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Factors Influencing Anxiety of Health Care Workers in the Radiology Department with High Exposure Risk to COVID-19

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Background: During the outbreak of COVID-19, health care workers in the radiology department frequently interact with suspected patients and face a higher risk of infection and sudden surges in workload. High anxiety levels seriously harm physical and mental health and affect work efficiency and patient safety. Therefore, it is critical to determine anxiety levels of health care workers and explore its risk factors.

Material/Methods: Self-Rating Anxiety Scale and Connor-Davidson Resilience Scale were used to evaluate the anxiety and resilience of 364 health care workers with high exposure risk from the radiology departments of 32 public hospitals in Sichuan Province, China. Multivariate linear regression was used to analyze factors related to anxiety.

Results: The mean anxiety score was 44.28±8.93 and 23.4% of our study participants reported mild (n=63), moderate (n=19), or severe (n=3) anxiety. Multiple linear regression analysis showed that age, job position, availability of protective materials, signs of suspected symptoms, and susceptibility to emotions and behaviors of people around them were identified as risk factors for anxiety, whereas psychological resilience was identified as a protective factor.

Conclusions: Our study suggests that the anxiety level of health care workers in the radiology department with a high exposure risk to COVID-19 was high in the early stage of the outbreak, although the majority remained within normal limits. Timely assessment and effective intervention measures can improve the mental health of these at-risk populations.

MeSH Keywords: Anxiety • COVID-19 • Infectious Disease Transmission, Professional-to-Patient • Nuclear Receptor Subfamily 4, Group A, Member 2 • Radiology Department, Hospital

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Background

In December 2019, a novel coronavirus (SARS-CoV-2) emerged in Wuhan, China that caused a new coronavirus disease (COVID-19) [1,2]. At first, SARS-CoV-2 mainly spread in China [3]. However, as the epidemic has continued to develop, COVID-19 is now considered a worldwide public health emergency [4]. By April 13, 2020, there are 1 773 084 confirmed cases and 111 652 deaths worldwide [4]. Prevention and control of the epidemic is urgent. COVID-19 is mainly transmitted through air droplets, aerosols, and direct contact [5,6], and it has been reported that asymptomatic carriers are the main cause of the rapid spread [7]. Clinical symptoms of COVID-19 are similar to influenza [8] and include fever, dry cough, and bilateral ground-glass opacities on chest computed tomography (CT) scans [9,10], making it challenging to detect in a timely manner.

Although the Chinese government took urgent and stringent actions to deal with the epidemic and prevent its wider spread [11], COVID-19 still spread across the country in the early stages of the outbreak. This situation not only brought great threat to public safety, but also affected mental health [12,13]. Recent studies have shown that negative emotions such as depression or anxiety have increased [14] with 8.4% of the Chinese public suffering from severe anxiety [15].

As the main place for the diagnosis and treatment of COVID-19, hospitals are undoubtedly conducive to the spread of SARS-CoV-2 and health care workers are at an increased of risk of infection [16,17]. A recent study found that stress disorders in Chinese health care workers are at a high level during this outbreak, and as many as 23.0% of first-line health care staff show anxiety [18]. Other studies also have shown a high prevalence of anxiety among health care workers treating patients with COVID-19 in China [19–21]. Considering that early diagnosis and screening of COVID-19 relies on CT or other diagnostic radiology examinations [22,23], the front-line staff face huge work pressure and a high risk of infection brought by the sudden surge of patients, and these workers are more likely to have psychological symptoms such as anxiety and fear.

While anxiety levels can benefit from keeping people away from pathogens [24,25], long-term negative emotions may negatively impact the immune system and disturb the physiological balance [26]. At the same time, people with high-level anxiety tend to seek out health-related information and reassurance from multiple doctors. This behavior may lead to increased cross infection and a waste of medical resources [27]. In addition, anxiety and other psychological problems in health care workers may lead to erroneous decisions that can seriously affect the diagnosis and treatment of patients [28,29].

There is no known information on the psychological anxiety of health care workers in radiology departments during the peak of the COVID-19 epidemic. Compared with other health care workers, the normal daily work load of radiology staff is relatively low with adequate work/rest balance and reduced chance of burnout due to anxiety [30,31]. Therefore, health care workers in the radiology department are a suitable population to observe the effect of the epidemic on anxiety symptoms. Our study represents the first psychological impact survey conducted in health care workers with a high exposure risk in radiology departments during the beginning of the outbreak in China. We aimed to understand the prevalence of psychological anxiety and identify risk and protective factors contributing to anxiety. A previous study showed that before effective approaches to support the mental health of health care professionals can be developed, it is critical to understand their specific sources of anxiety [32]. In addition, previous research showed that having good resilience can help medical health workers alleviate adverse effects brought on by various stresses [33], which is also conducive to coping with new difficulties and challenges in work and in daily life, and to having more positive expectations for the future [34]. Psychological resilience can play an important role, especially during serious epidemic and other emergencies. We also hope to determine the influence of a positive personality on anxiety by evaluating psychological resilience during the outbreak of COVID-19. This study may assist government agencies and health authorities in efforts to reduce the incidence of mental illness and safeguard the psychological well-being of health care workers at the front line, who work in radiology departments.

Material and Methods

Ethical approval

The study research protocol was approved by the biomedical ethics committee of West China Hospital, Sichuan University. The online questionnaires in this study were anonymous. Participants gave informed consent before starting the online survey.

Study participants

From February 7, 2020 to February 9, 2020, 377 health care workers were randomly selected from the radiology departments of 32 public hospitals in Sichuan province to participate in our multicenter cross-sectional survey. The inclusion criteria were as follows: (1) age of 18 years or older, (2) nurses and technicians working in the radiology departments, and (3) informed of the study and willing to participate in the survey. The exclusion criteria were as follows: (1) past substance abuse/dependence, (2) history of mental illness according to the Chinese

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Classification of Mental Disorders version 3 (CCMD-3) and the Diagnostic and Statistical Manual of Mental Disorders fourth edition (DSM-IV) [35], and (3) current brain lesion or serious physical disease. Participants were eliminated from the study when the online questionnaire was (1) filled out in a short time period (less than 2 minutes) and (2) there were obvious inconsistencies with the actual situation (the questionnaires were considered invalid if all the items of the SAS scale or the CD-RISD scale were presented with the highest or lowest scores). We included 364 health care workers in the final study population. The research was approved by the ethics committee of the corresponding research institutes and the online questionnaires in this study were anonymous. We used the Kendall's sample size calculation formula: the number of independent variables * (15–20)=[16+(4+3)]*(15–20)=23*(15–20)=345–460; we added 10% of the sample size to reduce experimental error caused by a loss of sample size, so we set the minimum sample size required as 380. There were 377 cases finally enrolled in the study according to the inclusion and exclusion criteria. We included 364 health care workers in the final study population after the invalid questionnaires were eliminated.

Study design

An observational and cross-sectional study was conducted using the self-reported questionnaires. Demographic and social data from the health care workers were obtained. Levels of anxiety and resilience were measured using validated questionnaires and scoring systems. Mobile devices with the WeChat app were used to fill in the online questionnaire. All questionnaires were completed anonymously by the 377 participating health care workers. After completion of the survey, it was automatically checked for missing data and time spent, and screened for errors. The data were then checked by the research team and entered into the database.

Demographic and social data

Demographic and social data from the study participants included gender, age, work experience, education, marital status, job function, hospital classification, residence status, presence of suspected symptoms in the participant or family members, contact with confirmed/suspected patients at work, degree of knowledge about COVID-19, availability of adequate protective materials, susceptibility to emotions and behaviors of people around them, and fear of an uncontrollable epidemic and inability to pay rent or mortgage.

The Self-Rating Anxiety Scale (SAS)

The Self-Rating Anxiety Scale (SAS) [36] was used to measure the levels of anxiety of the health care workers. The SAS questionnaire contained 20 items consisting of 4 dimensions, with questions based on feelings of anxiety in the previous 7 days. All item scores were added together to obtain a rough score. The rough score was multiplied by 1.25, and the integer part was the standard score. The total score ranged from 25 to 100 points. Higher scores indicated higher levels of anxiety. The scores were grouped into the following 4 categories: no anxiety (<50 score); mild anxiety (50 to 59 score); moderate anxiety (60 to 69 score), and severe anxiety (≥70 score) [36]. In our study, Cronbach's alpha for this scale was 0.839.

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

The Chinese Connor-Davidson Resilience Scale (CD-RISC) [37] was used to assess the levels of resilience among health care workers. The CD-RISC questionnaire contains 3 dimensions with a total of 25 entries according to the feelings of the respondents in the past week. The frequency of symptoms was mainly evaluated for this study. The total score ranged from 0 to 100, with a higher score indicating a higher resilience level [37]. In our study, Cronbach's alpha for this scale was 0.961.

Statistical analysis

All analyses were performed in statistical software package (SPSS) 19.0 for Windows. According to the normal test, the total score of anxiety accorded with the normal distribution which was presented by mean±standard deviation (SD) or percentage, whereas age and work experience did not conform to normal distribution which is presented by median with interquartile range. Mean±SD and median with interquartile range were used to describe the continuous data, and percentage was used to describe the categorical variables. We used the analysis of variance (ANOVA) or the independent sample *t* tests for between-group comparisons. Multivariate linear regression analysis was used to assess the effects of each variable in the anxiety scores. All the influencing factors with significant differences in the univariate analysis were used for further analysis in the multiple linear regression analysis. A *P*-value <0.05 was considered to be statistically significant.

Results

Demographic characteristics of participants

A total of 377 questionnaires were completed and the final data set included 364 valid questionnaires (96.6%). Among the 364 valid participants, the median age was 32 years (27–40 years) with a median work experience of 10 years (5–19 years); 150 participants were male (41%) and 214 participants were female (59%), and most participants were married (72.8%). The majority of health care workers had bachelor's degree (66.5%) and lived with their families (78.0%). Despite working at the

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Table 1. Demographic characteristics of participants (N=364).

Variables	N (%)
Gender	
Male	150 (41.2%)
Female	214 (58.8%)
Age	
<30	136 (37.4%)
≥30	228 (62.6%)
Work experience (yr)	
<10	176 (48.4%)
≥10	188 (51.6%)
Education	
College degree or below	115 (31.6%)
Bachelor	242 (66.5%)
Postgraduate or above	7 (1.9%)
Marital status	
Unmarried	93 (25.5%)
Married	265 (72.8%)
Divorced	6 (1.7%)
Job function	
Nurse	119 (32.7%)
Technician	245 (67.3%)
Hospital classification	
Grade 3A	240 (65.9%)
Grade 3B	112 (30.8%)
Grade 2A or below	12 (3.3%)
Residence status	
Live alone	48 (13.2%)
Live with a roommate(s)	32 (8.8%)
Live with family	284 (78.0%)
Presence of suspected symptoms in participant	
Yes	26 (7.1%)
No	338 (92.9%)
Presence of suspected symptoms in family members	
Yes	20 (5.5%)
No	344 (94.5%)
Contact with confirmed/suspected patients at work	
Yes	177 (48.6%)
No	187 (51.4%)
Availability of adequate protective materials	
Extreme shortage	48 (13.2%)
Mild shortage	137 (37.6%)
Sufficient	102 (28.0%)
Abundant	77 (21.2%)
Knowledge about COVID-19	
Insufficient	131 (36.0%)
Sufficient	233 (64.0%)
Susceptible to emotions and behaviours of people around them	
Yes	76 (20.9%)
No	288 (79.1%)
Fear of inability to pay rent or mortgage	
Yes	45 (12.4%)
No	319 (87.6%)
Fear of an uncontrollable epidemic	
Yes	316 (86.8%)
No	48 (13.2%)
Psychological resilience	
Low (<50 score)	59 (16.2%)
High (≥50 score)	305 (83.8%)

front line of the epidemic, 36.0% reported insufficient knowledge about COVID-19. Furthermore, 86.8% of the health care workers expressed concerns about the uncontrollable situation. Table 1 lists the demographic details of our study population.

The mean anxiety score measured by SAS was 44.28±8.93 and 23.4% of our study participants reported mild (n=63), moderate (n=19), or severe (n=3) anxiety (Table 2).

Univariate analyses of the factors associated with anxiety

We conducted univariate analysis to study the demographic data listed in Table 1. The results revealed a significant difference in age (t=–2.554, P=0.011), gender (t=–2.937, P=0.004), job function (t=3.214, P=0.001), availability of adequate protective materials (F=5.874, P=0.001), presence of suspected symptoms

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Table 2. Scoring of anxiety.

Variables	N (%)	Mean (SD)
Anxiety	364 (100.0%)	44.28 (8.93)
No anxiety	279 (76.6%)	40.29 (4.70)
Mild anxiety	63 (17.3%)	54.31 (2.64)
Moderate anxiety	19 (5.2%)	63.55 (3.01)
Severe anxiety	3 (0.8%)	82.50 (2.17)

in the participant (t=4.503, P<0.001), degree of knowledge about COVID-19 (t=1.978, P=0.049), susceptibility to emotions and behaviors of people around them (t=3.068, P=0.002), fear of an uncontrollable epidemic (t=2.382, P=0.018), and psychological resilience to anxiety (t=7.429, P<0.001) (Table 3). In addition, the results showed that compared with other groups, the anxiety level of health care workers who reported an extreme lack of protective materials was significantly higher.

Table 3. Univariate analyses of the factors associated with anxiety (N=364).

Variables	Mean (SD)	t/F	P
Gender		t=–2.937	0.004*
Male	42.65 (8.82)		
Female	45.41 (8.85)		
Age		t=–2.554	0.011*
<30	42.74 (7.92)		
≥30	45.19 (9.38)		
Work experience (yr)		t=–1.189	0.235
<10	43.70 (8.17)		
≥10	44.81 (9.58)		
Education		F=2.093	0.125
College degree or below	44.02 (8.60)		
Bachelor	44.20 (8.84)		
Postgraduate or above	51.07 (15.15)		
Marital status		F=1.765	0.173
Unmarried	42.86 (8.55)		
Married	44.81 (9.11)		
Divorced	42.50 (3.45)		
Job function		t=3.214	0.001*
Nurse	46.41 (9.84)		
Technician	43.24 (8.28)		
Hospital classification		F=0.351	0.704
Grade 3A	43.99 (9.06)		
Grade 3B	44.84 (8.73)		
Grade 2A or under	44.58 (8.81)		
Residence status		F=2.149	0.118
Live alone	42.40 (7.36)		
Live with a roommate(s)	42.54 (8.28)		
Live with family	44.79 (9.20)		

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Table 3 continued. Univariate analyses of the factors associated with anxiety (N=364).

Variables	Mean (SD)	t/F	P
Presence of suspected symptoms in participant		t=4.503	0.000*
Yes	51.68 (10.54)		
No	43.71 (8.55)		
Presence of suspected symptoms in family members		t=0.823	0.411
Yes	45.88 (8.46)		
No	44.18 (8.96)		
Contact with confirmed/suspected patients at work		t=1.021	0.308
Yes	44.77 (8.76)		
No	43.81 (9.09)		
Availability of adequate protective materials		F=5.874	0.001*
Extreme shortage	48.52 (11.36)		
Mild shortage	44.35 (8.09)		
Sufficient	44.07 (7.92)		
Abundant	41.77 (9.11)		
Knowledge about COVID-19		t=1.978	0.049*
Insufficient	45.51 (7.87)		
Sufficient	43.58 (9.42)		
Susceptible to emotions and behaviours of people around them		t=3.068	0.002*
Yes	47.04 (8.44)		
No	43.55 (8.93)		
Fear of inability to pay rent or mortgage		t=0.982	0.327
Yes	45.50 (8.24)		
No	44.10 (9.03)		
Fear of an uncontrollable epidemic		t=2.382	0.018*
Yes	44.71 (8.90)		
No	41.43 (8.69)		
Psychological resilience		t=7.429	0.000*
Low (<50 score)	51.65 (8.32)		
High (≥50 score)	42.85 (8.34)		

* P<0.05; SD – standard deviation.

Multivariate linear regression analysis of anxiety

We defined anxiety level as the dependent variable; the significant variables from the univariate analysis in Table 3 were used as independent variables. Our analysis revealed that age older than 30 years (β=0.105, *P*=0.030), a nursing role (β=–0.110, *P*=0.021), a lack of protective materials (β=–0.122, *P*=0.011), presence of suspected symptoms in the participant (β=–0.208, *P*<0.001), and high susceptibility to emotions and behaviors of people around them (β=0.128, *P*=0.007) were identified as risk factors for anxiety, whereas psychological resilience (β=–0.349, *P*<0.001) was protective for the development of anxiety (Table 4).

Discussion

Our study revealed that the level of anxiety among health care workers in the radiology departments was high. In comparison,

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Table 4. Multivariate linear regression analysis of anxiety.

Variables	*B*	*SE*	β	*t*	*P*
Presence of suspected symptoms in participant	–7.188	1.620	–0.208	–4.436	0.000
Susceptibility to emotions and behaviours of people around them	2.804	1.027	0.128	2.731	0.007
Job function	–2.085	0.902	–0.110	–2.311	0.021
Psychological resilience	–8.454	1.114	–0.349	–7.590	0.000
Availability of adequate protective materials	–1.125	0.437	–0.122	–2.572	0.011
Age	1.929	0.884	0.105	2.181	0.030

R^2=0.251, adjusted R^2=0.238, F=19.945, P<0.001.

our study population showed higher anxiety than previous reports of other Chinese health care workers during this outbreak [18] and a great deal higher than the average in China [37]. However, other studies have shown that at an earlier stage of the outbreak, Chinese health care workers in fever clinics or intensive care units reported average anxiety scores as high as 55.26 [38]. This may be related to the fact that the daily basic anxiety level of medical workers in radiology departments is lower than that of those working in wards, which are characterized by higher work intensity and irregular cycles of work and rest. In addition, our study also revealed that even if anxiety develops, it is usually mild to moderate. The relatively low incidence and low severity of anxiety disorders in this study could be explained by the abruptness of the COVID-19 outbreak compared to other stressors. However, the passage of time and the development of the epidemic could lead to continuous exposure to stressors and more serious anxiety symptoms. Therefore, we should maintain our vigilance on reviewing the psychological health of front-line health care workers.

In contrast to previous studies that have found a lower risk of anxiety in people older than 40 years of age [3], our study found that with an increase in age, the anxiety level of medical workers at high risk of radiation exposure also increased. A survey of medical workers fighting the Ebola epidemic also supports our findings [39]. This may reveal that older individuals who undertake greater family responsibilities and who are more likely to make risk-based empirical estimates have a higher risk of anxiety in the face of a threat to survival. Hence, more psychological attention should be paid to health care workers older than 30 years of age.

Interestingly, we also found that the anxiety level of nurses was significantly higher than that of technicians in the radiology department. This is consistent with previous studies showing higher anxiety levels in nurses than other health care workers [18,40]. This could be due to a higher frequency of contact with patients by nurses than technicians, as nurses need to administer drugs to patients, manage patients, and disinfect the environment and equipment, whereas technicians only interact with patients during the imaging examinations.

One study showed that participants with suspected symptoms showed higher anxiety that was likely related to the fear of infection as a result of viral nucleic acid tests that could not be carried out rapidly [31]. A previous study also revealed that specific physical symptoms (e.g., myalgia, dizziness, and coryza) were significantly associated with higher levels of anxiety during the outbreak of COVID-19 [15]. In this study, the mean anxiety score of the group of participant with suspected symptoms was above the normal limit indicating that the occurrence of these symptoms had a significant effect on anxiety. Therefore, timely screening for SARS-CoV-2 in health care workers with suspected symptoms may be beneficial to relieve psychological pressure and anxiety. Moreover, it is critical for all health care workers to have a more accurate understanding of the symptoms of COVID-19.

Sufficient supply of protective materials is important to ensure the safety of health care workers during the outbreak of COVID-19 [41]. We demonstrated that a lack of protective materials in the hospital greatly increase the anxiety level. If health care workers cannot guarantee their own safety, then their work enthusiasm and efficiency will inevitably be low, in addition to the threat to their physical and mental health. Therefore, each hospital should strive to ensure the supply of protective materials is adequate, especially in local hospitals, in order to adequately protect staff and to alleviate their anxiety.

In the current study, we found that health care workers with a high susceptibility to the emotions and behaviors of people around them, that this trait may affect their stress experience. A previous study showed that emotions between people can be transferred, and susceptible individuals tend to more easily catch negative emotions from others [42]. Another study reported that husbands and wives more easily transferred

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anxiety to each other [43]. In addition, alternative/past trauma can have an important psychological impact on human interaction, which could increase anxiety [11]. Hence, health care workers should distance themselves from personal emotion in this exceptional situation and contact people with positive emotions and optimistic attitudes.

Our study also showed that psychological resilience has a protective effect on anxiety level. Resilience allows humans to maintain adaptability in the face of life adversities, threats, or other major stressful events [44]. Current research suggests that having good resilience can help health care workers alleviate the adverse effects brought on by negative emotions such as anxiety, anger, and frustration [45]. Therefore, resilience training for health care workers who have a high exposure risk can enhance their adaptability and resistance to difficulties and should be routinely emphasized and strengthened.

Our study had the following limitations. First, this study investigated health care workers from the province of Sichuan, and further study is needed to conduct supplementary surveys in other provinces in China to extend our findings. Second, we only surveyed the radiology staff and the results of our study may not be directly extrapolated to other health care workers as there could be differences between the radiology department and other departments. Third, our study analyzed the general information of health care workers and did not consider the impact of their environment and family support, which may affect the interpretation of our data. Fourth, this study used self-application surveys and the diagnosis of psychological condition among health care workers may be fragile. Finally, this was a cross-sectional study and no follow-up was conducted. Anxiety likely changes over time and the effectiveness of different coping strategies need to be further investigated.

Conclusions

Our study demonstrated that at the beginning of the COVID-19 outbreak, the anxiety level was high in health care workers who had a high exposure risk in the radiology departments, but the vast majority of the workers had anxiety that remained within normal limits. Timely assessment and effective measures to improve mental health should be taken for those health care workers who are more likely to surpass normal anxiety levels.

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Conflicts of interest

None.

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