



Original article

Effect of prior outbreak work experience to future outbreak responses for nurses in Hong Kong: A cross-sectional study



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ABSTRACT

Background: During the early phase of the Coronavirus Disease 2019 (COVID-19) epidemic, health care workers had elevated levels of psychological distress. Historical exposure to disease outbreak may shape different pandemic responses among experienced health care workers.

Aim: Considering the unique experience of the 2003 SARS outbreak in Hong Kong, this study examined the association between prior epidemic work experience and anxiety levels, and the mediating role of perceived severity of COVID-19 and SARS in nurses.

Methods: In March 2020, a cross-sectional survey targeting practising nurses in Hong Kong was conducted during the early phase of the COVID-19 epidemic. The interrelationships among participants' work experience during the SARS outbreak, perceived severity of SARS and COVID-19, and anxiety level were elucidated using structural equation model (SEM).

Findings: Of 1,061 eligible nurses, a majority were female (90%) with a median age of 39 years (IQR = 32–49). A significant and negative indirect association was identified between SARS experience and anxiety levels ($B = -0.04$, $p = 0.04$) in the SEM with a satisfactory fitness (CFI = 0.95; RMSEA = 0.06). SARS-experienced nurses perceived SARS to be less severe ($B = -0.17$, $p = 0.01$), translated an equivalent perception to COVID-19 ($B = 1.29$, $p < 0.001$) and resulted in a lower level of anxiety ($B = 0.19$, $p < 0.001$).

Conclusions: The less vigorous perception towards the severity of SARS and COVID-19 may explain SARS-experienced nurses' less initial epidemic-induced anxiety. The possible role of outbreak-experienced nurses in supporting outbreak-inexperienced nurses, both emotionally and technically, should be considered when an epidemic commences. Interventions aiming to facilitate the understanding of emerging virus should also be in place.

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Summary of relevance

Problem or issue

Evidence regarding the effect of prior outbreak work experience to future outbreak response in nurses remains inadequate.

What is already known

A higher prevalence of anxiety was noted in younger nurses in both the present COVID-19 and past epidemics.

What this paper adds

SARS-experienced nurses perceived SARS to be less severe and such perception was translated to COVID-19 when robust information about the virus was yet to be available. The less fear towards COVID-19 and possibly the upcoming unknown threats might help SARS-experienced nurses better cope with the initial pandemic anxiety.

1. Introduction

In the 21st century, the world has been confronted by several major epidemics, including the outbreak of severe acute respiratory syndrome (SARS), swine flu, Middle East respiratory syndrome (MERS), and Ebola (Liu, Xu, Wang, & Wang, 2020). Notwithstanding the notable success of containment, fighting these outbreaks has unavoidably put health care workers into profound psychological distress (Busch, Moretti, Mazzi, Wu, & Rimondini, 2021). Erupting in late 2019, the Coronavirus Disease 2019 (COVID-19) pandemic has resulted in over 265 million severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections and 5.3 million related deaths globally as of December 2021 (World Health Organization, 2021). Hong Kong, a densely populated city with a citizen average of 12.5 daily social encounters (Kwok, Cowling, Wei, Riley, & Read, 2018), had experienced four main epidemic waves leading to over 12,000 cases (Centre for Health Protection, 2021; Kwok et al., 2021a; Kwok, Wong, Wei, Wong, & Tang, 2020a). In light of this alarming situation, it is very probable that the prolonged efforts combating the spread of COVID-19 would once again render an increased risk of psychiatric illnesses for nurses and health care workers (Greenberg, Docherty, Gnanapragasam, & Wessely, 2020).

During the early phase of the COVID-19 pandemic, the prevalence of anxiety in health care workers was estimated to be 23% (Santabárbara et al., 2021). Specifically, a higher toll was observed in younger nurses (Roberts et al., 2021). This association resembled the patterns seen in the past viral epidemics, proving that it was unlikely to be spurious (Serrano-Ripoll et al., 2020). Prior research has demonstrated that the lack of resilience (Roberts et al., 2021) and clinical knowledge (De Kock et al., 2021) in junior health care workers might contribute to their more intense anxiety during an epidemic. Health care workers' deficiency in work experience, quantified by year of service, was also believed to be one of the contributing factors (Roberts et al., 2021). Year of service provides a quantitative measurement of health care workers' experience, but it does not reflect the qualitative experience, particularly in terms of their previous involvement in disease outbreaks. Thus, it might be important to consider the nature of work experience when evaluation is conducted. Nurses and health care workers who have previous encounters with major disease outbreaks were expected to react differently to a future epidemic. The prior epidemic experience could confer them with higher adaptability and readiness in handling emergency and stressful situations (Lau, Chan, & Ng, 2020). However, this could also be an agonising experience that predisposed health care workers to long-term psychological sequelae, regardless of whether they had direct contact with patients (Maunder et al., 2006). The lack of empirical evidence investigating

the repercussion of epidemic experience has fuelled the motivation of this research.

Health care workers' perceptions towards an unfamiliar threat, like COVID-19, were also important to be considered during a novel disease outbreak. These perceptions played an essential role not only in modulating their psychological states (Serrano-Ripoll et al., 2020), but also directing their epidemic responses when scientific information was yet to be available (Kwok et al., 2020b). Examining the determinants of such perceptions would therefore be imperative. When COVID-19 first emerged, people constantly compared it with SARS and MERS given their entities in the coronavirus family and remarkable outbreak potential (Zhu et al., 2020). Yet, the influence of one's prior work experience during the SARS outbreak on their perceived severity of COVID-19 was still unknown. During the 2003 SARS epidemic, nosocomial infection was a notable feature of the widespread outbreaks (Hung, 2003; Kwok, Leung, Lam, & Riley, 2007). This has provided us with a unique opportunity to study the impact of previous epidemic work experience on health care workers' perceptions of COVID-19.

In this era of emerging infectious disease, it is important to tell how past lessons learnt by health care workers could aid in optimising the early response to novel threats in preparation for future epidemic encounters. Health care workers' mental well-being, which serves as the cornerstone of a resilient health care system, should also be safeguarded given their pivotal role in an epidemic (Shaw, Flott, Fontana, Durkin, & Darzi, 2020). To date, perceptions of COVID-19 and anxiety are well studied in health care workers (Busch et al., 2021; Polychronis; Roupas, 2020; Santabárbara et al., 2021). However, their associations with prior epidemic work experience and perception of SARS have remained unaddressed. Considering the unique work experience of nurses in Hong Kong during the SARS and COVID-19 outbreaks, this study was undertaken to examine the association between prior epidemic work experience and anxiety levels during the onset of COVID-19 pandemic, as well as the mediating role of perceived severity of COVID-19 and SARS in nurses.

2. Methods

A cross-sectional study was conducted among practising nurses in Hong Kong during the early stage of the COVID-19 outbreak, from March 16, 2020 to April 24, 2020, in which cumulative confirmed cases increased from 156 to 1,035 (Centre for Health Protection, 2021). With the support of the Association of Hong Kong Nursing Staff, a local nursing association with 30,000 members accounting for more than 60% of all the retired, practising and student nurses in Hong Kong, an email or letter invitation with an attached QR code linking to a self-administered anonymous online survey was sent to all of its members. Informed consent was sought before the start of the survey. Ethical approval was obtained from the Survey and Behavioural Research Ethics Committee, The Chinese University of Hong Kong (reference number: SBRE-19-251).

Constructed in Chinese language, the questionnaire was adapted from that used in previous studies about influenza vaccination conducted by our Research team (Chan, Lee, & Wong, 2021; Kwok et al., 2019). The core section of the questionnaire included (i) participants' demographics, (ii) work-related factors, and (iii) influenza vaccination. Two thematic sections related to (iv) COVID-19, and (v) anxiety were included in addition to the core section. In the COVID-19 section, work experience during the SARS outbreak, history of quarantine, contact with COVID-19 patients, supply of personal protective equipment (PPE) and perceived severity of SARS and COVID-19 were assessed. Participants were asked to indicate their job status and type of workplace during the 2003 SARS outbreak. Work experience during the SARS outbreak

was defined by their reported practice of nursing in either hospital or long-term care facility (LTCF) setting at that time in Hong Kong. Quarantine history was indicated if a participant was quarantined due to previous exposure to SARS-CoV-2 or suspected infection. Contact with COVID-19 patients refers to any direct clinical care offered to suspected or confirmed cases of COVID-19. Supply of PPE was evaluated based on the number of PPE items that the participant perceived to be in shortage at work, among goggles, face shields, surgical masks, N95 respirators, protective gloves, protective gowns, and surgical caps. The selection of more items indicated a more perceived inadequacy of PPE (0–7). We attempted to use three parsimonious metrics (infectivity, pathogenicity and fatality) with a 5-point Likert scale (1=lowest, 5=highest) to measure the nurse's perceived severity of COVID-19 and SARS. These metrics were considered as proxy indicators of three typical attributes employed in previous research for comparison among different pandemic species, including reproduction number, the proportion of symptomatic cases and case-fatality ratio (Petersen et al., 2020; Petrosillo, Viceconte, Ergonul, Ippolito, & Petersen, 2020). The Generalised Anxiety Disorder-7 scale (GAD-7) was used to measure the participant's anxiety by asking them to self-rate the frequency of seven anxiety symptoms over the past two weeks, on a 4-point Likert scale (0=not at all, 1=several days, 2=more than half the days, 3=nearly every day) (Spitzer, Kroenke, Williams, & Löwe, 2006). The sum of the seven items (0–21) was used to estimate the severity of anxiety, with the ranges of 5–9, 10–14 and 15–21 indicating mild, moderate and severe generalised anxiety, respectively (Spitzer et al., 2006). In this study, the internal consistency of GAD-7 was satisfactory (Cronbach's alpha coefficient = 0.95).

Incomplete and inconsistent entries were first removed, while the second attempt of two suspected duplicate entries, based on the collected email address and phone number, were also discarded. Ineligible responses from the retired, student or non-clinical and non-LTCF nurses were also excluded from the data analysis. We did not exclude those without providing direct care to suspected or confirmed COVID-19 patients as their frequent physical presence in high-risk settings could also contribute to anxiety. Stratified by their work experience during the SARS outbreak (SARS experience), categorical characteristics of study participants were summarised using frequency and percentage, with chi-square statistics used to detect differences in proportions. Continuous variables were summarised using means and 95% confidence intervals (CI) with their difference with respect to their SARS experience evaluated using Student's *t*-test. Pairwise correlation among age, perceived severity of SARS, COVID-19 and anxiety levels was determined using Spearman's rank correlation. Associations between nurses' SARS experience and the three subscales of perceived severity of COVID-19 were examined in multiple linear regression models, controlling for sex, work setting, chronic disease status, history of quarantine and contact with COVID-19 patients. Perceived severity of SARS was subsequently adjusted and its impact on the regression models was further evaluated.

Using structural equation modelling, the interrelationships among SARS experience, perceived severity of SARS and COVID-19 and anxiety were elucidated. Three latent factors for perceived severity of SARS, COVID-19 and GAD-7 respectively were constructed using confirmatory factor analysis and were incorporated into the structural equation model. Sex, work setting, quarantine history, contact with COVID-19 patient and perceived shortage in PPE were included as exogenous factors to reduce confounding. The direct effect between their SARS experience and anxiety levels, and the indirect effect through the serial mediation of perceived severity of SARS and COVID-19 were evaluated. Subgroup analysis based on participants' SARS experience was also performed to explore any differential impact of perceived severity of SARS

on anxiety. Parameter estimates were determined based on maximum likelihood estimation. Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) and Chi-square statistics (χ^2) were employed to assess the goodness-of-fit for each model. A satisfactory model fit was indicated by $CFI \geq 0.95$, $RMSEA \leq 0.06$, and a non-significant χ^2 (Hu & Bentler, 1999). Path diagrams labelled with unstandardized coefficients were constructed. Models were rerun to investigate the associations with anxiety severity using clinical cut-off threshold of GAD-7 as an ordinal outcome. Sensitivity analysis was also performed to examine the effect of age on the overall interrelationships. All statistical analyses were performed using R version 3.6.1. All tests were two-tailed and statistical significance was denoted by $p < 0.05$.

3. Results

Of 1,920 responses received, 667 incomplete, 21 inconsistent and 13 duplicate entries were eliminated. Another 158 ineligible entries (50 from retired nurses, 61 from student nurses and 47 from non-LTCF and non-clinical nurses) were excluded from data analysis. The effective sample size for analysis was 1,061 which allowed at most 50 parameters in the structural equation model (Kline, 2015). As shown in Table 1, the majority of participants were female (89.8%), full-time (91.2%) and registered nurses (64%), with a median age of 39 years (IQR=32–49). Over four-fifths worked in clinical settings (85.1%) with 14.9% employed in LTCFs. Having a chronic disease such as hypertension or diabetes was reported in approximately 14%. Some nurses (5.7%) were quarantined with 14.5% disclosing contact history with suspected or confirmed COVID-19 patients. Overall, less than half had worked in a hospital or LTCF during the SARS outbreak. (42.3%) A vast majority of SARS-experienced nurses (98.1%) aged 40 years or above. Significantly more of them were currently clinical, advanced practising nurses and chronic patients. Quarantine history did not differ significantly between nurses with or without work experience during the SARS outbreak, while more of the latter reported contact with COVID-19 patients.

Differences in continuous variables between SARS-experienced and SARS-inexperienced nurses are shown in Table 2. Out of 7 major types of PPE, respondents on average considered that at least 2 items were in shortage at work, with surgical masks (62.6%), protective gowns (56.2%) and n95 respirators (53.7%) perceived to be in the shortest supply. The perceived deficiency was significantly more pronounced in SARS-inexperienced nurses ($t=5.74$, $p < 0.001$). The mean scores (95% CI) of perceived severity of COVID-19 in terms of infectivity, pathogenicity and fatality were 4.61 (95% CI 4.56, 4.67), 4.03 (95% CI 3.97, 4.10) and 3.00 (95% CI 2.93, 3.08), respectively, while for SARS, the corresponding scores were 4.07 (95% CI 4.01, 4.13), 4.19 (95% CI 4.13, 4.25) and 3.88 (95% CI 3.81, 3.95). Compared to SARS-inexperienced nurses, the SARS-experienced group perceived both COVID-19 and SARS to be significantly less pathogenic (COVID: 3.95 vs 4.09, $p=0.03$; SARS: 4.10 vs 4.25, $p=0.02$), and fatal (COVID-19: 2.85 vs 3.11, $p < 0.001$; SARS: 3.76 vs 3.97, $p=0.003$). The mean anxiety score was 7.20 (SD=5.15, 95% CI 6.89, 7.51), reflecting mild generalised anxiety overall. In terms of severity of anxiety, mild, moderate, and severe generalized anxiety was indicated in 422 (39.8%), 190 (17.9%) and 92 (8.7%) nurses, respectively. Significantly more SARS-inexperienced nurses were suggestive of having a moderate level of anxiety (19.9% vs 15.1%) ($\chi^2=10.06$, $p=0.02$).

The Spearman's correlation coefficients are shown in Table 3. There were significant correlations between perceived infectivity ($r=0.38$, $p < 0.001$), pathogenicity ($r=0.36$, $p < 0.001$) and fatality ($r=0.37$, $p < 0.001$) of COVID-19 and that of SARS. Anxiety score was also significantly positively correlated with perceived pathogenicity ($r=0.13$, $p < 0.001$) and fatality of COVID-19 ($r=0.18$,

Table 1
Participants' characteristics and history of quarantine and contact with COVID-19 patients by work experience during the SARS outbreak (n = 1061)

	SARS-inexperienced		SARS-experienced		Total		χ^2
	n	%	n	%	n	%	
Sex							
Female	546	89.2	407	90.6	953	89.8	0.43
Male	66	10.8	42	9.4	108	10.2	
Age							
20-29	153	25	0	0	153	14.4	767.07***
30-39	379	61.9	4	0.9	383	36.1	
40-49	42	6.9	223	49.7	265	25.0	
≥ 50	38	6.2	222	49.4	260	24.5	
Mode of employment							
Full-time	566	92.5	402	89.5	968	91.2	2.46
Part-time/temporary	46	7.5	47	10.5	93	8.8	
Nurse ranking							
Enrolled Nurse ^a	128	20.9	50	11.1	178	16.8	127.46***
Registered Nurse	437	71.4	242	53.9	679	64.0	
Advanced Practising Nurse or above	47	7.7	157	35	204	19.2	
Work setting							
Clinical (e.g. hospital, clinic)	508	83	395	88	903	85.1	4.66*
Long-term care facility (LTCF)	104	17	54	12	158	14.9	
Elementary nurse qualification							
Local nursing school - diploma/degree	315	51.5	400	89.1	715	67.4	185.47***
Local university	291	47.5	38	8.5	329	31.0	
Non-local institution - diploma/degree	6	1	11	2.4	17	1.6	
Reported chronic disease(s) (e.g. hypertension, diabetes etc.)							
No	560	91.5	350	78	910	85.8	37.87***
Yes	52	8.5	99	22	151	14.2	
Quarantine history							
No	578	94.4	423	94.2	1001	94.3	0.00
Yes	34	5.6	26	5.8	60	5.7	
Contact with COVID-19 patients							
No	517	84.5	390	86.9	907	85.5	1.00
Yes	95	15.5	59	13.1	154	14.5	
Total (row percentage)	612	57.7	449	42.3	1061	100	-

^a Nurse who received shorter pre-licensing training than registered nurse; * p < 0.05; ** p < 0.01; *** p < 0.001

Table 2
Comparison of perceived shortage in PPE, perceived severity of COVID-19 and SARS and Generalized Anxiety Disorder 7-item scale (GAD-7) stratified by work experience during the SARS outbreak

	SARS-inexperienced Mean (95% CI)	SARS-experienced Mean (95% CI)	Total Mean (95% CI)	t
Number of PPE in shortage at work (0-7)	3.10 (2.95, 3.26)	2.46 (2.31, 2.62)	2.83 (2.72, 2.94)	5.74***
Perceived severity of COVID-19 (1-5) ^a				
Perceived infectivity	4.61 (4.54, 4.69)	4.61 (4.54, 4.69)	4.61 (4.56, 4.67)	-0.01
Perceived pathogenicity	4.09 (4.01, 4.18)	3.95 (3.86, 4.05)	4.03 (3.97, 4.10)	2.20*
Perceived fatality	3.11 (3.02, 3.21)	2.85 (2.74, 2.97)	3.00 (2.93, 3.08)	3.46***
Perceived severity of SARS (1-5) ^a				
Perceived infectivity	4.10 (4.02, 4.18)	4.02 (3.93, 4.12)	4.07 (4.01, 4.13)	1.22
Perceived pathogenicity	4.25 (4.17, 4.32)	4.10 (4.01, 4.20)	4.19 (4.13, 4.25)	2.25*
Perceived fatality	3.97 (3.88, 4.06)	3.76 (3.65, 3.87)	3.88 (3.81, 3.95)	2.95**
GAD-7 scale (0-21 for total score; 0-3 for each item) ^b				
Total score (SD = 5.15)	7.44 (7.03, 7.84)	6.88 (6.39, 7.36)	7.20 (6.89, 7.51)	1.75
Feeling nervous, anxious or on edge	1.25 (1.19, 1.31)	1.23 (1.16, 1.31)	1.24 (1.19, 1.29)	0.37
Not being able to stop or control worrying	1.00 (0.93, 1.07)	0.97 (0.89, 1.05)	0.99 (0.94, 1.04)	0.57
Worrying too much about different things	1.00 (0.93, 1.07)	0.98 (0.91, 1.06)	1.03 (0.98, 1.08)	1.56
Trouble relaxing	1.08 (1.02, 1.15)	0.99 (0.91, 1.07)	1.04 (0.99, 1.10)	1.82
Being so restless that it is hard to sit still	0.88 (0.82, 0.95)	0.83 (0.75, 0.91)	0.86 (0.81, 0.91)	1.04
Becoming easily annoyed or irritable	1.13 (1.06, 1.20)	1.00 (0.92, 1.07)	1.07 (1.02, 1.12)	2.60**
Feeling afraid as if something awful might happen	1.02 (0.95, 1.09)	0.88 (0.80, 0.96)	0.96 (0.91, 1.01)	2.71**
Level of anxiety severity, n (%)				
Minimal anxiety (0-4)	185 (30.2)	172 (38.3)	357 (33.6)	10.06* (χ^2)
Mild anxiety (5-9)	255 (41.7)	167 (37.2)	422 (39.8)	
Moderate anxiety (10-14)	122 (19.9)	68 (15.1)	190 (17.9)	
Severe anxiety (15-21)	50 (8.2)	42 (9.4)	92 (8.6)	

^a 1 = lowest; 5 = highest

^b 0 = not at all, 1 = several days, 2 = more than half the days, 3 = nearly every day, SD = standard deviation; CI = confidence interval; * p < 0.05,

** p < 0.01, *** p < 0.001

Table 3
Spearman correlation of age, perceived severity of COVID-19 and SARS, and Generalized Anxiety Disorder 7-item scale (GAD-7)

Variables ^a	1	2	3	4	5	6	7	8	9
1. Age (years)	1.00	0.00	-0.02	-0.08**	0.01	-0.08**	-0.15***	-0.09**	-0.09**
2. Perceived infectivity of SARS (1-5)		1.00	0.53***	0.28***	0.38***	0.28***	0.15***	0.07*	0.08**
3. Perceived pathogenicity of SARS (1-5)			1.00	0.48***	0.32***	0.36***	0.12***	0.02	0.03
4. Perceived fatality of SARS (1-5)				1.00	0.25***	0.26***	0.37***	0.07*	0.07*
5. Perceived infectivity of COVID-19 (1-5)					1.00	0.36***	0.16***	0.08**	0.08**
6. Perceived pathogenicity of COVID-19 (1-5)						1.00	0.42***	0.13***	0.13***
7. Perceived fatality of COVID-19 (1-5)							1.00	0.18***	0.18***
8. GAD-7 scale (0-21)								1.00	0.95***
9. Level of anxiety severity (0-3) ^b									1.00

^a Range of each item is shown in parentheses

^b 0 = minimal anxiety, 1 = mild anxiety, 2 = moderate anxiety, 3 = severe anxiety, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 4
Multiple linear regression results for perceived infectivity, pathogenicity and fatality of COVID-19

	Perceived infectivity		Perceived pathogenicity		Perceived fatality	
	Adjusted B, 95%CI	Adjusted B, 95%CI	Adjusted B, 95%CI	Adjusted B, 95%CI	Adjusted B, 95%CI	Adjusted B, 95%CI
Intercept	4.63*** (4.55, 4.71)	2.85*** (2.65, 3.04)	4.08*** (3.98, 4.18)	2.13*** (1.88, 2.39)	3.08*** (2.97, 3.20)	1.54*** (1.29, 1.79)
Sex						
Female	Ref	Ref	Ref	Ref	Ref	Ref
Male	0.09 (-0.08, 0.26)	0.10 (-0.05, 0.25)	0.08 (-0.12, 0.29)	0.09 (-0.10, 0.27)	-0.09 (-0.33, 0.15)	-0.15 (-0.37, 0.07)
Work setting						
Clinical	Ref	Ref	Ref	Ref	Ref	Ref
LTCF	-0.10 (-0.25, 0.05)	-0.04 (-0.17, 0.09)	0.11 (-0.07, 0.29)	0.16 (0.00, 0.32)	0.21* (0.00, 0.42)	0.22* (0.03, 0.41)
Reported chronic disease(s)						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.07 (-0.23, 0.08)	0.00 (-0.13, 0.13)	0.02 (-0.16, 0.20)	-0.01 (-0.17, 0.16)	0.03 (-0.18, 0.25)	0.02 (-0.18, 0.22)
Quarantine history						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.14 (-0.37, 0.09)	-0.10 (-0.30, 0.10)	-0.36* (-0.63, -0.08)	-0.23 (-0.47, 0.02)	0.02 (-0.30, 0.34)	0.11 (-0.19, 0.41)
Contact with COVID-19 patients						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.04 (-0.11, 0.19)	0.06 (-0.07, 0.20)	0.04 (-0.15, 0.22)	-0.01 (-0.17, 0.15)	0.00 (-0.22, 0.21)	-0.03 (-0.23, 0.17)
Work experience during the SARS outbreak						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.01 (-0.10, 0.12)	0.04 (-0.06, 0.13)	-0.14* (-0.26, -0.01)	-0.07 (-0.18, 0.05)	-0.26*** (-0.41, -0.11)	-0.17* (-0.31, -0.03)
Perceived severity of SARS						
Perceived infectivity	-	0.43*** (0.38, 0.47)	-	-	-	-
Perceived pathogenicity	-	-	-	0.46*** (0.40, 0.51)	-	-
Perceived fatality	-	-	-	-	-	0.39*** (0.33, 0.45)

B = unstandardised coefficient; CI = confidence interval; LTCF = long-term care facility; * p < 0.05, ** p < 0.01, *** p < 0.001

p<0.001). For age, it was significantly negatively correlated with perceived fatality of SARS (r=-0.08, p<0.01), perceived pathogenicity (r=-0.08, p<0.01), fatality of COVID-19(r=-0.15, p<0.001) and anxiety score (r=-0.09, p<0.01).

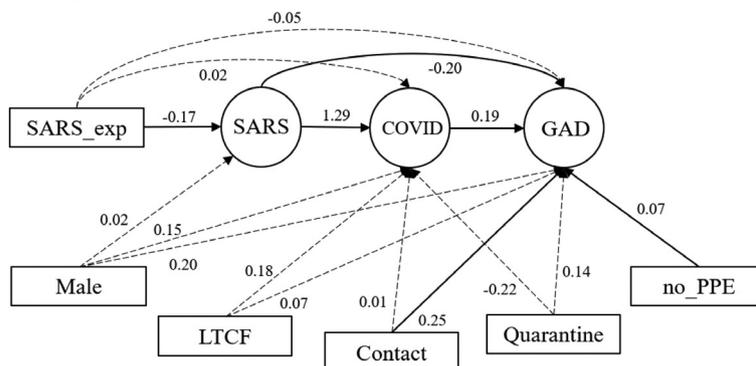
The results of the multiple linear regression analysis are shown in Table 4. Work experience during the SARS outbreak was significantly associated with a less severe perception towards pathogenicity (adjusted B=-0.14, 95% CI -0.26, -0.01) and fatality of COVID-19 (adjusted B=-0.26, 95% CI -0.41, -0.11), but not infectivity. With perceived severity of SARS subsequently included in the models, all the three subscales were shown to have significantly associated with their counterparts of COVID-19 (infectivity: adjusted B=0.43, 95% CI 0.38, 0.47; pathogenicity: adjusted B=0.46, 95% CI 0.40, 0.51; fatality: adjusted B=0.39, 95% CI 0.33, 0.45). In comparison with the previous model, the strength of association between SARS experience and perceived pathogenicity of COVID-19 decreased from adjusted B=-0.14 to -0.07 by 50% in terms of the absolute values. For the association between SARS experience and perceived fatality of COVID-19, it decreased from adjusted B=-0.26 to -0.17 by 35%.

The results of confirmatory factor analysis of GAD-7, perceived severity of COVID-19 and SARS are displayed in Supplementary data I. It suggested that the three-factor model nearly attained an acceptable goodness-of-fit (CFI=0.97; RMSEA=0.07; $\chi^2 = 332.83$, df=59, p<0.001), while the significance of chi-square statistics could be due to sensitivity to large sample size. With the latent

factors employed, the structural equation model demonstrated a satisfactory model fit as shown in Fig. 1A (CFI=0.95; RMSEA=0.06; $\chi^2 = 586.13$, df=127, p<0.001). Regarding the relationships between SARS experience and anxiety level, a direct association did not exist (B=-0.05). Yet, a significant, negative and indirect association was noted through the serial mediation of perceived severity of SARS and COVID-19 (B=-0.04, p=0.04): (a) SARS-experienced nurse perceived SARS to be significantly less severe (B=-0.17, p=0.01); (b) perceived severity of SARS were significantly and positively associated with that of COVID-19 (B=1.29, p<0.001); and (c) a less severe perception towards of COVID-19 was significantly associated with a lower level of anxiety (B=0.19, p<0.001). For exogenous factors, contact history with COVID-19 patients (B=0.25, p<0.01) and a perceived shortage of PPE (B=0.07, p<0.001) were associated with a higher level of anxiety.

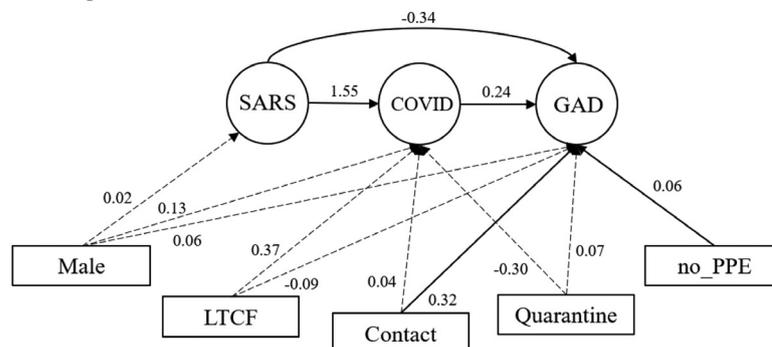
The results of subgroup analysis between nurses with and without SARS experience are presented in Figs. 1B and 1C respectively. In both groups, a positive association was observed between the perceived severity of SARS and that of COVID-19, as well as between the latter and anxiety level. Such indirect association mediated by perceived severity of COVID-19 was stronger in SARS-inexperienced nurses (B=0.37, p=0.006) compared to SARS-experienced nurses (B=0.16, p=0.04). A negative direct association between perceived severity of SARS and anxiety level was observed exclusively in SARS-inexperienced nurses (B=-0.34, p=0.02),

(A) All nurses



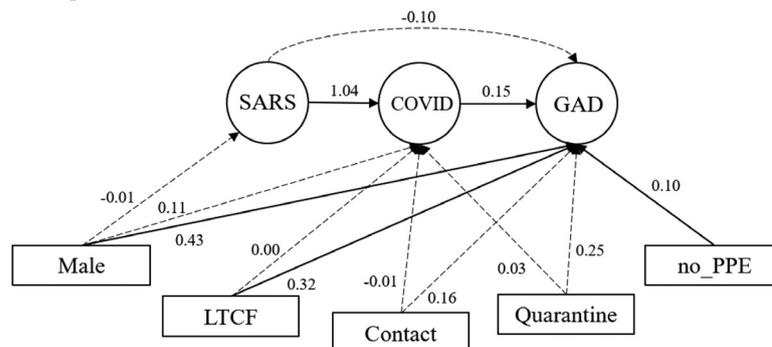
Fit indices:
 $\chi^2 = 586.13$; $df = 127$; $p < 0.001$; CFI = 0.95; RMSEA = 0.06

(B) SARS-inexperienced nurses



Fit indices:
 $\chi^2 = 349.65$; $df = 117$; $p < 0.001$; CFI = 0.95; RMSEA = 0.06

(C) SARS-experienced nurses



Fit indices:
 $\chi^2 = 364.46$; $df = 117$; $p < 0.001$; CFI = 0.94; RMSEA = 0.07

Fig. 1. Structural equation model of GAD-7, perceived severity of COVID-19 and SARS, and work experience during the SARS outbreak and the subgroup analysis. The path diagrams present the (A) interrelationships of GAD-7, perceived severity of COVID-19 and SARS with the work experience during the SARS outbreak, and the results of subgroup analysis between (B) nurses with and (C) without the SARS experience. Paths are labelled with unstandardized coefficients. Solid and dashed lines represent significant and non-significant associations, respectively. SARS_exp: work experience during the SARS outbreak LTCF: long-term care facility; no_PPE: number of personal protective equipment in shortage at workplace.

coupled with a positive association between contact with COVID-19 patients and anxiety level ($B=0.32$, $p=0.01$).

Using the clinical cut-off threshold of GAD-7, the interrelationships among severity of anxiety, perceived severity of COVID-19 and SARS with respect to the nurses' exposure to the SARS outbreak remained similar. The corresponding structural equation models are illustrated in Supplementary Data II. The results of sensitivity analyses showed a minimal effect of age on the structural equation model overall. A significant association emerged only between age and the perceived severity of COVID-19 ($B=-0.016$, $p=0.02$), but not the perceived severity of SARS ($B=0.01$, $p=0.22$).

The statistical significance of the indirect association between SARS experience and anxiety, and other associations of interest still held independent of the age effect.

4. Discussion

To the best of our knowledge, this is the first study which quantitatively elucidates the interrelationships among prior epidemic work experience, perceived severity of the emerging viruses and anxiety level among health care workers in a pandemic context. We found evidence to substantiate the favourable impact of prior

epidemic experience on relieving the initial anxiety brought by COVID-19, through a reduced perceived severity towards SARS and COVID-19. The timeliness of this investigation allowed us to gauge a more accurate estimate of anxiety prevalence pertaining to the onset of the COVID-19 epidemic. Our findings help provide insights into the provision of psychological support and mobilisation of the health care workforce in a future epidemic.

The present study showed a strong positive association between the perceived severity of SARS and COVID-19. This is in line with the reality that nurses were weighing the threat of COVID-19 against SARS in the absence of scientific evidence (Kwok et al., 2020b; Kwok et al., 2021b). During the influenza A (H1N1) pandemic, whether one was vaccinated against seasonal influenza was also revealed to be strongly associated with their perceptions of H1N1 (Gidengil, Parker, & Zikmund-Fisher, 2012). This result implies that juxtaposing prevailing and pre-existing species might be a useful strategy for the effective dissemination of knowledge during a novel outbreak.

This study also identified a less severe perception of SARS and COVID-19 in SARS-experienced nurses, suggesting that one's occupational exposure to an epidemic might help guide a lower perceived severity towards the outbreak-causing virus. In 2003, SARS had sparked massive outbreaks in hospitals and nursing homes in Hong Kong and infected 339 hospital workers (Ho, Hui, Kwok, & Woo, 2004; Lau et al., 2004). It is believed that the nurses' professional experience surviving the SARS outbreak has rendered them a downplayed seriousness of SARS, while an equivalent image has been translated to COVID-19 given their similarity (Griffiths & Lau, 2009). This phenomenon was replicated in another study, which observed a lower perceived severity of COVID-19 in older adults and inferred that the previous epidemic experience has desensitised them to novel threats, while such circumstance was termed "hazard familiarity" in another literature (Fielding et al., 2005; Pasion, Paiva, Fernandes, & Barbosa, 2020). Irrespective of SARS severity, a lower perceived severity of COVID-19 was also evidenced in SARS-experienced nurses in the regression models. This finding was echoed in other literature, in which a nurse's optimistic thinking (Tam, Lee, & Lee, 2007) and heightened readiness to counter a crisis (Koh, Hegney, & Drury, 2012), both attributed to the preceding epidemic experience, were considered to have deflated the perceived severity.

Our results also found that nurses with prior epidemic work experience might be less likely agitated by an emerging epidemic. In the existing body of evidence, it is generally believed that a nurse's previous experience could facilitate a better coping response to future outbreaks given their increased resilience (Labrague & De Los Santos, 2020; Roberts et al., 2021). In this study, we considered an alternative pathway to explain the reduced anxiety as a result of the less violent perception towards the emerging virus, in terms of habituation and sensitisation. Habituation and sensitisation refer to the reduction and inflation in fear response, respectively, over repeated exposures to irritating events, while the manifestation of which towards a future incident depends on their baseline arousal level (Hersen & Sledge, 2002). In this study context, the baseline arousal level refers to the intensity of nurses' response to the SARS outbreak in 2003, while the present COVID-19 pandemic was considered as a second exposure. Our results identified a higher perceived severity of SARS and a more positive association between that and anxiety level in SARS-inexperienced nurses. This has implied that nurses having no first-hand experience with SARS were more likely to be vigorously aroused by the SARS outbreak, probably as a consequence of vicarious traumatisation through media (Liu & Liu, 2020). Their fear towards COVID-19 was likely intensified by sensitisation and thus contributed to a higher level of anxiety. For SARS-experienced nurses, they appeared to be less aroused by the incident of SARS. Thus, the second appearance of a SARS-

like epidemic, such as COVID-19, would likely habituate them to a less provoking psychological response (Hersen & Sledge, 2002). Their less intimidating perception towards both epidemic species also suggested the unlikelihood of traumatisation by SARS and re-traumatisation by COVID-19. The plausibility of this interpretation was further upheld by the fact that nurses who were involved in and critically traumatised by the SARS outbreak should have already quit their jobs (Shiao, Koh, Lo, Lim, & Guo, 2007). Therefore, the remainder represented here would likely be more tolerant of external threats and in a better condition.

These results could also explain the higher COVID-19 vaccination hesitancy for older nurses in Hong Kong from a recent study (Kwok et al., 2021c). Perceived severity and anxiety have a double-edged sword nature. Lower perceived severity and reduced anxiety can foster a better mental health condition, but they can also lessen protective behaviours such as infection control practices and vaccination. (Apisarnthanarak et al., 2020; Kim & Choi, 2016) This is in line with our results in which SARS-experienced nurses acknowledged a less inadequate supply of PPE at work. The dichotomy of the beneficial and adverse effects of perceived severity and anxiety is a complex psychological phenomenon. While it is seemingly straightforward to recommend anxiety-reducing interventions or policies, we should also stress a cautionary note of being careful of their accompanying undesirable effect.

A negative direct association between perceived severity of SARS and anxiety was also noted exclusively in SARS-inexperienced nurses. One possible explanation could be that a minority of them devaluated the upcoming threats after witnessing the society overcoming the deadly SARS outbreak, and thus lowered their guard and put themselves at ease. This complacency is similar to the situation that people had decreased vigilance after waves of COVID-19 outbreaks, which should deserve more attention (South China Morning Post, 2020).

Our findings have provided implications for ameliorating nurses' responses to future epidemics. In general, a more prominent initial surge of anxiety was noted in SARS-inexperienced nurses. However, considering that most of them were suggestive of only mild anxiety (41.7%), this should not be conceived as a genuine psychiatric condition, but rather a transient fight-or-flight response to unanticipated threats (Daly & Robinson, 2021; Feingold et al., 2021). Under this circumstance, strategies targeting to keep the nurses posted with correct knowledge about the outbreak and secure a steady supply of PPE should be in place (Li et al., 2020). On the contrary, a moderate-to-severe level of anxiety was indicated in 28.1% of SARS-inexperienced nurses, slightly higher than that in SARS-experienced nurses (24.5%). This could be a sign of pathological anxiety that might prolong following exposure to a traumatic event (Ayazi, Lien, Eide, Swartz, & Hauff, 2014). They could also be severely traumatised that their work performance was being affected (Bock, Heitland, Zimmermann, Winter, & Kahl, 2020). It is therefore important to routinely assess the level of psychological distress to identify hidden mental health risks in health care workers, in particular those juniors.

This study does carry some limitations. The utilisation of an online survey might favour responses from nurses who are familiar with the use of smartphones and computers. Moreover, our study results could hardly be generalised to regions without the occurrence of a massive epidemic in the past. Extrapolation of results to other health care professionals should also be done with caution considering their marked difference in frequency of direct patient contact compared to nurses. Participating nurses' personality traits and pre-pandemic anxiety levels were not captured in the survey. This might lead to a biased estimate of anxiety prevalence in nurses and overestimate the influence brought on by the pandemic. Assessment of perceived severity of SARS and COVID-19 might not be all-inclusive due to the absence of a well-established

and validated scale. Nevertheless, the evaluation based on the three criteria could provide a general picture of nurses' outlook on the viruses that sufficiently serves the purpose of this study. Furthermore, results showed that age could conceivably confound the relationships between SARS experience and anxiety, given its correlation with perceived severity of SARS and COVID-19, and anxiety level. Indeed, we concurred with some alternative pathways that older people might be less likely to result in anxiety, for example, attributed to their positivity bias and higher capability of decision-making in uncertain contexts (Pasion et al., 2020). Yet, the fact that older people have accumulated more life experiences, mimicking the great deal of work experience among SARS-experienced nurses, has already subsumed a majority of the above explanations. Coupled with the dominance of SARS experience in the sensitivity analysis, this has added further strength to the role of prior epidemic experience in affecting anxiety independent of the age effect. Lastly, whether SARS-experienced nurses had provided direct or indirect care to SARS patients or were they or their colleagues diagnosed with SARS were not covered in this study. Their effects on perceived severity and anxiety could be potential research gaps that deserve future investigation.

5. Conclusions

In conclusion, our study has demonstrated that prior outbreak work experience could enable nurses to better cope with the initial anxiety brought by a pandemic, probably resulting from their less severe perception towards the prevailing virus. In response to future epidemics, the competence of nurses with previous epidemic encounters should not be overlooked, while their self-devotion to the front line should be encouraged. Interventions aiming to facilitate understanding of the outbreak-causing virus, for example delivering knowledge through formal lessons, should be considered when an epidemic commences (Chou et al., 2020). Engaging novice nurses with experienced seniors who were less emotionally sensitive to emerging threats should also be advocated so that they could learn safety strategies and epidemic-specific knowledge from their experience (Venise & Joan, 2020). Ensuring a safe workplace and making psychological support services available are also essential for nurses to cope with anxiety. It is hoped that this study could contribute to the formulation of measures for strengthening the overall epidemic response at a reduced cost of mental health of health care workers, who endeavour to battle against upcoming waves of COVID-19 and disease threats in future.

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Ethical statement

Ethical Approval was obtained from Survey and Behavioural Research Ethics Committee, The Chinese University of Hong Kong (reference number: SBRE-19-251) on January 3, 2020.

Conflicts of interest

None.

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Supplementary data

Supplementary data I. Three-factor model for GAD-7, perceived severity of COVID-19 and SARS, The path diagram presents results of confirmatory factor analysis of GAD-7, perceived severity of COVID-19 and SARS. Factor loading, residual variance and covariance among the latent factors and measured variables were shown. Solid and dashed lines represent significant and non-significant associations, respectively. GAD_1-7: items in GAD-7 scale; ε : residual variance.

Supplementary data II. Structural equation model of GAD-7 severity, perceived severity of COVID-19 and SARS and the subgroup analysis by work experience during the SARS outbreak, The path diagrams present the (A) interrelationships of GAD-7 severity, perceived severity of COVID-19 and SARS with the work experience during the SARS outbreak, and the results of subgroup analysis between (B) nurses with and (C) without the SARS experience. Paths are labelled with unstandardized coefficients. Solid and dashed lines represent significant and non-significant associations, respectively. SARS_exp: work experience during the SARS outbreak LTCF: long-term care facility; no_PPE: number of personal protective equipment in shortage at workplace.

Authorship contribution statement

Chin Pok Chan: Data curation, Formal analysis, Writing – original draft. **Kin Kit Li:** Conceptualisation, Formal analysis, Writing – review & editing. **Arthur Tang:** Conceptualisation, Writing – review & editing. **Samuel Yeung Shan Wong:** Resources, Writing – review & editing, Supervision. **Wan In Wei:** Data curation, Writing – review & editing. **Shui Shan Lee:** Resources, Writing – review & editing, Supervision, Funding acquisition. **Kin On Kwok:** Conceptualisation, Methodology, Formal analysis, Writing – review & editing.

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