depression disrupts circadian rhythm[52].

When evaluating the potential consequences of lockdown during a pandemic such as COVID-19, it is critical to consider how lockdown may predispose individuals to risk factors that impact mental health and sleep health. Poor sleep habits, anxiety, and depression are all recognized as affecting overall health and contributing to a number of risk factors for cardiovascular disease, obesity, hypertension, hyperlipidemia, and diabetes, among other chronic conditions that are increasingly prevalent in Jordan [53]. Similarly, poor mental health and sleep health are also found to be associated with excessive alcohol use and substance use[6,54]. Given that poor sleep habits, anxiety, and depression are also associated with decreased immune responsiveness, it is especially important to consider how the impacts of nation-wide lockdown on sleep health and mental health may make individuals particularly vulnerable to SARS-CoV-2, the causative agent of COVID-19, or other highly infectious pathogens[55].

The study findings, the lack of interventions in place to support the population during strict lockdowns (e.g., financial incentives, mental health resources), and the absence of discourse to address poor sleep health or mental health as a result of nation-wide lockdown highlight a gap in policymaking and planning during health emergencies and disease outbreaks in Jordan and likely in other countries. While the impact of lockdown on sleep health and mental health is not expected to be unique to Jordan, future research should focus on further elucidating the determinants of poor sleep health and mental health during lockdown and exploring the potential interactive impacts of specific risk factors that are exacerbated during lockdown on mental health and sleep health and their subsequent effects on susceptibility to disease. Future attention should also focus on articulating policies and designing interventions to not only address identified determinants and risk factors but also to uphold an international standard of individuals' right to health[56], especially for vulnerable and disadvantaged populations.

Limitations

This study's methodology is subject to several limitations. First, the sample population only includes individuals utilizing one social media platform, which introduces self-selection and volunteer bias and limits the generalizability of this study. Second, the information collected using the online survey includes exclusively self-reported data. As a result, responses, especially those measuring sleep health and mental health, can be considered subjective, decreasing the reliability of the study findings. Third, because our analysis did not adjust for additional confounding factors, such as substance use, residual confounding may have been introduced. Finally, given that this study utilizes a cross-sectional survey design, it cannot be used to analyze sleep health and mental health measures over an extended period of time.

Conclusions

This study provides evidence of reported anxiety and depressive symptoms and their association with poor sleep health outcomes during lockdown in Jordan in the face of the COVID-19 pandemic. Our findings draw attention to the potential negative consequences of lockdown and their impact on an individual's overall health, emphasizing the need for public health professionals and governments to not only monitor health profiles during lockdown but also to create interventions aimed at improving health and well-being, especially for vulnerable populations. More attention is required to investigate the impacts of lockdown in exacerbating risk factors for poor mental health and sleep health, and future interventions and policies should be tailored toward addressing identified risk factors and improving health outcomes in the context of nation-wide lockdown.

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Table 1. Participants' characteristics, anxiety and depression by poor sleep health, N(%)

	Total	Poor sleep quality	*p*[a]	Short sleep duration (≤7 h)	*p*[a]	Sleep problems	*p*[a]
Total	1,240 (100.0)	222 (17.9)		580 (46.8)		790 (63.7)	
Age							
18-24	127 (10.2)	21 (9.5)	0.156	37 (6.4)	**<0.001**	77 (9.8)	0.769
25-29	188 (15.2)	46 (20.7)		82 (14.1)		126 (16.0)	
30-39	471 (38.0)	82 (36.9)		226 (39.0)		303 (38.4)	
40-49	271 (21.9)	47 (21.2)		134 (23.1)		172 (21.8)	
≥50	172 (13.9)	26 (11.7)		96 (16.6)		106 (13.4)	
Missing	11 (0.9)	0 (0.0)		5 (0.9)		6 (0.8)	
Gender							
Male	656 (52.9)	105 (47.3)	0.063	285 (49.1)	**0.012**	404 (51.1)	0.104
Female	583 (47.0)	117 (52.7)		295 (50.9)		385 (48.7)	
Missing	1 (0.1)	0 (0.0)		0 (0.0)		1 (0.1)	
Employment							
Employed	673 (54.3)	113 (50.9)	0.286	320 (55.2)	**0.015**	418 (52.9)	0.155
Self-employed	205 (16.5)	36 (16.2)		85 (14.7)		131 (16.6)	
Student	84 (6.8)	13 (5.9)		30 (5.2)		49 (6.2)	
Unemployed/retired	275 (22.2)	60 (27.0)		145 (25.0)		190 (24.1)	
Missing	3 (0.2)	0 (0.0)		0 (0.0)		2 (0.3)	
Region[b]							
Northern	237 (19.1)	45 (20.3)	0.767	99 (17.1)	0.077	152 (19.2)	0.535
Central	970 (78.2)	170 (76.6)		461 (79.5)		614 (77.7)	
Southern	33 (2.7)	7 (3.2)		20 (3.5)		24 (3.0)	
Anxiety							
Minimal anxiety (0-4)	583 (47.0)	37 (16.7)	**<0.001**	212 (36.6)	**<0.001**	292 (37.0)	**<0.001**
Mild (5-9)	419 (33.8)	80 (36.0)		205 (35.3)		301 (38.1)	
Moderate (10-14)	160 (12.9)	60 (27.0)		100 (17.2)		128 (16.2)	
Severe (15-21)	78 (6.3)	45 (20.3)		63 (10.9)		69 (8.7)	
Difficulties caused by depression							
Not at all	650 (52.4)	72 (32.4)	**<0.001**	267 (46.0)	**<0.001**	369 (46.7)	**<0.001**
Several days	432 (34.8)	91 (41.0)		222 (38.3)		305 (38.6)	

Over half the days	96 (7.7)	34 (15.3)		53 (9.1)		69 (8.7)	
Nearly everyday	58 (4.7)	25 (11.3)		36 (6.2)		46 (5.8)	
Missing	4 (0.3)	0 (0.0)		2 (0.3)		1 (0.1)	
Depression							
Quartile 1 (0-3)	333 (26.9)	12 (5.4)	**<0.001**	117 (20.2)	**<0.001**	144 (18.2)	**<0.001**
Quartile 2 (4-6)	308 (24.8)	25 (11.3)		132 (22.8)		188 (23.8)	
Quartile 3 (7-11)	332 (26.8)	65 (29.3)		159 (27.4)		234 (29.6)	
Quartile 4 (12-27)	267 (21.5)	120 (54.1)		172 (29.7)		224 (28.4)	

[a]Chi-square test or Fisher's exact test

[b]Northern region includes Irbid (N=110), Jerash (N=10), Balqa'a (N=3), Zarqa (N=91), Ajloun (N=7), Mafrqa (N=16); Central Region includes Amman (N=925), Madaba (N=19), Salt (N=26); Southern Region includes Tafila (N=2), Karak (N=6), Ma'an (N=6), Aqaba (N=15), and Petra (N=4)

Table 2. Multivariable association (aPRs)[a] between anxiety, depression, and poor sleep health.

	Poor sleep quality	Short sleep duration (≤7 hours)	Sleep problems
	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)
Anxiety			
Minimal anxiety (0-4)	Referent	Referent	Referent
Mild (5-9)	3.10 (2.15, 4.49)**	1.36 (1.18, 1.57)**	1.43 (1.29, 1.58)**
Moderate (10-14)	6.06 (4.17, 8.82)**	1.75 (1.49, 2.06)**	1.59 (1.42, 1.78)**
Severe (15-21)	9.24 (6.35, 13.46)**	2.25 (1.93, 2.63)**	1.76 (1.56, 1.98)**
P for trend	<0.001	<0.001	<0.001
Depression			
Quartile 1 (0-3)	Referent	Referent	Referent
Quartile 2 (4-6)	2.24 (1.15, 4.36)*	1.22 (1.01, 1.48)*	1.42 (1.21, 1.65)**
Quartile 3 (7-11)	5.44 (2.98, 9.90)**	1.42 (1.18, 1.71)**	1.64 (1.42, 1.90)**
Quartile 4 (12-27)	12.38 (6.98, 21.96)**	1.90 (1.60, 2.25)**	1.95 (1.70, 2.23)**
P for trend	<0.001	<0.001	<0.001

[a]Adjusted for age, gender, region, and employment
aPR=adjusted prevalence ratio; CI=confidence interval
*p<0.05; **p<0.001

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5,6*
Bias	9	Describe any efforts to address potential sources of bias	4, 5
Study size	10	Explain how the study size was arrived at	-
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7, 16-17
		(b) Indicate number of participants with missing data for each variable of interest	7, 16-17
Outcome data	15*	Report numbers of outcome events or summary measures	7, 16-17

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7, 16-17
		(*b*) Report category boundaries when continuous variables were categorized	7, 16-17
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7, 16-17
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Anxiety and Depressive Symptoms are Associated with Poor Sleep Health During a Period of COVID-19 Induced Nation-wide Lockdown: A Cross-Sectional Analysis of Adults in Jordan

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Anxiety and Depressive Symptoms are Associated with Poor Sleep Health During a Period of COVID-19 Induced Nation-wide Lockdown: A Cross-Sectional Analysis of Adults in Jordan

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Abstract

Background: Jordan, a Middle Eastern country, declared a state of national emergency due to the novel coronavirus (COVID-19) and a strict nation-wide lockdown on March 17, 2020, banning all travel and movement around the country, potentially impacting mental health. This study sought to investigate the association between mental health (e.g., anxiety and depressive symptoms) and sleep health among a sample of Jordanians living through a state of COVID-19 induced nation-wide lockdown.

Methods: Using Facebook, participants (N=1,240) in Jordan in March 2020 were recruited and direct to a web-based survey measuring anxiety (items from GAD-7 instrument), depressive symptoms (items from DES-10), sleep health (items from the PSQI), and sociodemographic. A modified Poisson regression model with robust error variance. Adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were estimated to examine how anxiety and depressive symptoms may affect different dimensions of sleep health: 1) poor sleep quality, 2) short sleep duration, 3) encountering sleep problems.

Results: The majority of participants reported having experienced mild (33.8%), moderate (12.9%), or severe (6.3%) levels of anxiety during lockdown, and nearly half of respondents reported depressive symptoms during lockdown. Similarly, over 60 percent of participants reported having experienced at least one sleep problem in the last week, and nearly half reported having had short sleep duration. Importantly, Anxiety was associated with poor sleep health outcomes. For example, corresponding to the dose-response relationship between anxiety and sleep health outcomes, those reporting severe anxiety were the most likely to experience poor sleep quality (aPR =8.95; 95% CI =6.12–13.08), short sleep duration (aPR =2.23; 95% CI = 1.91–2.61), and at least one problem sleep problem (aPR = 1.73; 95% CI = 1.54–1.95). Moreover, depressive symptoms were also associated with poor sleep health outcomes. As compared to scoring in the first quartile, scoring fourth quartile was associated with poor sleep quality (aPR = 11.82; 95% CI = 6.64 – 21.04), short sleep duration (aPR = 1.87; 95% CI = 1.58–2.22), and experiencing at least one sleep problem (aPR = 1.90; 95% CI = 1.66 – 2.18).

Conclusions: Increased levels of anxiety and depressive symptoms can negatively influence sleep health among a sample of Jordanian adults living in a state of COVID-19 induced nation-wide lockdown.

Strengths and Limitations of this study

- This study utilized a relatively large sample for a population that is heavily understudied in public health research, as well as an increased number of exposure and outcome measures compared to the existing research conducted in the region.
- To the best of our knowledge, this is the first study to examine this association among a Middle Eastern population and one of the first to investigate the impact of an extremely strict extended lockdown on health outcomes.

- The reliance of subjective measures for both the exposure and the outcome may have introduced bias.
- The generalizability of the results is an acknowledged concern given that participants were Jordanian using the social media platform, Facebook.

Keywords: Coronavirus; COVID-19; Lockdown; Outbreak Control; Mental Health; Sleep Health

Introduction

On December 31, 2019, a pneumonia of unknown cause was first detected in Wuhan, the largest metropolitan area in China's Hubei province, and was reported to the World Health Organization (WHO) Country Office in China. A month later, the coronavirus (COVID-19) outbreak was declared as a public health emergency of international concern by the WHO. On March 2, 2020, Jordan detected its first COVID-19 case in the country. On March 11, 2020, as the number of COVID-19 cases outside China continued to increase, resulting in over 4,000 deaths at the time, WHO declared the COVID-19 a pandemic.[1,2]

As the COVID-19 pandemic continued to unfold across the world, Jordan began detecting tens of cases, and decided to impose some of the strictest measures to combat an outbreak. On March 14, 2020, a travel ban was issued, and all borders in Jordan were blocked. Few days after, a strict nation-wide lockdown was implemented, and residents were not allowed on the streets[3]. Although lockdown ended in Wuhan, China on April 8, 2020 after 76 days of being implemented[4], Jordanians continued to live under some of the strictest measures of a lockdown for nearly two months until early May 2020. This included allowing some movement outside households for some days of the week while completely disallowing such movement on other days. Additionally, all parks, restaurants, cafes, and any public open spaces were shut down indefinitely. Groceries were only available through delivery to households, and no cars could be driven on the streets in all regions of the country.

While a lockdown is considered a recommended measure in combating an outbreak, an extended lockdown may have severe effects on people's social lives, mobility, and the overall economy[5]. This includes influencing a set of health outcomes among the general population and could be an activator of stressors, such as anxiety, and several other symptoms of poor mental health[6-9]. In the context of a prolonged strict lockdown measures, large-scale social isolation is also induced among the population. In Jordan, a large proportion of the population is employed in working-class jobs, such as those in the industrial or agricultural sectors, which require manual labor and typically offer low pay. The lockdown has left many Jordanians unemployed and without the daily income they depend on, imposing significant financial stress. For instance, in a report demonstrating the impact of lockdown in Jordan on households across the country, three-quarters of respondents (72.5%), among a sample of 12,084 Jordanian adults, indicated having difficulties covering basic needs (rent, food, heating and medicine) due to the lockdown measures[3]. Additionally, 63.3% indicated that they did not have a source of support in case they run out of food and basic amenities required for survival[3].

In general, previous research has consistently demonstrated that poor mental health is associated with multiple negative health outcomes, including poor sleep health[6-9]. The *Diagnostic and Statistical Manual of Mental Disorders* 5th *Edition*, widely used by psychiatrists across the globe, lists sleep disturbance as one of the possible symptoms required for the diagnosis of both major depressive disorder and generalized anxiety disorder. Negative mental health outcomes may be heightened in epidemics, such as during the COVID-19 pandemic[10]. For instance, Wang et al. demonstrated that the

COVID-19 pandemic and the restriction of freedom during lockdowns has been shown to have a significant psychological impact related to stress, depression and anxiety[11]. Additionally, Brooks et al., reported that such psychosocial health outcomes (e.g., stress, anger, and fear) could be further increased during the state epidemic-induced lockdowns[12].

Importantly, research has shown that sleep and the circadian system exert a strong regulatory influence on immune functions[13]. Sleep and the circadian system cooperate bidirectionally at the systemic and cellular level to organize immune functions intime and space via neuroendocrine and sympathetic effector mechanisms[14-17]. The relationship between sleep health and the immune system is particularly of importance during times of epidemics. For example, Prather et al. showed that among a sample of 164 healthy men and women, shorter sleep duration, measured behaviorally using actigraphy prior to viral exposure, was associated with increased susceptibility to the common cold[18]. While there is a literature on the prevalence of mental health issues during the times of epidemics[19-24], as well as its relationship with sleep health among various populations [6-10,25-27], few studies have investigated such an association during times of nation-wide lockdowns[28-30], especially in the Middle East. Lockdown measures could be effective in controlling the transmission of infection, such measures could influence other health outcomes unrelated to their current outbreak, including sleep.

In this study, we sought to investigate the associations between mental health issues, namely anxiety and depressive symptoms, with poor sleep health among a sample of individuals residing in Jordan during a period of COVID-19 pandemic induced lockdown. We hypothesized that anxiety and depressive symptoms will be associated with a higher risk of poor sleep health among a sample of Jordanians, after controlling for demographic covariates.

Methodology

Data and Study Sample

Facebook, a social media platform, was utilized to recruit a sample of individuals across Jordan during a period of nation-wide lockdown put in place due to the COVID-19 pandemic outbreak in March 2020. Facebook was the platform of choice given its large spread among the Jordanian population, with approximately 83.21% of the population (9,903,802) being active users on Facebook in March 2020[31]. An advertised post was placed on Facebook targeting Jordanians between the ages of 18 – 65 years old who were in Jordan for the duration of the last two weeks of March 2020. The post was also placed by an independent researcher, and snowball sampling was also enabled by allowing the advertised post to be shared by individuals on Facebook. The survey was administered through Qualtrics, a platform for survey administration previously used in health research[32]. The survey was available to participants in both English and Arabic languages. The survey was originally written in English, and then translated independently by three bilingual researchers to Arabic. The survey was then piloted for readability and clarity among both English and Arabic speakers. The post was advertised for a period of four consecutive days and included assessment of eligibility and a total of 30 items including sociodemographic and measures for various constructs. These

included anxiety, depressive symptoms, and sleep health. Measures were taken to avoid duplicate answers by utilizing the "prevent ballot box stuffing" feature on Qualtrics. Additionally, internal protocol (IP) addresses associated with responses were reviewed manually to ensure no duplicates were recorded. On average, the survey took 7 minutes for completion.

Overall, 3,462 participants clicked on the link and were redirected to the survey, of which 2,202 participants were eligible to participant. 22 responses were excluded for being aged less than 18 years old. Overall, a total of 1,240 full responses were recorded, corresponding to a completion rate of 56.4% among those deemed eligible. Approximately two-thirds (67.4%) of the respondents completed the survey in Arabic. Overall, the completion rate of those who clicked the linked to the survey was 36.5%. All protocols and procedures were approved by the University of Jordan Hospital Institutional Review Board prior to data collection.

Patient and Public Involvement

No patient involved.

Measures

Anxiety

The General Anxiety Disorder 7-item (GAD-7) scale was used to measure anxiety among participants. The GAD-7 was developed to diagnose generalized anxiety disorders and has been validated in 2,740 primary-care patients[33]. Seven items were included in the survey, and participants' anxiety was determined according to their scoring on the item. A 7-item questionnaire was utilized where each item asked participants how often, during the last 2 weeks, they were bothered by a given symptom. Response options were "not at all," "several days," "more than half the days," and "nearly every day," scored as 0, 1, 2, and 3, respectively. Scores range from 0 to 21, with four categorizations of anxiety severity according to the score. Those who score between 0 to 4 were considered to have minimal anxiety, while those scoring between 5-9, 10-14, and 15-21 were noted to have mild, moderate, and severe anxiety, respectively. Cronbach's alpha was 0.87, indicating good internal consistency.

Depressive Symptoms

Ten (10) items were adopted from the Center for Epidemiologic Studies Depression Scale (CES-D). Those items were chosen to be consistent with cultural concerns regarding the topic of depression and to be appropriate when translated to the Arabic language. Response options were "rarely or none of the time (<1 day)", "some or a little of the time (1-2 days)", "occasionally or a moderate amount of time (3-4 days)", and "most or all of the time (5-7 days)", scored as 0,1,2, and 3, respectively. Three items worded in the positive direction were reverse coded and all items were summed for a total score, with a possible range of 0-30. During data analysis, the total scores were divided in quartiles:

the first quartile (Q1:0-3), the second quartile (Q2:4-6), the third quartile (Q3: 7-11), and the fourth quartile (Q4:12-27). Cronbach's alpha was 0.8145, indicating good internal consistency.

Sleep Health

Three items were adopted from the Pittsburgh Sleep Quality Index (PSQI), a reliable and validated tool [34], and included in the survey to measure for sleep health outcomes: sleep quality, sleep duration, and experiencing sleep problems. Sleep quality was measured using the item "During the past month, how would you rate your sleep quality overall?"[35]. Participants were asked to choose one of four options, including "Very good", "Fairly good", "Fairly bad", and "Very bad". Consistent with previous research on sleep health[36-39], the four response options were dichotomized in statistical analysis good sleep quality (e.g., includes "very good" and "fairly good") and poor sleep quality (e.g., includes "very bad" and "fairly bad"). To measure sleep duration, we used the question asking, "During the past month, how many h of actual sleep did you get each night? (This may be different from the number of hours you spent in bed.)"[35]. Participants then reported their response in hours as integers with one decimal place allowed (e.g., halves). Short sleep duration was defined as 7 hours or less[36,40,41]. Finally, sleep problems were assessed by asking the participants if they experienced any of three sleep-related problems in the past two weeks (e.g., the period of lock-down). Three statements were presented, and participants were given a "Yes" or "No" response options. These statements were "1) "I had trouble sleeping because I could not get to sleep within 30 min." (e.g., problems falling asleep) 2). "I had trouble staying awake while driving, eating meals, or engaging in social activity." (e.g., problems staying awake in the daytime also known as daytime sleepiness) 3) "I took medicine (prescribed or "over the counter") to help me sleep".[37]

Physical activity

Two items were adopted from the International Physical Activity Questionnaire (IPAQ) and included in this study. The IPAQ is a well-utilized instrument in health research, and has been shown to be reliable and valid across different populations[42-44]. The two items used measured the number of days in which moderate-to-vigorous physical activity (MVPA) was performed, as well as the duration of time in minutes spent in a given day, respectively. The reported answers for both items were then multiplied to calculate the MVPA variable, defined as the duration (in minutes) spent in MVPA per one full week. The participants were then grouped based on whether they met the World Health Organization's (WHO) adults physical activity guidelines or not (e.g., 150 minutes or more of MVPA per week)[45,46].

Sociodemographic

Four items were included to measure demographic variables among participants. Participants were asked to report their age (in years), gender (male or female), employment status (employed, self-employed, unemployed, student, or retired), and the city they currently reside in within Jordan. Cities were grouped into the following regions:

Northern region (Irbid, Jerash, Balqa'a, Zarqa, Ajloun, and Mafraq), Central Region (Amman, Madaba, and Salt), Southern Region (Tafila, Karak, Ma'an, Aqaba, and Petra).

Statistical Analysis

Descriptive statistics (frequencies, percentages) were calculated for sociodemographic characteristics, physical activity, anxiety, and depression according to sleep health outcomes (e.g., poor sleep quality, short sleep duration, and experiencing sleep problems). Chi-square or Mann-Whitney U tests were used to examine the differences in demographic characteristics, physical activity, anxiety, and depression between those with and without each sleep health outcome.

The association between anxiety, depression, and each poor sleep outcome was assessed using a modified Poisson regression model with robust error variance[47] due to the high prevalence of the sleep health outcomes[48-53]. The multivariable analysis adjusted for age, gender, employment status, region and physical activity. Adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were estimated. Test for p-trend was calculated by treating the categories of anxiety and depression as continuous variables. Two-sided $p < 0.05$ was considered statistically significant. Data were analyzed using Stata 16.0 (StataCorp, College Station, TX, USA).

Results

Table 1 presents the participants sociodemographic characteristics, anxiety, and depressive symptoms according to sleep health outcomes. The mean age was 37.35 (SD = 11.01), with over 60% of our sample aged less than 40 years old. The median age of the sample was 35.0. Approximately half of the sample (52.9%) were males. Additionally, more than three quarters of the participants reported residing in the Central region (78.2%), followed by the Northern region (19.1%). Most of the participants were either employed (54.3%) or self-employed (16.5%), while 17.6% reported being unemployed or 4.6% were retired at the current time. Approximately a third of our sample (31.5%) met the adult's physical activity guidelines for MVPA of 150 minutes or more per week. In terms of anxiety, 53% of the participants reported symptoms for mild (33.8%), moderate (12.9%), or severe anxiety (6.3%) during the period of national lockdown. Furthermore, approximately a quarter of our sample scored in each of the four quartiles for the depressive symptoms measures (e.g., 26.9% in the lowest quartile, 24.8% in the second quartile, 26.8% in the third quartile, and 21.5% in the highest quartile). Finally, and when measuring for sleep health outcomes, 17.9% of the participants reported poor sleep quality, 46.8% reported short sleep duration (equal or less than 7 hours of sleep on average for every night over the past week), while 63.7% reported experiencing at least one sleep problem over the past week.

Multivariable regressions with 95% confidence intervals were calculated to investigate the relationship between anxiety, depressive symptoms, and sleep health outcomes. The results, after adjusting for sociodemographic covariates, are presented in Table 2. Anxiety was associated with poor sleep health outcomes. Results demonstrated a dose-response relationship, as the aPRs for poor sleep health increased with increasing levels of both anxiety and depressive symptoms. Compared to those who reported minimal

anxiety, participants reporting mild anxiety were more likely to experience poor sleep quality (aPR = 3.01; 95% CI = 2.07–4.35), short sleep duration (aPR = 1.35; 95% CI = 1.17–1.56), and at least one problem sleep problem (aPR = 1.41; 95% CI = 1.27–1.56). Similarly, those reporting moderate anxiety were more likely to experience poor sleep quality (aPR = 5.78; 95% CI = 3.97 – 8.43), short sleep duration (aPR = 1.73; 95% CI = 1.47–2.04), and at least one problem sleep problem (aPR = 1.56; 95% CI = 1.39–1.75) compared to those reporting minimal anxiety. Similarly, and corresponding to the dose-response relationship between anxiety and sleep health outcomes, those reporting severe anxiety were the most likely to experience poor sleep quality (aPR = 8.954; 95% CI = 6.12–13.08), short sleep duration (aPR = 2.23; 95% CI = 1.91–2.61), and at least one problem sleep problem (aPR = 1.73; 95% CI = 1.54-1.95). P-trend <0.001 for all sleep outcomes.

Depressive symptoms were also associated with poor sleep health outcomes. This association also demonstrated dose-response relationship. As compared to scoring in the first quartile, scoring in the second, third, and fourth quartile was significantly associated with poor sleep quality (aPRs = 2.19, 5.27, and 11.82, respectively), short sleep duration (aPRs = 1.21, 1.41, and 1.87, respectively), and experiencing at least one sleep problem (aPRs =1.40, 1.62, and 1.90, respectively).

Discussion

This study is the first to empirically explore both mental health and sleep health measures during nationwide lockdown in response to the COVID-19 pandemic. It is also the first study to evaluate associations between mental health and sleep health in Jordan, and one of few studies to address the relationship between these measures among a severely understudied population; Middle Eastern adults. To the best of our knowledge, there is only one other study that has assessed sleep health in Jordan, which reported that poor sleep health, including a high risk of obstructive sleep apnea, snoring, and daytime sleepiness, was common among Jordanians attending primary care clinics[54].

In our study, the majority of participants reported having experienced mild (33.8%), moderate (12.9%), or severe (6.3%) levels of anxiety during lockdown, and nearly half of respondents reported depressive symptoms during lockdown. Similarly, over 60 percent of participants reported having experienced at least one sleep problem in the last week, and nearly half reported having had short sleep duration. In addition, we found that increased levels of reported anxiety or depression were both significantly associated with an increase in poor sleep health outcomes among Jordanians during lockdown in response to the COVID-19 pandemic.

Our findings that increased levels of self-reported anxiety or depression were significantly associated with an increase in poor sleep health outcomes can potentially be explained by the relationship between mental health and sleep health. The pathway by which depression alters sleep is thought to be through the loss of deep, slow-wave sleep and an increase in nocturnal arousal. The combination of these two effects contributes to a decrease in non-REM sleep, which may subsequently result in reduced REM sleep

latency[55]. Several studies have shown the association between depression and the disruption of REM sleep[56,57]. Furthermore, the cause of depression is most commonly attributed to the dysregulation of monoamines, such as serotonin, dopamine, norepinephrine, and dopamine. An individual's transition to REM sleep is typically accompanied by a rapid decrease in these monoamines[58], and such dysregulation may be associated with the disruption of REM sleep and the subsequent onset of depressive symptoms . Research has also demonstrated that depression is correlated with increased inflammatory markers and that depressive symptoms can be reduced by decreasing that inflammation[59]. As such, sleep loss has been associated with the increased production of inflammatory markers, such as C-reactive protein and interleukins[60]. Though the exact mechanism is not fully understood, there appears to be a relationship between sleep disturbance, inflammation, and depression[59,61]. Another potential pathway by which depression and sleep disturbances interact is through alternations in one's circadian rhythm. An individual's circadian rhythm is crucial to maintaining the sleep-wake cycle, and it has been observed that depression disrupts circadian rhythm[62].

Overall, our findings suggest the possible impact that economic, social, or health-related circumstances caused by nation-wide lockdown can have in exacerbating anxiety, depressive symptoms, and poor sleep health among respondents in Jordan. Particular to the context of lockdown in response to the COVID-19 pandemic, the Jordanian government did not provide economic support, financial incentives (e.g., stimulus), or loan forgiveness schemes to support individuals who may have lost significant portions of their income or faced additional financial obligations as a result of lockdown and their inability to engage with their given occupations consistently[3]. As a result, these economic circumstances may have contributed to increased anxiety, reported depressive symptoms, and poor sleep health. While it is expected that these economic circumstances would affect adult men in particular because they are typically considered financial providers for their families in the context of Jordanian culture[63], reported rates of anxiety, depressive symptoms, and poor sleep health were comparable between male and female respondents. This is the case despite that within Jordan, a larger proportion of men work outside the home than women. That being said, because childcare, elderly care, and housework are typically women's responsibilities in this context, the lockdown restrictions would be expected to disproportionately affect women's economic resilience, mental well-being, and sleep health, especially given rising levels of domestic violence and reduced access to sexual and reproductive health services during lockdown[64,65]. It should be noted that studies have shown that men tend to have a higher prevalence of sleep disorders such as obstructive sleep apnea, other studies have found that women are more likely than men to report an increased burden of depressive symptoms as a result of poor sleep health[66].

Other factors that have been found to affect sleep health and mental health outcomes that are also expected to be relevant or exacerbated during lockdown situations include tobacco or khat use, atypical work schedules, and violent or poor familial environments in households[67-71]. The increased recreational screen time during lockdown spent watching television, using a computer, or utilizing smartphones and the reality of isolation with limited social contact would also be expected to contribute to poor mental health

outcomes, including anxiety and depressive symptoms, found in our study[71-73]. In addition, unemployment has been noted to be associated with diminished mental health and is negatively correlated with sleep health measures[74]. Approximately 25% of unemployed or retired respondents in our study reported having experienced at least one sleep problem in the last week and short sleep duration. These risk factors are not only expected to work in tandem but are also expected to expose underlying vulnerabilities that also contribute to poor mental health and sleep health[74-76].

When evaluating the potential consequences of lockdown during a pandemic such as COVID-19, it is critical to consider how lockdown may predispose individuals to risk factors that impact mental health and sleep health. Poor sleep habits, anxiety, and depression are all recognized as affecting overall health and contributing to a number of risk factors for cardiovascular disease, obesity, hypertension, hyperlipidemia, and diabetes, among other chronic conditions that are increasingly prevalent in Jordan [77]. Similarly, poor mental health and sleep health are also found to be associated with excessive alcohol use and substance use[6,78]. Given that poor sleep habits, anxiety, and depression are also associated with decreased immune responsiveness, it is especially important to consider how the impacts of nation-wide lockdown on mental health and sleep health may make individuals particularly vulnerable to SARS-CoV-2, the causative agent of COVID-19, or other highly infectious pathogens[79].

The study findings, the lack of interventions in place to support the population during strict lockdowns (e.g., financial incentives, mental health resources), and the absence of discourse to address poor sleep health or mental health as a result of nation-wide lockdown highlight a gap in policymaking and planning during health emergencies and disease outbreaks in Jordan and likely in other countries. While the impact of lockdown on mental health and sleep health is not expected to be unique to Jordan, future research should focus on further elucidating the determinants of mental health and poor sleep health during lockdown and exploring the potential interactive impacts of specific risk factors that are exacerbated during lockdown on mental health and sleep health and their subsequent effects on susceptibility to disease. Additionally, the mechanism(s) in which such association occurs should be investigated. Future attention should also focus on articulating policies and designing interventions to not only address identified determinants and risk factors but also to uphold an international standard of individuals' right to health[80], especially for vulnerable and disadvantaged populations.

Limitations

This study's methodology is subject to several limitations. First, the sample population only includes individuals utilizing one social media platform, which introduces self-selection and volunteer bias and limits the generalizability of this study. Second, the information collected using the online survey includes exclusively self-reported data. As a result, responses, especially those measuring sleep health and mental health, can be implicated with decreasing the reliability and/or the validity of the study findings. Third, because our analysis did not adjust for additional confounding factors, such as substance use, education, and marital status, residual confounding may have been introduced.

However, we note that we utilized a limited survey to increase the survey completion rate. Finally, given that this study utilizes a cross-sectional survey design, it cannot be used to analyze mental health and sleep health measures over an extended period of time. Consequently, causal inference is limited.

Conclusions

This study provides evidence of reported anxiety and depressive symptoms and their association with poor sleep health outcomes during lockdown in Jordan in the face of the COVID-19 pandemic. Our findings draw attention to the potential negative consequences of lockdown and their impact on sleep health, emphasizing the need for public health professionals and governments to not only monitor health profiles during lockdown but also to create interventions aimed at improving sleep health and well-being. More attention is required to investigate the impacts of lockdown in exacerbating risk factors for poor mental health and sleep health, and future interventions and policies should be tailored toward addressing identified risk factors and improving health outcomes in the context of a nation-wide lockdown.

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Contributorship statement

YAA contributed to the design of this research work. GS was involved in data collection for this project. YAA and SHP was involved in data analysis and interpretation. YAA, SHP, JA, AB, and DTD were involved in drafting the article. WE and DTD provided critical revision of the article. YAA, SHP, JA, GS, AB, WE, and DTD approved the final version of the manuscript.

Competing interests

Authors Yazan A. Al-Ajlouni, Su Hyun Park, Jude Alawa, Ghaith Shamaileh, Aziz Bawab, Wafaa El-Sadr, and Dustin T. Duncan declare that they have no conflict of interest.

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Data sharing statement

Data are available upon reasonable request. Dataset uploaded into Dryad. DOI Number: DOI:10.5061/dryad.x0k6djhhc

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Table 1. Participants' characteristics, anxiety and depression by poor sleep health, N(%)

		Sleep health, %(n)		Sleep duration, %(n)		Sleep problems, % (n)	
	Total	Poor	Good	≤7 h	>6h	Yes	No
Total	1,240 (100.0)	222 (17.9)	1,018 (82.1)	580 (46.8)	660 (53.2)	790 (63.7)	450 (36.3)
Age, median (IQR)	35.0 (29.0, 43.0)	34.0 (29.0, 42.0)	36.0 (30.0, 44.0)	37.0 (30.0, 45.0)	35.0 (28.0, 42.0)*	35.0 (29.0, 43.0)	36.0 (29.0, 44.0)
Age							
18-24	127 (10.2)	21 (9.5)	106 (10.4)	37 (6.4)	90 (13.6)*	77 (9.8)	50 (11.1)
25-29	188 (15.2)	46 (20.7)	142 (14.0)	82 (14.1)	106 (16.1)	126 (16.0)	62 (13.8)
30-39	471 (38.0)	82 (36.9)	389 (38.2)	226 (39.0)	245 (37.1)	303 (38.4)	168 (37.3)
40-49	271 (21.9)	47 (21.2)	224 (22.0)	134 (23.1)	137 (20.8)	172 (21.8)	99 (22.0)
≥50	172 (13.9)	26 (11.7)	146 (14.3)	96 (16.6)	76 (11.5)	106 (13.4)	66 (14.7)
Missing	11 (0.9)	0 (0.0)	11 (1.1)	5 (0.9)	6 (0.9)	6 (0.8)	5 (1.1)
Gender							
Male	656 (52.9)	105 (47.3)	551 (54.1)	285 (49.1)	371 (56.2)*	404 (51.1)	252 (56.0)
Female	583 (47.0)	117 (52.7)	466 (45.8)	295 (50.9)	288 (43.6)	385 (48.7)	198 (44.0)
Missing	1 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)	1 (0.2)	1 (0.1)	0 (0.0)
Employment							
Employed	673 (54.3)	113 (50.9)	560 (55.0)	320 (55.2)	353 (53.5)*	418 (52.9)	255 (56.7)
Self-employed	205 (16.5)	36 (16.2)	169 (16.6)	85 (14.7)	120 (18.2)	131 (16.6)	74 (16.4)
Student	84 (6.8)	13 (5.9)	71 (7.0)	30 (5.2)	54 (8.2)	49 (6.2)	35 (7.8)
Unemployed/retired	275 (22.2)	60 (27.0)	215 (21.1)	145 (25.0)	130 (19.7)	190 (24.1)	85 (18.9)
Missing	3 (0.2)	0 (0.0)	3 (0.3)	0 (0.0)	3 (0.5)	2 (0.3)	1 (0.2)
Region[a]							
Northern	237 (19.1)	45 (20.3)	192 (18.9)	99 (17.1)	138 (20.9)	152 (19.2)	85 (18.9)
Central	970 (78.2)	170 (76.6)	800 (78.6)	461 (79.5)	509 (77.1)	614 (77.7)	356 (79.1)
Southern	33 (2.7)	7 (3.2)	26 (2.6)	20 (3.5)	13 (2.0)	24 (3.0)	9 (2.0)
Physical activity							
MVPA≥150mins	391 (31.5)	47 (21.2)	344 (33.8)*	162 (27.9)	229 (34.7)*	216 (27.3)	175 (38.9)*
MVPA<150min	849 (68.5)	175 (78.8)	674 (66.2)	418 (72.1)	431 (65.3)	574 (72.7)	275 (61.1)
Anxiety, median (IQR)	5.0 (3.0, 8.0)	9.0 (6.0, 14.0)	4.0 (2.0, 7.0)*	6.0 (3.0, 10.0)	4.0 (2.0, 7.0)*	6.0 (3.0, 9.0)	3.0 (1.0, 6.0)*
Anxiety							
Minimal anxiety (0-4)	583 (47.0)	37 (16.7)	546 (53.6)*	212 (36.6)	371 (56.2)*	292 (37.0)	291 (64.7)*
Mild (5-9)	419 (33.8)	80 (36.0)	339 (33.3)	205 (35.3)	214 (32.4)	301 (38.1)	118 (26.2)
Moderate (10-14)	160 (12.9)	60 (27.0)	100 (9.8)	100 (17.2)	60 (9.1)	128 (16.2)	32 (7.1)

Severe (15-21)	78 (6.3)	45 (20.3)	33 (3.2)	63 (10.9)	15 (2.3)	69 (8.7)	9 (2.0)
Difficulties caused by depression							
Not at all	650 (52.4)	72 (32.4)	578 (56.8)*	267 (46.0)	383 (58.0)*	369 (46.7)	281 (62.4)*
Several days	432 (34.8)	91 (41.0)	341 (33.5)	222 (38.3)	210 (31.8)	305 (38.6)	127 (28.2)
Over half the days	96 (7.7)	34 (15.3)	62 (6.1)	53 (9.1)	43 (6.5)	69 (8.7)	27 (6.0)
Nearly everyday	58 (4.7)	25 (11.3)	33 (3.2)	36 (6.2)	22 (3.3)	46 (5.8)	12 (2.7)
Missing	4 (0.3)	0 (0.0)	4 (0.4)	2 (0.3)	2 (0.3)	1 (0.1)	3 (0.7)
Depression, median (IQR)	6.0 (3.0, 11.0)	12.0 (8.0, 16.0)	5.0 (3.0, 9.0)*	8.0 (4.0, 13.0)	5.0 (3.0, 9.0)*	8.0 (4.0, 12.0)	4.0 (2.0, 8.0)*
Depression							
Quartile 1 (0-3)	333 (26.9)	12 (5.4)	321 (31.5)*	117 (20.2)	216 (32.7)*	144 (18.2)	189 (42.0)*
Quartile 2 (4-6)	308 (24.8)	25 (11.3)	283 (27.8)	132 (22.8)	176 (26.7)	188 (23.8)	120 (26.7)
Quartile 3 (7-11)	332 (26.8)	65 (29.3)	267 (26.2)	159 (27.4)	173 (26.2)	234 (29.6)	98 (21.8)
Quartile 4 (12-27)	267 (21.5)	120 (54.1)	147 (14.4)	172 (29.7)	95 (14.4)	224 (28.4)	43 (9.6)

[a]Northern region includes Irbid (N=110), Jerash (N=10), Balqa'a (N=3), Zarqa (N=91), Ajloun (N=7), Mafrqa (N=16); Central Region includes Amman (N=925), Madaba (N=19), Salt (N=26); Southern Region includes Tafila (N=2), Karak (N=6), Ma'an (N=6), Aqaba (N=15), and Petra (N=4)

MVPA, moderate-to-vigorous physical activity

*Indicates that significant differences at the 5 percent (0.05) level using a Chi-square test or Mann-Whitney U test.

Table 2. Multivariable association (aPRs)[a] between anxiety, depression, and poor sleep health.

	Poor sleep quality	Short sleep duration (≤7 hours)	Sleep problems
	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)
Anxiety			
Minimal anxiety (0-4)	Referent	Referent	Referent
Mild (5-9)	3.01 (2.07, 4.35)**	1.35 (1.17, 1.56)**	1.41 (1.27, 1.56)**
Moderate (10-14)	5.78 (3.97, 8.43)**	1.73 (1.47, 2.04)**	1.56 (1.39, 1.75)**
Severe (15-21)	8.95 (6.12, 13.08)**	2.23 (1.91, 2.61)**	1.73 (1.54, 1.95)**
P for trend	<0.001	<0.001	<0.001
Depression			
Quartile 1 (0-3)	Referent	Referent	Referent
Quartile 2 (4-6)	2.19 (1.12, 4.27)*	1.21 (1.00, 1.47)*	1.40 (1.20, 1.63)**
Quartile 3 (7-11)	5.27 (2.89, 9.61)**	1.41 (1.17, 1.69)**	1.62 (1.40, 1.87)**
Quartile 4 (12-27)	11.82 (6.64, 21.04)**	1.87 (1.58, 2.22)**	1.90 (1.66, 2.18)**
P for trend	<0.001	<0.001	<0.001

[a]Adjusted for age, gender, region, employment, and physical activity
aPR=adjusted prevalence ratio; CI=confidence interval
*p<0.05; **p<0.001

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5,6*
Bias	9	Describe any efforts to address potential sources of bias	4, 5
Study size	10	Explain how the study size was arrived at	-
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7, 16-17
		(b) Indicate number of participants with missing data for each variable of interest	7, 16-17
Outcome data	15*	Report numbers of outcome events or summary measures	7, 16-17

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7, 16-17
		(*b*) Report category boundaries when continuous variables were categorized	7, 16-17
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7, 16-17
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.