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Factors Associated with Resilience Among Medical Staff in Radiology Departments During The Outbreak of 2019 Novel Coronavirus Disease (COVID-19): A Cross-Sectional Study

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Background: A growing body of evidence suggests that in the face of life adversity, threats, or other major stressful events, resilience is more conducive to individual adaptation and growth.


Material/Methods: The Connor-Davidson Resilience Scale and the Chinese Perceived Stress Scale were used to evaluate the resilience and perceived stress of 600 medical staff members from the radiology departments in 32 public hospitals in Sichuan Province, China, respectively. Multiple linear regression was used to analyze factors related to resilience.

Results: The total resilience score was 65.76 ± 17.26 , wherein the toughness dimension score was 33.61 ± 9.52 , the strength dimension score was 21.25 ± 5.50 , and the optimism dimension score was 10.91 ± 3.15 . There was a significant negative correlation between perceived stress and resilience ($r = -0.635$, $P < 0.001$). According to multivariate analysis, the total perceived stress score ($\beta = -1.318$, $P < 0.001$), gender ($\beta = -4.738$, $P < 0.001$), knowledge of COVID-19 ($\beta = 2.884$, $P = 0.043$), knowledge of COVID-19 protective measures ($\beta = 3.260$, $P = 0.042$), and availability of adequate protective materials ($\beta = -1.268$, $P = 0.039$) were independent influencing factors for resilience.

Conclusions: The resilience level of the medical staff in the radiology departments during the outbreak of COVID-19 was generally low, particularly regarding toughness. More attention should be paid to resilience influence factors such as high perceived stress, female gender, lack of understanding of COVID-19 and protective measures, and lack of protective materials, and targeted interventions should be undertaken to improve the resilience level of the medical staff in the radiology departments during the outbreak of COVID-19.

MeSH Keywords: COVID-19 • Factor Analysis, Statistical • Medical Staff • Radiology Department, Hospital • Resilience, Psychological

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Background

Novel coronavirus pneumonia (NCP) emerged in Wuhan, China, in December 2019, and the outbreak has since spread rapidly worldwide [1,2]. On February 12, 2020, the World Health Organization officially named the disease caused by this novel coronavirus as “Coronavirus Disease 2019” (COVID-19) [3]. As of 10 am on February 29, 2020, a total of 53 countries had reported outbreaks of COVID-19, with the number of cases rising to 85,403, indicating a serious situation for prevention of the disease [4].

The novel coronavirus often causes pulmonary infection, and early and accurate identification of chest imaging characteristics is conducive to early diagnosis, timely isolation, and treatment [5,6]. Therefore, patients with fever or cough [7,8] must undergo imaging examinations for further clinical diagnosis of their condition. This makes it easy for the medical staff in the radiology departments to come into contact with patients with COVID-19 and places them in an environment with a high risk of infection [9]. Meanwhile, requirements for efficient and orderly clinical task completion and high-intensity work stress [10] may further increase the psychological load of the staff. If their psychological state cannot be promptly addressed, it is easy for the staff to have negative emotions, which impair their enthusiasm, initiative, and work efficiency and seriously harm their physical and mental health [11,12]. However, during the COVID-19 outbreak, there were no reports about the resilience level of the medical staff in the radiology department.

Resilience refers to a “rebound ability” that allows humans to maintain good adaptability in the face of life adversities, threats, or other major stressful events [13]. In the face of the sudden epidemic, the general population has different levels of anxiety, depression, severe stress, and other psychological impact, as do front-line medical staff [14].

Previous research showed that having good resilience can help medical staff alleviate adverse effects brought on by various stresses [15]. In the face of job burnout or stress, effective interventions should be undertaken to improve the resilience level of doctors, resulting in a more conducive way of coping with various challenges brought on by work stress [16]. Moreover, improving the resilience of nurses is conducive to their ability to cope with difficulties, adapt to new situations, and have more realistic and positive expectations for the future, which is very important to protect resilience in work and in daily life [17]. Another study found that measures taken to increase resilience can reduce the expected stress of an influenza outbreak, such as severe acute respiratory syndrome (SARS), on the medical staff as well as benefit the physical and mental health of the medical staff [18]. Furthermore, high-risk

appraisal can decrease resilience in hospital workers, whereas strengthening coping ability and relieving the intensity of negative emotions experienced increased resilience during the outbreak of Middle East Respiratory Syndrome [19].

Therefore, the objective of this study was to assess the resilience level of medical staff in radiology departments during the outbreak of COVID-19 and to explore factors related to it to provide a basis for more effective risk assessment and psychological intervention.

Material and Methods

Study design and participants

From February 7, 2020, to February 9, 2020, 600 medical staff members were randomly selected from the radiology departments of 32 public hospitals in Sichuan Province to take online electronic questionnaire surveys. Inclusion criteria were: (1) age 18 years or older; (2) being a nurse, technician, or doctor working in the radiology departments of public hospitals in Sichuan Province; (3) being informed about the study and willing to participate in the survey. Exclusion criteria were: (1) previous meeting the Chinese Classification of Mental Disorders version 3 (CCMD-3) and the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) diagnostic criteria for substance abuse and substance dependence [20]; (2) a history of mental illness; or (3) suffering from other brain organic lesions or serious physical diseases. Elimination criteria were: (1) filling out the electronic questionnaire in too short a period of time; and (2) submission of a questionnaire that was obviously inconsistent with the actual situation. Finally, 587 medical staff members were included in the final study cohort.

Data collection

Before the start of the study, 30 cases were selected from the hospital where the investigators worked to perform a pretest evaluation to check and improve the scale used in the survey, get familiar with the process and techniques of data collection, and measure the internal consistency of the scale. After the reliability and validity requirements were met, formal data collection began. The relevant scales were completed on a mobile phone by scanning the Wenjuanxing QR code. The members of the study group analyzed and screened the questionnaire responses filled in by the included subjects in strict accordance with the rejection criteria. After double-checking, the data obtained were transcribed to the SPSS database.

Questionnaire

Demographic characteristics

The scale was designed by the researchers themselves and included gender, age, working seniority, marital status, education, job category, contact with confirmed/suspected cases at work, whether the participant had symptoms, whether their family members had symptoms, knowledge of COVID-19, knowledge of COVID-19 protective measures, availability of adequate protective materials, knowledge of the psychological hotline, whether the participant was concerned about contact with suspected/confirmed cases at work, and whether the participant was concerned about work-related infections.

The Chinese Connor-Davidson Resilience Scale (CD-RISC)

This scale is used to assess an individual's ability to respond and adapt to life adversities, traumas, tragedies, threats, or other major life stresses [21]. The Chinese scale was used in this study [22]. The scale contains the three dimensions of toughness, strength, and optimism with a total of 25 entries. The total score ranges from 0 to 100, and a higher score indicates a higher resilience level. In this study, the Cronbach α coefficient of the scale was 0.959.

The Chinese Perceived Stress Scale

This scale is used to measure the overall and ubiquitous stress in an individual's life, reflecting the individual's degree of self-awareness of stress [23]. The Chinese scale was used in this study [24]. The scale contains two dimensions, namely loss of control and tension, with a total of 14 entries, wherein loss of control is scored in reverse. The total score ranges from 14 to 70, and a higher score indicates greater mental stress. In this study, the Cronbach α coefficient of the scale was 0.867.

Ethics statement

The study protocol was approved by the ethics committee of the corresponding research institute. The online questionnaires involved in this study were anonymous and informed consent of the participants was obtained before starting.

Data analysis

All analyses were performed using the IBM Statistical Package for Social Sciences (SPSS) version 19.0. Composition ratio (quartile) and mean (standard deviation) were used to describe demographic data, the resilience score, and the perceived stress score. The total resilience score conformed to a normal distribution by the normality test, and age, work seniority, and perceived stress conformed to a non-normal distribution. Analysis

of variance (ANOVA) or independent sample t test was used for single-factor analysis, Spearman correlation analysis was used for correlation analysis, and multiple linear regression analysis was used for multivariate analysis. The total test level was set at $P < 0.05$.

Results

Demographic data from the medical staff in the radiology departments

Of the 600 questionnaires issued, 587 were valid, with an effective rate of 97.8%. Among the 587 valid participants, 282 (48%) were males and 305 (52%) were females, with a median (interquartile range [(IQR)] age of 33 (28–43) years and a median (IQR) work seniority of 10 years (5–21) (Table 1).

Among the included medical staff members who took the survey, the total resilience score was 65.76 ± 17.26 . The scores for each dimension are shown in Table 2.

Related factors for resilience of the medical staff in the radiology departments

Through the one-way ANOVA, nine factors were statistically significant ($P < 0.05$), gender ($t = 5.167$, $P < 0.001$), job category ($F = 3.647$, $P = 0.027$), the participant with symptoms ($t = -3.125$, $P = 0.002$), knowledge of COVID-19 ($F = 20.534$, $P < 0.001$), knowledge of COVID-19 protective measures ($t = -6.284$, $P < 0.001$), availability of adequate protective materials ($F = 3.247$, $P = 0.022$), knowledge of the psychological hotline ($t = 3.044$, $P = 0.002$), Whether the participant was concerned about contact with suspected/confirmed cases at work ($t = -2.292$, $P = 0.022$), and whether the participant was concerned about work-related infections ($t = -2.737$, $P = 0.006$) (Table 3).

The total perceived stress score was 32 (37–42). Spearman correlation analysis with perceived stress showed that there was a significant negative correlation between resilience and perceived stress ($r = -0.635$, $P < 0.001$).

Spearman correlation analysis of resilience with age and work seniority was carried out. The results showed that there was no correlation ($r = 0.048$, $P = 0.243$; $r = 0.055$, $P = 0.187$, respectively).

Multiple linear regression analysis

Multiple linear regression analysis was carried out with 10 factors as important predictive variables: gender, job category, symptoms in participants, knowledge of COVID-19, knowledge of COVID-19 protective measures, availability of adequate protective materials, knowledge of the psychological

Table 1. Demographic characteristics of participants (N=587).

Variable	Category	n	%
Gender	Male	282	48.0
	Female	305	52.0
Marital status	Unmarried	138	23.5
	Marriage	439	74.8
	Divorced	10	1.7
Education	Diploma degree	140	23.9
	Bachelor degree	385	65.6
	Master's degree or doctor's degree	62	10.6
Job category	Nurse	119	20.3
	Technician	245	41.7
	Doctor	223	38.0
Contact with confirmed/suspected cases at work	Yes	223	38.0
	No	364	62.0
Participant with symptoms	Yes	34	5.8
	No	553	94.2
Family members with symptoms	Yes	29	4.9
	No	558	95.1
Knowledge of COVID-19	Lack of understanding	6	1.0
	Part of understanding	203	34.6
	Significant understanding	378	64.4
Knowledge of protective measurements	Part of understanding	169	28.8
	Significant understanding	418	71.2
Availability of adequate protective materials	Significant shortage	77	13.1
	Partial shortage	242	41.2
	Partial abundance	157	26.7
	Significant abundance	111	18.9
Knowledge of the psychological hotline	Yes	395	67.3
	No	192	32.7
Whether the participant was concerned about contact with suspected/confirmed cases at work	Yes	345	58.8
	No	242	41.2
Whether the participant was concerned about work-related infections	Yes	341	58.1
	No	246	41.9

Table 2. Resilience and the scores for each dimension.

Variables	Entries	Score ranges	Mean (SD)	Entries mean (SD)
Resilience	25	1–100	65.76 (17.26)	2.63 (0.69)
Toughness	13	1–52	33.61 (9.52)	2.59 (0.73)
Optimism	4	0–16	10.91 (3.15)	2.73 (0.79)
Strength	8	0–32	21.25 (5.50)	2.66 (0.69)

Table 3. Univariate analyses of the factors associated with resilience (N=587).

Variable	Category	Mean (SD)	t/F	P
Gender			t=5.167	0.000
	Male	69.51 (17.10)		
	Female	62.30 (16.69)		
Marital status			F=0.034	0.966
	Unmarried	65.52 (16.39)		
	Marriage	65.86 (17.58)		
	Divorced	64.88 (15.84)		
Education			F=1.369	0.255
	Below the undergraduate	64.49 (17.92)		
	Undergraduate	65.73 (17.38)		
	Master and above	68.84 (14.64)		
Job category			F=3.647	0.027
	Nurse	62.16 (18.21)		
	Technician	67.33 (17.77)		
	Doctor	65.97 (15.91)		
Contact with confirmed/suspected cases at work			t=0.217	0.828
	Yes	65.96 (16.95)		
	No	65.64 (17.46)		
The participant with symptoms			t=-3.125	0.002
	Yes	56.85 (14.58)		
	No	66.31 (17.27)		
Family members with symptoms			t=-0.552	0.581
	Yes	64.04 (18.22)		
	No	65.85 (17.22)		
Knowledge of COVID-19			F=20.534	0.001
	Lack of understanding	49.43 (12.63)		
	Part of understanding	60.31 (16.41)		
	Very understanding	68.95 (16.91)		

Table 3 continued. Univariate analyses of the factors associated with resilience (N=587).

Variable	Category	Mean (SD)	t/F	P
Knowledge of COVID-19 protective measures			t=-6.284	0.001
	Part of understanding	58.95 (16.10)		
	Very understanding	68.52 (16.96)		
Availability of adequate protective materials			F=3.247	0.022
	Very shortage	65.39 (19.21)		
	Partial shortage	64.64 (15.85)		
	Partial abundance	64.46 (17.29)		
	Very abundance	70.30 (18.20)		
Knowledge of the psychological hotline			t=3.044	0.002
	Yes	67.26 (17.36)		
	No	62.68 (16.67)		
Whether the participant was concerned about contact with suspected/confirmed cases at work			t=-2.292	0.022
	Yes	64.40 (16.94)		
	No	67.71 (17.55)		
Whether the participant was concerned about work-related infections			t=-2.737	0.006
	Yes	64.12 (16.59)		
	No	68.05 (17.92)		

Table 4. Hierarchical multiple regression of resilience (N=587).

Model	B	SE	Beta	t	P	95% CI
Gender	-4.885	1.226	-0.142	-3.985	0.000	-7.293~-2.478
Participant with symptoms	3.279	2.394	0.044	1.369	0.171	-1.424~7.982
Knowledge of COVID-19	2.849	1.425	0.083	1.999	0.046	0.049~5.648
Knowledge of COVID-19 protective measures	3.323	1.605	0.087	2.070	0.039	0.169~6.476
availability of adequate protective materials	-1.270	0.615	-0.070	-2.067	0.039	-2.478~-0.063
Knowledge of the psychological hotline	-1.315	1.220	-0.036	-1.078	0.281	-3.712~1.081
Whether the participant was concerned about contact with suspected/confirmed cases at work	2.090	1.305	0.060	1.601	0.110	-0.474~4.653
Whether the participant was concerned about work-related infections	-0.005	1.276	0.000	-0.004	0.997	-2.512~2.501
The total perceived stress score	-1.318	0.078	-0.581	-16.900	0.000	-1.475~-1.167
Job category=nurse	0.676	1.630	0.016	0.415	0.679	-2.526~3.878
Job category=doctor	0.464	1.251	0.013	0.371	0.711	-1.993~2.920

F=38.738, P=0.000, R²=0.426, Adjusted R²=0.415.

hotline, whether the participant was concerned about contact with suspected/confirmed cases at work, whether the participant was concerned about work-related infections, and the total score of perceived stress. High total perceived stress score ($\beta=-1.318$, $P<0.001$), female ($\beta=-4.738$, $P<0.001$), less knowledge of COVID-19 ($\beta=2.884$, $P=0.043$), less knowledge of COVID-19 protective measures ($\beta=3.260$, $P=0.042$), and lack of protective materials in the hospital ($\beta=-1.268$, $P=0.039$) were important related factors for resilience of the medical staff in the radiology departments ($P<0.05$), which accounted for 41.5% of the total variation of the regression equation (Table 4).

Discussion

The outbreak of COVID-19 occurred suddenly and severely. Because computed tomography/diagnostic radiology is an important diagnostic method for early clinical screening of COVID-19 [25], the medical staff in the radiology departments are faced with great work stress and will inevitably be in a state of high mental stress. Meanwhile, as a high-risk group who are more likely to have close contact with patients with COVID-19, they will also suffer greater mental stress and be prone to negative emotions. If the medical staff do not have good resilience, it means that not only can they not recover after experiencing stress, but also that they may continuously accumulate negative emotions and even develop psychological disorders in severe cases [26]. This is extremely detrimental to the effective work of the medical staff in the radiology departments in response to the outbreak.

In our study, the total resilience score of the medical staff in the radiology departments was 65.76, which was lower than the 68.50 score of 463 medical students [27] and even more significantly lower than the 78.75 score reported for 560 nurses in China [28]. An international study of medical staff reported a score of 71.8 points [17]. This study's results indicated that the resilience level of the medical staff in the radiology departments during the outbreak of COVID-19 was relatively low. The reasons are multiple. First, pathogenesis and transmission route of COVID-19 was not clear enough because of the sudden outbreak [29,30]. Medical staff in the radiology departments were not mentally prepared, and they were worried about being unable to protect themselves and unable to do the best job at this time. Second, there was less confidence in coping because of the highly contagious nature of COVID-19 and the high number of deaths [31,32]. It is completely unknown when the outbreak will be effectively contained and when such high-intensity and high-risk working conditions will change. Third, as a high-risk group, the medical staff members were worried about the safety of their families because of their work and the staff showed restlessness and anxiety. Therefore, hospital administrators should realize the adverse

psychological effects of the high-stress state on the mental health of the medical staff in the radiology departments during the outbreak of COVID-19, and should take targeted measures to alleviate these effects in order to avoid serious and complicated psychological problems. The psychological high-stress state may not only affect the normal and orderly work of the medical staff in the radiology departments, but it may also lead to a decline in their immunity, resulting in a higher risk of infection [33,34].

The results also showed that among the dimensions of resilience, the items in the toughness dimension had the lowest average score, suggesting that medical staff were less resilient in terms of toughness. When they are depressed and frustrated, it is more difficult to consciously integrate the control behavior, goal-setting, and decision-making behavior, and they lack more effective buffers in terms of stress resistance [35]. On the other hand, the average score for items on the optimism dimension was the highest, indicating that medical staff were more inclined to treat the outbreak with an optimistic attitude and have confidence in overcoming the current difficulties [13]. Therefore, hospital administrators can pick people with consistent good psychological quality and strong decision-making ability to share their psychological experience and coping behavior with others. In addition, hospital administrators can encourage medical staff to discuss and reach a consensus regarding the outbreak and develop a set of more effective behavioral norms that integrate control, goal-setting, and decision-making behaviors, so as to relieve the stressful experience of being overwhelmed by inner conflict and optimize the psychological adjustment mechanism. In addition, resilience training for medical staff should be emphasized and strengthened in daily life.

From the analysis of related factors for resilience, the results showed that perceived stress, gender, knowledge of COVID-19, knowledge of COVID-19 protective measures, and availability of adequate protective materials were all statistically significant factors related to the medical staff's resilience. Some of these results were consistent with results of previous studies. Perceived stress reflects an individual's psychological experience after the self-interpretation of stressful events [36]. The results showed that greater perceived stress indicated worse resilience of the medical staff. Another study also found that good resilience enables a person to more successfully cope with the stresses and demands of life [37]. It is not difficult to predict that with an increase in self-perceived stress, an individual's adaptability to stress will decline and their self-recovery ability after psychological adjustment will also be affected, showing a low level of resilience. Therefore, hospital administrators should take whatever measures are feasible to relieve the stress level of the medical staff in their radiology departments. On the other hand, hospital administrators can start

by reducing their sensitivity to and perception of stress, promoting relaxation, reducing anxiety, and treating the outbreak objectively and rationally.

The results showed that resilience of female medical staff in the radiology departments was significantly lower than that of male medical staff. A study found that women had higher levels of psychological distress, and that the resilience of women had less impact on their psychological distress than did the resilience of men on their psychological distress [38]. Meanwhile, another study also found that the resilience of women was significantly lower than that of men [39]. The reason may lie in the differences between the different genders in their perspectives and ways of looking at problems. Women are more susceptible and sensitive; their anti-stress ability is also relatively weak and thus possibly inadequate for psychological adaptability. Therefore, more attention and emotional counseling should be given to female medical staff in the radiology departments.

A greater understanding of COVID-19 equated to better resilience, which means that a comprehensive and in-depth understanding of COVID-19 is more conducive to an objective and rational view of the outbreak. Thus, excessive anxiety and panic can be avoided, and the evolution of the outbreak can be viewed with a more peaceful attitude. Therefore, the medical staff in the radiology departments should be encouraged to obtain information on COVID-19 and to enhance their understanding of the disease. Meanwhile, hospital administrators can also collect valuable positive information about the outbreak and provide timely notification to medical staff in their radiology departments.

This study also found that a greater understanding of protective measures for COVID-19 equated with better resilience, which means that a comprehensive understanding of those measures is necessary to improve medical staff resilience. Only by mastering good protective measures can risk of infection be fundamentally reduced and the psychological security of the medical staff increased. Only with psychological security can medical staff promptly get rid of anxiety, panic, and other negative emotions and persevere through the epidemic [40]. Therefore, the hospital administrators should training medical staff in their radiology departments on how to protect themselves from COVID-19 as soon as possible, without just depending on the staff's own knowledge and self-learning. Instead, guidance on unified, professional, and scientific protective measures that fit the outbreak should be organized to foster clear and consistent behavioral norms. Thus, the negative impact of adversity on individuals can be minimized and adaptation and growth can be maximized.

The results also showed that when medical staff are faced with a shortage of protective materials, they will have worse resilience. A study demonstrated the importance of ensuring the adequacy of medical supplies during the outbreak of COVID-19 [41]. Adequate protective materials are the most fundamental prerequisite for personal safety of medical staff. Lack of protective materials will also lead to lack of psychological security. That pessimism and helplessness will significantly reduce the ability to mobilize protective factors, make risk factors gradually become stronger, and hinder psychological "recovery." Therefore, current efforts of hospital departments – especially in some local hospitals – to ensure a supply of protective materials are particularly necessary if medical staff in the radiology departments are to maintain good resilience.

Despite unprecedented advances in medical technology over the past few decades, awareness of and vigilance about epidemics have fallen far short [42]. As a result, when SARS, Middle East respiratory syndrome, and even this outbreak of COVID-19 suddenly appeared, it was difficult for medical staff in radiology departments to make full preparations. Psychologically, it was difficult to establish enough confidence to cope with and maintain good resilience to adapt. Therefore, we need to make some preparations during normal times. In terms of government functions, it is important to ensure that radiology departments at all hospital levels (including community hospitals), not just at large-scale hospitals, are well prepared for public health emergencies. In terms of hospital administration, it is necessary to strengthen the study and practice of scientific and systematic response measures daily for all kinds of public health emergencies, which can not only enhance the awareness of self-protection of medical staff in radiology departments, but also increase their confidence about self-protection so that they can calmly respond to an outbreak. In addition, daily training among medical staff in radiology departments, especially women, should also be actively carried out to improve their psychological anti-stress ability and enable them to transform negative emotions into positive emotions promptly and effectively under stress. All of the above are conducive to medical staff in radiology departments maintaining good resilience during an emergency.

Our study has the following limitations. First, only medical staff in the radiology departments in Sichuan Province were included, and further study is needed to conduct supplementary surveys in other provinces in China to improve generalization of the findings. Second, the related factors included in this study only accounted for 41.5% of the total variation in the equation, and more relevant factors that are clinically valuable need to be included in subsequent studies to provide a more comprehensive and in-depth basis for implementation of scientific and effective interventions in the future. Finally, because of the limited conditions, we only studied medical

staff in radiology departments, and it was impossible to determine whether their resilience differed from that of staff in other departments.

Conclusions

The resilience level of medical staff in radiology departments during the outbreak of COVID-19 was generally low, especially in the aspect of toughness. Attention should be paid to factors that may influence resilience, including high perceived stress, female gender, lack of understanding of COVID-19 and

COVID-19 protective measures, and lack of protective materials for staff. Targeted efforts should be made to improve the resilience level of radiology staff during the outbreak of COVID-19.

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References:

1. Neher RA, Dyrdak R, Druelle V et al: Potential impact of seasonal forcing on a SARS-CoV-2 pandemic. *Swiss Med Wkly*, 2020; 150: w20224
2. Wang C, Pan R, Wan X et al: Immediate psychological responses and associated factors during the initial stage of the 2019 Coronavirus Disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health* 2020; 17(5): 1729
3. Roosa K, Lee Y, Luo R et al: Short-term forecasts of the COVID-19 epidemic in Guangdong and Zhejiang, China: February 13–23, 2020. *J Clin Med*, 2020; 9(2): 596
4. World Health Organization: "Situation report – 40." World Health Organization. 28 Feb (2020). https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200229-sitrep-40-covid-19.pdf?sfvrsn=7203e653_2
5. Hosseiny M, Kooraki S, Gholamrezaezhad A et al: Radiology perspective of coronavirus disease 2019 (COVID-19): Lessons from severe acute respiratory syndrome and Middle East respiratory syndrome. *Am J Roentgenol*, 2020; 214(5): 1078–82
6. Bai HX, Hsieh B, Xiong Z et al: Performance of radiologists in differentiating COVID-19 from viral pneumonia on chest CT. *Radiology*, 2020 [Online ahead of print]
7. Guan WJ, Ni ZY, Hu Y et al: Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med*, 2020; 382(18): 1708–20
8. Chen N, Zhou M, Dong X et al: Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. *Lancet*, 2020; 395(10223): 507–13
9. Cheng LT-E, Chan LP, Tan BH et al: Déjà vu or jamais vu? How the severe acute respiratory syndrome experience influenced a Singapore radiology department's response to the coronavirus disease (COVID-19) epidemic. *Am J Roentgenol*, 2020 [Online ahead of print]
10. Zhang H-W, Yu J, Xu H-J et al: Corona virus international public health emergencies: Implications for radiology management. *Acad Radiol*, 2020; 27(4): 463–67
11. Ma HZ, Li D, Li Q et al: Intervention on negative feelings of nurses caring terminal cancer patients. *J Nursing Sci*, 2015; 30(5): 80–83
12. Pu J, Li JR, Cao LL et al: [Investigation and analysis of the psychological status of the clinical nurses in a class A hospital facing the novel coronavirus pneumonia [EB/OL].] *Chongqing Medicine*, 2020 [in Chinese]
13. American Psychology Association: The road to resilience [EB/OL]. 14 Nov 2011. <http://www.apa.org/helpcenter/road-resilience.aspx>
14. Wang W, Tang J, Wei F: Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. *J Med Virol*, 2020; 92(4): 441–47
15. Brennan EJ: Towards resilience and wellbeing in nurses. *Br J Nurs*, 2017; 26(1): 43–47
16. O'Dowd E, O'Connor P, Lydon S et al: Stress, coping, and psychological resilience among physicians. *BMC Health Serv Res*, 2018; 18(1): 730
17. Çam O, Büyükbayram A: Nurses resilience and effective factors. *Journal of Psychiatric Nursing/Psikiyatri Hemsireleri Dernegi*, 2017; 8(2): 118–26
18. Maunder RG, Leszcz M, Savage D, et al. Applying the lessons of SARS to pandemic influenza: an evidence-based approach to mitigating the stress experienced by healthcare workers. *Can J Public Health*, 2008; 99(6): 486–88
19. Son H, Lee WJ, Kim HS et al: Hospital workers' psychological resilience after the 2015 Middle East respiratory syndrome outbreak. *Soc Behav Pers*, 2019; 47(2): 13
20. Zhang T, Wang L, Good MJ et al: Prevalence of personality disorders using two diagnostic systems in psychiatric outpatients in Shanghai, China: A comparison of uni-axial and multi-axial formulation. *Soc Psychiatry Psychiatr Epidemiol*, 2012; 47(9): 1409–17
21. Connor KM, Davidson JRT: Development of a new resilience scale: The Connor-Davidson Resilience scale (CD-RISC). *Depression Anxiety*, 2003; 18(2): 76–82
22. Yu X, Zhang J: Factor analysis and psychometric evaluation of the Connor-Davidson Resilience Scale (CD-RISC) with Chinese people. *Soc Behav Pers*, 2007; 35(1): 19–30
23. Cohen S, Kamarck T, Mermelstein R: A global measure of perceived stress. *J Health Soc Behav*, 1983; 24(4): 385–96
24. Yang T, Huang H: An epidemiological study on mental stress of urban residents in social transition. *Chinese J Epidemiol*, 2003; 24(9): 760–64
25. Kooraki S, Hosseiny M, Myers L, Gholamrezaezhad A: Coronavirus (COVID-19) outbreak: What the department of radiology should know. *J Am Coll Radiology*, 2020; 17(4): 447–51
26. Huang JZ, Han MF, Luo TD et al: [Mental health survey of 230 medical staff in a tertiary infectious disease hospital for COVID-19.] *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi*, 2020; 38(3): 192–95 [in Chinese]
27. Lu ZX, Wu DX, Xu X et al: Reliability and validity test of Chinese Connor-Davidson Resilience Scale in medical students. *China J Health Psychol*, 2016; 24(8): 1209–12
28. Bian J, Guo X, Pang JJ et al: Effects of resilience on depression for nurses. *Occupation Health*, 2017; 33(24): 3391–94
29. Rothan HA, Byrareddy SN: The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *J Autoimmun* 2020; 109: 102433
30. Trilla A: One world, one health: The novel coronavirus COVID-19 epidemic. *Med Clin (Barc)*, 2020; 154(5): 175–77
31. Lin Q, Zhao S, Gao D et al: A conceptual model for the coronavirus disease 2019 (COVID-19) outbreak in Wuhan, China with individual reaction and governmental action. *Int J Infect Dis*, 2020; 93: 211–16
32. Chinazzi M, Davis JT, Ajelli M et al: The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science*, 2020; 368(6489): 395–400
33. Cruz-Pereira JS, Rea K, Nolan YM et al: Depression's unholy trinity: Dysregulated stress, immunity, and the microbiome. *Annu Rev Psychol*, 2020; 71: 49–78
34. Dhabhar FS, Saul AN, Holmes TH et al: High-anxious individuals show increased chronic stress burden, decreased protective immunity, and increased cancer progression in a mouse model of squamous cell carcinoma. *PLoS One*, 2012; 7(4): e33069
35. Zou Z, Wang D: A stress-buffering in personality: hardiness. *Adv Psychol Sci*, 2007; 2: 241–48
36. Boals A, Banks JB: Effects of traumatic stress and perceived stress on everyday cognitive functioning. *Cogn Emot*, 2012; 26(7): 1335–43

37. Gerber M, Brand S, Feldmeth AK et al: Adolescents with high mental toughness adapt better to perceived stress: A longitudinal study with Swiss vocational students. *Personality Individual Differences*, 2013; 54(7): 808–14
38. Zhang M, Zhang J, Zhang F et al: Prevalence of psychological distress and the effects of resilience and perceived social support among Chinese college students: Does gender make a difference? *Psych Res*, 2018; 267: 409–13
39. Nicholls AR, Polman RCJ, Levy AR, Backhouse SH: Mental toughness in sport: Achievement level, gender, age, experience, and sport type differences. *Personality Individual Differences*, 2009; 47(1): 73–75
40. Khalid I, Khalid TJ, Qabajah MR et al: Healthcare workers emotions, perceived stressors and coping strategies during a MERS-CoV Outbreak. *Clin Med Res*, 2016; 14(1): 7–14
41. Fang Y, Nie Y, Penny M: Transmission dynamics of the COVID-19 outbreak and effectiveness of government interventions: A data-driven analysis. *J Med Virol*, 2020 [Online ahead of print]
42. Zumla A, Niederman MS: The explosive epidemic outbreak of novel coronavirus disease 2019 (COVID-19) and the persistent threat of respiratory tract infectious diseases to global health security. *Curr Opin Pulm Med*, 2020; 26(3): 193–96