

Risk perception and Emotion evaluation of Health care workers varied during different periods of COVID-19: a repeated cross-sectional research

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Research article

Keywords: COVID-19, Health care worker, Risk perception, Negative emotion

Posted Date: June 23rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-32610/v1>

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Abstract

Background Health care workers (HCWs) on the front line of the COVID-19 were facing greater risks than usual, and their perception of these risks could also be an important part of their anti-epidemic work. This study aimed to examine risk perception and negative emotions of during two periods of the COVID-19 and emphasized emotional intervention management of HCWs impacting the risk perceptions and self-protection and would provide plausible intervention points for the psychological aid under a stressful condition.

Methods The current study was adapted a repeated cross-sectional research participated by 504 Chinese HCWs who were assigned to work at the current disease resistance line. The demographic information about gender, profession, and location were collected in the demographic questionnaire. Risk perception questionnaire was adapted for COVID-19 to assess risk perception and the Chinese version of emotional self-rating scale (PANAS) was used to evaluate HCWs' negative emotions.

Results Findings revealed the risk perception and negative emotions of HCWs varied in different gender, profession and the location, as well as in different periods of COVID-19. Besides, the levels of tension, fear, worry and risk perception were higher during Period 1 than they were during Periods 2 of COVID-19. Over the different periods, the predominated negative emotions of HCWs presented varied, but the positive relations to risk perception were consisted and could be a significant predictor of risk perception. Worry was found to be closely related to and a significant predictor of high-level risk perception in the period 1; whereas in the period 2 the predictive type of negative emotion was tension.

Conclusion The significance of this research lies in its examination of risk perception and negative emotions of HCWs combating the COVID-19 during two periods of the pandemic. The findings showed both risk perception and negative emotions of HCWs were affected by the COVID-19 and underscored the importance of negative emotions as a significant factor for risk perception of Chinese HCWs enduring the great challenge of pandemic. To ensure safety and prevent the return of the pandemics, it would be better to monitor the risk perception and negative emotions of HCWs and emphasize the risk protection behaviors.

Background

On February 12, 2020, the novel coronavirus was officially named by the world health organization as COVID-19. Due to its rapid spread, the outbreak of covid-19 has not only caused widespread public health concern, but also caused great psychological stress to the public. The researchers assessed the burden of mental health brought by COVID-19, analytically showed that in Chinese samples, the medical personnel would bear the brunt of the risk of mental health problems, which affected their attention, cognitive function and clinical decision, and even endangered the patient due to medical negligence [1]. In addition, while saving lives, frontline health care workers (HCWs) were also faced with increasing workload and risk of infection. According to the report of National Health Commission of China, 1,716 HCWs were infected up to February 11, 2020, and 11 of them died up to February 24, 2020. Hence, HCWs on the front line of the epidemic resistance were facing greater risks than usual, and their perception of these risks could also be an important part of their anti-epidemic work.

Risk perception, a psychological term, refers to the individual's perception and understanding of various objective risks existing in the outside world, and emphasizes the influence of the experience acquired by

individuals from intuitive judgment and subjective feelings on cognition[2]. Notably, individuals' ability to perceive risks associated with the virus is important for rapid changes and adaptation of population behaviors as for self-protective measures[3]. Given the importance of human psychological and behavioral factors in staving off pandemics, it is crucial to assess psychological and behavioral responses to the situation and determine how perceived risk is impacted by the pandemic[4]. Combined with studies in other fields and relevant literature analysis[5–7], HCWs' risk perception refers to their knowledge, feelings and understanding of risk factors and risk characteristics in the health care profession. However, a clear definition is still discussed and explored. Recently, a study on the influencing factors of risk perception was participated by 608 nurses and concluded that risk perception of HCWs could be clustered into five dimension: personal safety; physical function; occupational exposures; psychosocial concerns; organization safety; timing pressure[8]. The key constructs of HCW's risk perception included personal health risks, health risks to others, social isolation and acceptance of risks[9]. A high perception of risk can influence the retention of HCWs within the workforce and their willingness to care for infected patients[10], particularly if they are concerned about their own and their family's health and safety from the risk[11]. In contrast, HCWs with very low risk perceptions may be non-compliant to protective behaviors such as vaccinations and personal protective equipment (PPE), increasing both their own risk as well as increasing the risk of propagation of nosocomial transmission within the hospital and community[12]. As we hypothesized, with regard to the particularity of health care profession and the uncertainty of the disease in patients, HCWs combating against the pandemic are undertaken the risk of occupational exposure combined with the busy working status and shift work, which undoubtedly render their body in a state of fatigue and busy for a long time, hence, HCWs' risk perception would be significant influenced by the outbreak of COVID-19.

Against the backdrop of epidemics, a paucity of previous studies has assessed the risk perception of HCWs. Koh et al. [13] conducted a qualitative interview schedule and attained that suffering from the infectious diseases, such as, would significantly impact the nurses' risk perception. The latest study of Diego et al. conducted in Latin American HCWs showed HCWs perceived limited access to protective equipment and supports, which indicated the organizational safety were also added to the epidemic-related risk for HCWs[14]. However, the mechanism of the effect of COVID-10 on HCW's risk perception were scarce. Many factors play a role in one's perceptions and these may be varied between individuals. Related studies showed that the cognitive and decision-making abilities of health care workers are influenced by their own emotions[15, 16]. This knowledge can inform us the psychological status reflected by HCWs' emotion could associate with the perceptions of personal or organization risks. Previous studies found that HCW's distress and fears were generated after their exposure to infectious diseases[17, 18]. In 2003, HCW faced the earliest exposures of SARS and then showed some psychological problems signaling with negative emotions such as fear, anxiety, anger and depression[19]. Presently, researches during COVID – 19 epidemic using online questionnaire to assess the respondents' depression and anxiety found that symptoms of depression and anxiety were presented in a majority of HCWs, indicating the salient existence of negative emotion[20–22]. Therefore, the in-depth understanding of negative emotions of HCWs defending against covid-19 and their association with risk perception will help to reduce the adverse risk judgment of HCWs due to negative emotions. Importantly, it could also improve HCWs self-protection and clinical treatment level.

To explore the potential mechanism of pandemic effects on risk perception of HCW's after the outbreak of COVID-19, the current study was adapted a repeated cross-sectional research participated by Chinese HCWs

who were assigned to work at the current disease resistance line, assessing risk perception and evaluating their emotional state. Two cross-sectional assessments conducted in a same group sample. The first cross-sectional assessment was conducted immediately after the outbreak of COVID-19, when the HCWs were dispatched to the most-hit areas in China; the other were at the period of resumption when the new confirmed cases of COVID-19 came to none and HCWs were back to their regular positions. Two main hypotheses were proposed:

1. The level of HCWs' risk perceptions would decrease given the knowledges and protections against the pandemic were gradually improved.
2. After the peak of COVID-19, HCWs' overall negative emotions would be eased, while the remarkable or major subtype of negative emotions could be different in the two period.
3. HCWs' negative emotions could be significantly related to risk perception in both periods and there would be differences in the pattern of the association between the subtypes of negative emotions and risk perception across two periods. Based on the literature in this field, we would expect that negative emotions would become more meaningful in the explanation of risk perception.

We aimed at exploring in a public health emergency HCWs' negative emotional association with the level of perceived risk from emotional and cognitive behavior perspective, which emphasized emotional intervention management of HCWs impacting the risk perceptions and self-protection and would provide plausible intervention points for the psychological aid under a stressful condition.

Methods

Participants

The current study was conducted during two periods of the course of COVID-19.

"Period 1" was 3rd to 5th of February 2020, when the HCWs had been assigned to medical defense of COVID-19 for 10 to 15 days responding to the national first level emergency response. "Period 2" was 3rd to 5th of May 2020, when all the dispatched HCWs were returned to their previous location (Shanghai) and the resumption of their work. HCWs were recruited from hospitals of Shanghai and using online questionnaires. For Period 1, there were 220 questionnaires qualified with the criteria of the jobs of subjects (only involving HCWs) and the standard time for completing the questionnaires (set at 500–1500 ms). The average age of the subjects was 31.91 ± 7.0 . For Period 2, there were 304 qualified questionnaires collected from HCWs with a mean age of 30.75 ± 9.28 . There was no age difference of the two stage samples from the same group ($t = 1.56, p = 0.120$) and a detailed description of the demographic differences of the two samples was presented in Table 1.

Table 1
Demographic characteristics: difference between the samples for the different periods of COVID-19.

	Period 1(n = 220)	Period 2(n = 304)	t/ χ^2
Mean age \pm SD	31.91 \pm 7.0	30.75 \pm 9.28	1.56
Gender			17.23***
Males	38	18	
Females	182	286	
Profession			45.51***
Doctors	61	19	
Nurse	159	285	
Location			9.89*
Shanghai	151	245	
Dispatched to Wuhan	69	59 (now back to Shanghai)	

Measures

Demographic questionnaire

This questionnaire included questions regarding gender, age, profession, whether they were assigned to Wuhan hospital where the HCWs were in short.

Risk perception questionnaire

The questionnaire of HCWs' risk perception for the COVID-19 was referred to the risk perception questionnaire of nursing staff[8]. The questionnaire was self-rated including 14 questions pertaining to five dimensions: personal safety risk (questions 1–2), physical function risk (questions 3–4), occupational exposure risk (questions 5–7), psychosocial evaluation risk (questions 8–10), organizational risk (questions 11–12), and time pressure (questions 13–14). The rating potentiality of risk was divided into five grades from "never" to "almost always", and was assigned 1–5 points in turn. The higher the score for each dimension, the higher HCWs' awareness of the risk. The total score represents the general level of risk perception. The self-compiled questionnaire had good internal consistency, and its Cronbach Alpha was 0.905.

The self-assessment questionnaire for negative emotions

The Chinese version of Watson and Tellegen (1988) emotional self-rating scale (PANAS- Positive and negative emotions scale) was adopted in the experiment of emotional self-rating scale, which was verified by Chinese scholars to be of cross-cultural consistency [23–25]. The internal consistency of this scale was with a good reliability of 0.87 and widely used. The scale contained 20 words describing emotions, including 10 positive words and 10 negative words. The participants were asked to evaluate the emotional intensity they experienced on current state on a scale of 5, among which 1 meant "very slight or no"; 2 for "a little"; 3 for "moderate"; 4 for

“relatively strong”, and 5 for “extremely strong”. Adapting to the needs of the survey, seven negative emotions were extracted in the emotional assessment to form a reduced version of the emotional scale, which was composed of seven emotions: impatience, sadness, upset, tension, guilt, fear and worry.

Procedure

Prior to administration of the questionnaires, the research was evaluated and approved by the ethics committee of the Navy Medical University. In accordance with the requirements of the ethics committee, the written informed consent was obtained from the managers of the hospital and the HCWs from the e-mails. All participants were informed that the researchers were interested in their experiences during COVID-19;

participation was voluntary and anonymity was emphasized. HCWs were recruited from the city of Shanghai, China through our contacting with their hospital managers who helped us to distribute the online questionnaires and emphasize the anonymity of this study. All the qualified questionnaires were scrutinized by our researches according to selection criteria-being HCW and finishing the questionnaires within the standard time.

Statistical methods

SPSS24.0 statistical software was used for data processing and analysis. The subtypes of negative emotions were represented by the mean scores of the sub-dimensions, while the risk perception was the sum of five risk perception dimensions. The Mean and standard deviation (SD) of the statistical score data were reported. The t-test was used to analyze the differences in emotion and risk perception with the control of the demographic factors as these calculated variables were normal distributed in a large sample. In addition, a MANOVA was performed with seven subtypes of negative emotion (i.e., Impatience, Sadness, Upset, Tension, Guilt, Fear, Caution) to explore the differences in two periods. In this analysis, disparate demographic variables of the two samples was treated as covariates. Then, we computed zero-order correlations between negative emotions and risk perception among the participants for each of the two periods (each period was evaluated separately). Fisher's test was used to examine the significance of the difference between each two correlation coefficients. Finally, stratified regression analyses were employed to examine the differences in the contribution of negative emotions in predicting levels of risk perception across the two periods under the control of the demographical factors. All the test levels were at $\alpha = 0.05$.

Results

Demographic differences in negative emotions and risk perception across the two periods

In light of the composition of the two samples, a higher percentage of females than males, a higher percentage of nurses than doctors (this issue was particularly acute for the Period-2 sample) and a small proportion of dispatched HCWs were consisted in the two samples, therefore, demographic differences in the study variables for each period were examined. The findings of this analysis are presented in Table 2. This analysis revealed gender differences was not significant in the overall negative emotions, except that in the period 2 females

show more worry than males with slight significance ($t=-2.55, p=0.017$). Notably, professional difference in the two periods were not consistent. Only in period 1, doctors rated higher than nurses in risk perception ($t=2.23, p=0.027$) and negative emotions including impatience ($t=3.64, p<0.001$), sadness ($t=3.22, p=0.002$), upset ($t=2.60, p=0.01$), and tension ($t=2.55, p=0.012$). In Period 2, no significantly different risk perception was discovered in the location of HCWs ($t=1.26, p=0.209$), however, compared to HCWs dispatched, those not dispatched to Wuhan presented more negative emotions including impatience ($t=2.39, p=0.018$), sadness ($t=2.44, p=0.016$), tension ($t=3.08, p=0.003$), fear ($t=2.91, p=0.038$) and worry ($t=2.57, p=0.011$). Due to the demographic differences found for the study variables, in subsequent analyses, these differences were treated as a covariate.

Table 2
Demographical differences in negative emotions and risk perception across the two periods.

	Gender(Mean ± SD)			Profession(Mean ± SD)			Location(Mean ± SD)			
	Period 1	Males	Females	t	Doctors	Nurses	t	Shanghai	Wuhan	t
Risk perception		38.95 ± 9.71	37.36 ± 9.48	0.94	39.92 ± 9.45	36.75 ± 9.42	2.23*	37.43 ± 9.71	38.07 ± 9.13	0.64
Impatience		1.79 ± 0.91	1.53 ± 0.83	1.71	1.90 ± 1.00	1.45 ± 0.74	3.63***	1.60 ± 0.83	1.52 ± 0.87	0.66
Sadness		1.61 ± 0.86	1.49 ± 0.82	0.75	1.84 ± 1.00	1.39 ± 0.72	3.22**	1.52 ± 0.86	1.49 ± 0.76	0.25
Upset		1.92 ± 0.82	1.71 ± 0.93	1.31	2.00 ± 1.00	1.65 ± 0.86	2.60**	1.79 ± 0.95	1.64 ± 0.80	1.19
Tension		2.13 ± 1.00	1.87 ± 0.88	1.62	2.16 ± 1.00	1.82 ± 0.85	2.55*	1.88 ± 0.96	2.00 ± 0.75	-1.00
Guilt		1.26 ± 0.50	1.32 ± 0.66	-0.49	1.34 ± 0.60	1.30 ± 0.65	0.51	1.28 ± 0.64	1.36 ± 0.64	-0.84
Fear		1.47 ± 0.80	1.164 ± 0.85	-1.13	1.74 ± 0.91	1.57 ± 0.80	1.36	1.59 ± 0.87	1.67 ± 0.76	-0.63
Worry		1.45 ± 0.72	1.51 ± 0.85	-0.43	1.66 ± 0.89	1.44 ± 0.79	1.74	1.54 ± 0.90	1.42 ± 0.65	1.09
Period 2									(Back to Shanghai)	
Risk perception		32.72 ± 7.03	34.64 ± 9.92	0.42	32.58 ± 7.97	34.65 ± 9.88	0.37	34.87 ± 10.07	33.08 ± 8.36	0.21
Impatience		1.5 ± 0.92	1.66 ± 0.86	-0.75	1.47 ± 0.84	1.66 ± 0.86	-0.91	1.7 ± 0.89	1.44 ± 0.70	2.39*
Sadness		1.39 ± 0.70	1.41 ± 0.73	-0.09	1.32 ± 0.58	1.41 ± 0.74	-0.55	1.44 ± 0.76	1.24 ± 0.54	2.44*
Upset		1.83 ± 1.10	1.8 ± 0.92	0.13	1.68 ± 1.00	1.81 ± 0.92	-0.59	1.85 ± 0.94	1.63 ± 0.83	1.66
Tension		1.33 ± 0.60	1.52 ± 0.82	-0.97	1.26 ± 0.56	1.53 ± 0.82	-1.94	1.57 ± 0.85	1.29 ± 0.56	3.08**
Guilt		1.11 ± 0.32	1.24 ± 0.57	-0.94	1.11 ± 0.32	1.24 ± 0.57	-1.67	1.23 ± 0.53	1.24 ± 0.68	-0.11
Fear		1.22 ± 0.43	1.29 ± 0.64	-0.45	1.26 ± 0.56	1.29 ± 0.63	-0.17	1.31 ± 0.66	1.17 ± 0.42	2.09*
Worry		1.11 ± 0.32	1.33 ± 0.70	-2.55*	1.21 ± 0.54	1.33 ± 0.70	-0.71	1.36 ± 0.74	1.17 ± 0.42	2.57*

Note:*p < 0.05;**p < 0.01,***p < 0.001

Differences in negative emotions and risk perception across the two periods

To test the first and second research hypotheses were related to differences in negative emotions and risk perception among HCWs during the two different periods, a multivariate analysis was used to reveal the main effect for period which proved to be significant [Wilks' $\lambda = 0.874$, $F_{(8, 513)} = 9.21$, $p < 0.01$, $\eta p^2 = 0.13$]. Given the significance of the results of the overall test, the univariate main effects were examined and are reported in Table 3. Gender [$F_{(8, 513)} = 2.71$, $p = 0.006$, $\eta p^2 = 0.04$], the professional [$F_{(8, 513)} = 3.45$, $p = 0.001$, $\eta p^2 = 0.05$] and location [$F_{(8, 513)} = 2.13$, $p = 0.032$, $\eta p^2 = 0.03$] differences were found to be significant covariates. We found that period had a main effect on tension, fear, worry and risk perception (see Table 3). The negative emotions, including tension, fear, and worry, and risk perception were all significantly higher during Period 1 than they were during Periods 2 (mean difference_{tension} = -0.38, $p < 0.001$, mean difference_{fear} = -0.30, $p < 0.001$; mean difference_{worry} = -0.16, $p = 0.024$; mean difference_{risk perception} = - 2.76, $p = 0.002$). No significant differences were found between the levels of impatience, sadness, upset, and guilt during the two periods.

Table 3
Means, standard deviations (SD), and univariate F results for negative emotions and risk perception during the two periods (1 and 2) with demographic differences as covariates.

	Period 1(Mean ± SD)	Period 2(Mean ± SD)	F	P value	ηp^2
Risk perception	37.63 ± 9.51	34.83 ± 9.78	9.45	.002	.018
Impatience	1.58 ± 0.84	1.65 ± 0.86	2.28	.132	.004
Sadness	1.51 ± 0.83	1.40 ± 0.73	.493	.483	.001
Upset	1.75 ± 0.91	1.81 ± 0.93	1.17	.279	.002
Tension	1.92 ± 0.90	1.51 ± 0.81	22.74	.000	.042
Guilt	1.31 ± 0.64	1.23 ± 0.56	1.74	.188	.003
Fear	1.61 ± 0.84	1.29 ± 0.62	19.60	.000	.036
Worry	1.50 ± 0.83	1.32 ± 0.70	5.12	.024	.010

Table 4
The Pearson correlation coefficients of negative emotions and risk perception across two periods.

	Period	N	Impatience	Sadness	Upset	Tension	Guilt	Fear	Worry
Risk Perception	1	220	0.40**	0.38**	0.41**	0.42**	0.20**	0.44**	0.44**
	2	304	0.39**	0.45**	0.46**	0.48**	0.30**	0.38**	0.35**
Z			0.08	-1.06	-0.66	-0.76	-1.16	0.81	1.20

The association of negative emotions to the prediction of stress reactions

across the two periods

As showed in Table 3, the correlation between all types of negative emotions and risk perception were all significantly (all the P values were less than 0.01) and the strength of their associations were remained the same across two period ($|z|1.96 > |z|$). To closely examine the complex associations between negative emotions and risk perception among HCWs, two regression analyses were employed for the two periods. Levels of risk perception served as outcomes in these regressions. In Block 1, the predictors were dummy-coded variables representing gender (0 = female),

profession (0 = doctor), and location (0 = not dispatched). In Block

2, main effects of different types of negative emotions were examined (see Table 5). The results indicated that under the control of the covariates of demographic difference, in period 1, the negative emotion of worry could contribute most to risk perception ($B = 2.67, p = 0.005$), while in period 2, the negative emotion of tension turned to be the significant contributor ($B = 2.95, p = 0.006$).

Table 5
Results of the hierarchical multiple regression analysis predicting risk perception.

	Period 1(N = 220)					Period 2(N = 304)				
	R ²	B	SE	Beta	t	R ²	B	SE	Beta	t
Block1	0.03					0.01				
Gender		2.15	2.40	0.09	0.90		0.29	3.58	0.01	0.08
Profession		-4.43	2.03	-0.21	-2.18*		0.91	3.52	0.02	0.26
Location		0.28	1.38	0.01	0.20		-1.50	1.56	-0.06	-0.97
Block2	0.27					0.27				
Gender		-0.38	2.20	-0.02	-0.17		1.62	3.13	0.04	0.52
Profession		-1.01	1.89	-0.05	-0.53		-0.08	3.07	0.00	-0.02
Location		0.86	1.25	0.04	0.69		0.38	1.38	0.02	0.27
Impatience		0.19	1.16	0.02	0.17		0.73	0.88	0.06	0.83
Sadness		0.03	1.08	0.01	0.03		2.14	1.12	0.16	1.91
Upset		1.45	1.10	0.14	1.32		1.43	0.96	0.14	1.48
Tension		1.25	0.99	0.12	1.27		2.95	1.06	0.24	2.80**
Guilt		-0.61	1.09	-0.04	-0.56		-0.64	1.24	-0.04	-0.52
Fear		1.46	1.20	0.13	1.21		0.56	1.50	0.04	0.38
Worry		2.67	0.95	0.23	2.82**		-0.22	1.23	-0.02	-0.18

Discussion

Our findings revealed the risk perception and negative emotions of HCWs varied in different gender, profession and the location, as well as in different periods of COVID-19. Our findings also revealed differences in the association between risk perception and negative emotions across the two periods. The levels of tension, fear, worry and risk perception were higher during Period 1 than they were during Periods 2 of COVID-19. Over the different periods, worry was found to be closely related to and a significant predictor of high-level risk perception in the period 1; whereas the predictive type of negative emotion changed to tension in the period 2.

The current study examined differences in risk perception and negative emotions and the varied associations between those variables among HCWs across two period of COVID-19. The first hypothesis that risk perception and negative emotions decreased during two successive periods of COVID-19 were supported by our findings, which were convergent to the development of the pandemic. In fact, our study was consisted with few longitudinal or cohort studies conducted after the outbreak of SARS which showed during the initial phases of the SARS outbreak a steady increase showed in risk perception and then leveled off in later phases[17, 26]. As a infectious disease, the increase of risk perception could be neutralized by the effective vaccines or behavioral containment measures, so that it is likely the notion of risk will be less concerned. As regards the negative emotion components, significant decreases were found in tension, fear, and worry across the two studied periods. In period 1, which was the peak of the pandemic, an initial knowledge about the origin or the life course of a newly emerging virus was lack and visible effects are delayed, therefore, unknown risks and threats to public health were produced[9]. HCWs, as the first-line warriors for the public health, were dispatched to the hardest-hit areas or mandated to work under the threat of infection. Hence, tension, fear and worry were dominated in the dimension of HCWs negative emotions. Whereas in period 2, when the pandemic was contained with protective measures, tension, fear and worry were gradually relieved and the perception of the pandemic was reduced, however, the risk was not nullified as none specific treatment and vaccine were developed at this moment. From the practical views of the results, in the acute stage of COVID-19, tension, fear and worry are likely to be imminent and therefore hamper the rational perception about gains and losses related to protective behaviors of HCWs not only for themselves but also their patients. In such cases, the proper emotion copying ways could be avail for fending off the invisible losses and long-term consequences. In the later stage, risks were downplayed due to the emotional copying strategy, which would have double effects on the protective behaviors. To ensure the safety, it would be better to monitor the risk perception and negative emotions of HCWs for the sake of preventing the return of the pandemics.

Notably, some demographical differences were detected in the analysis. In China's COVID-19 responses, female nurses and community health workers were the first line of defense against the outbreak, which could explain why the two samples were dominated by female HCWs, most of who were nurses. Therefore, the study might be less convinced for the interpretation of gender difference, but we specially found doctors were more negative feelings, like impatience, sadness, upset and tension in the period 1. It may be reflected the hardship of doctors since there were the overwhelm stress from saving the life-threaten patience and numerous patience waiting for them. Consequently, the risk perception was also higher in the doctors with more negative emotions. While in period 2, nurses showed higher risk perception than doctors, which could be explained by that in the stage nurses had to take more care supports for the patience and intense contacts. More importantly, in the late stage of COVID-19, not dispatched HCWs rated higher in the subscale of impatience, sadness, tension and worry compared to HCWs dispatched to Wuhan, while their risk perception was not significantly different. It could be the potential reasons that on the one hand dispatched HCWs received more psychological and substantial

helps and on the other, they could have improvement in coping emotions after confronting with the worse stress. Alternatively, it could be a caveat for the sampling bias. Thereby, more studies focused on the difference between dispatched HCWs and not dispatched to clear the pandemic's impacts on HCWs mental health.

After controlled the effect of gender, profession and location, the further exploration for association between negative emotions and risk perception not only provided the supports for our third hypothesis, but also the emotion-based risk perception. Damasio[27] has thus suggested that automated incentive or alarm signals linked to pleasant or unpleasant "gut feelings" often precede cognitive reasoning. In a similar vein, processing theories have emphasized the importance of an emotion–cognition pathway[28, 29]. In an acute threat situation like COVID-19, emotional aspects might gain more immediate importance, especially in the early stages of an outbreak when experts are unable to make more than tentative statements and provide partly contradictory prognoses and recommendations. Under these circumstances cognitive risk assessments might be severely hampered by lack of evidence-based information. Consequently, individuals might have little choice but to rely on experiential judgement. Our results showed the consistent positive relation between negative emotions and risk perception in the entire course of the pandemic, similar to the results of Goodwin and Sun[30] using public samples and a lot researches about the emotion and risk perception for vaccine. This study was novel not only the background and subjects but also the repeated cross-sectional method which could give light on the emotional effect on risk perception. As the analytical data showed, worry could be prominent contributor to the higher level of risk perception immediately after the outbreak of pandemic, while gradually the prominent components of negative emotions varied with the course of pandemic, and thus in the our second studied period of COVID-19, tension, reflecting the local situation and the severity of pandemic, played a key role in the risk perception. However, what role exactly an emotion-based judgement plays in interaction with risk-related cognition is still an issue in need of clarification. Besides, only a minority of the subgroup of studies which investigated the possible predictive role of risk perception for protective behaviors could actually be considered model-based. The resulting lack of opportunity for studying the complexity of the decision-making process is bound to also affect the extent to which findings for the relationship between risk perception and protective behaviors can be interpreted. Thus, a more systematic application of multifactor models, including the emotion-based models, would allow for far more complex insights into the workings of risk perceptions in shaping behavior.

The current study has some limitations that should be addressed. First, the data were collected in the midst of COVID-19. Therefore, some degree of potential sample bias should be taken into account. For

example, the two samples each included a higher percentage of females than males, nurses than doctors (This issue was particularly acute for the Period 2 sample). Therefore, future studies should recruit larger samples of male and female HCWs. Moreover, the current study employed a cross-sectional repeated design to examine differences in the levels of negative emotions and risk perception. Further studies should adopt a longitudinal design, to follow the same sample of HCWs across different periods. That type of study would be the best way to examine changes in the levels of different variables and the associations between those variables among the same individuals over time, which could also provide more valuable findings to the emotion-cognition-behavior model of risk perception. Moreover, the follow-up researches could achieve more convinced results about the effect of being dispatched for HCWs defending against the pandemics and contribute to the targeted help services for HCWs.

Conclusion

The significance of this research lies in its examination of risk perception and negative emotions of HCWs combating the COVID-19 during two periods of the pandemic. The findings showed both risk perception and negative emotions of HCWs were affected by the COVID-19. In addition, the predominated negative emotions of HCWs presented varied with time course, but the positive relations to risk perception were constant and could be a significant predictor of risk perception. These findings underscore the importance of negative emotions as a significant factor for risk perception of HCWs enduring the challenge of pandemic within Chinese population. More importantly, our results underscore studying the change of pandemic risk perceptions and their “true” influence over time remains an important objective, requiring not only studies with longitudinal designs, starting after potential future outbreaks, but also long-term surveillance studies which are initiated before an actual outbreak occurs.

Abbreviations

COVID-19

Coronavirus Disease 2019; HCWs:Health care workers; PANAS:Positive and negative emotions scale; PPE:Personal protective equipment; SARS:Severe Acute Respiratory Syndromes; MANOVA:Multivariate analysis of variance; SD:Standard deviations.

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committees of the Navy Military University. A complete survey description was first presented to the participants. Informed written consent, together with oral approvals, was obtained before the testing session according to the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed and materials used in this study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Note

* $p < 0.05$; *** $p < 0.001$

Note

** p < 0.01

Note

** p < 0.01; Risk perception entered as the dependent variable.

Funding

There was no special funding for the study.

Authors' contributions

QY, TH contributed to the writing of this article and part of statistical analysis. WD and GD led the whole study, including putting forward this study, getting source and carrying out the study, and was the corresponding author. AC contributed to revise this article and part of statistical analysis. YL, PC and XS contributed to perform the investigation and collection of all data. We are all accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. We all agree to submit our research result in the article to this journal. All authors read and approved the final manuscript.

Acknowledgments

The authors would like to acknowledge the volunteers who participated in the study and appreciate the endeavor of the Health Care Workers. Please allow us to send our best respects and wishes to all the sacrificed HCWs.

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