Anxiety among Health Care Professionals during COVID-19 in Anhui, China
A Cross-Sectional study

by

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Abstract

Background

The World Health Organization has identified the psychological health of those providing care for COVID-19 patients as a research priority. Anxiety is a precursor to other psychosocial health issues such as depression, substance use, and burnout. In health care professionals (HCPs), burnout is associated with personal suffering, decreased quality of patient care, and increased attrition rates, which affect the ability of health care systems to work to their full capacity. The objective of this study was to assess the prevalence and predictors of anxiety among HCPs during the COVID-19 pandemic in Anhui province, China.

Methods

The study design was cross-sectional. Participants were recruited using convenience sampling and data was collected through an online survey. The primary exposure of interest was working directly with patients during COVID-19 in Anhui. The outcomes were state anxiety (S-Anxiety), measured using the State-Trait Anxiety Inventory for Adults (STAI); and generalized anxiety disorder (GAD), measured using a Generalized Anxiety Disorder 7-Item (GAD-7) Scale summary score ≥10. The summary score is the total of all the response scores added together. Summary scores were used to assess anxiety symptoms reported in both the STAI and the GAD-7. Univariate and multiple linear (STAI) and logistic (GAD) regression models were used to examine the relationship between each outcome and several other potential predictors.

Results

A total of 1657 participants completed the survey, 1521 (92.6%) HCPs, 121 (7.4%) non-HCPs, and 15 (0.9%) participants' professions were unknown due to errors. The mean age of participants was 38.5 (SD 8.9) years. Females comprised 72.2% (n=1196) of the sample population. The main professional fields of practice in health care were clinical

medicine (n=639; 38.7%), nursing (n=558; 33.8%), and public health (n=454; 27.5%). Practice qualifications included medical doctor (MD) (n=787; 47.9%), registered nurse (RN) (n=572; 34.8%), and "Other" allied HCPs and non-HCPs (n=283; 17.2%). The majority of the participants were HCPs with direct patient contact (n=1129; 68.8%), approximately a quarter were HCPs with no direct patient contact (n=392; 23.9%), and a small number were not HCPs (n=121; 7.4%). A small proportion were involved in the direct medical response to COVID-19, including treatment and nursing (n=213; 12.9%). The median years worked was 15 (IQR 7, 25).

The prevalence of GAD was 12.1% in HCPs with direct patient contact compared to 7.4% in HCPs with no direct patient contact and 7.4% in non-HCPs. The mean STAI score (range 20-80) was 42.2 (SD 9.6) in HCPs with direct patient contact, 39.6 (SD 9.1) in HCPs with no direct patient contact, and 39.3 (SD 10.2) in non-HCPs.

The mean STAI scores of HCPs with no direct patient contact (β=-0.77, 95% CI -2.18 to 0.63, p=0.280) and non-HCPs (β=-1.92, 95% CI -4.67 to 0.83, p=0.172) were decreased compared to HCPs with direct patient contact, although the finding lacked statistical significance.

Risk factors for state anxiety included working as a nurse (β=2.08, 95% CI 0.74 to 3.43, p=0.002) compared to working as a medical doctor. Working in tertiary hospitals also carries a higher risk for state anxiety compared to working in primary hospitals/township health centres (β=-3.20, 95% CI -4.68 to -1.72, p<0.001), neighbourhood community health clinics (β=-3.08, 95% CI -5.60 to -0.56, p=0.017), other health services agencies (β=-2.37, 95% CI -3.87 to -0.86, p=0.002), or non-health care organizations (β=-3.59, 95% CI -6.96 to -0.22, p=0.037).

Risk factors for GAD included working as a HCP with direct patient contact compared to non-HCPs (OR=0.35, 95% CI 0.13 to 0.90, p=0.030). Working in secondary hospitals also carries a higher risk for GAD (OR=1.75, 95% CI 1.14 to 2.67, p=0.010) compared to working in tertiary hospitals. Lastly, holding an administrative position in hospitals or health

care institutions was a risk factor for GAD (OR=1.98, 95% CI 1.08 to 3.61, p=0.026) compared to not holding an administrative position. Increased age was associated with a reduced risk of state anxiety (β=-0.18, 95% CI -0.25 to -0.12, p<0.001) and GAD (OR=0.97, 95% CI 0.95 to 0.99, p=0.001).

Conclusion

Health care professionals in Anhui province of China are at increased risk of anxiety and would likely benefit from the development and provision of interventions that support their mental health during times of crisis such as the COVID-19 pandemic.

Preface

This thesis is an original work completed by Holly Sullivan under the supervision and guidance of the supervisory committee, Dr. Shelby Yamamoto, Prof. Gian S. Jhangri and Dr. Keith Dobson.

This study falls under the ethics approval of a larger research project, led by Dr. Shelby Yamamoto, that is investigating the impact of the COVID-19 pandemic on maternal and health care professionals' psychosocial health in Anhui province, China. The larger research project was approved through the Research Ethics Boards of the University of Alberta, University of Calgary, York University and Anhui Medical University (ethics number: Pro00099276).

No part of this thesis has been previously published.

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Lastly, I would like to thank all the participants that took the time to complete the survey while working on the frontlines of the COVID-19 pandemic. I wish you all health, happiness and peace through these challenging times.

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List of Abbreviations

China CDC	Chinese Center for Disease Control and Prevention
COVID-19	Coronavirus Disease 2019
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition
EVD	Ebola Viral Disease
GAD	Generalized Anxiety Disorder (as defined in the DSM-IV)
GAD-7	Generalized Anxiety Disorder 7-Item Scale
GRADE	Grading of Recommendations, Assessment, Development and Evaluation
HCP	Health care professional
MD	Medical doctor
MERS	Middle East Respiratory Syndrome
PPE	Personal protective equipment
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRC	People's Republic of China
PTSD	Post-traumatic Stress Disorder
RN	Registered nurse
RM	Registered midwife
ROBIS	Risk of Bias Tool for Systematic Reviews
S-Anxiety	State anxiety
SARS	Severe Acute Respiratory Syndrome
SAS	Self-Reported Anxiety Scale
STAI	State-Trait Anxiety Inventory for Adults
TCM	Traditional Chinese medicine
T-Anxiety	Trait anxiety
WHO	World Health Organization

Chapter 1: Introduction

Concern about the psychosocial impacts of working as a health care professional (HCP) during the coronavirus disease 2019 (COVID-19) pandemic has been expressed globally as well as nationally (Anxiety Canada, 2020; United Nations, 2020; World Health Organization, 2020c). In February 2020, the World Health Organization (WHO) identified the psychological health of those providing care for COVID-19 patients as a research priority (World Health Organization, 2020a). Evidence from previous outbreaks, including Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), influenza and Ebola Viral Disease (EVD), has demonstrated negative impacts on HCPs' psychosocial health in both the short and long-term (Barello et al., 2020; Kisely et al., 2020; Preti et al., 2020). Indicators of psychosocial health that have been of particular interest to researchers are the symptoms of anxiety, depression, distress, insomnia and post-traumatic stress disorder (PTSD) (Barello et al., 2020; Kisely et al., 2020; Preti et al., 2020).

What is Anxiety?

Anxiety is an umbrella term that is used to describe both passing emotional states and personality traits. State anxiety (S-Anxiety) is used to refer to passing emotional states and trait anxiety (T-Anxiety) is used to refer to persistent personality traits (C. D. Spielberger, 2010). For the purpose of this study, the term anxiety will be used broadly to refer to state anxiety and generalized anxiety disorder (GAD).

The State-Trait Anxiety Inventory (STAI) for Adults defines state anxiety as "subjective feelings of tension, apprehension, nervousness, and worry, and…activation or arousal of the autonomic nervous system" (C. D. Spielberger, 2010). GAD is a type of anxiety disorder that is defined as "excessive anxiety and worry occurring more days than not for a period of at least six months, about a number of events or activities (such as work or school performance)" (CAMH, 2021). It is characterized by "difficulty in controlling worry

and at least three associated physical symptoms (e.g., muscle tension, sleep difficulties, trouble concentrating)" (CAMH, 2021). Anxiety is an outcome that has frequently been used by researchers as an indicator of the psychological impact of the COVID-19 pandemic (Luo et al., 2020). Although there are several different types of anxiety and anxiety disorders, state anxiety and GAD were the focus of this study for reasons discussed in more detail in the methodology.

Health Care Professional Anxiety

Several challenges and fears that may be faced on a daily and ongoing basis by HCPs during the COVID-19 crisis can provoke anxiety. They include, but are not limited to: a high risk of exposure to the virus, concerns about transmitting the virus to others (patients, colleagues, family), concerns about becoming ill, suffering long-term morbidity or dying of the virus, having to quarantine or be hospitalized, an increase in the number of patient deaths, colleague deaths due to the virus, overwhelmed health care systems and hospitals, lack of medical resources, lack of access to any or sufficient amounts of personal protective equipment (PPE), mental and physical exhaustion, and stigma and fear from others leading to further social isolation (Anxiety Canada, 2020; Barello et al., 2020; Muller et al., 2020).

Prioritizing a better understanding of anxiety among HCPs during the COVID-19 pandemic is necessary for the development of appropriate and useful ways to support HCPs' psychosocial health. Anxiety is a precursor to other mental health issues such as depression (Rice et al., 2004), substance use (Brady et al., 2013) and burnout (Ding et al., 2014; Turnipseed, 1998). HCP burnout can lead to a decrease in the quality of patient care as well as an increase in attrition rates (Batterham et al., 2013; Ding et al., 2014; Jackson et al., 2018). Therefore, the psychosocial health of HCPs is not only important for their own well-being but also for the quality of patient care and the ability of health care systems to work to their full capacity.

This master's thesis is a study of HCPs' anxiety during the COVID-19 pandemic in Anhui, China. Anhui is a province located in the People's Republic of China (PRC) and shares part of its western border with Hubei province, the epicentre of the COVID-19 pandemic (L. Wang et al., 2021). The province's permanent population is approximately 63.7 million, with a floating population of approximately 8.0 million (L. Wang et al., 2021). The first confirmed case of COVID-19 in Anhui was January 22, 2020 and by February 9, 2020, the province had 779 confirmed cases (R. Wang et al., 2020). Fortunately, the province was able to quickly control the spread of the virus and as of June 30, 2021, had only reported a total of 1006 COVID-19 cases and 6 COVID-19 related deaths (Center for Systems Science and Engineering (CSSE), 2021).

Significance and Impact of the Research

Review studies have cited the need for ongoing research about the impacts of the COVID-19 pandemic on HCPs' psychosocial health (da Silva Neto, 2021; Muller et al., 2020; Pappa et al., 2020; Vindegaard & Benros, 2020; Yamamoto et al., n.d.). Broadly, this study will add to the existing research on the topic and will contribute to building a more comprehensive understanding of the issue globally.

More specifically, this study will contribute to a better understanding of the mental health impacts of the pandemic on HCPs in Anhui province, China. This focus will enable a more targeted management approach to supporting HCPs across settings and roles in Anhui during the current COVID-19 crisis and future health crises.

The study will also establish the prevalence of anxiety in this population of HCPs during the COVID-19 pandemic, which can be used to inform interventions, programs and/or other studies that address anxiety using longitudinal data.

Research Objective and Questions

The objective of this study is to assess the prevalence and predictors of health care professionals' anxiety during the COVID-19 pandemic in Anhui, China.

The research questions are:

1. What is the prevalence of anxiety in HCPs working during the COVID-19 pandemic in Anhui province, China?
2. Are there any differences in the prevalence of anxiety in the study population based on demographic and/or professional characteristics?
3. Further to question 2 above, are there any factors that increase or decrease the risk of anxiety in the study population?

Organization of Thesis

The thesis is organized into five chapters. The first chapter is an introduction to the topic of HCPs' anxiety during the COVID-19 pandemic. The second chapter is a review of the literature as well as an overview of the thesis study. The third chapter describes the study methodology. The fourth chapter describes the analysis and results of the study, including tables of results. The fifth chapter is a discussion and conclusion of the results and recommendations for research on the topic moving forward.

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Chapter 2: Literature Review

At the end of October 2020, when the literature search for this study was done, relevant research reviews were identified from the Medline, PsycINFO and Global Health databases. They included studies on HCPs' anxiety during the COVID-19 pandemic and/or studies from previous outbreaks with evidence about their impact on HCPs' psychosocial health as it relates to the current crisis.

Although the scope of the literature search was global, the COVID-19 reviews identified at the time of the search for this literature review were based primarily on studies done in China. The reviews were completed early in the pandemic period. The majority of the evidence synthesized in the reviews was from studies that had been published by late May 2020/early June 2020. This was approximately five months after the Chinese Center for Disease Control and Prevention (China CDC) was first dispatched to Wuhan city, the epicentre of the pandemic (L. Wang et al., 2021), and only a few months after the World Health Organization declared the COVID-19 outbreak a pandemic (World Health Organization, 2020b). This timing also coincides with the timing of the data collection for this study. One of the reviews identified included studies published up until the beginning of August 2020 and none of the reviews included studies beyond this point in time.

Anxiety Symptom Assessment Tools

The complete list of tools used by researchers to assess anxiety symptoms in HCPs during the pandemic is extensive. The standard was to use validated, self-reported tools similar to the tools used to collect data for this study (Luo et al., 2020), which were the Generalized Anxiety Disorder 7-item (GAD-7) Scale and the State-Trait Anxiety Inventory (STAI) for Adults. Both of these tools will be described in further detail in the methods chapter of this study.

Prevalence of Anxiety in Health Care Professionals

Research on the prevalence of anxiety in HCPs during the COVID-19 pandemic is dynamic. The health crisis is ongoing across the world and research is demonstrating that the prevalence of anxiety among HCPs is associated with multiple factors. These include the region HCPs are working in, the point in time the data was collected, and demographic and professional characteristics such as the gender and professional qualifications of HCPs (Luo et al., 2020; Pappa et al., 2020; Preti et al., 2020).

Anxiety in health care professionals has been researched during previous health crises, such as during outbreaks of Severe Acute Respiratory Syndrome (SARS), the Middle East Respiratory Syndrome (MERS), and Ebola Viral Disease (EBD), as well as during non-pandemic times (Barello et al., 2020, Luo et al. 2020). For example, a study on a mindfulness intervention for nurses working in AIDS care in Changsha, Hunan province, China in non-pandemic times (2019) reported a baseline mean STAI S-Anxiety score of 43.4 (SE 11.9) and a post-intervention score of 39.3 (SE 10.3) (Pan et al., 2019). During the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak in Hong Kong, mean STAI S-Anxiety scores were 52.9 (SD 8.6) for health care assistants, 52.0 (SD 9.8) for nurses, 47.8 (SD 9.8) for doctors, 47.8 (SD 10.9) for allied health care professionals, 47.8 (SD 9.8) for technicians, and 47.1 (SD 10.6) for administrative staff (Poon et al., 2004).

In a rapid review of the psychological impacts of epidemics and pandemics on frontline and non-frontline HCPs, Preti et al. reported a prevalence of severe anxiety symptoms in approximately 45% of HCPs during the COVID-19 outbreak. This statistic was based on two out of the five COVID-19 studies included in the review. Both studies used validated surveys to collect information from frontline staff to measure anxiety during a peak period of the pandemic (Preti et al., 2020). All five of the COVID-19 studies were cross-sectional. The HCPs were all located in China and included physicians, nurses and auxiliary staff. Medical staff reported increased distress and decreased sleep quality and

self-efficacy due to their anxiety levels. Studies included in this review had been published by March 30, 2020 (Preti et al., 2020).

A systematic review and meta-analysis of the prevalence of depression, anxiety, and insomnia among medical and non-medical HCPs during the COVID-19 pandemic by Pappa et al. reported a pooled anxiety prevalence of 23.2% among medical and non-medical HCPs based on twelve cross-sectional studies (Pappa et al., 2020). However, the prevalence of anxiety was comparable to that reported in the general population (22.6%-36.5%) for the same period. A pooled analysis of GAD outcomes, measured using the GAD-7 from four cross-sectional studies, found a 36.9% prevalence of GAD in medical and non-medical HCPs and the general population. Case definitions of GAD included the pooled analysis ranged from summary GAD-7 scores of ≥5 to ≥9 (Pappa et al., 2020). The studies included in the review and meta-analysis were primarily from China. Health care professionals were categorized into physician, nurse, or "other" groups (Pappa et al., 2020). There was a higher prevalence of mild anxiety (17.9%) than moderate to severe anxiety (6.9%) in a subgroup analysis of the severity of anxiety among medical and non-medical HCPs. Studies included in this review had been published by April 17, 2020 (Pappa et al., 2020).

A rapid systematic review of the mental health impact of the COVID-19 pandemic on frontline and non-frontline HCPs by Muller et al. included 22 observational studies with anxiety results. Most of the studies were cross-sectional. The individual studies that collected data on HCPs' anxiety were from a range of countries including France, Iran, Germany, India, Singapore, Italy, Australia, New Zealand, Taiwan, and the United States of America, with the majority from China. The professional qualifications of HCPs in the studies were primarily physicians and nurses but also included other HCPs that performed clinical tasks and health administration workers. The range of HCPs reporting anxiety was from 9%-90% with a median of 24%. Unfortunately, the authors did not report the anxiety results by country. Studies included in this review were published by May 11, 2020 (Muller et al., 2020).

Lastly, a systematic review and meta-analysis by Luo et al. compared mental health outcomes during the COVID-19 pandemic between frontline and non-frontline HCPs to the general population and to patients with higher COVID-19 risk. The review included 41 quantitative studies with anxiety results. Thirteen of the studies included results on HCPs' anxiety. The pooled prevalence of anxiety of all the groups studied was 33% and there was variability in effect estimates due to considerable heterogeneity (rather than sampling error) (I^2 99.7%, $p<0.001$). HCPs were grouped into one category named "medical staff" (Luo et al., 2020). The prevalence of anxiety in HCPs was 26%, compared to 32% in the general population and 56% in patients with pre-existing health conditions and COVID-19 infection. Luo et al. noted that the prevalence of anxiety among HCPs varied greatly by country. For example, in Singapore, the anxiety prevalence was 7% whereas the prevalence in Italy was 57%. Some individual studies from China, Italy, Turkey, Spain, and Iran reported higher anxiety prevalence compared to the pooled meta-analysis anxiety prevalence for both HCPs and the general public. Studies in this review were published by May 25, 2020 (Luo et al., 2020)

Identified Risk and Protective Factors

Risk and protective factors for anxiety among HCPs during the COVID-19 pandemic included, but were not limited to, gender, profession, exposure to patients with COVID-19 infection, socio-economic status and social support (Du et al., 2020; Lai et al., 2020; Luo et al., 2020; Preti et al., 2020).s

Only one of the meta-analyses identified in the literature search examined the pooled prevalence of anxiety by gender. Pappa et al. reported a pooled prevalence of anxiety among male HCPs of 20.9% (95% CI 11.86 to 31.65; I^2 98%) compared to 29.1% (95% CI 20.21 to 38.78; I^2 99%) among female HCPs based on six cross-sectional studies (Pappa et al., 2020). One of the studies included in the meta-analysis found females had a higher risk of anxiety (OR 1.69, 95% CI 1.23 to 2.33, p=0.001) compared to males (Lai et al., 2020).

Another study reported that anxiety was higher in female frontline HCPs (OR 2.70, 95% CI 0.99 to 7.37, $p \geq 0.05$) compared to male frontline HCPs but that the result was not statistically significant (Du et al., 2020).

The same meta-analysis reported a pooled anxiety prevalence of 21.7% (95% CI 15.3 to 29.0; I^2 97%) among MDs and 25.8% (95% CI 19.20 to 33.00; I^2 98%) among RNs based on six studies (Pappa et al., 2020). A cross-sectional study of 11,118 medical staff by Guo et al. included in the meta-analysis reported that the median Self-Reported Anxiety Scale (SAS) score of RNs (43) was significantly higher than the median score for MDs (41) ($p<0.0005$) (Guo et al., 2021). Another cross-sectional study included in the meta-analysis reported that the median GAD-7 score was significantly higher ($p=0.008$) in RNs (4.0, IQR 1.0-7.0) compared to MDs (3.0, IQR 0-7.0).

A cross-sectional study by Lai et al. found that frontline HCPs caring for patients with COVID-19 infection had a higher risk of symptoms of anxiety (OR 1.57; 95% CI 1.22 to 2.02; $p<0.001$) compared to HCPs that did not provide direct care to patients with COVID-19 infection. They also reported a higher risk of symptoms of anxiety in HCPs in intermediate professional roles (OR 1.82; 95% CI 1.38 to 2.39; $p<0.001$) compared to those in higher level professional roles. Lastly, the study found that those with a lack of family support had a higher risk of anxiety symptoms (OR 2.32; 95% CI 1.27 to 4.35; $p<0.001$) compared to those with family support (Lai et al., 2020).

The standard among the studies was to use validated self-report tools to collect anxiety data, however, the potential for bias in several studies and the heterogeneity of the study populations makes it difficult to get a clear understanding of the prevalence of anxiety in HCPs working during the COVID-19 outbreak. The range of anxiety prevalence reported in the studies was large, as much as 81% in one review (Muller et al., 2020). Despite the challenges of the research, some general observations can be made. Firstly, anxiety prevalence continuously changes based on factors such as the timing of the study, where the study was done and the demographics of the participants. Secondly, when subgroup

analyses were done, differences in anxiety prevalence also existed between groups which demonstrated that there were factors that either pre-disposed health care professionals to or protected them from anxiety during the COVID-19 pandemic. Gaps noted in the literature on anxiety symptoms during the COVID-19 pandemic that were examined in this study were female gender as a confounder for anxiety in HCPs, anxiety in managers working in health care institutions and studies focused on HCPs in Anhui province.

Quality of the Evidence

Due to the scope of this literature review, a formal quality assessment of the studies was not performed. However, a brief comparison of the systematic reviews to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) and the Risk of Bias Tool for Systematic Reviews (ROBIS) (Whiting et al., 2016) made evident that not all of the reviews were of high quality. For this reason, if more than one systematic review covered a similar timeline, the reviews that appeared to be of higher quality were cited here.

With regards to the quality of the individual studies cited in the reviews, the main limitations identified by review authors were the potential for bias due to a lack of comparison groups, a lack of longitudinal data and a lack of generalizability (Muller et al., 2020; Vindegaard & Benros, 2020). A systematic review that included 22 studies on the impact of the COVID-19 pandemic on HCPs' anxiety, concluded based on Grading of Recommendations, Assessment, Development and Evaluation (GRADE) criteria, that their confidence in the prevalence estimates of anxiety symptoms was "very low"(p1) (Muller et al., 2020). Lacks of comparison data for pre-pandemic HCPs' anxiety symptoms as well as for the general population were some of the quality issues identified. Other quality issues related to a lack of information on the methods of the studies included in the reviews (Muller et al., 2020).

A systematic review and meta-analysis done later in the year that included 13 studies with results on the impacts of COVID-19 on HCPs' anxiety, concluded that the majority of the studies scored high in their quality assessment (Luo et al., 2020). The discrepancy in the assessment of study quality is likely due to the use of different quality assessment tools. The quality issues of concern for these authors were a lack of response rates and a lack of identification of study limitations (Luo et al., 2020).

Summary

In summary, health care professionals are at risk of negative impacts to their mental health while working during an outbreak, which has been demonstrated by research on previous outbreaks as well as the current COVID-19 pandemic. The measurement of anxiety symptoms, specifically state anxiety symptoms, is one of the ways to assess the impact of outbreaks on mental health and have frequently been used by researchers during the current crisis.

During the COVID-19 pandemic, HCPs are being exposed to unique challenges and fears to which not all professions or the general public may be exposed. How this exposure has impacted HCPs' anxiety appears to change based on regional, temporal and demographic factors.

The available evidence on the impact of the COVID-19 pandemic on HCPs' anxiety is dynamic. An increasing amount of evidence has been produced as the pandemic has progressed but there is still a need for more information on the topic, particularly from longitudinal and qualitative studies.

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Chapter 3: Methodology

Study Population and Setting

The population of interest in this study is health care professionals (HCPs) working during the COVID-19 pandemic in Anhui province, China. The criteria for participation in the study was being a "health care worker" at any point during the COVID-19 outbreak (Appendix A). Anhui is a province located in the People's Republic of China (PRC) and shares part of its western border with Hubei province, the epicentre of the COVID-19 pandemic (Figure 1). The first confirmed case of COVID-19 in Anhui was January 22, 2020, and by February 9, 2020, the province had 779 confirmed cases (R. Wang et al., 2020). Fortunately, the province was able to quickly control the spread of the virus and as of June 30, 2021, has only reported a total of 1006 COVID-19 cases and 6 COVID-19 related deaths (Center for Systems Science and Engineering (CSSE), 2021).

Figure 1. Map of Anhui Province, China.

(Pang, 2021)

Health care institutions in China are primarily public and private, with a small number of personalized clinics (National Health Commission of the People's Republic of China, 2019). Although there are private and personalized clinics, the majority of health care institutions, health care services and public health research are publicly funded (Tian, 2021). Both Western medicine and traditional Chinese medicine (TCM) are practiced in hospitals in China (National Health Commission of the People's Republic of China, 2019). Tertiary hospitals provide specialized health services at the city, provincial or national level and typically have a capacity of ≥500 patient beds. Secondary hospitals provide comprehensive health services and typically have a capacity between 100-499 patient beds. Primary and township health centres provide preventative care, minimal health care and rehabilitation services and typically have <100 patient beds (Long, 2021).

Study Design

The study is a cross-sectional design that analyzes the prevalence of anxiety among HCPs during the COVID-19 pandemic in Anhui, China. The data available for this study is for one time point (June 1-20, 2020). However, participants were encouraged to re-screen using the surveys every 3 months after their initial screening, during and after the COVID-19 pandemic has resolved, so that the longitudinal effects can be assessed across the population.

The study was collaboration between academics and clinicians in Canada and China from the University of Alberta, University of Calgary, York University and Anhui Medical University.

Exposure

The primary exposure of interest was working directly with patients during COVID-19 in Anhui.

Outcomes

The primary outcome of interest was anxiety among health care professionals. Outcome metrics were state anxiety and clinically significant generalized anxiety measured using the *State-Trait Anxiety Inventory for Adults (STAI*) and the *Generalized Anxiety Disorder 7-item (GAD-7) Scale*, respectively. These tools are discussed in detail below in the data collection section. Clinically significant generalized anxiety was defined as a summary GAD-7 score of ≥10. The summary score is the total of all the response scores added together. A summary GAD-7 score of ≥10 maps onto the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) diagnoses of Generalized Anxiety Disorder (GAD) with 89% sensitivity and 82% specificity (Spitzer et al., 2006).

Data Collection

The data collection tool used was an online survey, which included a demographic questionnaire (Appendix B) developed by the research teams and the validated self-report tools for anxiety symptoms. The data was collected voluntarily, with written consent. The data was not completely anonymous as telephone numbers were collected. Participants had the option to leave their name and contact details to be interviewed for a qualitative study. The online survey data was collected throughout the month of June 2020, 5 months after the first confirmed case of COVID-19 in Anhui province, China (R. Wang et al., 2020). The data was collected in Mandarin, translated into English and then translations were verified before analysis.

Demographic Questionnaire

The demographic questionnaire was developed in English by the research team in Canada in consultation with the research team in China, then translated into Mandarin and further vetted and edited by the research team in China. To identify risk factors for anxiety while working during the COVID-19 pandemic, participants were asked about their age

(open response), gender (male, female), place of residence in Anhui (open response) and marital status (never married, currently married, cohabitating, separated/divorced, widowed), as well as about their education, profession and work environment. More specifically, they were asked about their highest level of education completed (junior high school and below, high school, skilled worker's school, technical secondary school, junior college, bachelor's, master's, PhD), practice qualifications (practicing physician (MD), assistant practicing physician, traditional Chinese medicine (TCM) doctor, assistant practicing doctor of traditional Chinese medicine, registered nurse (RN), midwife (RM), other (specify)), main professional category (clinical medicine, nursing, public health), total years of work experience (open response), the type of healthcare organization they worked in (tertiary hospital, secondary hospital, township health centre/primary care hospital, neighbourhood community health clinic, other health services agency (option for open question response)), the department they worked in (internal medicine, surgical, obstetrics and gynaecology, pediatrics, traditional Chinese medicine, prevention and education, other clinical departments (specify)), if they held an administrative position (director of the hospital/centre, vice-director of the hospital/centre, director of the department, vice-director of the department, head nurse, no administrative position, other administrative position (specify)), and their current working status (part-time, full-time, on leave, resigned/unemployed). A variable named *Health Care Professional patient contact* was created after the data was collected to group participants based on their likelihood of direct contact with patients, regardless of the patient's diagnosed or suspected COVID-19 status (HCPs with direct patient contact, HCPs with no direct patient contact, non-HCPs). This variable was informed by participants practice qualification and main professional category. The different roles of HCPs in the Chinese health care system were verified with the translator of the data set to ensure participants were grouped as accurately as possible (Appendix C). Further, information specific to working during the COVID-19 outbreak was collected. Participants were asked to identify whether they were directly involved in the

medical response to COVID-19, including treatment and nursing (yes, no), whether they had provided additional healthcare services during the epidemic other than the direct COVID-19 response (yes (specify), no) and if they had used psychological services during the COVID-19 outbreak (yes, no).

Generalized Anxiety Disorder 7-item (GAD-7) Scale

Clinically significant generalized anxiety was measured using the Generalized Anxiety Disorder 7-item (GAD-7) Scale (Appendix D). The Generalized Anxiety Disorder 7-item (GAD-7) Scale is a validated self-report questionnaire related to the participants' experiences of bothersome anxiety symptoms over the previous two weeks and was developed using diagnostic criteria for Generalized Anxiety Disorder as defined in the DSM-IV (Spitzer et al., 2006). The GAD-7 was chosen as an anxiety assessment tool because it is a brief survey that captures recent generalized anxiety symptoms (within the last 2 weeks) and has been used in other studies to measure HCPs' anxiety during COVID-19 (Pappa et al., 2020; Preti et al., 2020).

A translated and validated Chinese version of the GAD-7 was used (He et al., 2010). It includes seven questions in total and each response has a numerical value that ranges from 0 to 3. The responses are totaled to produce a continuous measure, or summary score. The minimum possible score is 0 and the maximum is 21. Scores are then categorized to signify the severity of anxiety symptoms using cut off values of 5, 10 and 15. Scores of 0-4 indicate minimal anxiety, scores of 5-9 indicate mild anxiety, scores of 10-14 indicate moderate anxiety and scores of ≥15 indicate severe anxiety (Spitzer et al., 2006). A score of ≥10 on the GAD-7 was defined as clinically significant anxiety in this study given that a diagnosis of Generalized Anxiety Disorder (GAD) as defined in the DSM-IV, maps onto a summary GAD-7 score of ≥10 with 89% sensitivity and 82% specificity (Spitzer et al., 2006).

State-Trait Anxiety Inventory for Adults (STAI)

State anxiety (S-Anxiety) was measured using the state anxiety section (Form Y-1/S-Anxiety) of the State-Trait Anxiety Inventory for Adults (STAI) (Appendix E). The STAI is also a validated self-report questionnaire, and the S-Anxiety form identifies participants anxiety symptoms at the time they complete the assessment by asking participants to identify how they describe their symptoms in the *present* or at that moment in time (C. D. Spielberger, 2010). The purpose of administering the S-Anxiety form but not the trait anxiety (T-Anxiety) form, was to capture participants anxiety symptoms during the pandemic. According to Spielberger et al., S-Anxiety scores are a "sensitive indicator of changes in transitory anxiety"(C. D. Spielberger, 2010), "increase in response to physical danger and psychological stress" (C. D. Spielberger, 2010), and can be used to measure anxiety due to "unavoidable real-life stressors" (C. D. Spielberger, 2010). The STAI has also been used in other studies to assess HCPs' anxiety during COVID-19 (di Tella et al., 2020; Hacimusalar et al., 2020).

A translated and validated Chinese version of the STAI was used (Shek, 1988; C. Spielberger, 1977). The STAI consists of 20 questions, 10 of which describe the presence of anxiety and 10 that describe the absence of anxiety. Each response has a numerical value of 1, 2, 3 or 4, which is totaled to produce a continuous measure, or summary score. Reverse scoring is used for responses to questions that indicated the absence of anxiety. Therefore, responses to questions that indicate the presence of anxiety increase the summary score, while responses to questions that indicate the absence of anxiety decrease the summary score. The minimum possible score of STAI is 20 and the maximum is 80 (Appendix E). Reliability of STAI scores is determined by comparison to "normative" (C. D. Spielberger, 2010) scores collected from "working adults, college students, high school students, and military recruits" (C. D. Spielberger, 2010). The internal consistency (reliability) of the S-Anxiety test is measured using alpha coefficients. The overall median

alpha coefficient of the S-Anxiety scores in the normative sample was 0.92 (C. D. Spielberger, 2010).

Sampling Method

Sampling was done using a convenience method via the *WeChat* app. *WeChat* is the most popular messaging app in China and has been used by hospitals to improve communication, including within departments and units (D. Wang et al., 2020). The link to the survey was sent by the research team at Anhui Medical University via *WeChat* message to their HCP and hospital contacts as well as to relevant health care *WeChat* groups within their network. Contacts were asked to complete the survey and forward the link to their own HCP and/or hospital contacts and health care group chat mailing lists to recruit further participants.

Statistical Analysis

The prevalence of anxiety among the different levels of HCPs and non-HCPs was measured by identifying the proportion of participants in each group with clinically significant anxiety, defined as a GAD-7 summary score ≥10. The relationship between anxiety and the predictors was measured by examining the change in units of anxiety scores for continuous scores as well as by examining the counts and proportions of the categorical anxiety measures.

Missing Data and Errors

There were no unanswered questions in the data set however there were entry errors for individual responses and across responses. The online survey was designed so that a response for a question was required before being able to move onto the next question. When cleaning the data, if an error was found across responses, all variables that were in question were marked as missing. For example, if the participant indicated their

practice qualification was nursing but then chose clinical medicine as their main professional category as opposed to nursing, both the professional qualification and the main professional category responses were marked as missing given that it was impossible to know which of the entries was the error.

Descriptive Data

Total STAI scores are continuous measurement that were normally distributed therefore were reported as mean ± SD. Summary GAD-7 scores were reported as median with interquartile range (IQR) for the continuous scores as the distribution was right-skewed. The categorical measurements (minimal, mild, moderate, severe and GAD-7 score <10 or ≥10) were reported as counts and percentages. Exploratory data analysis to examine the visual distribution of variables and the associations between them was done using histograms and scatterplots with a line of best fit for continuous variables, and tables for categorical outcomes.

Univariate Regression

To examine associations between individual demographic and professional characteristics with anxiety scores, univariate linear regression analyses were used for the summary STAI S-Anxiety score (continuous outcome), and univariate logistic regression analyses were used for the summary GAD-7 scores <10 or ≥10 (binary outcome).

Multiple Regression

Multiple linear regression analysis was used to examine associations between the summary STAI S-Anxiety score (continuous outcome) and the demographic and professional characteristics of survey respondents.

Multiple logistic regression was used to examine associations between summary GAD-7 scores <10 or ≥10 (binary outcome) and demographic and professional characteristics of survey respondents.

Both multiple linear and multiple logistic regression models were developed using a hypothesis-driven approach that included relevant, statistically significant and confounding variables in the final model. For each model, the backward stepwise elimination method was applied, wherein important variables and those with p-values ≤0.2 in the univariate model were included in the first full model as covariates. Age and gender have been identified as relevant predictors of anxiety in HCPs as well as potential confounders of predictors (Guo et al., 2021; Muller et al., 2020; Pappa et al., 2020; Turnipseed, 1998). Therefore, age and gender variables were included in all first and subsequent models, regardless of their level of statistical significance.

To create a parsimonious multiple linear regression model, the variable *Main Professional Category (clinical medicine, nursing, public health)* was not included in the full model despite statistical significance of some of the groups in the univariate linear regression. This variable contained similar information to the variable *Practice Qualification (medical doctor, registered nurse, other (HCPs and non-HCPs))* but more information could be gleaned from the practice qualification responses due to the "Other" response option. A sensitivity analysis was performed at the end of the multiple linear regression analysis to ensure that leaving out the *Main Professional Category* variable did not change the results significantly. No statistically significant changes were found with the inclusion of the variable in the final model. Similarly, although there were significant decreases in the estimated average STAI score in some departments compared to others (Table 4), the variable *Department Worked in (internal medicine, surgical, obstetrics and gynaecology, pediatrics, traditional Chinese medicine, prevention and education, or other clinical departments (specify))* was not included in the multiple linear regression model. The information that could be gleaned from this variable was similar to information obtained from the variable

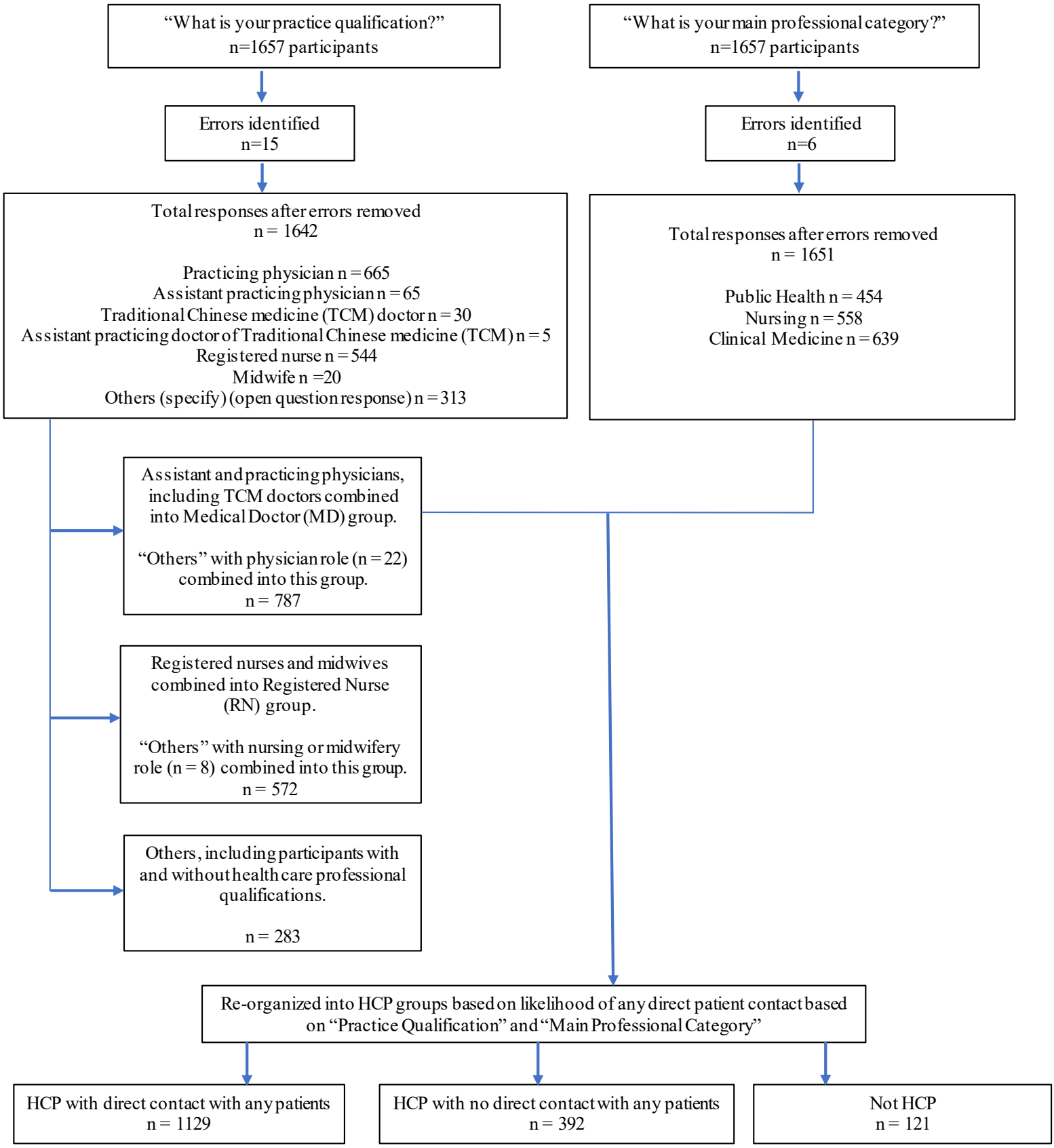
Institution Worked in (tertiary hospital, secondary hospital, township health centre/primary care hospital, neighbourhood community health clinic, other health services agency (option for open question response)). Further, on reviewing the data, it was discovered that not all the participants worked in a department. However, they all worked in an institution of some type, therefore only the health care institution variable was included in the model.

Total work experience in years was also statistically significant in the univariate linear regression (β=-0.17, 95% CI -0.21 to -0.12, p<0.001), however was not included in the multiple linear regression model due to collinearity with age (r=0.95). Age was included in the multiple linear regression model instead of total work experience in years due to the importance of keeping the age variable in the model.

To answer the study questions regarding the prevalence of anxiety among HCPs during the COVID-19 pandemic, respondents were grouped into categories for descriptive and regression analyses based on their likelihood of contact with *any* patients (not just patients with COVID-19 infections), based on information from both their practice qualification and main professional category (Figure 2).

After the full model was run, variables with the highest p-values ≥0.05 were removed one by one from the model and overall significance of the removed variable from the model was checked using nested regressions. Variables were kept in the model if the p-value was <0.05. If a variable was removed from the model because it was not statistically significant, the confounding effect on other predictors was examined based on a threshold of >15% change in regression coefficients (i.e., change in slopes for linear regression and odds ratios for the logistic regression). Confounding of each variable was checked immediately after it was removed. Whenever a confounding relationship occurred between any two variables, both were retained in the model, and the variable with the next highest statistically non-significant p-value was considered for elimination. This iterative process of variable elimination and retention persisted until the best main effects model was obtained.

Figure 2. Flow Chart of Health Care Professional (HCP) Patient Contact Categories.



Once the main effects model was determined, biologically plausible interaction terms (gender and practice qualifications, gender and HCP level of patient contact) were used to check for effect modification. If an interaction was statistically significant (p-value of <0.05), it was kept in the model.

After checking for effect modification, the final regression models were run. Residual analyses were performed to ensure assumptions of linearity, independence, normality, and homoscedasticity were met for the multiple linear regression model. For logistic regression, the Hosmer-Lemeshow test was used for a goodness of fit test. STATA/IC 16.1 was used to perform the statistical analyses. A $p<0.05$ was considered statistically significant.

Ethical Considerations

This study falls under the ethics approval of the larger research project, led by Dr. Yamamoto, that is investigating the impact of the COVID-19 pandemic on maternal and health care providers' psychosocial outcomes in China. The larger research project was approved through the Research Ethics Boards of the University of Alberta, University of Calgary, York University and Anhui Medical University (ethics number: Pro00099276).

All health care professionals that participated in the study were offered mental health resources and the study supported those interested in counselling.

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Chapter 4: Results

Characteristics of Study Participants

A total of 1657 participants completed the online survey from June 01-20, 2020. All participants completed all three components of the survey (demographic and professional characteristics, STAI, GAD-7). The mean age of participants was 38.5 (SD 8.9) years. The majority were female (n=1196; 72.2%) and lived in Anhui province (n=1646; 99.6%). Most of the participants were either married or cohabitating (n=1398; 84.4%) and the rest were either single or divorced or widowed (n=259; 15.6%). Just over half of the sample had a bachelor's degree as their highest level of education (n=922; 55.6%), while 30.2% (n=500) reported attaining a level of education at or below the junior college level (junior high school or below/high school/technical secondary school/skilled worker's school) and 14.2% (n=235) reported having completed a graduate degree (master's/PhD). The practice qualification to become a medical doctor or a traditional Chinese medicine (TCM) doctor in China is a bachelor's degree. Demographic characteristics of study participants are presented in Table 1.

Respondents were fairly evenly distributed across the main professional categories of clinical medicine (n=787; 38.7%), nursing (n=572; 33.8%), and public health (n=454; 27.5%). Slightly under half (n=787; 47.9%) of participants fell into the practice qualification category of medical doctor (MD) (medical doctor, assistant medical doctor, traditional Chinese medicine doctor, assistant traditional Chinese medicine doctor), 34.8% (n=572) into the category of registered nurse (RN) (nurse, midwife) and 17.2% (n=283) into the category of "Other", that included both HCPs other than MD or RN and non-HCPs. A small number (n=213; 12.9%) of participants reported being directly involved in the medical response to COVID-19, including treatment and nursing.

Although the study recruitment message sent out on *WeChat* specified a need for "health care workers" to complete the surveys, the range of professionals that responded

Table 1. Demographic Characteristics of Health Care Professionals (HCPs) (n = 1657)

		STAI	GAD-7
Characteristics	**n (%)**	**Mean (SD)**	**Median (IQR)**
Age in Years			
Mean ± SD	38.5 ± 8.9	-	-
Gender			
Female	1196 (72.2)	41.9 (9.6)	4 (1,7)
Male	461 (27.8)	40.2 (9.3)	3 (0,7)
Residence			
Anhui province	1646 (99.6)	41.4 (9.6)	3 (0,7)
Not Anhui province	7 (0.4)	40.4 (8.9)	4 (0,8)
Marital Status			
Married/Cohabitated	1398 (84.4)	41.2 (9.5)	3 (0,7)
Single, Divorced, Widowed	259 (15.6)	42.3 (9.8)	3 (0,7)
Highest Level of Education*			
Junior College and Below	500 (30.2)	40.4 (9.7)	3 (0,7)
Bachelor's Degree	922 (55.6)	41.9 (9.8)	4 (1,7)
Graduate Degree	235 (14.2)	41.6 (8.2)	4 (1,6)

*Junior College and Below = Junior High School or Below/High School/Technical Secondary School/Skilled Worker's School, Bachelor's Degree = Bachelor's/Medical Doctor, Graduate Degree = Master/PhD.

was broad. Participants worked in roles that ranged from HCPs that had direct patient contact with patients diagnosed with or suspected of having a COVID-19 infection; HCPs that had direct patient contact with any patients; HCPs that had no direct patient contact, as well as participants that were not HCPs but worked within the health care system.

The median number of years of work experience was 15 (IQR 7, 15). Most of the participants (n=1623; 98.0%) worked full-time versus a small percent (n=34; 2.1%) that did not work full-time (part-time, paid leave, resignation/unemployment).

Just under half (n=747; 45.1%) of respondents worked in a tertiary hospital, 15.0% (n=249) worked in a secondary hospital, 15.8% (n=262) worked in a primary hospital or township health centre, 4% (n=66) worked in a neighbourhood community health clinic,

17.5% (n=289) worked in a health care agency other than those previously listed, and 2.6% (n=43) did not work in a health care organization. Some examples of non-health care organizations that participants worked in include kindergarten health care room, public security judicial expertise centre, and vocational college. When broken down further by department worked in, 31.7% (n=526) worked in internal medicine, 12.1% (n=200) worked in prevention and education, 1.8% (n=29) worked in TCM, 6.5% (n=107) worked in pediatrics, 11% (n=182) worked in obstetrics and gynaecology, 11.3% (n=187) worked in surgical, and 25.7% (n=426) worked in departments other than those previously listed or not in a department.

Just over half of the sample did not hold any administrative position (n=984; 59.5%). Of those that did, 6.5% (n=107) were either vice-head RN or head RN. Of the positions held at the departmental level, 16.6% (n=275) were administrative , including either assistant to the vice-director, vice-director or director of a department. Of the positions held at the facility level, 6.4% (n=277) were administrative, including either assistant to the vice-director, vice-director or director of a hospital or centre. Finally, 0.7% (n=12) held administrative positions other than those listed above.

A small number of participants (n=106; 6.5%) reported providing additional health care services during the COVID-19 pandemic. Some examples include vaccinations and health care education.

Lastly, a small percentage (n=152; 9.2%) of participants reported having accessed psychological services during the COVID-19 crisis. Professional characteristics of study participants are presented in Table 2.

Table 2. Professional Characteristics of Health Care Professionals (HCPs) (n=1657)

		STAI	GAD-7
Characteristics	**n (%)**	**Mean (SD)**	**Median (IQR)**
Practice Qualification			
Medical Doctor	787 (47.9)	40.2 (9.0)	3 (0,6)
Registered Nurse	572 (34.8)	43.6 (9.7)	4 (1,7)
Other (HCP and Not HCP)	283 (17.2)	40.2 (10.1)	2 (0,6)
HCP patient contact			
HCP with direct contact	1129 (68.8)	42.2 (9.6)	4 (1,7)
HCP no direct contact	392 (23.9)	39.6 (9.1)	3 (0,6)
Not HCP	121 (7.4)	39.3 (10.2)	2 (0,7)
Main Professional Category			
Clinical Medicine	639 (38.7)	40.8 (9.2)	3 (0,7)
Nursing	558 (33.8)	43.6 (9.8)	4.5 (1,7)
Public Health	454 (27.5)	39.5 (9.3)	3 (0,6)
Total Years of Work Experience			
Median, IQR	15 (7,25)	-	-
Type of Health Care Organization			
Tertiary Care Hospital	747 (45.1)	43.2 (8.9)	4 (1,7)
Secondary Care Hospital	249 (15.0)	41.7 (10.8)	4 (1,7)
Primary Care Hospital/Township Health Centre	262 (15.8)	39.5 (9.4)	2 (0,7)
Neighbourhood Community Health Clinic	66 (4.0)	38.8 (10.1)	3 (0,6)
Other Health Care Agency	289 (17.5)	39.4 (9.4)	2 (0,6)
Not Health Care Organization	43 (2.6)	37.5 (9.1)	2 (0,4)
Department Worked in			
Internal Medicine	526 (31.7)	42.4 (9.7)	4 (1,7)
Prevention and Education	200 (12.1)	39.2 (9.1)	2 (0,6)
Traditional Chinese Medicine	29 (1.8)	42.8 (8.8)	6 (3,7)
Pediatrics	107 (6.5)	39.9 (9.3)	3 (0,6)
Obstetrics and Gynaecology	182 (11.0)	41.5 (10.0)	4 (1,7)
Surgical	187 (11.3)	43.8 (8.8)	4 (1,7)
Other*	426 (25.7)	40.4 (9.6)	3 (0,6)
Administrative Position Held			
None	984 (59.5)	41.9 (9.6)	3 (0.5,7)
Vice/Head Registered Nurse	107 (6.5)	42.4 (9.4)	4 (2,8)
Vice/Director of the Department	275 (16.6)	40.4 (8.8)	3 (0,6)
Vice/Director of the Hospital/Centre	277 (16.7)	40.2 (9.9)	3 (0,7)
Not Health Care Related	12 (0.7)	37.7 (11.6)	4 (0.5,7)
Working Status			
Full-time	1623 (98.0)	41.4 (9.5)	3 (0,7)
Not Full-time†	34 (2.1)	42.4 (10.9)	4.5 (0,7)
Direct Involvement in Medical Response to COVID-19?			
Yes	213 (12.9)	41.1 (9.6)	4 (1,7)

Characteristics	n (%)	STAI Mean (SD)	GAD-7 Median (IQR)
No	1444 (87.2)	41.4 (9.6)	3 (0,7)
Provided Additional Health Care Services during COVID-19?			
None	1,550 (93.6)	41.5 (9.6)	3 (1,7)
Education	14 (0.9)	37.7 (10.3)	3.5 (1,5)
Epidemiology	13 (0.8)	40.9 (9.0)	3 (2,5)
Other Health Care Services	26 (1.6)	38.4 (10.7)	1 (0,7)
Other[‡]	53 (3.2)	39.4 (8.7)	1 (0,5)
Received Psychological Services During COVID-19?			
No	1505 (90.8)	41.5 (9.6)	3 (0,7)
Yes	152 (9.2)	40.8 (9.1)	4 (0.5,7)

[*]Includes a range of administrative, technical, or operational areas as well as some health care services that fall under the category of a department.
[†]Includes part-time, paid leave, and resignation/unemployment.
[‡]Participants indicated that they provided additional health care services during COVID-19 but either did not provide specifics about the type of work they performed or if they did, were not health care services.

State-Trait Anxiety Inventory for Adults (STAI), S-Anxiety

The STAI, S-Anxiety score is a continuous measure that ranges from 20 to 80. The mean summary S-Anxiety score in our study was 41.4 (SD 9.6). STAI frequency and percentage by question and mean summary STAI, S-Anxiety score are presented in Table 3.

Table 3. State-Trait Anxiety Inventory for Adults (STAI), S-Anxiety* Score Frequency and Percentage for each Question and Summary Score (n = 1657)

STAI Question†	n (%)			
	1 Not at all	2 Somewhat	3 Moderately So	4 Very Much So
I feel calm‡	56 (3.4)	542 (32.7)	762 (46.0)	297 (17.9)
I feel secure‡	75 (4.5)	441 (26.6)	727 (43.9)	414 (25.0)
I am tense	225 (13.6)	1216 (73.4)	190 (11.5)	26 (1.6)
I feel strained	294 (17.7)	1125 (67.9)	205 (12.4)	33 (2.0)
I feel at ease‡	82 (5.0)	570 (34.4)	741 (44.7)	264 (15.9)
I feel upset	254 (15.3)	1187 (71.6)	188 (11.4)	28 (1.7)
I am presently worrying over possible misfortunes	496 (29.9)	975 (58.8)	154 (9.3)	32 (1.9)
I feel satisfied‡	65 (3.9)	557 (33.6)	760 (45.9)	275 (16.6)
I feel frightened	453 (27.3)	1074 (64.8)	110 (6.6)	20 (1.2)
I feel comfortable‡	53 (3.2)	561 (33.9)	783 (47.3)	260 (15.7)
I feel self-confident‡	64 (3.9)	603 (36.4)	734 (44.3)	256 (15.5)
I feel nervous	629 (38.0)	871 (52.6)	128 (7.7)	29 (1.8)
I am jittery	470 (28.4)	1033 (62.3)	128 (7.7)	26 (1.6)
I feel indecisive	292 (17.6)	1157 (69.8)	181 (10.9)	27 (1.6)
I am relaxed‡	74 (4.5)	612 (36.9)	738 (44.5)	233 (14.1)
I feel content‡	63 (3.8)	569 (34.3)	746 (45.0)	279 (16.8)
I am worried	283 (17.1)	1175 (70.9)	170 (10.3)	29 (1.8)
I feel confused	525 (31.7)	978 (59.0)	129 (7.8)	25 (1.5)
I feel steady‡	47 (2.8)	588 (35.5)	777 (46.9)	245 (14.8)
I feel pleasant‡	44 (2.7)	587 (35.4)	775 (46.8)	251 (15.2)
STAI S-Anxiety Summary Score Mean ± SD	41.4 ± 9.6 (min 20, max 80)			

*S-Anxiety = State Anxiety (Form Y-1).
†"Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best."(C. D. Spielberger, 2010, p.72)
‡Anxiety-absent items. Scoring weights for anxiety-absent items is reversed.

Summary STAI, S-Anxiety Scores Linear Regression Analyses

Univariate and multiple linear regression analyses were performed to assess associations between the summary STAI, S-Anxiety scores and each demographic and professional characteristic. The results of these analyses are presented in Table 4.

Table 4. State-Trait Anxiety Inventory for Adults (STAI), S-Anxiety* Score - Univariate and Multiple Linear Regression Analyses (n=1657)

	Univariate analysis		Multivariable analysis	
Characteristic	***Coeff.*** † ***(95% CI)***	***p-value***	***Coeff.*** † ***(95% CI)***	***p-value***
Age (Years)	-0.19 (-0.24, -0.14)	<0.001	-0.18 (-0.25, -0.12)	<0.001
Gender				
Female	Reference			
Male	-1.70 (-2.73, -0.68)	0.001	-0.33 (-1.48, 0.82)	0.572
Marital Status				
Married, Common-Law	Reference			
Single, Divorced, Widowed	1.11 (-0.16, 2.38)	0.087	-1.03 (-2.40, 0.33)	0.138
Highest Level of Education‡				
Junior College or Below	Reference			
Bachelor's Degree	1.54 (0.50, 2.58)	0.004	-0.06 (-1.25, 1.13)	0.922
Graduate Degree	1.18 (-0.30, 2.67)	0.118	-0.49 (-2.32, 1.34)	0.601
Practice Qualification				
Medical Doctor	Reference			
Registered Nurse	3.35 (2.34, 4.37)	<0.001	2.08 (0.74, 3.43)	0.002
Other (HCP and Not HCP)	0.01 (-1.27, 1.30)	0.987	0.44 (-1.44, 2.32)	0.648
HCP patient contact				
HCP with any patient contact	Reference			
HCP with NO patient contact	-2.56 (-3.65, -1.46)	<0.001	-0.77 (-2.18, 0.63)	0.280
Not HCP	-2.89 (-4.68, -1.11)	0.001	-1.92 (-4.67, 0.83)	0.172
Main Professional Category				
Public Health	Reference			
Clinical Medicine	1.27 (0.14, 2.40)	0.028		
Nursing	4.09 (2.92, 5.26)	<0.001		
Total Work Experience (Years)	-0.17 (-0.21, -0.12)	<0.001		
Type of Health Care Organization				
Tertiary Care Hospital	Reference			
Secondary Care Hospital	-1.46 (-2.81, -0.10)	0.035	-0.72 (-2.13, 0.70)	0.321
Primary Care Hospital/Township Health Centre	-3.61 (-4.94, -2.3)	<0.001	-3.20 (-4.68, -1.72)	<0.001
Neighbourhood Community Health Clinic	-4.32 (-6.70, -1.95)	<0.001	-3.08 (-5.60, -0.56)	0.017

Characteristic	Univariate analysis		Multivariable analysis	
	Coeff. [†] *(95% CI)*	*p-value*	*Coeff.* [†] *(95% CI)*	*p-value*
Other Health Service Agency	-3.74 (-5.02, -2.46)	<0.001	-2.37 (-3.87, -0.86)	0.002
Not Health Care Organization	-5.65 (-8.54, -2.75)	<0.001	-3.59 (-6.96, -0.22)	0.037
Department Worked in				
Internal Medicine	Reference			
Prevention and Education	-3.14 (-4.69, -1.60)	<0.001		
Traditional Chinese Medicine	0.46 (-3.08, 4.01)	0.797		
Pediatrics	-2.48 (-4.45, -0.50)	0.014		
Obstetrics and Gynaecology	-0.81 (-2.41, 0.79)	0.319		
Surgical	1.43 (-0.15, 3.02)	0.076		
Other[§]	-1.98 (-3.19, -0.76)	0.001		
Administrative Position Held				
No Administrative Position	Reference			
Vice/Head Registered Nurse	0.51 (-1.40, 2.41)	0.602	-0.69 (-2.75, 1.38)	0.513
Asst/Vice/Director of the Department	-1.57 (-2.85, -0.30)	0.016	0.67 (-0.74, 2.08)	0.349
Asst/Vice/Director of the Hospital/Centre	-1.77 (-3.04, -0.50)	0.006	0.95 (-0.83, 2.73)	0.297
Not Health Care Related	-4.28 (-9.71, 1.16)	0.123	-1.26 (-6.63, 4.11)	0.645
Working Status				
Full-time	Reference			
Not Full-Time[¶]	1.00 (-2.25, 4.26)	0.544		
Direct Involvement in Medical Response to COVID-19				
No	Reference			
Yes	-0.29 (-1.67, 1.08)	0.676		
Additional Health Care Services				
None	Reference			
Education	-3.83 (-8.87, 1.20)	0.136	-2.43 (-7.37, 2.51)	0.334
Epidemiology	-0.62 (-5.85, 4.60)	0.815	1.21 (-3.98, 6.41)	0.647
Health Care Services	-3.12 (-6.83, 0.59)	0.099	-1.93 (-5.68, 1.83)	0.314
Other[#]	-2.15 (-4.77, 0.47)	0.108	-0.91 (-3.50, 1.69)	0.494
Psychological Services Received During COVID-19				
No	Reference			
Yes	-0.67 (-2.27, 0.93)	0.412		

[*]S-Anxiety = State Anxiety (Form Y-1).
[†]Standardized beta coefficient.
[‡]Junior College and Below = Junior High School or Below/High School/Technical Secondary School/Skilled Worker's School, Bachelor's Degree = Bachelor's/Medical Doctor, Graduate Degree = Master/PhD.
[§]Includes a range of administrative, technical or operational areas as well as some health care services that fall under the category of a department.
[¶]Includes part-time, paid leave, and resignation/unemployment.
[#]Participants indicated that they provided additional health care services during COVID-19 but either did not provide specifics about the type of work they performed or if they did, were not health care services.

Demographic characteristics

In the univariate linear regression models, there was a significant decrease in STAI scores in males (β=-1.70, 95% CI -2.73 to -0.68, p=0.001) compared to females. Participants with a bachelor's degree had a significantly higher STAI score (β=1.54, 95% CI 0.50 to 2.58, p=0.004) compared to those with a junior college or below level of education. However, the significance did not remain in the multiple linear regression model for either of these variables.

In the multiple linear regression model, with every year increase in age, the mean summary STAI score decreased by 0.18 points (95% CI 0.12 to 0.25, p<0.001).

No other demographic characteristics were statistically significant in the univariate or multiple linear regression analyses.

Professional characteristics

In the univariate linear regression models, the mean STAI score of HCPs with direct patient contact was significantly higher compared to HCPs with no direct patient contact (β=-2.56, 95% CI -3.65 to -1.46, p<0.001) and non-HCPs (β=-2.89, 95% CI -4.68 to -1.11, p=0.001). However, the significance did not remain in the multiple linear regression model. Despite the lack of statistically significant difference between the levels of patient contact in the multiple linear regression model, there is a positive, linear trend in the increase of STAI scores as the level of patient exposure increases (β=1.87, 95% CI 1.13 to 2.61, p<0.001).

Participants that indicated nursing or clinical medicine as their main professional category had significantly higher STAI scores (β=4.09, 95% CI 2.92 to 5.26, p<0.001 and β=1.27, 95% CI 0.14 to 2.40 p=0.028, respectively) when compared to those that indicated public health as their main professional category in the univariate linear regression model.

To create a parsimonious multiple linear regression model, the variable *Main Professional Category (clinical medicine, nursing, public health)* was not included in the full model despite the statistical significance of some of the groups in the univariate linear regression model. Information obtained from the variable *Main Professional Category* was similar to information obtained from the *Practice Qualification (MD, RN, Other (HCPs and non-HCPs)* variable but more information could be gleaned from the practice qualification responses due to the "Other" option. A sensitivity analysis was performed at the end of the multiple linear regression analysis to ensure that leaving out the *Main Professional Category* variable did not change the results significantly. No statistically significant changes were found with the exclusion of the variable in the final model.

Similarly, although there were significant decreases in the mean STAI score among those who worked in some departments compared to others (Table 4), the variable *Department Worked in (internal medicine, surgical, obstetrics and gynaecology, pediatrics, Traditional Chinese Medicine, prevention and education, or other clinical departments (specify))* was not included in the multiple linear regression model. Information that could be gleaned from this variable was similar to information obtained from the variable *Institution Worked in (tertiary hospital, secondary hospital, township health centre/primary care hospital, neighbourhood community health clinic, other health services agency (option for open question response))*. Additionally, not all the participants worked in a department, whereas all participants worked in institutions.

Total work experience in years was also statistically significant in the univariate linear regression model (β=-0.17, 95% CI 0.21 to -0.12, p<0.001), however was not included in the multiple linear regression model due to collinearity with age (r=0.95). Age was included in the multiple linear regression model instead of total work experience in years due to its clinical and theoretical importance.

In the multiple linear regression model, working as a RN increased the mean STAI score by 2.08 points (95% CI 0.74 to 3.43, p=0.002) when compared to working as an MD.

Participants that worked in tertiary hospitals had increased STAI scores when compared to those working in primary hospitals/township health centres (β=-3.20, 95% CI -4.68 to -1.72, p<0.001), neighbourhood community health clinics (β=-3.08, 95% CI -5.60 to -0.56, p=0.017), other health services agencies (β=-2.37, 95% CI -3.87 to -0.86, p=0.002), and non-health care organizations (β=-3.59, 95% CI -6.96 to -0.22, p=0.037).

No other demographic characteristics were significant predictors of STAI scores. There was no effect modification by gender and practice qualification or levels of patient contact, which were analyzed based on previous research that suggested that females and nurses are at higher risk of anxiety symptoms during the COVID-19 pandemic (Muller et al., 2020; Pappa et al., 2020).

Generalized Anxiety Disorder 7-item (GAD-7) Scale

The summary GAD-7 scores ranged from 0 to 21, and the median score was 3 (IQR 0, 7). Categorization of scores was based on GAD-7 scoring guidelines in the screening tool (Spitzer et al., 2006). Just over half (n=987; 59.6%) of respondents had anxiety within the minimal range (GAD-7 score 0-4), 29.6% (n=491) had mild anxiety (GAD-7 score 5-9), 8% (n=132) had moderate anxiety (GAD-7 score 10-14), and 2.8% (n=47) had severe anxiety (GAD-7 score ≥15) (Table 5).

The prevalence of anxiety was determined using a case definition of Generalized Anxiety Disorder (GAD) based on a GAD-7 cut-off score of ≥10. A GAD-7 score of ≥10 is an indication for further mental health evaluation and has a sensitivity of 89% and a specificity of 82% for a diagnosis of Generalized Anxiety Disorder (GAD) as defined in the DSM-IV.[7] Based on this case definition, the prevalence of GAD in HCPs with direct patient contact was 12.1% compared to 7.4% in both HCPs with no direct patient contact and non-HCPs. GAD-7 score frequency and percentage by question, summary score, and cut-off points are presented in Table 5.

Table 5. Generalized Anxiety Disorder 7-item (GAD-7) Scale Score Frequency and Percentage by Question, Summary Score and Cut-Off Points (n = 1657)

GAD-7 Question	n (%)			
	0 Not at all sure	1 Several days	2 Over half the days	3 Nearly every day
Feeling nervous, anxious, or on edge	694 (41.9)	776 (46.8)	130 (7.9)	57 (3.4)
Not being able to stop or control worrying	955 (57.6)	549 (33.1)	113 (6.8)	40 (2.4)
Worrying too much about different things	695 (41.9)	733 (44.2)	174 (10.5)	55 (3.3)
Trouble relaxing	873 (52.7)	596 (36.0)	114 (6.9)	74 (4.5)
Being so restless that it's hard to sit still	1106 (66.8)	458 (27.6)	66 (4.0)	27 (1.6)
Becoming easily annoyed or irritable	709 (42.8)	763 (46.1)	122 (7.4)	63 (3.8)
Feeling afraid as if something awful might happen	1043 (63.0)	505 (30.5)	83 (5.0)	26 (1.6)

GAD-7 Summary Score	
Median (IQR)	3 (0, 7) (min 0, max 21)

GAD-7 categorized	**n**	**(%)**
Minimal anxiety (0-4)	987	(59.6)
Mild anxiety (5-9)	491	(29.6)
Moderate anxiety* (10-14)	132	(8.0)
Severe anxiety* (≥15)	47	(2.8)

*Scores ≥10 indicate clinically significant anxiety.

GAD-7 Scores ≥10 and Logistic Regression Analyses

Univariate and multiple logistic regression analyses were performed to explore associations between Generalized Anxiety Disorder (GAD), defined as summary GAD-7 scores ≥10, and each demographic and professional characteristic (Table 6).

Table 6. Generalized Anxiety Disorder (GAD) Outcome (Yes/No)* - Univariate and Multivariable Logistic Regression Analyses (n=1657)

Characteristic	n (%) had GAD	Univariate analysis		Multivariable analysis	
		OR[†] *(95% CI)*	*p-value*	*OR*[†] *(95% CI)*	*p-value*
Age (Years)		0.97 (0.95, 0.99)	0.001	0.97 (0.95, 0.99)	0.001
Gender					
Female	136 (11.4)	Reference			
Male	43 (9.3)	0.80 (0.59, 1.15)	0.231	0.86 (0.58, 1.30)	0.478
Marital Status					
Married, Common-Law	153 (10.9)	Reference			
Single, Divorced, Widowed	26 (10.0)	0.91 (0.59, 1.40)	0.666		
Highest Level of Education[‡]					
Junior College or Below	43 (8.6)	Reference			
Bachelor's Degree	115 (12.5)	1.51 (1.05, 2.19)	0.027		
Graduate Degree	21 (8.9)	1.04 (0.60, 1.80)	0.880		
Practice Qualification					
Medical Doctor	70 (8.9)	Reference			
Registered Nurse	78 (13.6)	1.62 (1.15, 2.28)	0.006		
Other (HCP and Not HCP)	26 (9.2)	1.04 (0.65, 1.66)	0.883		
HCP patient contact					
HCP with any patient contact	9 (7.4)	Reference			
HCP with NO patient contact	29 (7.4)	0.58 (0.38, 0.89)	0.012	0.59 (0.35, 1.00)	0.051
Not HCP	136 (12.1)	0.59 (0.29, 1.18)	0.137	0.35 (0.13, 0.90)	0.030
Main Professional Category					
Public Health	35 (7.7)	Reference			
Clinical Medicine	64 (10.0)	1.33 (0.87, 2.05)	0.192		
Nursing	79 (14.2)	1.97 (1.30, 3.00)	0.001		
Total Work Experience (Years)		0.97 (0.95, 0.99)	<0.001		
Type of Health Care Organization					
Tertiary Care Hospital	88 (11.8)	Reference			
Secondary Care Hospital	44 (17.7)	1.61 (1.08, 2.38)	0.018	1.75 (1.14, 2.67)	0.010
Primary Care Hospital/ Township Health Centre	18 (6.9)	0.55 (0.33, 0.94)	0.028	0.58 (0.34, 1.01)	0.054
Neighbourhood/Community Health Clinic	7 (10.6)	0.89 (0.39, 2.00)	0.776	1.20 (0.52, 2.78)	0.663
Other Health Service Agency	19 (6.6)	0.53 (0.31, 0.88)	0.015	0.68 (0.38, 1.22)	0.199
Not Health Care Organization	3 (7.0)	0.56 (0.17, 1.85)	0.344	1.07 (0.28, 4.10)	0.918

Characteristic	n (%) had GAD	Univariate analysis		Multivariable analysis	
		OR[†] *(95% CI)*	*p-value*	*OR*[†] *(95% CI)*	*p-value*
Department Worked in					
Internal Medicine	68 (12.9)	Reference			
Prevention and Education	12 (6.0)	0.43 (0.23, 0.81)	0.009		
Traditional Chinese Medicine	5 (17.2)	1.40 (0.52, 3.80)	0.505		
Pediatrics	8 (7.5)	0.54 (0.25, 1.17)	0.119		
Obstetrics and Gynaecology	27 (14.8)	1.17 (0.72, 1.90)	0.516		
Surgical	26 (13.9)	1.09 (0.67, 1.77)	0.735		
Other[§]	33 (7.8)	0.57 (0.37, 0.88)	0.011		
Administrative Position Held					
No Administrative Position	108 (11.0)	Reference			
Deputy/Head Registered Nurse	17 (15.9)	1.53 (0.88, 2.67)	0.132	1.31 (0.71, 2.40)	0.392
Asst/Vice/Director of the Department	21 (7.6)	0.67 (0.41, 1.09)	0.108	0.89 (0.52, 1.54)	0.684
Asst/Vice/Director of the Hospital/Centre	32 (11.6)	1.06 (0.70, 1.61)	0.787	1.98 (1.08, 3.61)	0.026
Not Health Care Related	1 (8.3)	0.74 (0.09, 5.77)	0.772	1.00 (0.12, 8.15)	0.998
Working Status					
Full-time	173 (10.7)	Reference			
Not Full-Time[¶]	6 (17.7)	1.80 (0.73, 4.40)	0.200		
Direct Involvement in Medical Response to COVID-19					
No	152 (10.5)	Reference			
Yes	27 (12.7)	1.23 (0.80, 1.91)	0.346		
Additional Health Care Services					
None	170 (11.0)	Reference			
Education	2 (14.3)	1.35 (0.30, 6.10)	0.694		
Epidemiology	2 (15.4)	1.48 (0.32, 6.71)	0.615		
Health Care Services	2 (7.7)	0.68 (0.16, 2.89)	0.598		
Other[#]	3 (5.7)	0.49 (0.15, 1.58)	0.231		
Psychological Services Received During COVID-19					
No	163 (10.8)	Reference			
Yes	16 (10.5)	0.97 (0.56, 1.67)	0.908		

[*]Dichotomized outcome. Yes (GAD-7 score ≥10) or No (GAD-7 score <10) Generalized Anxiety Disorder. Scores ≥10 indicate clinically significant anxiety due to high likelihood of Generalized Anxiety Disorder (GAD) diagnoses.
[†]OR=Odds Ratio of GAD.
[‡]Junior College and Below = Junior High School or Below/High School/Technical Secondary School/Skilled Worker's School, Bachelor's Degree = Bachelor/Medical Doctor, Graduate Degree = Master/PhD.
[§]Includes a range of administrative, technical, or operational areas as well as some health care services that fall under the category of a department.
[¶]Includes part-time, paid leave, and resignation/unemployment.
[#]Participants indicated that they provided additional health care services during COVID-19 but either did not provide specifics about the type of work they performed or if they did, were not health care services.

Demographic characteristics

In univariate logistic regression models, respondents with a bachelor's degree had higher odds of GAD (OR 1.51, 95% CI 1.05 to 2.19, p=0.027) compared to those with a junior college or below level of education. However, the significance did not remain in the multiple logistic regression model.

In the multiple logistic regression model, for every year increase in age, the estimated odds of GAD were reduced by 3% (OR 0.97, 95% CI 0.95 to 0.99, p=0.001).

No other demographic characteristics were statistically significant in the univariate or multiple logistic regression analyses. There was no effect modification by gender and practice qualification, which was analyzed based on previous research that suggested that females and nurses are at higher risk of anxiety symptoms during the COVID-19 pandemic (Muller et al., 2020; Pappa et al., 2020).

Professional characteristics

In the univariate logistic regression models, being an RN increased the odds of GAD (OR 1.62, 95% CI 1.15 to 2.28, p=0.006) compared to MDs, however the significance did not remain in the multiple logistic regression model. Although statistically significant in the univariate logistic regression model, the variables *Main Professional Category (clinical medicine, nursing, public health)*, *Total Years Worked* and *Department Worked in (internal medicine, surgical, obstetrics and gynaecology, pediatrics, Traditional Chinese Medicine, prevention and education, or other clinical departments (specify))* were not included in the full logistic regression model for the same reasons mentioned above in building the linear regression model for the STAI measure.

In the multiple logistic regression model, the odds of having GAD was higher in HCPs with direct patient contact compared to non-HCPs (OR=0.35, 95% CI 0.13 to 0.90, p=0.030). The odds of GAD was also higher in those that worked in secondary hospitals (OR=1.75, 95% CI 1.14 to 2.67, p=0.010) compared to working in tertiary hospitals. Lastly,

participants that held an administrative position in a hospital or health care institution had a higher odds of GAD (OR=1.98, 95% CI 1.08 to 3.61, p=0.026) compared to those that held no administrative position.

There is a positive, linear trend in the increase of GAD-7 summary scores as the level of patient exposure (not HCP, HCP no direct patient contact, HCP direct patient contact) increases (OR=1.42, 95% CI 1.20 to 1.68, p<0.001). No other professional characteristics were significant predictors of GAD.

Correlation of Summary S-Anxiety STAI scores and Summary GAD-7 scores

Although the STAI and GAD-7 measure different constructs of anxiety, we found a strong, positive, linear relationship between the two measures in our study (r=0.69). Other authors have also found a strong correlation between the STAI and GAD-7 (r=0.74) (Doi et al., 2018). The high correlation of the two measures indicates that both tools are providing similar information about the relationships between outcomes and predictors. Therefore, we can be more confident in the findings.

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Chapter 5: Discussion

This study is part of an ongoing research project that is measuring state anxiety and Generalized Anxiety Disorder (GAD) symptoms among health care professionals during and after the COVID-19 pandemic in Anhui, China. It establishes the prevalence of state anxiety and GAD in this population during the pandemic, as well as identifies predictors of these types of anxiety that can be used to inform interventions, programs and future studies. It is important to note that there are several different types of anxiety and anxiety disorders that may have been present in this population that were not captured in our study.

A literature review on anxiety in health care professionals working during the early period of the COVID-19 pandemic provided insight into the effects of the crisis as well as gaps in the literature. This study contributed to and supported existing knowledge on the mental health effects of working during the COVID-19 crisis in health care professionals.

In our study, we did not find a statistically significant difference in state anxiety or GAD by gender. The mean STAI score for females was 41.9 (9.6) compared to 40.2 (9.3) for males. The percentage of GAD was higher in females 11.4% (n=136) compared to 9.3% (n=43) in males. Results from other cross-sectional studies have been mixed regarding whether gender is a risk factor for anxiety. A cross-sectional study of HCPs working in China during the COVID-19 pandemic found females had a higher risk of anxiety (OR 1.69, 95% CI 1.23 to 2.33, p=0.001) compared to males (Lai et al., 2020). Another study of HCPs working in China around the same time, reported that anxiety was higher in female frontline HCPs (OR 2.70, 95% CI 0.99 to 7.37, $p \geq 0.05$) compared to male frontline HCPs but that the result was not statistically significant (Du et al., 2020). When results from six cross-sectional studies of HCPs working in China during the COVID-19 pandemic were pooled in a meta-analysis, there was a pooled prevalence of anxiety among male HCPs of 20.9% (95% CI 11.86 to 31.65; I^2 98%) compared to 29.1% (95% CI 20.21 to 38.78; I^2 99%) among female HCPs (Pappa et al., 2020). The differences in findings may be due in part to the

timing of data collection, the region of China they were collected from, and the supports available to HCPs at the time. Future meta-analysis of study results may clarify whether or not female gender is clearly a risk factor for anxiety in HCPs working during the COVID-19 pandemic in China.

Although not a significant predictor of state anxiety in our study, there is a positive, linear trend in the increase of STAI S-Anxiety scores as the level of exposure to patients increases. Other studies have found similar trends in anxiety levels based on level of contact with patients during the COVID-19 pandemic (da Silva Neto, 2021; Lu et al., 2020). Lu et al. found that anxiety was higher in groups of health care professionals at high probability of patient contact compared to health care professionals at low probability of patient contact and to non-health care professionals (Lu et al., 2020). A systematic review and meta-analysis by da Silva Neto et al. found that anxiety was significantly higher in health care professionals when compared to professionals from other areas (da Silva Neto, 2021). This finding is likely due to the increased risk of contracting COVID-19 while working directly with patients as a health care professional and the potential implications of becoming infected with the virus (Muller et al., 2020).

In our study, the mean STAI S-Anxiety summary score in HCPs with direct involvement in the medical response to COVID-19 (including treatment and nursing) was not significantly different than those that did not have direct involvement in the medical response to COVID-19. This contrasts with findings by Lai et al. who reported that the odds of anxiety were higher in HCPs with direct contact with patients that had or were suspected of having a COVID-19 infection (OR 1.57; 95% CI 1.22 to 2.02; $p<0.001$) compared to HCPs that were not (Lai et al., 2020). Another study by Liu et al., also found a higher risk of anxiety among HCPs with direct contact with patients with COVID-19 infection using the Zung Self-Assessment Anxiety Scale (SAS) (β=2.33, 95% CI 0.65 to 4.00, p=0.0068), compared to HCPs with no direct contact.

Our findings of no significant difference between the two groups may be due to the different timing of data collection and regions from where the data was collected. Lai et al. surveyed more health care professionals from Wuhan/Hubei province (n=1210; 81.3%) than from other regions due to the severity of the outbreak in the area at that time (Lai et al., 2020). Only 14.3% (n=73) of participants in the Liu et al. (Liu et al., 2020) study were from Hubei province, China. However, HCPs in Hubei province were found to have a higher risk of anxiety (β=3.71, 95% CI 1.53 to 5.90, p=0.0009) than HCPs outside of Hubei (Liu et al., 2020). Further, the survey responses in the Lai et al. and Liu et al. studies were collected during the first wave of COVID-19 in China between January 29 to February 3, 2020 (Leung et al., 2020; Xu et al., 2020). Our survey data was collected in June 2020 which was not during or immediately after the COVID-19 outbreak period in the region.

To our knowledge, there is no normative comparison group for health care professionals in the STAI manual or a validated cut-off score for this population against which to compare our results (C. D. Spielberger, 2010). Studies conducted on state anxiety in health care professionals in non-pandemic times as well as during other outbreaks can be used for broad comparison. A study on a mindfulness intervention for nurses working in AIDS care in Changsha, Hunan province, China in non-pandemic times (2019) reported a baseline mean STAI S-Anxiety summary score of 43.4 (SE 11.9) and a post-intervention summary score of 39.3 (SE 10.3) (Pan et al., 2019). During the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak in Hong Kong, mean STAI S-Anxiety summary scores were 52.9 (SD 8.6) for health care assistants, 52.0 (SD 9.8) for nurses, 47.8 (SD 9.8) for doctors, 47.8 (SD 10.9) for allied health care professionals, 47.8 (SD 9.8) for technicians, and 47.1 (SD 10.6) for administrative staff (Poon et al., 2004). The mean STAI S-Anxiety summary scores by professional qualification in our sample were 40.2 (SD 9.0) for medical doctors, 43.6 (SD 9.7) for nurses, and 40.2 (SD 10.1) for the "Other" category which included allied health care professionals and non-health care professionals. Using these studies as comparisons, the mean STAI S-Anxiety summary scores in nurses in our

study were comparable to nurses working in AIDS care prior to the mindfulness intervention to reduce their anxiety, and higher than the post-intervention scores. The mean STAI S-Anxiety summary scores in our study were lower than those measured during the 2003 SARS outbreak across all categories of health care professionals.

Predictors of State Anxiety

Risk factors for state anxiety in our study included working as a nurse (β=2.08, 95% CI 0.74 to 3.43, p=0.002) compared to working as a medical doctor. Working in tertiary hospitals also carries a higher risk for anxiety as compared to working in primary hospitals/township health centres (β=-3.20, 95% CI -4.68 to -1.72, p<0.001), neighbourhood community health clinics (β=-3.08, -5.60 to -0.56, p=0.017), other health services agencies (β=-2.37, -3.87 to -0.86, p=0.002), and non-health care organizations (β=-3.59, 95% CI -6.96 to -0.22, p=0.037).

Other researchers have also found working as a nurse to be a risk factor for anxiety during the COVID-19 outbreak (Guo et al., 2021; Lin et al., 2020; Pappa et al., 2020). Some authors have argued that this finding is potentially confounded by female gender. Anxiety among females is generally higher than anxiety among males and nurses are primarily female (Lai et al., 2020; Pappa et al., 2020). There is the potential for similar confounding in our sample. In our study, the breakdown of gender by practice qualification was Medical Doctor: female/male n=445/342 (56.5/43.5%); RN: 564/8 (98.6/1.4%); and "Other": 178/105 (62.9/37.1%). When checked for effect modification of STAI S-Anxiety summary scores by gender and practice qualification, no significant differences were found between the groups.

Although we were unable to assess in our study whether the increased risk for anxiety in nurses was due to female gender, we were able to look at anxiety in health care professionals by level of patient contact, which had a more balanced ratio of genders between the groups. The breakdown of gender by patient contact group was HCPs with

direct patient contact: female/male n=863/266 (76.4/23.6%); HCPs with no patient contact: 248/144 (63.3/36.7%); and non-HCPs: 76/45 (62.8/37.2%). When analyzed from this perspective, it appears that the level of patient contact, and not gender, is the risk factor for anxiety. We stratified levels of patient contact by gender to check for effect modification of STAI S-Anxiety summary scores based on level of patient contact. No significant differences were found between the groups.

In our study we found a higher risk of anxiety among health care professionals working in tertiary hospitals compared to lower-level health care facilities. This finding has also been reported in other studies and is likely due to tertiary sites receiving the most critical and high risk COVID-19 cases (da Silva Neto, 2021; Hasan et al., 2020; Lu et al., 2020).

In our study, the median years of work experience was 15 (IQR 7, 25). Increased age was associated with a reduced risk of state anxiety in our sample (β=-0.18, 95% CI -0.25 to -0.12, p<0.001). Findings in the literature of the effect of age on anxiety in health care professionals is mixed. da Silva Neto et al. found that anxiety was higher in younger medical teams (<30 years of age) when compared to older medical teams, but the difference was not statistically significant (da Silva Neto, 2021). Similar to the results in our study, Guo et al. found a decreased risk of anxiety with increased age among hospital staff during the current COVID-19 pandemic. Further, a study on STAI S-Anxiety in nurses in non-pandemic times also reported a decreased risk of anxiety as age increased (Turnipseed, 1998).

Age is potentially confounded by years of work experience and both variables could be viewed as proxies for each other (Turnipseed, 1998). In our study, there was a high correlation between age and years of work experience (r=0.95). For this reason (i.e. multicollinearity between these two variables), years of work experience was left out of the multiple linear and logistic regression models.

Turnipseed et al. have theorized that health care professionals with more work experience may have more developed coping strategies in stressful situations than those with less work experience (Turnipseed, 1998). This is a plausible explanation for our study population, given that some of the health care professionals in our sample could have also worked during the SARS outbreak in China in 2003 (CIEC, n.d.; Guo et al., 2021).

Prevalence of Generalized Anxiety Disorder

The prevalence of GAD in our population was almost 5% higher in HCPs with direct patient contact compared to HCPs with no direct patient contact and to non-HCPs. The prevalence of anxiety among health care professionals in our study is both lower and higher than the prevalence reported in other studies (Luo et al., 2020; Muller et al., 2020; Pappa et al., 2020; Preti et al., 2020). This could be due to the different case definitions and tools used to assess anxiety between the studies as well as due to different contextual factors affecting the study populations such as location, point in time anxiety was assessed in the pandemic, and demographic and professional characteristics. For example, in a systematic review and meta-analysis by Pappa et al., four studies used the GAD-7 tool to measure the prevalence of anxiety among HCPs during the COVID-19 pandemic. However, all of the studies used a lower cut-off value for their case definitions of anxiety than ≥10 (i.e. ≥5, ≥8 and ≥9) (Pappa et al., 2020). The decision to use a GAD-7 cut-off score of ≥10 in our study was based on ability of the tool to identify those with a potential diagnosis of GAD, as defined in the DSM-IV, with 89% sensitivity and 82% specificity using this cut-off score (Spitzer et al., 2006).

Predictors of Generalized Anxiety Disorder

Predictors of GAD included working as HCPs with direct patient contact compared to non-HCPs (OR=0.35, 95% CI 0.13 to 0.90, p=0.030), working in secondary hospitals (OR=1.75, 95% CI 1.14 to 2.67, p=0.010) compared to tertiary hospitals, and holding an

administrative position in a hospital or health care institution (OR=1.98, 95% CI 1.08 to 3.61, p=0.026) compared to not holding an administrative position. There is a positive, linear trend in the increase of GAD summary scores as the level of exposure to patients increases. As mentioned above, other researchers have also found that the risk for anxiety increases as the level of exposure to patients increases (da Silva Neto, 2021; Lu et al., 2020).

Our finding that working in a secondary hospital compared to a tertiary hospital increased the odds of GAD is in line with findings from a study by Lai et al. (Lai et al., 2020) and contrasts the findings of some others (Cabarkapa et al., 2020; Hasan et al., 2020; Lu et al., 2020). Lai et al. reported more severe anxiety symptoms (OR=1.43, 95% CI 1.08 to 1.90, p=0.01) among HCPs working in secondary hospitals compared to HCPs working in tertiary hospitals. It is unclear why the odds of GAD was higher in HCPs in secondary hospitals compared to tertiary hospitals in our sample. It may be due in part to the differences between how the tools assess anxiety. STAI S-Anxiety questions reflect how a person is feeling in that moment or the present (C. D. Spielberger, 2010), while GAD-7 questions reflect bothersome anxiety symptoms in the previous two weeks (Spitzer et al., 2006). It is possible that there was an anxiety provoking event that occurred in a secondary hospital in the two weeks prior to the surveys being completed that was responsible for the significant difference between the two levels of care in our sample. Perhaps resources were also being diverted into tertiary hospitals leaving fewer supports in secondary hospitals.

Lastly, the increased odds of anxiety among those that hold an administrative position in a hospital or health care institution during the COVID-19 pandemic, compared to those that do not, is understandable due to the extreme pressures put on health care systems and health care professionals during this time (Muller et al., 2020; Pappa et al., 2020; Preti et al., 2020). It is important to note that in our study this variable represented administrators in management roles in the health care system, including assistant/vice-directors/directors of a hospital/centre, assistant/vice-directors/directors of a department,

and vice-head/head registered nurses. In a study by Graf-Vlachy et al. on predictors of managers' mental health during the COVID-19 pandemic, the authors found that 9.3% of managers had symptoms of moderate to severe generalized anxiety (Graf-Vlachy et al., 2020). This study represented 646 managers from 49 different countries.

Finally, increased age was associated with a reduced odds of GAD (OR=0.97, 95% CI 0.95 to 0.99, p=0.001). As mentioned above, findings are mixed about whether age is a risk factor for anxiety and may be confounded by years worked.

Correlation of Summary S-Anxiety STAI scores and Summary GAD-7 scores

Although the STAI S-Anxiety and GAD-7 surveys measure different constructs of anxiety (C. D. Spielberger, 2010; Spitzer et al., 2006), and did not identify exactly the same predictors in our study, we found a strong, positive, linear relationship between the two measures (r=0.69). The decision to use two different tools in our study was made to capture both state anxiety and generalized anxiety disorder (GAD) in the study population. The tools measure anxiety in the previous two weeks (GAD-7) and in the present (STAI S-Anxiety) which was important for capturing anxiety levels during the COVID-19 pandemic. Other researchers have also found a high correlation between the two tools (Doi et al., 2018). The strong, positive, linear relationship between the two measures in our study suggests that we have used tools that have captured some of the complex relationship between anxiety and predictors in health care professionals working during the COVID-19 pandemic in Anhui.

Recommendations

Our findings suggest that in this population of health care professionals, it would be useful to focus mental health support efforts on HCPs with direct patient contact during the ongoing pandemic and in future outbreaks, regardless of their professional role. While HCPs with direct patient contact was a risk factor for anxiety regardless of professional role,

nurses and health care professionals working in tertiary and secondary hospitals were at increased risk of anxiety compared to medical doctors and those working in all other health care facilities. Therefore, these subgroups of HCPs with direct patient contact may warrant specific attention. Further, there is an increased risk of anxiety among managers compared to workers that are not in management roles. Therefore, mental health support efforts would likely benefit managers as well.

The survey questions in our study identified a small number of predictors for anxiety in health care professionals working during the COVID-19 outbreak in Anhui (STAI S-Anxiety Adj R^2 0.07%). Future studies may benefit from looking at potential predictors other than the ones in our study or predictors that are already well supported in the literature. For example, determinants such as pre-existing or prior mental health issues, social support, and employment/income precarity. There were considerably fewer qualitative studies done than quantitative studies when the literature search for this study was performed. More qualitative research on the reasons behind anxiety among health care professionals could provide insight into other predictors that have not yet been explored quantitatively.

There were several scoping and systematic reviews on anxiety among health care professionals during COVID-19 that had been published when the literature search for this study was performed. However, there were limited longitudinal and meta-analyses studies. More longitudinal and meta-analyses studies would better inform our understanding of anxiety among health care professionals during the COVID-19 pandemic and direct future research.

Lastly, finding ways to support the mental health of health care professionals throughout and after the pandemic may lead to more resilient clinicians and in turn, more resilient health care systems in the future. Policy implications could include making accessible individual level resources and supports for HCPs based on identified risk factors. It could also involve health system level changes to support HCPs vulnerable to anxiety and

an ongoing investment into longitudinal research of HCPs mental health in both pandemic and non-pandemic times.

Strengths and Limitations

Strengths

The study had a large sample size which reduces random errors. The data set had minimal errors. Comparisons between groups were possible within the sample. Level of patient contact among health care professionals as well as their direct involvement in the medical response to COVID-19 (including treatment and nursing) could be examined.

This study has identified regionally relevant predictors of anxiety in health care professionals in Anhui, including potentially overlooked subgroups such as HCPs in secondary care hospitals and managers. Regionally specific information can facilitate a targeted and potentially more effective management approach to supporting the mental health of health care professionals in Anhui during the current and future health crises.

Limitations

The data available for this study was collected for one time point. A cross-sectional design can identify the prevalence of an outcome and be used to generate hypotheses however, it cannot be used to confidently conclude associations between an exposure and an outcome (Celentano & Szklo, 2019).

Without pre-COVID-19 data on S-Anxiety and GAD in this specific population, we do not have a direct comparison group to analyze differences in the prevalence of anxiety in HCPs in Anhui before and during the COVID-19 pandemic. Therefore, we cannot conclude that working as HCPs during the COVID-19 pandemic has increased S-Anxiety or GAD in this population, only that anxiety is increased among HCPs with direct patient contact when

compared to HCPs with no direct patient contact and to non-HCPs during the COVID-19 pandemic.

This study may be affected by selection bias. Participants were recruited using online convenience sampling. While "WeChat" is a very common form of communication among health care professionals in China (D. Wang et al., 2020), there is the potential that some health care professionals did not receive the invitation to participate that would have fallen into the study recruitment demographic. Given that the data was collected five months into the pandemic, it is possible that there were already health care professionals that were on leave due to the psychosocial challenges presented by working during the COVID-19 pandemic. Further, of the 1657 study participants, only 213 reported that they were directly involved in the medical response to COVID-19, including treatment and nursing. If HCPs did not participate in the study because they were already having difficulty coping due to their professional responsibilities during the COVID-19 pandemic, bias would be introduced into the study and an underestimation of the prevalence of anxiety in the study population could occur.

Lastly, regionally specific results can limit the generalizability of the study results to other populations.

Conclusion

Health care professionals in Anhui province of China are at increased risk for anxiety during the COVID-19 pandemic. There is a need for more research on anxiety among health care professionals during the pandemic, including longitudinal studies and meta-analyses. The results of this study can be used to inform interventions, programs and future studies to support the mental health of health care professionals.

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Appendix A: Recruitment message to health care professionals in Anhui province, China through *WeChat*

English version

"If you are a health care worker, we are researchers interested in learning about the impact that COVID-19 has had on your psychosocial health. Please click on the link to fill out this 20 to 30-minute survey."

Appendix B: Demographic questions for health care professionals

1. What is your age?
    - Open question response
2. What is your gender?
    - Male
    - Female
3. Which city in Anhui province do you currently reside?
    - Open question response
4. What is your current marital status?
    - Never married
    - Currently married
    - Cohabitating
    - Separated/divorced
    - Widowed
5. What is the highest level of education you have completed?
    - Junior high school and below
    - High school
    - Skilled worker's school
    - Technical secondary school
    - Junior college
    - Bachelor
    - Master
    - PhD
    - Medical doctor
6. What is your practice qualification?
    - Practicing physician
    - Assistant practicing physician
    - Traditional Chinese Medicine doctor
    - Assistant practicing doctor of Traditional Chinese Medicine
    - Registered nurse
    - Midwife
    - Others (specify) (open question response)
7. What is your main professional category?
    - Clinical medicine
    - Nursing
    - Public health
8. What are your total years of work experience?
    - Open question response
9. What type of health care organization do you work in?
    - Tertiary Care Hospital
    - Secondary Care Hospital
    - Township Health Centre/Primary Care Hospital
    - Neighbourhood Community Health Clinic
    - Other Health Services Agency (option for open question response)

10. Which department do you work in?
    - Internal Medicine
    - Surgical
    - Obstetrics and Gynaecology
    - Pediatrics
    - Traditional Chinese Medicine
    - Prevention and Education
    - Other clinical departments (specify) (open question response)
11. What administrative position do you hold?
    - Director of the Hospital/Center
    - Vice-Director of the Hospital/Center
    - Director of Department
    - Vice-Director of Department
    - Head Nurse
    - No administrative position
    - Other administrative position (specify) (open question response)
12. What is your current working status?
    - Part-time
    - Full-time
    - On leave
    - Resigned/Unemployed
13. Were you directly involved in the medical response to COVID-19? (including treatment and nursing)
    - Yes
    - No
14. Did you provide additional heath care services during the epidemic (services other than direct COVID-19 response)? If yes, what services did you provide? (specify) (open question response)
    - Yes
    - No
15. Did you receive psychological services during the COVID-19 outbreak?
    - Yes
    - No
16. Please provide your email or telephone number if you would like to participate in an interview
    - Open question response

Appendix C: Generalized Anxiety Disorder 7-item (GAD-7) Scale and Scoring Guide

Over the last 2 weeks, how often have you been bothered by the following problems?	Not at all sure	Several days	Over half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it's hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3
Add the score for each column	+	+	+	
Total Score *(add your column scores)* =				

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all _____
Somewhat difficult _____
Very difficult _____
Extremely difficult _____

Scoring

Scores of 5, 10, and 15 are taken as the cut-off points for mild, moderate and severe anxiety, respectively. When used as a screening tool, further evaluation is recommended when the score is 10 or greater.

Using the threshold score of 10, the GAD-7 has a sensitivity of 89% and a specificity of 82% for GAD. It is moderately good at screening three other common anxiety disorders - panic disorder (sensitivity 74%, specificity 81%), social anxiety disorder (sensitivity 72%, specificity 80%) and post-traumatic stress disorder (sensitivity 66%, specificity 81%).

Source: Spitzer RL, Kroenke K, Williams JBW, Lowe B. A brief measure for assessing generalized anxiety disorder. *Arch Intern Med.* 2006;166:1092-1097.

Appendix D: State-Trait Anxiety Inventory for Adults (Form Y - 1/S-Anxiety)

SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1
Please provide the following information:

Name_____Date_____S_____

Age_____ Gender (*Circle*) **M** **F** T_____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

Appendix E: State-Trait Anxiety Inventory for Adults Scoring Key (Form Y-1/S-Anxiety)

Form Y-1	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1.	4	3	2	1
2.	4	3	2	1
3.	1	2	3	4
4.	1	2	3	4
5.	4	3	2	1
6.	1	2	3	4
7.	1	2	3	4
8.	4	3	2	1
9.	1	2	3	4
10.	4	3	2	1
11.	4	3	2	1
12.	1	2	3	4
13.	1	2	3	4
14.	1	2	3	4
15.	4	3	2	1
16.	4	3	2	1
17.	1	2	3	4
18.	1	2	3	4
19.	4	3	2	1
20.	4	3	2	1