Covid-19-stress associated with worse sleep quality, particularly with increasing age

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Abstract

Objectives: Based on SST, one might predict that older adults' well-being would be less negatively impacted by Covid-19-stress, as with other stressors, than younger people. However, whether sleep quality, which is negatively affected by aging, is similarly protected from the negative consequences of Covid-19-stress with age is unknown. Here, we examined the association between Covid-19-stress, above and beyond general-stress, and sleep quality and how it varies by age.

Method: From December 2020 to April 2021, 386 adults reported their Covid-19-stress, sleep quality, and resilience in an online study.

Results: While older age was related to lower Covid-19-stress, Covid-19-stress was associated with worse sleep quality with greater age.

Discussion: These results suggest that at least some aspects of one's well-being may be more susceptible to the negative consequences of stress with increasing age. Our results might be better understood via SAVI model, which posits that older adults have increased susceptibility to prolonged and unavoidable stress.

Keywords: Covid-19 pandemic, Sleep, Resilience

Introduction

Aging is characterized by a reduced quantity and quality of sleep (Mander et al., 2017). Poor sleep in older adults has been related to reductions in everyday functioning, increased risk of cognitive decline, reduced social engagement, and greater depressive symptoms (Krivanek et al., 2021). Thus, it is essential to identify potential risk factors contributing to sleep disturbances across the adult lifespan. Compared to pre-pandemic, a greater proportion of the population has reported sleep disturbances after the outbreak of Covid-19 (Jahrami et al., 2021). Various pandemic-related stressors are likely to increase distress, and worsen sleep quality (Saalwirth & Leipold, 2021). However, only a few studies have directly examined the relationship between Covid-19-stress and sleep. Werner et al. (2021) found that a higher level of Covid-19-stress predicted worse sleep quality in German sample. The same pattern was observed in samples of Israeli and U.S. adults (Coiro et al., 2021). However, it remains unknown how the association between Covid-19-stress and sleep quality varies across the adult lifespan. Also, as previous studies did not account for the effect of general-stress (i.e., not Covid-19 specific), it is unclear whether Covid-19-stress, per se, is predictive of poor sleep. Thus, this study investigated if Covid-19-stress above and beyond general-stress, predicts one's sleep quality, and how this relationship varies by age.

By doing so, this study provided an opportunity to understand the age-related differences in the impact of this unprecedented stressor. Socioemotional selectivity theory (SST; Carstensen, the 1992) proposed that older adults show improved emotional well-being resulting from motivational shifts with perceived limited future time. Given that, older adults are believed to be better at regulating negative emotions from daily stressors (Scott et al., 2013). For instance, older adults showed smaller increases in daily stress in response to interpersonal stressors than younger adults (Neupert et al., 2007). Furthermore, some evidence suggests that older adults are less likely to suffer mental issues following disastrous

experiences, including acts of terror or natural disasters (Bonanno et al., 2006; Shrira et al., 2014). For example, older adults showed the lowest prevalence of PTSD following the 9/11 terrorist attacks (Bonanno et al., 2006).

Based on SST and supporting evidence, one might predict that older adults' well-being, including sleep, may be relatively impervious to Covid-19-stress. However, considering older adults' greater vulnerability to Covid-19 in terms of health complications and survival (Shahid et al., 2020) and their susceptibility to sleep disturbance (Mander et al., 2017), it is also possible that Covid-19-stress has a more adverse impact on sleep in older adults compared to younger adults. To disambiguate these possibilities, we investigated the impact of age on the association between Covid-19-stress and sleep.

Also, it is of interest to identify the protective factor that can attenuate the negative association between perceived stress and sleep. One such factor is resilience—one's ability to successfully adapt to adversity (Aburn et al., 2016). Previous findings suggested that resilience can buffer the negative impact of stress on sleep in a variety of stressful contexts, such as HIV (Downing et al., 2016) or pregnancy (G. Li et al., 2016). Given that, the role of resilience in maintaining a good quality of sleep, has been highlighted during the pandemic (Grossman et al., 2021), but it remains unclear whether resilience weakens the negative relationship between Covid-19-stress and sleep. To answer this question, we examined the moderating effect of resilience on the association between Covid-19-stress and sleep.

Collectively, the goal of the current study is to investigate the relationship between Covid-19-stress and sleep quality across young to older adults and to examine the role of resilience as a protective factor that reduces the negative effect of Covid-19-stress on sleep.

Methods

Participants

Participants were recruited via Prolific, an online recruitment platform. Data were collected from December 2020 to April 2021, after the lockdown period in the U.S. Inclusion criteria were native English speakers located within the U.S., aged between 18-80. Of the 417 participants who completed the experiment, 31 participants were excluded from analyses due to low-quality responses in the Pittsburgh Sleep Quality Index (e.g., reporting impossible sleep hours such as 30 hours/day). Thus, 386 participants (M_{age}=41.06; *S.D.*=15.03; range=18-79) were included in analyses: 147 men (38.1%), 229 women (59.3%), ten gender-queer (2.6%); race: 248 non-Hispanic White (64.2%), 138 non-White (35.8%); highest education: 40 high-school (10.4%), 262 college-degree (67.9%), and 83 graduate-degree (21.5%). Informed consent was provided electronically, and participants were compensated $10/hour. This study was approved by the Georgia Institute of Technology Institutional Review Board.

Measures

Sleep quality: The Pittsburgh Sleep Quality Index (PSQI, Buysse et al., 1989) was used to assess sleep quality (Mean=8.17, S.D.=3.73). PSQI includes 19 items assessing seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep quality, sleep disturbances, use of sleeping medication, and daytime dysfunction (Cronbach's α=.83). Higher scores indicate lower sleep quality.

General-stress: We used the short-form version of the stress subscale of the Depression Anxiety Stress Scales (Henry & Crawford, 2005) to measure general-stress (Mean=4.33, S.D.=4.58). It includes seven questions assessing difficulty relaxing, nervous arousal, and

being easily upset/agitated and irritable/over-reactive (Cronbach's α=.52). Respondents rates the extent to which they have experienced each state over the past week.

Covid-19-stress: Covid-19-stress (Mean=4.71, S.D.=4.73) was assessed with an 11-item questionnaire we developed that evaluated how much the participant has been affected by different types of Covid-19-stressors (see *Supplementary Materials*), including employment and work-related difficulties, increased family care duties, health-limitations, and mental issues (Cronbach's α=.79).

Resilience: The Resilience Appraisals Scale (Johnson et al., 2010) was used to measure resilience (Mean=46.80, S.D.=9.45). This 12-item questionnaire measures an individual's appraisals of their emotional coping, problem-solving, and gaining social support abilities (Cronbach's α=.76).

Analysis

Statistical analyses were conducted using SPSS-24. First, a correlation analysis was conducted to verify the associations between age and psychological variables including general-stress, Covid-19-stress, and resilience. Descriptive statistics and the correlation coefficients of study variables are reported in ***Table1***. We conducted hierarchical multiple regression to examine how Covid-19-stress, age, and resilience related to one's sleep. In block1, gender, race, education, and general-stress were included as covariates. In block2, Covid-19-stress, age, and resilience were entered as main predictors of sleep quality. In block3, to assess whether age moderates the relationship between Covid-19-stress and sleep, the age x Covid-19-stress interaction was included. Also, the resilience by Covid-19-stress interaction was entered to examine if resilience weakened the negative association between Covid-19-stress and sleep. In follow-up analyses, further potential confounders such as data collection month, physical conditions, and Covid-19 infection were considered as covariates,

but they did not change the overall relationship among main study variables (see Supplementary Materials).

Results

Descriptive statistics and correlations among study variables are reported in ***Table 1***. Older age was negatively correlated with Covid-19-stress and positively correlated with resilience. Also, a higher level of Covid-19-stress was related to lower resilience. The results of the hierarchical regression are shown in ***Table 2***. Among covariates, gender and general-stress were significantly related to sleep quality, but race and education had no effects. Specifically, men showed better sleep quality, and greater general-stress was related to worse sleep. Even after the effects of general-stress and other covariates were controlled, Covid-19-stress and age were significantly associated with worse sleep quality, while higher resilience was related to better sleep. In the final block, the resilience by Covid-19-stress interaction was insignificant (B=-.001, SE=.004, β=-.007, p=.859). This interaction was excluded from our model since it cannot explain the variance of sleep quality and lowers the model fit. We found a significant age x Covid-19-stress interaction. As shown in the Johnson-Neyman plot (**Figure1**), a higher level of Covid-19-stress was significantly associated with worse sleep quality from middle age. This association becomes more robust with age, showing the most substantial effects in older adults.

Discussion

This study examined how U.S. adults' sleep quality is related to Covid-19-stress and to investigate age-related differences in this relationship. We found that Covid-19-stress related to worse sleep quality, even after accounting for the effect of general-stress. Notably, the negative relationship between Covid-19-stress and sleep quality was exacerbated by

increased age. Although resilience is associated with better sleep, it did not attenuate the negative relationship between Covid-19-stress and sleep quality.

The negative impact of Covid-19-stress on sleep quality is consistent with emerging findings (Coiro et al., 2021; Werner et al., 2021). Our results build upon these prior results by showing that the effect of Covid-19-stress on sleep remained significant, even after controlling the effect of general-stress. These data suggest that Covid-19-stress should be considered as a new risk factor of sleep disturbances in the era of the pandemic. As greater resilience is related to better sleep quality, interventions fostering resilience, such as facilitating social support and promoting positive attribution (Helmreich et al., 2017), could improve sleep and well-being.

Our results show both consistency and discrepancies with previous aging studies. Older age was related to lower Covid-19-stress, lower general-stress, and greater resilience. These results are consistent with the SST pattern of better emotional well-being with increasing age, suggesting the pattern holds even during the Covid-19 pandemic. Some studies conducted during the pandemic have shown that older adults have relatively better emotional well-being, showing more frequent reports of positive and less frequent reports of negative emotions compared to younger adults (Carstensen et al., 2020). Older age was associated with lower reports of loneliness and depressive symptoms (Losada-Baltar et al., 2021) and fewer anxiety symptoms (Bruine de Bruin, 2021) during the initial period of the pandemic.

However, we also found that when older adults do experience high levels of Covid-19-stress, their sleep was more significantly impacted compared to that of younger adults. This result is inconsistent with previous findings showing *reduced* reactivity to Covid-19-stress in older adults (Jiang, 2020; Knepple Carney et al., 2021). Knepple Carney et al. (2021)

showed that while perceived Covid-19-related disruption was similar across age, older adults' stress and negative affect were less impacted by this perceived disruption than younger adults. Similarly, Jiang (2020) reported that the associations between Covid-19-stress and high-arousal positive and negative affect were weaker with increasing age, showing that affective reactivity to Covid-19-stress may be attenuated with age. This discrepancy in stress-reactivity can be better understood via the Strength and Vulnerability Integration model (SAVI; Charles & Luong, 2013). While SST emphasizes the "motivational shift", the SAVI model suggests that "avoidance of stressor" with aging plays an essential role in the age-related difference in emotional well-being. Thus, this model posits that older adults may be more resistant to short-term stressors but more vulnerable to the effects of prolonged and inescapable stressors. Based on the SAVI model, one possible factor contributing to the discrepancy between our study and the prior ones is the duration of the stress exposure. Notably, these prior studies were conducted in the initial phase of the pandemic (i.e., March-April 2020), and the authors acknowledged the necessity of follow-up studies in later periods to examine the impact of sustained Covid-19-stress across adulthood (Knepple Carney et al., 2021). Our data collection transpired between December 2020 and April 2021, more than nine months after the outbreak of Covid-19 in the U.S. Thus, the prolonged Covid-19-stress might contribute to increased vulnerability to sleep problems in older adults. Another study conducted in a later phase of the pandemic (October 2020) also reported that older adults' anxiety and depressive symptoms were more greatly related to Covid-19-stress than that of younger adults (Pearman et al., 2021), supporting the possibility of increased vulnerability in older adults with prolonged stress of the pandemic.

Another non-mutually exclusive possibility is related to the different outcome measures across studies. The prior studies have focused on affective responses (Jiang, 2020; Knepple Carney et al., 2021), which are known to be more positive with aging. Sleep quality,

by contrast, is reduced with age and older adults' sleep is particularly sensitive to negative influences, including illness, medications, and psychological stress (reviewed in J. Li et al., 2018). Consistent with this, Trabelsi et al. (2021) reported that older adults' sleep quality was exacerbated during the Covid-19 pandemic, and Wang et al. (2020) showed that older adults were more likely to report sleep disturbances compared to younger adults during lockdowns in China. Collectively, unlike affective well-being, older adults' sleep might be more susceptible to the stress resulting from the Covid-19 pandemic compared to that of younger adults.

Our study has some limitations. First, our study design does not allow us to examine the direction of the relationships we assessed, though it is likely that the relationship between stress and sleep is bi-directional (Yap et al., 2020). Second, our sample was primarily highly-educated, White, with the ability to participate in an online study, and had a relatively small number of older adults, which may reduce the generalizability of the findings. Third, there can be further confounders that might impact both stress and sleep, such as marital status or living arrangements that were not considered in this study. Despite these limitations, our findings have important implications. It was the first study investigating how the relationship between Covid-19-stress, above and beyond general-stress, and sleep varies across the adult lifespan. We found that older adults with higher Covid-19-stress are especially vulnerable to sleep problems. The positive association between resilience and sleep further suggests that interventions enhancing resilience can help promote sleep quality across ages. These findings may inform public health policies for targeting at-risk populations and developing strategies to reduce sleep problems in scenarios of pandemics or other highly distressing events.

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The annotated data and syntax are available at: https://osf.io/g598f/. This work was not preregistered.

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Tables

Variables	Mean	S.D.	1	2	3	4	5	6	7
1. Race	.36	.48	-						
2. Gender	.38	.49	.038	-					
3. Education	2.11	.55	-.062	-.004	-				
4. General-stress	4.33	4.58	.018	-.021	-.056	-			
5. Age	41.06	15.03	-.311**	-.139**	.139**	-.249**	-		
6. Covid-19-stress	4.71	4.73	.030	.013	-.061	.522**	-.218**	-	
7. Resilience	46.80	9.45	-.077	.017	.299**	-.431**	.179**	-.172**	-
8. Sleep quality	8.17	3.73	-.017	-.173**	-.117**	.488**	.035	.293**	-.395**

Table1. Descriptive statistics and correlation coefficient of study variables. (N=386)

Notes: *p < .05. **p < .01. Race (non-Hispanic white = 0, Other = 1), Gender (women or genderqueer = 0, men=1), Education (high-school = 0, College or university = 1, Grad-school =2).

	Block1			Block2			Block3		
	F(5, 379) = 29.05**			F(8, 376) = 24.88**			F(9, 375) = 22.84**		
R^2	.277			.346			.354		
ΔR^2	.277**			.069**			.008*		
	B	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Race (White vs. non-White)	-.22	.34	-.03	.08	.34	.01	.10	.34	.01
Gender (Men vs. Women/ Genderqueer)	-1.22	.34	-.16**	-1.02	.32	-.13**	-1.10	.32	-.14**
Education (College degree vs. high school)	.08	.54	.01	.32	.54	.04	.42	.54	.05
Education (Graduate degree vs. high school)	-1.03	.62	-.11	-.50	.63	-.06	-.49	.62	-.05
General-stress	.39	.04	.48**	.30	.04	.37**	.31	.04	.38**
Age				.05	.01	.18**	.05	.01	.22**
Covid-19-stress				.08	.04	.10*	.09	.04	.12*
Resilience				-.09	.02	-.24**	-.09	.02	-.23**
Age x Covid-19-stress							.01	.00	.10*

Table 2. Summary of Hierarchical Multiple Regression Coefficients for Sleep Quality

Note: *$p < 0.05$, ** $p < 0.01$; Insignificant interaction terms were excluded in Block 3.

Figures

Figure 1. Johnson-Neyman plot of Age x Covid-19-stress interaction on sleep quality.

Note: The red line represents slope coefficients of Covid-19-stress on sleep quality, across ages. The darker region represents the age range when the slope of the Covid-19-stress on sleep quality significantly differs from zero. The shaded region represents the 95% confidence interval. The dashed line is the Johnson-Neman value (age=37.43), indicating that the slope over this point is significantly different from zero. This plot shows that Covid-19-stress was significantly associated with worse sleep quality from middle age (age>37.43), and this association becomes more robust with increasing age.

Figure 1