Personality and perceived stress during COVID-19 pandemic: Testing the mediating role of perceived threat and efficacy

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ABSTRACT

Prolonged stress is associated with poor physical and mental health outcomes. Understanding the mediators between personality and stress is critical for developing effective stress management interventions during a pandemic. Our study explored whether perceptions of threat from COVID-19 and efficacy to follow government recommendations for preventing COVID-19 would mediate the relationships between personality traits (e.g., neuroticism, conscientiousness-goal-striving, extroversion-activity and sociability) and perceived stress. In an online survey of a representative sample of Canadian adults ($n = 1055$), we found that higher neuroticism and extroversion were associated with higher levels of stress during the pandemic and a greater increase in stress levels compared to levels before the pandemic. Perceived threat and efficacy significantly mediated the relationship between neuroticism and stress, which suggested that individuals with higher neuroticism experienced higher levels of stress due to higher levels of perceived threat and lower levels of efficacy. Perceived threat did not mediate the relationship between extroverts and stress, which suggested that the source of stress may stem from elsewhere (e.g., inability to socialize). Our findings highlighted that personality traits could be an important factor in identifying stress-prone individuals during a pandemic and that stress management interventions need to be personality specific.

1. Introduction

The 2019 novel coronavirus (COVID-19) was declared as a pandemic on March 11, 2020 (Cucinotta and Vanelli, 2020). Consequently, many countries around the world have instructed their citizens to stay at home and to engage in "physical or social distancing." Similar to previous epidemics and pandemics, the COVID-19 pandemic caused significant stress (Bao et al., 2020). A recent survey study of the general public in China showed that 8.1% reported moderate to severe stress levels (Wang et al., 2020). This translates to about 112 million people living in China. Similarly, a nationwide survey among Italians reported 27.2% (~16.2 million people) experienced high to extremely high-stress levels during the pandemic (Mazza et al., 2020). Prolonged stress are significantly associated with mortality, poor mental health outcomes and lower quality of life (Marshall et al., 2008; Nielsen et al., 2008; Prior et al., 2016). Thus, understanding ways to manage stress is critical, particularly during a pandemic.

Stress is an individual's adaptation response to internal or external threats (Lecic-Tosevski et al., 2011). Perceived stress is the result of a person's appraisal of a stressor as threatening or non-threatening, as well as one's own abilities to cope (e.g. one's perceived efficacy or resources to respond to the threat). One of the factors that can influence stress appraisal and response is personality. There are five broad personality traits based on the Five-Factor Model, which consists of neuroticism (e.g., tendency to be emotionally unstable, and experience such feelings as anxiety, worry, and fear), conscientiousness (e.g., tendency to be responsible, organized, hard-working, goal-directed), extroversion (e.g., tendency to be sociable, assertive, positive, and with a high activity level), openness (e.g., tendency to be perceptive, creative, reflective and appreciate fantasy, and aesthetics), and agreeableness (e.g., tendency to be kind, cooperative, altruistic, trustworthy and generous) (Vollrath, 2001).
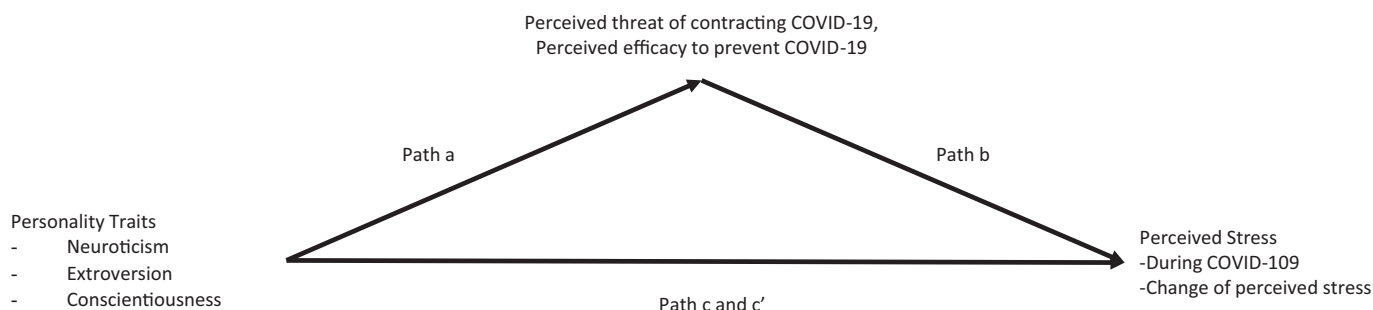
Fig. 1. Hypotheses model of the association between personality traits and stress.

Certain personality traits such as neuroticism, conscientiousness, and extroversion have particularly strong associations with perceived stress (Afshar et al., 2015; Ebstrup et al., 2011). Specifically, individuals with higher levels of neuroticism tend to experience greater levels of perceived stress than individuals with higher levels of conscientiousness and extroversion (Lecic-Tosevski et al., 2011). Those individuals with higher levels of neuroticism have the tendencies to perceive events as highly threatening and often have limited coping resources, self-regulation and perceived efficacy, and thus resulting in a higher level of stress (Ebstrup et al., 2011; Hoyle, 2006; Lecic-Tosevski et al., 2011). A recent study found that during the COVID-19 pandemic, individuals with high neuroticism showed higher levels of perceived threat of COVID-19 virus leading to an increased level of negative affect (Kroencke et al., 2020). On the other hand, people with higher levels of conscientiousness are less likely to assess a stressor as threatening than individuals with higher levels of neuroticism because they have higher perceived efficacy, self-regulation and coping resources (Ebstrup et al., 2011; Hoyle, 2006; Lecic-Tosevski et al., 2011; Matthews et al., 2000). For example, people with higher levels of conscientiousness, particularly those with high goal-striving qualities, may be exceptionally receptive to follow COVID-19 preventive measures. Consequently, this quality may further enhance their coping resources to prevent COVID-19 while minimizing their perceived threat of COVID-19, and resulting in lower stress (Vollrath, 2001).

Extraversion is generally associated with a lower level of perceived stress (Jackson and Schneider, 2014; Schneider et al., 2012). However, given the social isolation and quarantine measures during COVID-19, the generalizability that extraversion is associated with less stress may be limited (Brooks and Moser, 2020). Social connectedness is a significant mediator explaining the relationship between extraversion and perceived well-being (Lee et al., 2008). Individuals with high extraversion, particularly those with high levels of activity and sociability qualities, may not be as effective in controlling their environment once the social aspect is removed; thus, it may result in higher levels of distress (Abbott et al., 2008). This idea is reflected in a number of mainstream media news articles highlighting that the pandemic is a "golden age for introverts" (Brooks and Moser, 2020).

Currently, no studies have examined the relationships of neuroticism, conscientiousness-goal-striving, extraversion-activity and sociability on perceived threat from COVID-19, perceived efficacy to follow government guidelines in preventing COVID-19 and perceived stress. Previous studies have shown that the mediators of the stress response, such as perceived threat and efficacy, are important target constructs for stress management interventions (Bandura, 2004; Bíró et al., 2017; Gaab et al., 2003). Applying stress management techniques (e.g. cognitive restructuring, problem-solving, self-instruction) in an intervention can effectively alter perceived threat and self-efficacy and ultimately lead to lower perceived stress (Bíró et al., 2017; Gaab et al., 2003). Thus, understanding the mediators between personality and perceived stress during the COVID-19 pandemic is critical to developing personalized stress management interventions during pandemics.

Thus, the objective of this study was to explore whether perceptions of threat from COVID-19 and efficacy to follow government guidelines in preventing COVID-19 would mediate the relationships between personality traits (e.g., neuroticism, conscientiousness-goal-striving, extroversion-activity and sociability) and perceived stress (e.g., stress during the COVID-19 pandemic, change of perceived stress). Based on previous studies (Ebstrup et al., 2011; Kroencke et al., 2020) and the unique physical or social distancing measures introduced during COVID-19, we hypothesize that:

a) Individuals with higher neuroticism would experience higher levels of stress due to higher levels of perceived threat related to COVID-19 and lower levels of perceived efficacy.
b) Due to the physical or social distancing measures, higher extraversion (activity and sociability) would be associated with higher perceived stress; perceived threat would not explain the relationship between extraversion (sociability and activity) and stress; but perceived efficacy would be a significant mediator.
c) Higher conscientiousness (goal-striving) would not predict higher stress. This type of personality trait would be more likely to engage in positive appraisals of efficacy to prevent COVID-19 and would have lower perceived threat.

See Fig. 1 for a visual representation of our hypotheses.

2. Methods

2.1. Participants and procedure

This was a cross-sectional study that took place from May 1 to May 7, 2020. Overall, 1230 participants responded to the online survey. Given an average completion time of 19 min, surveys that took < 5 min to complete and surveys with > 30% of missing data were excluded. One thousand fifty-five participants were included in the final sample. Participants were adults living in Canada, aged 18+ years. A third-party market research company, Maru/Blue was used to recruit the sample. We received ethics approval from the University of Victoria Human Research Ethics Board (#20-0187), and informed consent was obtained by all participants prior to answering the survey.

2.2. Measures

Demographics including sex, age, education, and family income were measured using self-report instrumentation. Perceived stress was measured using a single item on individual's stressful feelings in general: "Before the pandemic of COVID-19 got serious in Canada and when things were normal, how stressful was your life in general?" and "After the social distancing policies were implemented by the Canadian government to cope with COVID-19, how stressful was your life in general?". Questions were answered on a 7-point Likert scale from "*Not at all stressful*" to "*extremely stressful*." The change of stress was

Table 1

The bivariate correlation analysis for personality traits, threat, efficacy and stress.

Variables	Mean ± SD	Pearson correlation						
		1	2	3	4	5	6	7
1. Stress during pandemic	3.67 ± 1.71	–						
2. Change of stress	0.60 ± 1.64	0.53**	–					
3. Perceived Efficacy	24.15 ± 3.54	−0.11**	−0.001	–				
4. Threat	22.83 ± 4.29	0.12**	0.11**	0.54**	–			
5. Neuroticism	24.91 ± 7.53	0.48**	0.01	−0.12*	0.05	–		
6. Extroversion	22.29 ± 5.11	0.11**	0.12**	−0.07*	−0.04	0.19**	–	
7. Conscientiousness	18.06 ± 3.25	−0.09**	−0.03	0.12*	−0.01	−0.38**	0.30**	–

Note.

* $P < 0.05$.
** $P < 0.01$.

computed by calculating the difference between perceived stress during the pandemic and pre-pandemic.

Personality traits (neuroticism, extraversion, conscientiousness) were measured using select items from the NEO Five-Factor Inventory (Costa and McCrae, 1989). The neuroticism scale ($\alpha = 0.89$) and subscales of extraversion (activity and sociability) ($\alpha = 0.72$) (Saucier, 1998) and conscientiousness (goal-striving) ($\alpha = 0.73$) were collected. Questions were answered on a 5-point Likert scale from "*strongly disagree*" to "*strongly agree.*"

Perceived threat was measured using the instruments developed as part of the EPPM (Barnett et al., 2009; Witte et al., 1996). Specifically, participants responded to items assessing perceived severity and susceptibility that were constructed in accordance with the EPPM. The items were: "I believed that COVID-19 is severe", "I believed that COVID-19 is serious", "I believed that I was at risk for getting COVID-19", and "I believed that it was possible that I would contract COVID-19". The items were scored on the following scale: 1 = *strongly disagree*, 4 = *neutral*, 7 = *strongly agree*. We combined perceived susceptibility and severity to obtain perceived threat ($\alpha = 0.83$).

Perceived efficacy to follow government recommendations for preventing COVID-19 was measured by adapting the instruments from the EPPM (Barnett et al., 2009; Witte et al., 1996). The items included: "I was able to do the recommended responses" and "the recommended responses were easy to do." For response efficacy, participants first read the following instructions: "Please answer the following statements about your perceptions of the government recommendations for preventing COVID-19 (coronavirus) after the government ordered physical or social distancing in your area". The items were: "I believed that the recommended responses would work in preventing COVID-19" and "I believed that if I did the recommended responses, I would be less likely to get COVID-19". The items were combined to calculate perceived efficacy to prevent COVID-19. The items were scored on the following scale: 1 = *strongly disagree*, 4 = *neutral*, 7 = *strongly agree*. We combined perceived self-efficacy and response efficacy scores to obtain perceived efficacy ($\alpha = 0.80$).

2.3. Statistics

Descriptive statistical analyses were used to analyze demographic data. Bivariate correlations were used to analyze the relationship among the personality traits, perceived threats, perceived efficacy, perceived stress during the pandemic, and change of stress. Mediation analyses were based on 5000 bootstrapped samples using Hayes' PROCESS Macro v3.5 (Hayes, 2017). Multiple mediation analyses were used to examine whether perceived threat accounted for the covariance between each of the personality traits (neuroticism, extraversion, and conscientiousness) and perceived stress during COVID-19 and change of stress and between each of the personality traits and change of stress. This process involved examining path a, the association between the personality trait (independent variable) and perceived treat, path b, the

impact of perceived threat (mediator variables) on perceived stress during COVID-19 or change of stress; and path c, the total effect of the personality traits (independent variable) on perceived stress during the pandemic or change of stress (outcome variable). The same multiple mediation analyses procedure was used to examine whether perceived efficacy accounted for the covariance between personality traits and perceived stress. All analyses controlled for age, sex, education and income. Perceived stress before the pandemic was entered into the models as a covariate only when the outcome variable was the change of stress. Perceived threat was entered as a covariate when efficacy was entered as a mediator. Efficacy was entered as a covariate when the threat was entered as a mediator. The 95% CIs must not cross zero in order to satisfy the criteria for mediation (Preacher and Hayes, 2008). SPSS was used to conduct statistical analyses. All significance was set to $p < 0.05$.

3. Results

3.1. Descriptive statistics

The sample ($n = 1055$) consisted of 51.2% female and 48% male (0.6% did not identify as male or female). The mean age was 48.7 years (range 18–89 years of age). The majority of the sample received either a college (29%), bachelor (34%), or advanced degrees (15%). 22% of the sample completed a high school. The sample's family income distribution was < $40,000 (19%), $40,000–79,999 (32%), $80,000–99,999 (14%), > $100,000 (33%) (2% did not report family income). The bivariate correlation analysis for personality traits, perceived threat, efficacy and stress are shown in Table 1.

3.2. The relationships among perceived threat, personality traits, and stress

Perceived threat of contracting COVID-19 showed a significant partial mediation between neuroticism and perceived stress during the pandemic (indirect effect = 0.04; 95%CI: 0.02, 0.06), as well as between neuroticism and change in stress relative to pre-pandemic stress (indirect effect = 0.03; 95%CI: 0.02, 0.05). Specifically, higher neuroticism was associated with a higher perceived threat. Higher perceived threat predicted higher levels of stress during the pandemic, as well as a greater increase in the change of stress relative to pre-pandemic (Table 2). The partial mediation was due to the significant direct effect between neuroticism and perceived stress and between neuroticism and change of stress. Specifically, higher neuroticism was significantly associated with higher levels of stress during the pandemic (total effect = 0.50, 95% CI: 0.44, 0.57; direct effect = 0.47; 95%CI: 0.40, 0.53) and a greater increase in the change of stress relative to pre-pandemic (total effect = 0.36, 95%CI: 0.29, 0.43; direct effect = 0.33; 95%CI: 0.26, 0.40).

Perceived threat did not significantly mediate the relationship between conscientiousness and perceived stress during the pandemic

Table 2
The relationships among perceived threat, personality traits, and stress.

Effects	β	95%CI		R²
		LL	UL	
1. Neuroticism - Stress during pandemic				
Path a Neuroticism - Threat	0.21**	0.15	0.27	0.35
Path b Threat - Stress during pandemic	0.19**	0.13	0.26	0.30
Path c′ Neuroticism - Stress during pandemic	0.47**	0.40	0.53	0.30
Path c Neuroticism - Stress during pandemic	0.51**	0.44	0.57	0.28
2. Neuroticism - ΔStress[b]				
Path a Neuroticism - Threat	0.17**	0.11	0.24	0.36
Path b Threat - ΔStress	0.17**	0.11	0.23	0.33
Path c′ Neuroticism - ΔStress	0.33**	0.25	0.40	0.33
Path c Neuroticism - ΔStress	0.36**	0.29	0.43	0.31
3. Extroversion - Stress during pandemic[a]				
Path a Extroversion - Threat	0.05	−0.001	0.108	0.35
Path b Threat - Stress during pandemic	0.19**	0.13	0.26	0.30
Path c′ Extroversion - Stress during pandemic	0.18**	0.12	0.23	0.30
Path c Extroversion - Stress during pandemic	0.19**	0.13	0.25	0.28
4. Extroversion - ΔStress[b]				
Path a Extroversion - Threat	0.051	−0.003	0.106	0.36
Path b Threat - ΔStress	0.17**	0.11	0.23	0.33
Path c′ Extroversion - ΔStress	0.18**	0.12	0.23	0.33
Path c Extroversion - ΔStress	0.19**	0.13	0.24	0.31
5. Conscientiousness - Stress during pandemic[a]				
Path a Conscientiousness - Threat	−0.03	−0.09	0.03	0.35
Path b Threat - Stress during pandemic	0.19**	0.13	0.25	0.30
Path c′ Conscientiousness - Stress during pandemic	0.05	−0.009	0.109	0.30
Path c Conscientiousness - Stress during pandemic	0.04	−0.02	0.10	0.28
6. Conscientiousness - ΔStress[b]				
Path a Conscientiousness - Threat	−0.04	−0.10	0.02	0.36
Path b Threat - ΔStress	0.17**	0.11	0.24	0.33
Path c′ Conscientiousness - ΔStress	−0.01	−0.05	0.07	0.33
Path c Conscientiousness - ΔStress	0.004	−0.055	0.064	0.31

Note. β, standardized beta.
CI = confidence intervals; LL = lower limit; UL = upper limit.
** P < 0.01.
[a] Model covariates included age, gender, education, income, perceived efficacy.
[b] Model covariates included age, gender, education, income, perceived efficacy, perceived stress before the pandemic.

(indirect effect = −0.01, 95%CI: −0.02, 0.01) as well as between conscientiousness and change of stress (indirect effect = −0.01, 95%CI: −0.02, 0.004). Similarly, perceived threat did not significantly mediate the relationship between extroversion and perceived stress during the pandemic (indirect effect = 0.01, 95%CI: −0.001; 0.02) as well as between extroversion and change of stress (indirect effect = 0.01, 95%CI: −0.002; 0.02). However, a significant total effect was observed between extroversion and perceived stress during the pandemic (total effect = 0.19, 95%CI: 0.13, 0.25; direct effect = 0.18, 95%CI: 0.12, 0.23) and between extroversion and change of stress relative to pre-pandemic (total effect = 0.19, 95%CI: 0.13, 0.24; direct effect = 0.18, 95%CI: 0.12, 0.23). Specifically, higher extroversion was significantly associated with higher levels of stress during the pandemic and a greater increase in the change of stress relative to pre-pandemic (Table 2).

3.3. The relationships among perceived efficacy, personality traits, and stress

Perceived efficacy to prevent contracting COVID-19 significantly mediated the relationship between conscientiousness and perceived stress during the pandemic (indirect effect = −0.01, 95%CI: −0.025, −0.004; direct effect = 0.05, 95%CI: −0.01, 0.11; total effect = 0.04, 95%CI: −0.02, 0.10) and between conscientiousness and change of stress relative to pre-pandemic (indirect effect = −0.01, 95%CI:

Table 3
The relationships among perceived efficacy, personality traits, and stress.

Effects	β	95%CI		R²
		UL	LL	
Neuroticism - Stress during pandemic[a]				
Path a Neuroticism - Efficacy	−0.15**	−0.21	−0.09	0.35
Path b Efficacy - Stress during pandemic	−0.15**	−0.21	−0.08	0.30
Path c′ Neuroticism - Stress during pandemic	0.47**	0.40	0.53	0.30
Path c Neuroticism - Stress during pandemic	0.49**	0.42	0.56	0.29
Neuroticism - ΔStress[b]				
Path a Neuroticism - Efficacy	−0.12**	−0.18	−0.05	0.35
Path b Efficacy - ΔStress	−0.13**	−0.19	−0.06	0.33
Path c′ Neuroticism - ΔStress	0.33**	0.26	0.40	0.33
Path c Neuroticism - ΔStress	0.34**	0.27	0.41	0.32
Extroversion - Stress during pandemic[a]				
Path a Extroversion - Efficacy	−0.10**	−0.15	−0.04	0.35
Path b Efficacy - Stress during pandemic	−0.15**	−0.21	−0.08	0.30
Path c′ Extroversion - Stress during pandemic	0.18**	0.12	0.23	0.30
Path c Extroversion - Stress during pandemic	0.19**	0.14	0.25	0.29
Extroversion - ΔStress[b]				
Path a Extroversion - Efficacy	−0.09**	−0.15	−0.04	0.35
Path b Efficacy - ΔStress	−0.13**	−0.19	−0.06	0.33
Path c′ Extroversion - ΔStress	−0.18**	0.12	0.23	0.33
Path c Extroversion - ΔStress	−0.19**	0.13	0.25	0.32
Conscientiousness - Stress during pandemic[a]				
Path a Conscientiousness - Efficacy	0.09**	0.04	0.15	0.35
Path b Efficacy - Stress during pandemic	−0.15**	−0.21	−0.08	0.30
Path c′ Conscientiousness - Stress during pandemic	0.05	−0.01	0.11	0.30
Path c Conscientiousness - Stress during pandemic	0.037	−0.02	0.10	0.29
Conscientiousness - ΔStress[b]				
Path a Conscientiousness - Efficacy	0.10**	0.04	0.16	0.35
Path b Efficacy - ΔStress	−0.13**	−0.19	−0.06	0.33
Path c′ Conscientiousness - ΔStress	0.01	−0.05	0.07	0.33
Path c Conscientiousness - ΔStress	−0.001	−0.06	0.06	0.32

Note. β, standardized beta.
CI = confidence intervals; LL = lower limit; UL = upper limit.
** P < 0.01.
[a] Model covariates included age, gender, education, income, perceived threat.
[b] Model covariates included age, gender, education, income, perceived threat, perceived stress before the pandemic.

−0.02, −0.004; direct effect = 0.01, 95%CI: −0.05, 0.07; total effect = −0.002, 95%CI: −0.06, 0.06). Higher conscientiousness showed a significant positive association with efficacy. Perceived efficacy showed a negative association with perceived stress during and change of stress (Table 3).

Perceived efficacy showed a significant partial mediation between neuroticism and perceived stress during the pandemic (indirect effect = 0.02, 95%CI: 0.01;0.04; direct effect = 0.47, 95%CI: 0.40, 0.53; total effect = 0.49, 95%CI: 0.42, 0.56) and change of stress relative to pre-pandemic (indirect effect = 0.02, 95%CI: −0.01, 0.02; direct effect = 0.33, 95%CI: 0.26, 0.40; total effect = 0.35, 95%CI: 0.27, 0.41) (Table 3). Similarly, partial mediation for perceived efficacy was observed between extroversion and perceived stress during the pandemic (indirect effect = 0.01, 95%CI: 0.01, 03; direct effect = 0.18, 95%CI: 0.12, 0.23; total effect = 0.19, 95%CI 0.14, 0.25); as well as between extroversion and change of stress relative to pre-pandemic (indirect effect = 0.01, 95%CI 0.003, 0.02; direct effect = 0.18, 95%CI: 0.12, 0.23; total effect = 0.19, 95%CI: 0.13, 0.25). The partial mediations observed for these variables were due to the significant direct effect between neuroticisms and stress (e.g. perceived stress and change of stress) and between extroversion and stress (e.g. perceived stress and change of stress) (Table 3).

4. Discussion

The study aimed to examine whether perceived threat of COVID-19 and efficacy to prevent COVID-19 would mediate the relationships between personality traits and perceived stress. We hypothesized that higher neuroticism and extroversion (activity and sociability) would be associated with higher levels of stress during the pandemic and a greater increase in stress levels compared to levels before the pandemic. By contrast, higher conscientiousness (goal-striving) would not predict higher perceived stress. Our findings fully supported our hypotheses. Neuroticism had the strongest association with perceived stress during the pandemic and change of stress. This finding was supported in previous studies (Ebstrup et al., 2011; Vollrath, 2001).

It is worth noting that a previous study has reported that higher extroversion was associated with lower perceived levels of stress (Jackson and Schneider, 2014; Lecic-Tosevski et al., 2011). Extraverts are known to seek out social stimulation and opportunities to engage with others, and social connectedness mediates the well-established relationship between extraversion and perceived well-being (De Raad, 2000; Lee et al., 2008). Thus, the quarantine during the pandemic may have hindered the ability of extroverts to fulfill this social stimulation and may have led to higher levels of perceived stress than individuals with lower extroversion. Alternatively, the higher stress experienced by those with higher levels of extraversion may also stem from a lack of cognitive appraisal skills necessary to regulate their emotions, and/or external regulations of stress (Kobylińska et al., 2020).

The COVID-19 quarantine has been described to be a "golden age for introverts"(Brooks and Moser, 2020), and our results provide initial evidence for this proposal because extroverts, particularly individuals with high activity and sociability aspect of the extroversion showed higher levels of distress. However, this does not mean that introverts do not need any forms of social connection. Social connection is essential to well-being (Small et al., 2011). Introverts typically have fewer social interactions than extraverts (Lucas et al., 2008), and therefore physical or social distancing measures during the pandemic may have produced relatively small shifts in their regular social behavior. Future research is needed to explore the reasons why extroverts and introverts experience stress differently during the pandemic.

Our findings also revealed the mechanisms in which neurotic, conscientious (goal-striving), and extroverts (activity and sociability) may experience perceived stress and change in stress during the pandemic differed. Our findings supported our hypotheses. Specifically, individuals with a strong neurotic personality experienced higher levels of stress during the pandemic due to higher levels of perceived threat related to COVID-19 and lower levels of perceived efficacy. Perceived threat and efficacy had the strongest mediating effect for neurotic compared with the other personality traits. This finding was supported by previous research (Ebstrup et al., 2011; Moeini et al., 2008; Vollrath, 2001). Our results also suggested that perceived threat did not explain the relationship between extroversion and high levels of stress. Higher levels of perceived stress from extraversion during the pandemic may stem from the inability to socialize, as mentioned earlier. The negative association between extroversion and efficacy suggests that it may be challenging for extroverts to carry out preventive COVID-19 measures. Extroverts were associated with lower engagement with social distancing behaviors during COVID-19 (Carvalho et al., 2020). Finally, our results suggest that individuals with high conscientiousness (goal-striving) personality traits may perceive COVID-19 as challenges rather than threats and are more likely to engage in positive appraisals of efficacy to prevent COVID-19. This finding is well reflected in the conscientiousness personality trait as these individuals value orderliness and following directions (Hoyle, 2006; Lecic-Tosevski et al., 2011). Thus, the ability to follow preventive measures for COVID-19 may lead individuals with high conscientiousness to perceive a lower level of threat. It is possible that the lower levels of perceived threat observed in individuals with high conscientiousness are a reflection of their self-regulation and emotional regulation skills (Hoyle, 2006). Future research is needed to better understand the influence of these regulation skills on perceived threat between the personality traits as a result of the pandemic.

There are several important implications for applied settings as a result of our findings. First, our results contribute to the existing COVID-19 literature that personality traits should be taken into consideration when identifying individuals at risk. One potential way to identify personality traits and at-risk individuals on a large scale is through infoveillance – the use of user-generated online information to help improve public health outcomes (Liu et al., 2019). Second, our findings may help inform the development of future behavior interventions to manage stress during pandemics. In order to improve stress management for individuals with higher levels of neuroticism, interventions need to address their levels of perceived threat and efficacy. Individuals with higher levels of neuroticism need help with managing their perceived threat and improving perceived efficacy to prevent COVID-19. Based on the EPPM, extreme fear messages that highlight the severity and susceptibility of COVID-19 may not necessarily be useful for individuals with higher levels of neuroticism, as this may further elevate their perceived levels of stress (Barnett et al., 2009). In addition to considering personality traits, a person's age and education should be taken into consideration, as these demographic variables were positively associated with perceived threat. Extraverts, particularly individuals with high extroversion activity and sociability, are not threatened, but they are likely to experience distress from social restrictions. This could be approached with creative means to maintain social connections such as regular video chats with family and friends, or online meetups. Interventions tailored for individuals with higher levels of neuroticism and extroversion should also aim to develop efficacy. Perceived efficacy can be improved through mastery experiences (e.g., ensuring people practice physical or social distancing) or vicarious experiences (e.g., observing others that successfully carried COVID-19 preventive measures) (Bandura, 2004).

A strength of this study is the large national sample and the use of validated questionnaires. However, one study limitation was that our sample included only English speakers in Canada; thus, this may limit the generalizability of our findings. Second, perceived stress was measured using a single item, thus caution is required when interpreting our findings. Future studies should use multi-item stress measures for replication or may consider applying context-specific COVID-19 related measures (Lee et al., 2008). Third, the influence of agreeableness and openness personality traits on perceived stress was not examined in this study. Previous studies have shown that neuroticism, conscientiousness, and extroversion have a stronger association on perceived stress than agreeableness and openness (Afshar et al., 2015; Ebstrup et al., 2011). Thus, based on previous research and an effort to minimize participant burden, we focused on neuroticism, conscientiousness, and extroversion. Finally, the design of our study is cross-sectional, and therefore the analyses of stress before COVID-19 are based on retrospective interpretations. Future studies using intensive longitudinal data collected by ecological momentary assessment can offer more sensitive assessments (Dunton, 2017).

5. Conclusion

We found that individuals with high neuroticism and extroversion demonstrated higher levels of perceived stress during the pandemic, as well as a greater increase in stress relative to pre-pandemic. Neurotic personality experienced higher levels of stress due to higher levels of perceived threat related to COVID-19 and lower levels of perceived efficacy. Meanwhile, the inability to socialize during the pandemic may have contributed to higher levels of perceived stress among extroverts. Higher conscientiousness was not associated with a higher level of threat, but instead showed a higher level of efficacy to prevent COVID-19. Our findings highlighted the importance of taking personality traits

into consideration when developing future stress management interventions during a pandemic.

CRediT authorship contribution statement

Sam Liu: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, Funding acquisition.**Alexander Lithopoulos:**Conceptualization, Methodology, Validation, Writing - review & editing.**Chun-Qing Zhang:**Conceptualization, Methodology, Writing - review & editing.**Mauricio A. Garcia-Barrera:**Writing - review & editing.**Ryan E. Rhodes:**Conceptualization, Methodology, Formal analysis, Writing - review & editing, Funding acquisition, Supervision.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article to disclose.

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References

Abbott, R. A., Croudace, T. J., Ploubidis, G. B., Kuh, D., Richards, M., & Huppert, F. A. (2008). The relationship between early personality and midlife psychological well-being: Evidence from a UK birth cohort study. *Social Psychiatry and Psychiatric Epidemiology, 43*(9), 679.

Afshar, H., Roohafza, H. R., Keshteli, A. H., Mazaheri, M., Feizi, A., & Adibi, P. (2015). The association of personality traits and coping styles according to stress level. *Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences, 20*(4), 353.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143–164. https://doi.org/10.1177/1090198104263660.

Bao, Y., Sun, Y., Meng, S., Shi, J., & Lu, L. (2020). 2019-nCoV epidemic: Address mental health care to empower society. *The Lancet, 395*(10224), e37–e38.

Barnett, D. J., Balicer, R. D., Thompson, C. B., Storey, J. D., Omer, S. B., Semon, N. L., ... Lanza, K. M. (2009). Assessment of local public health workers' willingness to respond to pandemic influenza through application of the extended parallel process model. *PLoS One, 4*(7).

Bíró, É., Veres-Balajti, I., Ádány, R., & Kósa, K. (2017). Social cognitive intervention reduces stress in Hungarian university students. *Health Promotion International, 32*(1), 73–78.

Brooks, C., & Moser, J. (2020). Surviving or thriving? Enduring COVID-19 as an introvert and extrovert. https://msutoday.msu.edu/news/2020/surviving-or-thriving-enduring-covid-19-as-an-introvert-and-extrovert/.

Carvalho, L.d. F., Pianowski, G., & Gonçalves, A. P. (2020). Personality differences and COVID-19: Are extroversion and conscientiousness personality traits associated with engagement with containment measures? *Trends in Psychiatry and Psychotherapy, AHEAD, 42*(2), https://doi.org/10.1590/2237-6089-2020-0029.

Costa, P. T., & McCrae, R. R. (1989). *NEO five-factor inventory (NEO-FFI)*. Odessa, FL: Psychological Assessment Resources3.

Cucinotta, D., & Vanelli, M. (2020). WHO declares COVID-19 a pandemic. *Acta Bio-Medica: Atenei Parmensis, 91*(1), 157–160.

De Raad, B. (2000). *The Big Five Personality Factors: The psycholexical approach to personality*. Hogrefe & Huber Publishers.

Dunton, G. F. (2017). Ecological momentary assessment in physical activity research. *Exercise and Sport Sciences Reviews, 45*(1), 48.

Ebstrup, J. F., Eplov, L. F., Pisinger, C., & Jørgensen, T. (2011). Association between the Five Factor personality traits and perceived stress: Is the effect mediated by general self-efficacy? *Anxiety, Stress, and Coping, 24*(4), 407–419.

Gaab, J., Blättler, N., Menzi, T., Pabst, B., Stoyer, S., & Ehlert, U. (2003). Randomized controlled evaluation of the effects of cognitive–behavioral stress management on cortisol responses to acute stress in healthy subjects. *Psychoneuroendocrinology, 28*(6), 767–779.

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Publications.

Hoyle, R. H. (2006). Personality and self-regulation: Trait and information-processing perspectives. *Journal of Personality, 74*(6), 1507–1526.

Jackson, S., & Schneider, T. (2014). Extraversion and stress. *Psychology of Extraversion* (pp. 121–131). .

Kobylińska, D., Zajenkowski, M., Lewczuk, K., Jankowski, K. S., & Marchlewska, M. (2020). The mediational role of emotion regulation in the relationship between personality and subjective well-being. *Current Psychology,* 1–14.

Kroencke, L., Geukes, K., Utesch, T., Kuper, N., & Back, M. (2020). *Neuroticism and emotional risk during the Covid-19 pandemic*.

Lecic-Tosevski, D., Vukovic, O., & Stepanovic, J. (2011). Stress and personality. *Psychiatriki, 22*(4), 290–297.

Lee, R. M., Dean, B. L., & Jung, K.-R. (2008). Social connectedness, extraversion, and subjective well-being: Testing a mediation model. *Personality and Individual Differences, 45*(5), 414–419.

Liu, S., Chen, B., & Kuo, A. (2019). Monitoring physical activity levels using Twitter data: Infodemiology study. *Journal of Medical Internet Research, 21*(6), Article e12394.

Lucas, R. E., Le, K., & Dyrenforth, P. S. (2008). Explaining the extraversion/positive affect relation: Sociability cannot account for extraverts' greater happiness. *Journal of Personality, 76*(3), 385–414.

Marshall, L. L., Allison, A., Nykamp, D., & Lanke, S. (2008). Perceived stress and quality of life among doctor of pharmacy students. *American Journal of Pharmaceutical Education, 72*(6).

Matthews, G., Schwean, V. L., Campbell, S. E., Saklofske, D. H., & Mohamed, A. A. R. (2000). Personality, self-regulation, and adaptation: A cognitive-social framework. *Handbook of self-regulation* (pp. 171–207). Elsevier.

Mazza, C., Ricci, E., Biondi, S., Colasanti, M., Ferracuti, S., Napoli, C., & Roma, P. (2020). A nationwide survey of psychological distress among Italian people during the COVID-19 pandemic: Immediate psychological responses and associated factors. *International Journal of Environmental Research and Public Health, 17*(9), 3165.

Moeini, B., Shafii, F., Hidarnia, A., Babaii, G. R., Birashk, B., & Allahverdipour, H. (2008). Perceived stress, self-efficacy and its relations to psychological well-being status in Iranian male high school students. *Social Behavior and Personality: An International Journal, 36*(2), 257–266.

Nielsen, N. R., Kristensen, T. S., Schnohr, P., & Grønbæk, M. (2008). Perceived stress and cause-specific mortality among men and women: Results from a prospective cohort study. *American Journal of Epidemiology, 168*(5), 481–491.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879–891.

Prior, A., Fenger-Grøn, M., Larsen, K. K., Larsen, F. B., Robinson, K. M., Nielsen, M. G., ... Vestergaard, M. (2016). The association between perceived stress and mortality among people with multimorbidity: A prospective population-based cohort study. *American Journal of Epidemiology, 184*(3), 199–210.

Saucier, G. (1998). Replicable item-cluster subcomponents in the NEO Five-Factor Inventory. *Journal of Personality Assessment, 70*(2), 263–276.

Schneider, T. R., Rench, T. A., Lyons, J. B., & Riffle, R. R. (2012). The influence of neuroticism, extraversion and openness on stress responses. *Stress and Health, 28*(2), 102–110.

Small, R., Taft, A. J., & Brown, S. J. (2011). The power of social connection and support in improving health: Lessons from social support interventions with childbearing women. *BMC Public Health, 11*(5), S4.

Vollrath, M. (2001). Personality and stress. *Scandinavian Journal of Psychology, 42*(4), 335–347.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International Journal of Environmental Research and Public Health, 17*(5), 1729.

Witte, K., Cameron, J., McKeon, J., & Berkowitz, J. M. (1996). Predicting risk behaviors: Development and validation of a diagnostic scale. *Journal of Health Communication, 1*(4), 317–341.