A Survey Study of the Impact of COVID-19 Vaccine on Sleep, Physical Health and Mental Health

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Abstract:

The COVID-19 pandemic has brought long-term stress to people. The COVID-19 lockdown not only aggravated the sleep problems of pre-pandemic good sleepers, but also affected the mental health of many different groups of people, since a decline in sleep quality is often associated with adverse mental health. In December 2020 Emergency Use Authorization (EUA) of COVID-19 vaccine was granted both in the UK and the U.S.. This good news provided hope to fight with and stop the spreading of COVID-19. On the other hand, the uncertainty of long-term side effects of COVID-19 vaccine became a new source of anxiety. In October 2021 we conducted an online survey study to investigate how COVID-19 vaccine affects people's sleep quality, physical health, and mental health. A total of 146 participants completed the survey. Our results revealed that after COVID-19 vaccines were administered for more than 10 months, when everyone was allowed to get the vaccine, participants still reported poor sleep quality, low physical health, poor wellbeing, and mild anxiety.

Keywords: COVID-19; sleep quality; physical health; mental health

1. INTRODUCTION

COVID-19 (Coronavirus Disease 2019) is a new type of coronavirus that started in December 2019 and has spread worldwide. It has been affecting many people's lives. By the end of March 2022, the prevalence of COVID-19 has reached almost 80 million in the U.S. alone (https://covid.cdc.gov/covid-data-tracker/). By early August 2022, the prevalence of COVID-19 has reached over 92 million, and the mortality rate also reached very high(over 1 million) in the U.S. alone.

The COVID-19 pandemic has brought long-term stress to people all over the world, and it has been shown to significantly affect the sleep time of different groups of people(Jalal et al., 2021). To reduce the spread of COVID-19, many countries adopted lockdowns to confine people to their homes, which disrupts normal life routines, and more often aggravate the sleep problems of pre-pandemic good sleepers (Kocevska et al., 2020). The COVID-19 lockdown is associated with changes in sleep schedule and in the quantity and quality of night-time sleep (Guptaet al., 2020). In addition, the pandemic is also associated with new stressors, uncertainties about physical health and mental health. The objective of this study was to discover how the epidemic affects people's sleep quality, physical health, and mental health.

2. LITERATURE REVIEW

In this section, the affecting factors of sleep quality were first reviewed, followed by the interference and improvement of the sleep quality. The section ended with a review of how COVID- 19 has affected people's sleep quality.

2.1 Sleep Quality

2.1.1 Affecting factors

Previous studies show that sleep quality is affected by multiple factors. First, stressful life events are related to worse sleep quality (Gupta et al., 2020; Li et al., 2019;Guastella & Moulds, 2007). Second, technology usage (Fry, 2021) including mobile phone addiction (Liu et al., 2017) and the massive exposure to social media among youth (Alonzoet al., 2019) was shown to be detrimental to sleep quality and even bad well-being. Finally, psychological factors such as forgiveness of interpersonal transgressions, and management of emotional feeling (e.g. anger and hostility) also relate to sleep quality (Stoia-Caraballo et al., 2008).

2.1.2 Interference/Improvement

There are many ways to improve sleep quality. Rumination and trait anxiety could fully mediate the associations between loneliness and depressed mood as well as poor sleep quality(Zawadzki et al., 2013). A significant increase in sleep quality and a significant decrease of ruminative thoughts after one week in a daily self-compassion intervention is another way to improve sleep quality (Butz& Stahlberg, 2018). Relaxing classical music(Harmat et al., 2008)and adjusting sleep schedules(Stern et al., 2020)have also been proven to be an effective intervention in reducing sleeping problems.

2.1.3 COVID-19 and Sleep Quality

Various studies reported that COVID- 19 has affected people's sleep quality(Jalal et al., 2021; Kocevska et al., 2020;Gupta et al., 2020). Adolescents reported less daytime sleepiness and longer school night sleep duration during COVID-19 (Becker et al., 2021), but it is also possible that some youth experience improved sleep in certain domains (Becker & Gregory, 2020), or the sleep quality could be similar as before and during the lockdown(O'Kane et al., 2021). While the COVID-19 lockdowns caused school closures and changes in daily schedules, children and families need to adjust sleep schedules to be well rested and arise appropriately to start their day (Stern et al., 2020).

2.2 Physical Health in Pandemic

In addition to sleep quality, the COVID-19 lockdown had a negative impact on the physical activity levels, and well-being of physically active Spanish adults (Martínez-de-Quel et al., 2021). As a result, people gained more weight during self-quarantine due to inadequate sleep, snacking after dinner, lack of dietary restraint, eating in response to stress, and reduced physical activity(Zachary et al., 2020). Previous study (Gupta et al., 2002) suggested that adequate sleep and good sleep quality are important factors to prevent childhood obesity.

2.3 Mental Health in Pandemic

The impact of COVID-19 on anxiety and depression has been reported. Since the COVID-19 pandemic started, the anxiety level was found higher than before the pandemic (Leung et al., 2020). One possible source of anxiety could be the social media exposure (SME).People with anxiety use social media more frequently (Gao et al., 2020).

The closure of school might effectively space out the social distance, but it could also harm mental health, particularly impactful for children and adolescents, as they navigate developmental changes in peer relationships in an unprecedented and more isolated way (Fry, 2021).The separation from friends could cause them stress and anxiety(O'Kane et al., 2021). Adolescents with ADHD in particular frequently experience co-occurring mental health symptoms such as depression and anxiety (Becker et al., 2021).

3. METHODS

3.1 Research Questions

This study addressed following three research questions:
RQ1: How did the COVID-19 vaccine influence people's sleep quality?
RQ2: How did the COVID-19 vaccine influence people's physical health?
RQ3: How did the COVID-19 vaccine influence people's mental health?

3.2 Participant

A total of 144 participants were recruited from an online survey platform: SurveyMonkey.com. Anyone who lives in the U.S., above 18 years old and can read English is eligible for this study.We paid SurveyMonkey $5 per response. However, each participant will NOT obtain $5 for completing the survey. Instead, each survey respondent who finishes a survey receives a $0.50 donation to the participating charity of their choice and an entry into an instant win sweepstakes to win a $100 Amazon gift card. In addition, each respondent earns at least $0.25 in credit for every survey they finish. Respondents can, after a certain threshold has been met, redeem their credits for either a gift card or a donation made by SurveyMonkey to a charitable organization Each participant earned a reward from SurveyMonkey after they complete the survey.

3.3 Procedure

After an online survey was created on Surveymonkey.com and upon IRB approval, the survey was published at Surveymonkey.com. Within a day, we obtained 146 responses. After removing two incomplete data, we got a total of 144 valid responses.

3.4 Survey Design

In this study, we investigated the impact of COVID-19 vaccine on sleep quality, physical health and mental health. The survey was adapted from previous related scales: PSQI (Pittsburgh Sleep Quality Index, 2021)for sleep quality, SF-36

(RAND 36-Item Short-Form Health Survey 1.0, n.d.)for mental health, and GAD-7(General Anxiety Disorder- 7, n.d.)& WHO-5 (The World Health Organisation- Five Well-Being Index, n.d.)formental health. The survey consists of 44 items, including 4 items related to demographic information (age, education,household income, ethnicity), and 40 items for three constructs (sleep quality, physical health, mental health). Table 1 illustrated the detailed mapping of our RQs, survey constructs, survey questions and survey sources.

Table 1: Survey Design Matrix for This Study

RQ	Construct	Questions	Source
	Demographic Info	Q2: Age Q3: Education Q4: Income Q5: Ethnicity	
RQ1	Sleep Quality	*During the past month…* Q6: How long (in minutes) has it taken you to fall asleep each night? Q7: How many hours of actual sleep did you get at night? Q8: How many hours were you in bed? Q9* During the past month, how often have you had trouble sleeping *because you* ... 　Q9A. Cannot get to sleep within 30 minutes 　Q9B. Wake up in the middle of the night or early morning 　Q9C. Have to get up to use the bathroom 　Q9D. Cannot breathe comfortably 　Q9E. Cough or snore loudly 　Q9F. Feel too cold 　Q9G. Feel too hot 　Q9H. Have bad dreams 　Q9I. Have pain *During the past month, how often ...* Q10*: have you taken medicine (prescribed or "over the counter") to help you sleep? Q11*: have you had trouble staying awake while driving, eating meals, or engaging in social activity? Q12*: During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? Q13: During the past month, how would you rate your sleep quality overall? (0=very good; 1=fairly good; 2=fairly bad; 3=very bad) *** scoring**: (0=not during the past month; 1=less than once in a week; 2=once or twice a week; 3=three or more times a week)	PSQI
RQ2	Physical Health	Q14[#]: In general, would you say your health is… (1=excellent; 2=very good; 3=good; 4=fair; 5=poor) Q15[#]: Compared to one year ago, how would you rate your health in general now? (1=much better; 2=somewhat better; 3=about the same; 4=somewhat worse; 5=much worse) Q16: The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much? (Yes, limited a lot = 1; Yes, limited a little = 2; No = 3) 　Q16.1 **Vigorous** activities, such as running, lifting heavy objects, participating in strenuous sports 　Q16.2 **Moderate** activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf 　Q16.3 Lifting or carrying groceries 　Q16.4 Climbing several flights of stairs 　Q16.5 Climbing one flight of stairs	SF-36

		Q16.6 Bending, kneeling, or stooping	
		Q16.7 Walking more than a mile	
		Q16.8 Walking several blocks	
		Q16.9 Walking one block	
		Q16.10 Bathing or dressing yourself	
		[#] **scoring**: (1 = 100, 2 = 75, 3 = 50, 4 = 25, 5 = 0)	
RQ3	Mental Health		
	Depression	Q17: Please indicate for each of the five statements which is closest to how you have been feeling over the last two weeks (Note: higher numbers mean better well-being). (5=all the time; 4=;most of the time; 3=more than half of the time; 2=less than half of the time; 1=some of the time; 0=at no time) Q17A. I have felt calm and relaxed. Q17B. I have felt active and vigorous. Q17C. I woke up feeling fresh and rested. Q17D. I have felt cheerful in good spirits. Q17E. My daily life has been filled with things that interest me.	WHO-5
	Anxiety	Q18: Over the last 2 weeks, have you felt bothered by any of these things?(0=not at all; 1=several days; 2=more than half the days; 3=nearly everyday) Q18A. Feeling nervous, anxious, or on edge Q18B. Not being able to stop or control worrying Q18C. Worrying too much about different things Q18D.Trouble relaxing Q18E. Being so restless that it's hard to sit still Q18F. Becoming easily annoyed or irritable Q18G. Feeling afraid as if something awful might happen	GAD-7

3.5 Survey Scoring:

3.5.1 Sleep Quality Scoring (PSQI)

Table 2 detailed how questions are scored for sleep quality.A PSQI score of "5" or greater is indicative of poor sleep quality, and it is suggested to discuss the sleep habits with a healthcare provider.

Table 2. PSQI Scoring.

Component Name	Component Formula	Scoring Rule
subjective sleep quality	C1= Q13	
sleep latency	C2 = Q6 + Q9a	Q6: (<15min =0; 16-30min=1; 31-60 min=2; >60min=3)
sleep duration	C3= Q7	Q7: (>7=0; 6-7=1; 5-6=2; <5 =3)
habitual sleep efficiency	C4 = (Q7/Q8)*100	Q8: (>85%=0; 75%-84%=1; 65%-74%=2; <65%=3)
sleep disturbances	C5 = sum (Q9b - Q9j)	
use of sleeping medications	C6 = Q10	
daytime dysfunction	C7 = Q11 + Q12	
PSQI	**Sum of C1-C7**	

3.5.2 Physical Health Scoring (SF-36)

For physical health, only two constructs (general health and physical functioning) were used from SF-36. Table 3 showed how to convert from original value to recoded value so that a high score defines a more favorable health state. The range of score is 0 to 100. General health is measured by the average of Q14 and Q15. Physical functioning is measured by the average of 10 items of Q16 given the reliability of 10 items is .943.

Table 3. SF-36 Scoring

Construct	Items	Original Recoded Value	Value	→
General Health	Q14, Q15	$1 \rightarrow 100; 2 \rightarrow 75; 3 \rightarrow 50; 4 \rightarrow 25; 5 \rightarrow 0$		
Physical Functioning	Q16.1–Q16.10	$1 \rightarrow 0; 2 \rightarrow 50; 3 \rightarrow 100$		

3.5.3 Mental Health Scoring

For mental health, there are two measures: depression and anxiety.

Depression was measured from WHO-5 items. The raw score is calculated by totaling the five items. The raw score range is 0-25, and 0 represents the worst possible and 25 represents the best possible quality of life. Then multiply the raw score by 4 to get the percentage score ranging from 0-100, 0 represent the worst possible and 100 represent the best possible quality of life. A total of raw score below 13 indicates poor wellbeing.

Anxiety was measured from GAD-7 items. The raw score is calculated by totaling the seven items. The raw score range of 1-4 represents minimal symptoms, 5-9 represents mild symptoms, 10-14 represents moderate symptoms, 15-21 represents severe symptoms.

4. RESULTS

In the following, we first report the reliability results of all survey constructs. Then we present the survey results corresponding to three research questions.

4.1 Reliability Results

As shown in Table 4, all three constructs of our survey reached acceptable reliability (Crobach's alpha $>.85$).

Table 4. Reliability Results of Survey Constructs**.**

Construct/Scale	Items	Cronbach's Alpha	Mean	SD
Physical Functioning (physical health)	10	.94	39.68	6.30
Anxiety	7	.92	7.09	5.67
Depression	5	.87	12.85	5.83

4.2 Results of Demographic Analysis

As shown in Table 5, participants are almost equally distributed in different age groups. Majority of participants are high school (38%) and college (34%) graduates. In terms of their annual income, the majority of them are in the range of ($25k-149). In terms of ethnicity, the majority are white (65%) followed by African American (12%), Asian (10%), Hispanic (10%), Pacific Islander (1.4%).

Table 5. Results of Demographic Information.

Measure	Items	Count	%
Age	18-24	22	15.1%
	25-34	27	18.5%
	35-44	28	19.2%
	45-54	18	12.3%
	55-64	28	19.2%
	65 or more	23	15.8%
Education	> High school	3	2.1%
	High school	55	37.7%
	Bachelor	50	34.3%
	Master	24	16.4%
	Doctorate	5	3.4%
	Other	9	6.2%
Household Income	> $25k	22	15.1%
	$25k - $34,999	22	15.1%
	$35k - $49,999	13	8.9%
	$50k - $74,999	36	24.7%
	$75k - $99,999	24	16.4%
	$100k - $149,999	19	13.0%
	$150k - $199,999	4	2.7%
	$200k +	6	4.1%
Ethnicity	African American	18	12.3%
	Asian	15	10.3%
	Hispanic	15	10.3%
	Pacific Islander	2	1.4%
	White	96	65.8%

4.3 Results for Sleep Quality

As stated in 3.5.1 a PSQI score of "5" or greater is indicative of poor sleep quality, Table 6 showed that the average of PSQI of 8.85 (sd=4.47). Our participants reported poor sleep quality due to COVID-19.

Table 6: Results of Sleep Quality Construct (mean, SD)

Construct	Mean	SD
subjective sleep quality	1.28	0.83
sleep latency	1.53	1.04
sleep duration	1.41	1.09
habitual sleep efficiency	0.88	1.10
sleep disturbances	1.40	0.73
use of sleeping medications	1.01	1.18
daytime dysfunction	1.42	0.97
PSQI_Total	8.85	4.47

Table 7 showed that only 24 out of 144 total participantshad a score less than 5, which represents healthy sleep quality, while the rest of 120 participants had a score greater or equal to 5, which represents poor sleep quality. Thus, both Table 6 and Table 7 revealed that the majority of our parcitipants had poor sleep quality due to COVID-19.

Table 7: Distribution of PSQI Total in Our Study

PSQI Total	N	%
<5	24	17%
≥5	120	83%

4.4 Results for Physical Health

As shown in Table 8, both General Health (54.72 out of 100) and Physical Functioning (65.82 out of 100) were rated relatively low. Compared to last year, the general health was about the same (52.27 out of 100).

Table 8. Results of Physical Health Construct (mean, SD)

Construct	Mean	SD
General Health	54.72	23.73
Physical Functioning	65.82	32.27
Change from Last Year	52.27	25.16

4.5 Results for Mental Health

Figure 1 showed that the total score of WHO-5 in our study is 11.67 (std=6.27) on the average. When the total of raw score of WHO-5 is less than 13, it indicates poor wellbeing and possible depression. In Figure 1,the participants 1) have more than half of the time felt cheerful in good spirits; 2) less than half of the time felt calm and relaxed; 3) active and vigorous; 4) woke up feeling fresh and rested; and 5) feel daily life has been filled with things that interest them. In sum, our results showed that the participants in this study indicated poor wellbeing.
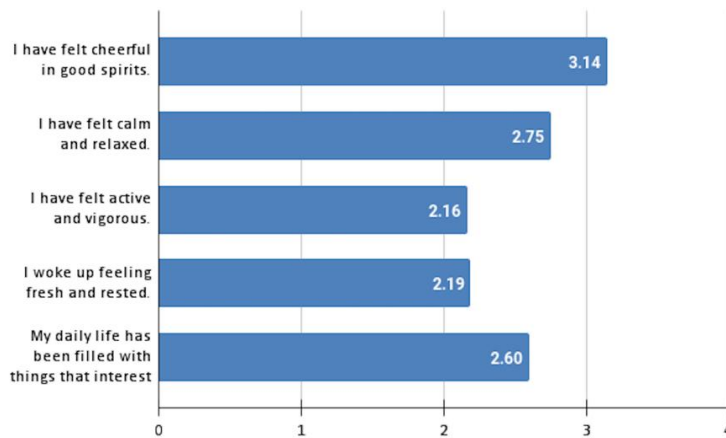

Figure 1. Result of Mental Health - Depression (WHO-5) (0=No time, 1=Some of the time, 2=Less than half of the time, 3=More than half of the time, 4=Most of the time, 5=All the time)

Figure 2 showed that the total of GAD-7 was 6.76 (std=5.62) on the average, indicating a mild level of anxiety. Among 7 items in Figure 2, the participants only reported on one item "feeling nervous, anxious, or on edge"close to the rating 3: nearly everyday(mean=2.57). All rest of 6 items received the rating around 1: more than half the days - 2) not being able to stop or control worrying (mean=1.11); 3) worrying to much about different things (mean=1.15); 4) trouble relaxing (mean=1.02); 5) being so restless that it's hard sit still (mean=0.84); 6) becoming easily annoyed or irritable (mean=1.19); and 7) feeling afraid as if something awful might happen (mean=0.91). In sum, our results showed that the participants in this study indicated mild anxiety.
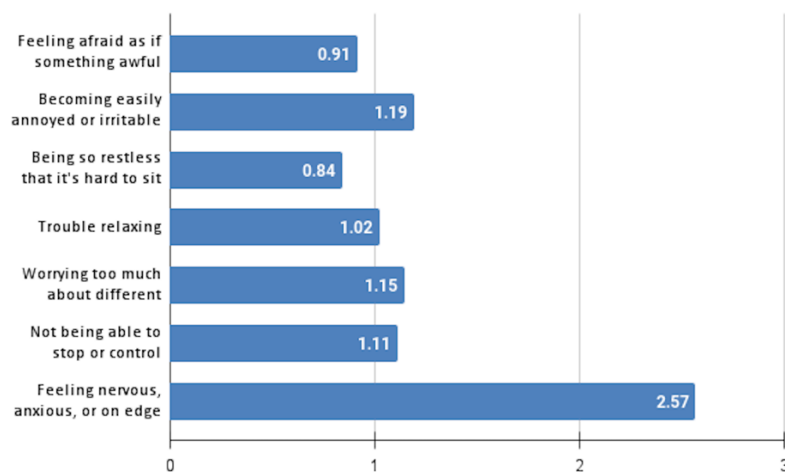

Figure 2. Result of Mental Health – Anxiety (GAD-7) (0=Not at all, 1=Several days, 2=More than half the days, 3=Nearly every day).

5. DISCUSSION AND CONCLUSION

In the following we will discuss the findings of this study along three proposed research questions.

5.1 COVID-19 Vaccine and Sleep Quality

While COVID-19 vaccine provides potential protection to human beings, the sufficient offering of vaccines would have brought peace and hope to the public, thus increasing people's sleep quality. However, our results failed in supporting this assumption. Our result showed that from 144 participants, only 24 of them had healthy sleep quality, the rest of them had poor sleep quality. This result suggested that COVID-19 still affected people's sleep quality even after the vaccine has been widely inoculated.

5.2 COVID-19 Vaccine and Physical Health

The epidemic has led to changes in people's life patterns such as staying at home for a long time, which has also affected people's health.
Compared to a similar study(Jenkinson et al., 1993), which scored 93.9 for physical functioning, our study only showed an average score of 65.8. Such huge score differences implied that the effect of COVID-19 on people's physical health has not been improved even after the vaccine became available to the public.

5.3 COVID-19 Vaccine and Mental Health

Despite the COVID-19 vaccine was widely available to everyone, our results showed that people still felt nervous, anxious, or on edge more than half of the days. For depression, out of total score 25, our participants only got 13, which indicated poor wellbeing. For anxiety, out of the total score 21, our participants only got 6.76, which again indicated mild anxiety.

5.4 Conclusion

In summary, our results provided convincing evidence that COVID-19 still has a negative effect on people's life even after the COVID-19 vaccine was widely inoculated and provided to the public. Based on the scale of PSQI, SF-36, WHO-5, and GAD-7, people have poor sleep quality, low physical health, and mild mental health with poor well-being.

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