UNIVERSITY OF THE WITWATERSRAND

FACULTY OF HEALTH SCEINCES

SCHOOL OF PUBLIC HEALTH

Title: The Relationship between Mental Health and Work Stress in Healthcare Workers during COVID-19 in Gauteng, South Africa (2020)

Name: Themba Archiford Butao

Student number: 1385032

A research report submitted to the faculty of Health sciences,
University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements of Master of Science (MSc) degree in Epidemiology and Biostatistics.

Supervisor: Dr. Kerry Wilson, National Institute of Occupational Health

June 2023

Dedication

This MSc Epidemiology (Epidemiology and Biostatistics) degree is dedicated to my wife, mother and late parents who have motivated me and have always believed in me. To my daughter, Chipochashe, you give me hope when I have felt hopeless.

Abstract

Background: Research into the 2003 severe acute respiratory syndrome (SARS) outbreak in Toronto, by Maunder et al (2006), revealed that health care workers (HCWs) experienced high "levels of burnout ($p=0.019$), psychological distress ($p<0.001$) and posttraumatic stress ($p<0.001$)" compared to HCWs that were working in Hamilton at hospitals that were not treating SARS infected patients. In June 2012, the Middle East Respiratory syndrome (MERS) had high nosocomial transmissions, and this led to increased distress among HCWs. Coronavirus Disease 2019 (COVID-19) is the most recent global pandemic, and it is has led to a negative impact on the healthcare sector and its employees. The impact of pandemics such as COVID-19 on the mental health of HCWs in low-middle income countries like South Africa is not fully known. Previous studies have shown that low-middle income countries, such as South Africa experience higher stress and burnout levels due to their limited resources such as access to personal protective equipment. High stress during patient care in high income countries has resulted in HCWs experiencing fear, exhaustion and stress in the past.

Aim: To investigate the relationship between work stress and mental health in HCWs working in public hospitals and CHCs during COVID-19 in Gauteng in 2020.

Methods: The study was a cross-sectional study using secondary data from a longitudinal study that was conducted in Gauteng, South Africa in 2020. The primary study was conducted by sending a questionnaire to HCWs working in large hospitals and some clinics in Gauteng, South Africa in 2020. The questionnaire consisted of the General Health Questionnaire-12 (GHQ-12), Job-Related Tension Index (JRTI) and COVID-19 related questions. A sample size of 223 was required for the study and was analysed using STATA® 16 software. Regression analysis was conducted to analyse the different relationships and odds ratios were obtained at the end of the study.

Results: A total of 336 HCWs participated from 6 facilities. Of the occupations that could be identified, Professional nurses made up the highest percentage of HCWs (19.11%). A majority 55.22% and 54.33% of HCWs experienced mental distress and work stress respectively. The prevalence of both mental health disorders and work stress in HCWs in Gauteng during the COVID-19 pandemic was 39.10%. The odds of developing mental health disorders among HCWs who were experiencing work-stress in Gauteng, 2020, were 7.51

times the odds of developing mental health disorders among HCWs not experiencing work-stress in Gauteng, 2020 (p <.001, CI: 2.99, 18.85). The study also showed that a unit increase in the JRTI score was associated with a 19% increase in the GHQ-12 score (p < .001, CI: 0.14, 0.25).

Discussion and conclusion: Work-stress significantly affected mental health among HCWs working in public hospitals and community health centres (CHCs) in Gauteng during the early COVID-19 pandemic. The study also shows that pandemics such as the COVID-19 pandemic can lead to a high proportion of work-stress as well as mental health disorders in HCWs. Negative perceptions of risk during COVID-19 also played a significant role in the work stress and the mental wellbeing of HCWs.

Recommendations: Decision makers at the district and provincial level should aim to provide constant counselling services even during periods of less work-stress. Sufficient outbreak response training should be provided as part of HCWs Continual Professional Development (CPD) courses so that there is better readiness for future pandemics. There should permanent policy changes that reduce the number of hours worked by HCWs, and more effort staff retention in the public sector as this is what majority of the country uses for seeking healthcare services. Smaller healthcare facilities should also be better equipped with not just only professional HCWs but equipment, including training and storage of such equipment, and regularly checked as preparation for future outbreaks.

Acknowledgements

I would like to acknowledge the assistance of my Supervisor, Dr. Kerry Wilson *Epidemiologist at National Institute for Occupational Health South Africa*. Thank you for the excellent support and advice throughout this research.

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Nomenclature / definitions

1. Burnout: physical, emotional or motivational exhaustion that may be as a result of prolonged frustration or stress. (61)
2. Stress: mental or bodily tension that may be as a result of factors that may have altered an existing balance. (62)
3. Work-related stress: this is a response that people may have when work demands and pressures are not aligned to the knowledge and skills they possess, and may lead to an inability to cope with work. (63)
4. Mental health: “the general condition of one’s mental and emotional state”. (64)
5. Mental well-being: this can be defined as thriving in different aspects of life, e.g. relationships and work, despite there being ups and downs in life. (65)

Chapter 1: Introduction

The COVID-19 pandemic for most South African healthcare professionals that had not encountered a healthcare crisis of this nature was thought to have provided a challenging and stressful work environment. Healthcare professionals from better resourced countries had in the past experienced similar epidemics, and these experiences may have strengthened their response to the outbreak. In this chapter, the background of the COVID-19 pandemic globally and in South Africa will be discussed. The literature review will show an in-depth analysis of historical pandemics and COVID-19, and how these have had an impact on healthcare worker mental health as well as work stress.

Background

Coronavirus disease 2019 (COVID-19) can be regarded as one of the worst pandemics the world has experienced (5). The last pandemic to have had such a massive impact on the globe can be dated back to the 1918 "Spanish Flu" that led to approximately 500 million people being infected and an estimated 50 million people dying after infection (6). COVID-19 is the most virulent atypical pneumonia outbreak since the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003 (7). The Middle-East Respiratory Syndrome (MERS) (5) and the Ebola virus (8) are some examples of outbreaks that have also affected regions of the world and have led to negative outcomes on the healthcare sectors of the affected countries.

COVID-19 globally

Data available on the 14th of June 2022, shows that COVID-19 has infected over 500 million people globally and has led to over 6 million confirmed deaths. COVID-19 is caused by a coronavirus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2); the first cases were identified in the Hubei province of China in December 2019 (9). COVID-19 infected individuals usually develop an upper respiratory tract infection accompanied by a high fever, dyspnoea and a dry cough (10). Those with severe COVID-19 symptoms often require hospitalisation, and in some cases, they require oxygen support through the use of ventilators. COVID-19 exhibited high transmission rates and quickly spread from China to neighbouring Asian countries as well as countries in the global west (9). On the 30th of

January 2020, the World Health Organization's emergency committee declared COVID-19 a global health emergency of international concern (11).

COVID-19 had many scientists and healthcare professionals around the globe worried as it posed a similar threat as the "Spanish Flu", there were no known treatments for it and no vaccines existed to help lower infections (9). China's response was to stop the spread of the COVID-19 virus by putting in place lock down measures. China first initiated stringent lockdown measures in the Hubei province on the 23rd of January 2020 (12). These measures imposed restrictions on movement and social gatherings thus putting a massive strain on the daily activities of the people living in the Hubei province. In Europe, Italy saw a rise in cases and had its first death on the 21st of February 2020 (12). On the 11th of March, the WHO declared COVID-19 a pandemic as cases started to rise all over Europe and in the United States (12).

Italy experienced a high mortality rate in the early stages of the pandemic, reporting 919 daily deaths by the 27th of March which at the time was higher than most affected countries (12). As the virus spread throughout Italy, the healthcare system observed low capabilities in coping with the rapid increase in cases and deaths (12). This became a common issue in many countries as healthcare systems became overwhelmed with infections. European governments instituted restrictive measures that were meant to lower transmission, although some countries such as England were slow to implement these measures (12). The lockdown measures were also adopted in other parts of the world including South Africa as cases rose.

COVID-19 in South Africa (2020)

On the 5th of March 2020 South Africa experienced its first COVID-19 case in Kwazulu-Natal; patient zero had flown into the country from Italy which at that time was experiencing high infection rates (13). In South Africa, efforts aimed at reducing the transmission of the virus and lowering the cases, popularly known as "flattening the curve", became common terminology among the scientific community as the South African government resorted to a hard lockdown that was aimed at restricting movement into the country and within the country thus lowering contact between individuals (12). The lockdown measures in South Africa were viewed as the strictest on the continent as "non-essential" services were closed

and people were only allowed to go out of their homes for essential services (13). Essential services included, but were not limited to, health care workers, pharmacy workers and food retail, production and transport staff (13). This group of workers was therefore in the frontline of the battle against the pandemic.

Intensive Care (ICU) capacity was an issue not only in South Africa, but worldwide and initial projections showed that the South African public sector would encounter a shortage of ICU beds (14). Lockdown measures were implemented to slow down the spread of infections as the health care system was deemed to be ill-equipped to handle a massive influx of infected patients seeking admission into ICU wards (14). In Gauteng, South Africa, the provincial government was under the impression that the peak of the pandemic in 2020 would produce a higher number of infections than their bed capacity (15). This assessment was made after the initial modelling, and led to the provincial government repurposing some hospital wards to create extra beds specifically for COVID-19 infected patients and the creation of a field hospital (15). Figure 1 illustrates the different waves of infection South Africa went through in 2020 with daily cases being at their lowest in the first couple of months (March to May) then the first big wave of infections began.

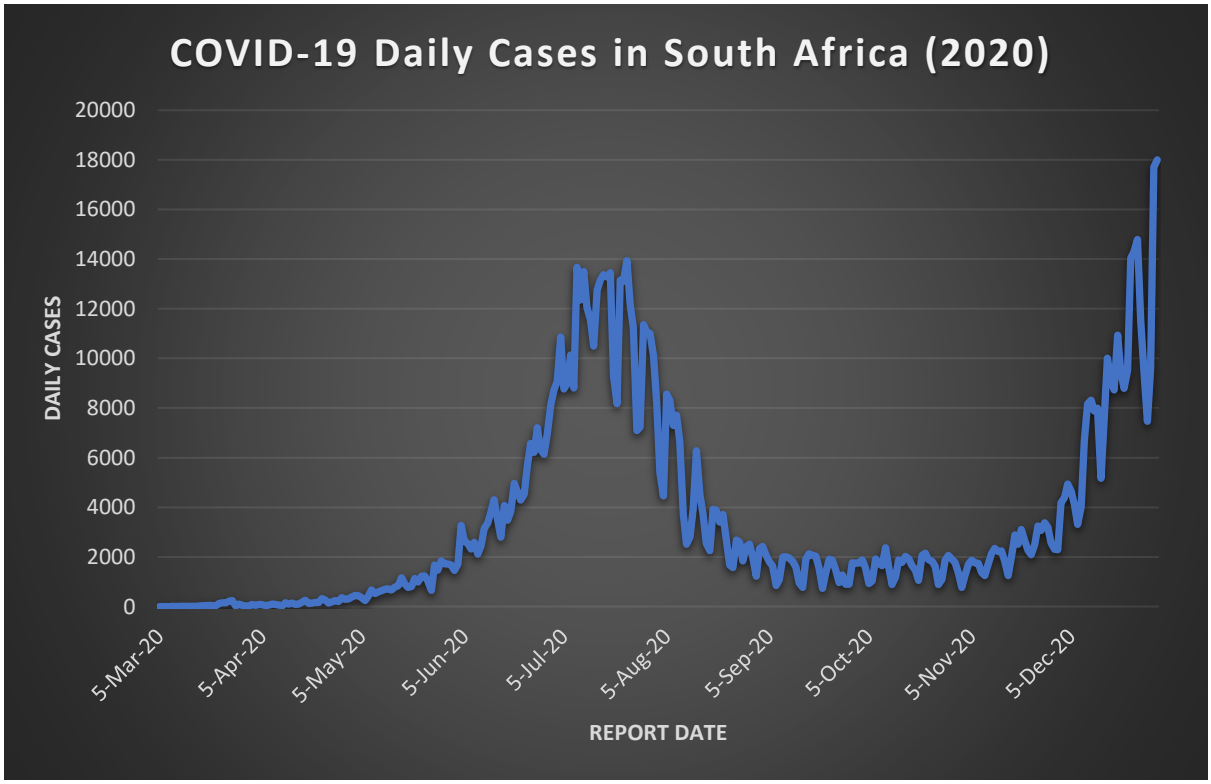


Figure 1: COVID-19 cases in South Africa (2020) (66)

In 2020, South Africa experienced two COVID-19 infection "waves" that led to lockdown measures being relaxed when infections decreased, which ultimately led to more infections and a massive second wave at the end of the year. COVID-19 infections in South Africa differed in geographic locations as provinces with major metros experienced high infection rates (16). Figure 2 illustrates the COVID-19 infections by province on the 10th of February 2022, Gauteng experienced the highest number of infections followed by KwaZulu-Natal and the Western Cape.

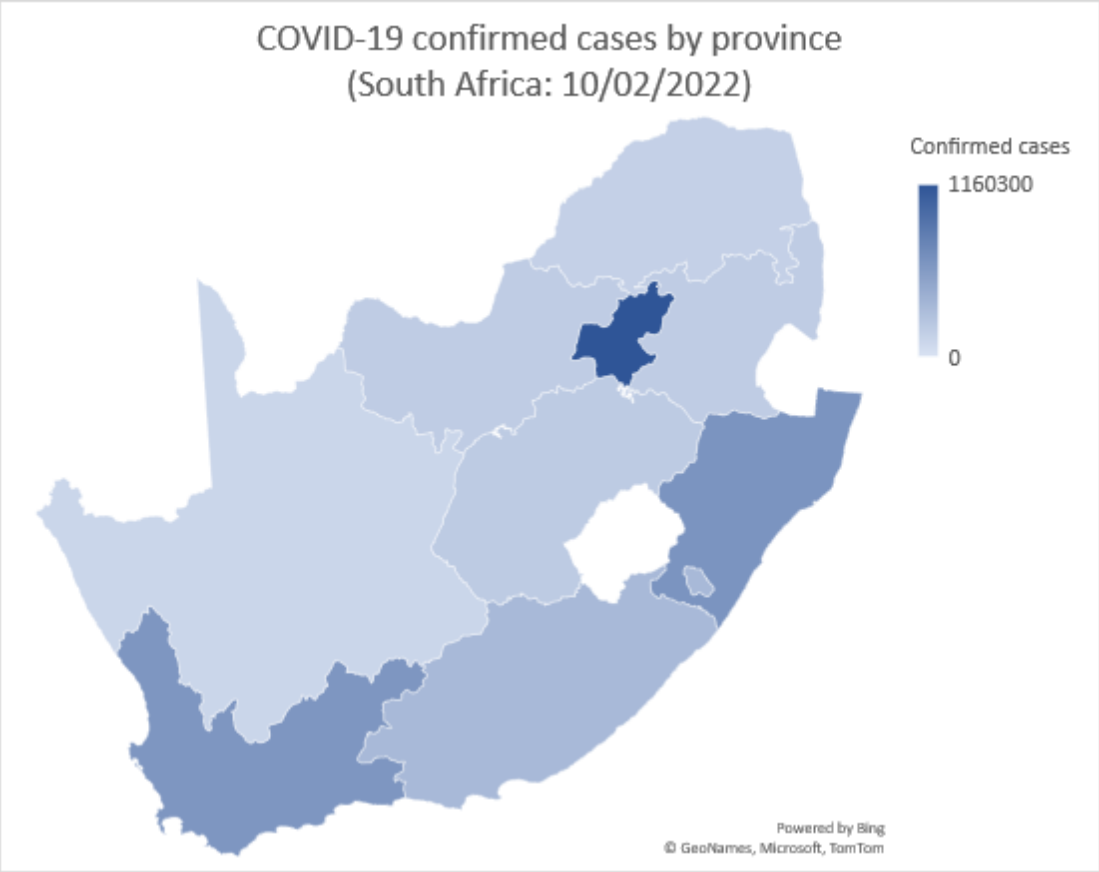


Figure 2 COVID-19 cases by province (10 Feb. 22)

International epidemics: SARS and MERS

Public health events, such as epidemics and pandemics, have been shown to have long-lasting and detrimental psychological effects on health care professionals (17). The first pandemic of the 21st century was SARS which had its first confirmed infections in the Guangdong Province of China in 2002 (18). SARS was a novel coronavirus that was easily spread via international air travel, and this led to Hong Kong, Singapore and Toronto becoming hot zones (19). It is estimated that around a third of the infections seen were among HCWs

working in hospitals (20). High infection rates within hospitals might have been due to the absence/lack of personal protective equipment (19).

MERS was a novel coronavirus infection that was first identified in Saudi Arabia in June 2012 (20). Like SARS, MERS managed to infect people outside of Saudi Arabia due to air travel and also led to hospital acquired infections (20). In May 2015 another outbreak of MERS was experienced in South Korea and these cases were mostly due to hospital acquired infections leaving HCWs at risk (20). In Africa, the Ebola virus disease (EVD) was an infectious disease of major concern, specifically in West-African countries.

Previous African epidemics: Ebola virus disease

Ebola virus disease (EVD), is a zoonotic disease that may cause infections in humans when there is direct contact with blood or fluids from an infected animal (8). Bats are suspected to be a natural reservoir for the Ebola virus and were suspected of being the source of the 2013-2016 outbreak (8). Ebola can be transmitted between humans via direct contact with bodily fluids and blood when an individual is symptomatic; transmission can also occur when there is direct contact with an infected deceased person (8). The 2013-2016 outbreak mostly affected Guinea, Liberia and Sierra Leone, this outbreak had detrimental effects on HCWs and their families in each country, as well as spreading fear among the public (8).

The EVD outbreak of 2013-2016 was also declared a public health emergency of international concern by the WHO after numerous requests from NGOs and other agencies that were working in Guinea during the outbreak (8). Some HCWs lost their lives during this outbreak and there was a lot of distrust and conspiracy theories being spread by the public that led to some HCWs being attacked and killed (8). Another issue that the affected countries faced was the lack of resources to tackle the treatment and prevention of Ebola. All 3 West-African countries did not have sufficient treatment facilities, they lacked protective protection equipment and did not have enough trained HCWs (8).

Literature review

In this literature review the effects of previous global pandemics (SARS and MERS), that have affected the African continent (Ebola Virus Disease), and the current COVID-19 pandemic on HCWs psychological wellbeing will be explored.

SARS and MERS: Coronavirus diseases of the past and psychological wellbeing

Following both the SARS and MERS pandemics, research into their effects on HCWs was conducted in countries that were severely affected by these pandemics. In a study conducted by Maunder (2004) in Canada, hospital staff that were treating SARS infected patients experienced negative psychological outcomes (21). The factors leading to psychological distress included, direct contact with SARS-infected patients, being a parent, perceived social rejection, job stress and being a nurse (21). Maunder et al (2006) conducted another study that sought to, "assess the long-term psychological and occupational impact of SARS outbreak on HCWs and to identify personal and systemic factors that increase vulnerability" (1). This study was able to prove that most transmissions occurred within hospitals, where mostly HCWs contracted the virus (1). The results of the study showed that HCWs in Toronto at the time experienced "significantly higher levels of burnout ($p=0.019$), psychological distress ($p<0.001$) and posttraumatic stress ($p<0.001$)" compared to HCWs that were working in hospitals that were not treating SARS infected patients (1). These results substantiated Maunder's findings in his 2004 study (21) which showed the negative impact of SARS on the mental health of HCWs.

Chong et al (2004) (22) conducted a study on the psychological impact of SARS on HCWs in Taiwan and they sought to "determine the psychosocial effects associated with working in a hospital" and examined the determinants of these effects (22). Chong et al were able to highlight the overwhelming levels of fear that HCWs were experiencing due to their exposure to SARS and the fear of infecting their families (22). Su et al (2007) (23) also conducted a study in Taiwan which substantiated Maunder et al (1) describing other psychological effects of SARS on nurses working in wards that had not been observed in the previous studies were also described, these included symptomatic depression, post-traumatic stress disorder (PTSD), and insomnia (23). Another determinant that was observed was that receiving support from their family members improved their ability to cope with the psychological symptoms over time (23).

The MERS pandemic had an impact on the wellbeing of HCWs once again as they were in the front line of fighting the pandemic. Khalid et al (2) studied the "emotions, perceived stressors and the coping strategies" that HCWs in Saudi Arabia experienced during the MERS outbreak in 2014 (2). Similar to the previous coronavirus pandemics, MERS had high

nosocomial transmissions, and this led to increased distress among HCWs (2). This study had some limitations as it had a small sample size and did not include other professionals (2).

Ebola virus: 2013-2016 Outbreak

The Ebola virus was first discovered in 1976 in Northern Zaire and has since caused 29 outbreaks with the 2013-2016 outbreak being the largest (8). This outbreak had a case fatality rate of 88% and many cases were nosocomial (8). Similar to the SARS and MERS pandemics, EVD had psychological and physical effects that had a lasting effect once an outbreak ends (24). EVD had a devastating impact on the population and healthcare systems of the countries affected. On the individual and community level, the EVD outbreaks left a lot of families experiencing psychological effects such as anxiety, depression and PTSD (24). There was a lot of distrust of HCWs due to different conspiracy theories in the communities, this led to some HCWs being attacked and killed by community members (24). Almost 900 HCWs were infected by EVD and over 500 HCWs lost their lives (24). These may have been contributing factors to the adverse mental health effect HCWs experienced during the outbreak.

COVID-19: The novel Coronavirus disease

COVID-19 infections in high-income countries and mental health

China has experienced a coronavirus outbreak in the past, the SARS pandemic, thus China's healthcare system was better prepared compared to many countries that did not experience the SARS outbreak. This was highlighted by the presence of fever clinics that were able to assist infected patients when SARS-CoV-2 infections started. These clinics became easily overwhelmed as the rate of infection increased at a faster rate than that of the SARS outbreak in 2003 (25). The COVID-19 outbreak led to increased pressure on the healthcare system and resulted in psychological effects like those experienced during the SARS outbreak in 2003 (26). As a way to cope with the pressure exerted on the healthcare system, China was able to convert some of its stadia and convention centres into mobile clinics, but these were staffed by HCWs from different medical backgrounds who were not experienced in dealing with infectious diseases (25).

The Chinese HCWs were reported to have experienced anxiety, depression and insomnia with females, frontline HCWs and nurses in Wuhan experiencing more severe symptoms

(26). These results validate a rapid review conducted by De Kock et al (27) showing front-line hospital staff with greater levels of psychological distress due to the COVID-19 pandemic in China. However, a study conducted by Wu et al (25) found that frontline workers were less likely to experience burnout compared to HCWs working in their usual wards. This study was conducted within the first two months of the COVID-19 outbreak and thus may not have fully captured HCWs experiences for the rest of 2020.

Italy experienced one of the most severe COVID-19 outbreaks, their healthcare system saw HCWs being recruited to assist in the front line regardless of experience with infectious diseases (28). Conti et al (28) conducted a survey in Italy with the objective of identifying the psychological effects of COVID-19 and the psychological care needs of HCWs. The results of this survey confirmed the previous studies that had been conducted in China. There were differences between the two nations as half to two-thirds of the HCWs that participated in the Italian survey experienced high levels of psychological distress regardless of their professional title (28). The authors reported that not only those in direct contact with affected patients suffer psychological effects but all individuals that form part of the healthcare system are affected. In the Middle East, Khalid et al (2) highlighted that the impact of outbreaks does differ with different geographical locations. The aforementioned studies and other rapid reviews, e.g. De Kock et al (27), investigating the effects of pandemics on the mental health of HCWs were carried out in urban settings, and HCW experiences differed based on the stage at which each country was at in the pandemic (27).

COVID-19 in low-middle income countries and mental health

Brazil had one of the highest infection rates in South America that led to over 5 million cumulative infections and over 160 000 deaths by November 2020 (29). Due to the reluctance to institute lockdown measures by the president of the country, Brazil experienced a massive second wave of infections that led to its hospitals running low on medication and oxygen (29). HCWs in Brazil were affected by the handling of the COVID-19 outbreak, a cross-sectional study conducted in the first 6 months of 2020 showed that the majority of the HCWs experienced high levels of anxiety and depression (29). The HCWs also experienced a decrease in their salary, relocation to different hospitals and changes to their work environment as a measure to take on more COVID-19 infected patients. These measures are thought to have increased the anxiety and depression of HCWs in Brazil (29).

South Africa is regarded as a higher-middle income country, but it has one of the most unequal societies in the world (30). The South African healthcare system comprises the public and private sectors, the public sector has low resources while servicing 83% of the population (31). This unequal distribution of healthcare resources in South Africa has led to the healthcare system exhibiting a limited capability when dealing with outbreaks compared to sufficiently resourced healthcare systems and high-income countries. This reduced capability might expose many HCWs to environments that could induce mental health disorders as well as high work-related stress. An unsuitable job and work overload have been found to be risk factors for major depression in the workplace (32). In South Africa, there have been a myriad of factors that may have led to undesirable mental health outcomes among HCWs; these have been staff shortages, critical care bed shortages, and limited testing and tracing capability (33).

One issue seen at the beginning of the pandemic was shortage of Personal Protective Equipment (PPE), this is in contrast with countries that had prior exposure to pandemics such as SARS and MERS (33). Low availability of PPE may have exposed HCWs to nosocomial infections and placed their families at risk of being infected. This exposure may have been a factor for negative mental health outcomes for HCWs as fears of transmitting the virus to their family members or possibly dying would have been consistently present in their thoughts (34). In settings that had sufficient supply of PPE for its HCWs, its uncertain as to whether sufficient training was provided on how to use and decontaminate used PPEs (33). Staff shortages led to unusual shifts for many HCWs as many healthcare systems in Africa implemented longer shifts which ultimately affected HCWs work-life balance (33).

Mental health in South Africa

The South African healthcare system in the past has been neglectful in dealing with mental health disorders (35). The most recent data on this topic is from the 2004 South African Stress and Health Survey (SASH) which used a diagnostic interview (35). This survey reported a prevalence of 16.5% of mental disorders over a 12-month period and a lifetime prevalence of 30.3% of common mental disorders among adults (35). During the COVID-19 pandemic 2020 the Human Sciences Research Council reported that 33% of South Africans were suffering from depression and 45% were fearful due to COVID-19 (36).

In South Africa's two-tier (public and private) healthcare system, those working in the tertiary hospitals are thought to be better protected against mental health conditions as they

are better equipped and better staffed compared to secondary and/or district hospitals and clinics in the public sector (37). An observational study conducted by Hoque et al (2021) (38) in a rural primary healthcare setting in South Africa showed that COVID-19 led to high negative psychological symptoms among the HCWs working in that setting. These results also substantiate the outcomes from a rapid scoping review that was conducted by Robertson et al (2020) (37) that also showed a negative mental wellbeing among HCWs in South Africa and Sub-Saharan Africa.

In May 2020, some HCWs in the Eastern Cape refused to treat COVID-19 infected patients due to fear of contracting the virus; as well as citing the lack of proper training and provision of PPE for them to provide the healthcare services required in the community (22). Fear of contracting a viral infection during a pandemic by HCWs has also been highlighted in studies conducted by authors that are in well-resourced settings (34). In a setting with limited resources, such as South Africa or other African countries, poor mental health and high work stress could lead to a decline in the quality of health care services provided.

Work-stress during a pandemic

During the SARS pandemic, hospital staff were reported to experience high stress during patient care and this resulted in some of them experiencing fear, exhaustion and stress (4). A study by Kuo et al (4) found that medical technicians experienced more stress compared to administrators, and those HCWs who had minor children experienced a higher degree of stress compared to those without minor children (4). Personal protective equipment, though necessary for HCWs, was also linked to some discomfort (4). During the COVID-19 outbreak in Singapore, research showed that HCWs experienced an increase in stress and job burnout (39). There was an observed decline in stress levels among HCWs as lockdown ended but an increase in job burnout was observed as healthcare services that had not been offered during the lockdown period were now recommenced (39). This suggests that job burnout during the lockdown phase of the COVID-19 pandemic was not as high as the post-lockdown phase of the pandemic. HCWs in Singapore also experienced increased job burnout, stress and anxiety due to longer hours of work, and contact with COVID-19 patients was also associated with job burnout (39).

In a recent review conducted by Leo et al (3), HCWs working in intensive care units and sub-intensive care units reported higher burnout levels. This corroborates Kuo et al's study that

highlighted that HCWs in contact with COVID-19 patients experienced job burnout (4). Female HCWs were found to experience higher levels of burnout compared to their male counterparts due to their patient facing roles as well as the double shift effect of having to take care of their families at home (3). The review also highlighted the higher stress and burnout levels in low-middle income countries, such as South Africa, due to their limited resources such as access to personal protective equipment (3). In South Africa, it is believed that there is an imbalance in the distribution of HCWs between the public and private sectors as well as between the provinces (40). The private sector is usually well staffed and equipped in South Africa compared to the public sector as the private sector serves 16% of the population compared to the public sector that serves 84% of the population (41). This imbalance is believed to be a source physical and mental exhaustion (40), this could be due to some HCWs having to perform duties that go beyond their own scope of practice.

Mental health and work-stress among non-COVID-19 treating HCWs

During the COVID-19 pandemic, not all HCWs were working in the front-lines and thus did not have contact with COVID-19 infected patients. However, this did protect them from the effects of the pandemic. A study by Wu et al showed that HCWs that were working in their usual wards experienced higher levels of burnout compared to those that were working in COVID-19 treating wards or facilities (25). HCWs working in normal wards are thought to have had less control compared to HCWs working in facilities and wards that were treating COVID-19 as they had better access to information (25). In other situations, HCWs were distressed not because of fear of facing patients but the opposite of this. Other HCWs such as Psychotherapists depend on face-to-face consultations with their patients and due to different restrictive measures that were put into place during the pandemic, some Psychotherapists developed distress and anxiety due to financial losses caused by the pandemic (42).

Chapter 2: Methods

In the primary study data was collected using standardized tools. This chapter will describe the data collection tools used for this study, as well as the data analyses conducted in the secondary study to answer the research question. To summarise, these data collection tools include the General Health Questionnaire (GHQ-12) and Job-Related Tension Index (JRTI). Finally, the objectives of this study will be discussed at the end of this chapter.

Screening for mental health disorders and work stress

In this study, the Job-Related Tension Index (JRTI) and the General Health Questionnaire (GHQ-12) were used as data collecting tools. The JRTI is a standardized tool that was used to observe job tension, and the GHQ-12 was selected as it is often used to identify mental health issues and their impact in the population (43). According to Wooten et al (2010), contributors to job tension or work stress include conflicts and ambiguity over one's role in their profession (1). Role conflicts can arise as a result of contradictory expectations that may be within or outside a person's role set thus leading to role pressures (44).

Use of the 15-item JRTI identified whether individuals were likely to be affected in their job performance, job intentions and personal accomplishment (44). Role ambiguity results from unclear role demands and unpredictable expectations (44), this could be a catalyst for job-related stress in the South African and African healthcare system context.

The GHQ-12 is often used to screen common mental health disorders (45) and it consists of short questionnaire that can score levels of symptoms using Likert-type scale. The 4-point Likert scale allows for parametric analysis to be conducted easily (45) and thus will be used in this study.

Instrument validity and reliability

The GHQ-12 has been found to have an internal consistency with a Cronbach's alpha score of 0.78 and studies that have been done in English speaking countries showed that the GHQ-12 has a higher reliability compared to non-English speaking countries (46). The conciseness of the questionnaire has allowed it to become a widely used tool to detect psychological distress in non-clinical studies (43). The 3-factor GHQ-12 used in other studies allowed for i) anxiety and depression, ii) social dysfunction and iii) loss of confidence to be determined

(45). Its use helps in identifying rather than diagnosing mental health disorders hence its use in this study (47)

Primary study

The primary study was conducted in the second half of 2020 during the COVID-19 pandemic in South Africa. The study was a longitudinal study with a baseline cross-sectional survey conducted in selected hospitals, clinics and CHCs in Gauteng. A questionnaire with demographic related questions, standardised work stress and mental health related questions was sent to wellness coordinators at some large hospitals and some clinics in Gauteng. Along with these questions, a few questions regarding opinion on access to personal protective equipment (PPE), fears of COVID-19 infection and support from community and family were included. HCWs working in these facilities were requested to answer questions using a Likert scale for the responses. The standardised tools used to gather data for the primary research were the JRTI and the GHQ-12. Once these questionnaires were completed and returned, the responses were captured into REDCap® at the National Institute of Occupational Health (NIOH).

Primary study objectives

The primary study comprised of objectives different from the current study and these were;

1. To describe mental stress of selected HCWs in public health facilities in Johannesburg during the COVID-19 pandemic.
2. To determine the predictors of mental stress in HCWs.
3. To describe the knowledge, attitudes, perceptions and behaviour of the selected staff towards COVID-19 and its prevention.

Primary study population

The study population of the primary study included anyone working in the healthcare facilities such as doctors, nurses, cleaners, accountants and all jobs required for a functioning facility. The primary study excluded anyone below 18 years of age and those that did not consent to take part in the study. Data from the baseline survey will only be utilized.

Primary study ethics approval

Permission to conduct the study was received from the Gauteng Department of Health. The University of the Witwatersrand human research ethics committee provided ethics clearance for the study (M2006103).

Secondary study

Study design

An analytical cross-sectional study will be utilized for this study as a secondary analysis.

Study site

The study sites that were used for the primary study were Bheki Mlangeni district hospital, Rahima Moosa mother and child hospital, Helen Joseph hospital, Discoverers CHC, Hillbrow CHC and Tladi provincial clinic in Gauteng, South Africa in 2020. The study sites that were used in this analysis have similar primary working conditions. Helen Joseph is a public tertiary level 3 hospital located in the Auckland Park and Bheki Mlangeni District hospital is a public district hospital located in Soweto. Rahima Moosa Mother and Child hospital is a regional hospital that also provides some tertiary services, and it is located in Coronationville in Johannesburg. Discoverers CHC and Hillbrow CHC are all public community healthcare centres located in Roodepoort and Johannesburg CBD respectively. Tladi provincial clinic is a large public clinic located in Soweto. Tertiary hospitals in South Africa offer basic lab/X-ray, theatre, ICU, and sophisticated diagnostic and therapeutic management combined with specialist outpatient care (48). Tertiary hospitals also have Nurses, Doctors, specialists in major disciplines, and experts in subspecialties and minor disciplines (48). District hospitals in South Africa have Nurses, Doctors and occasional access to specialists in major disciplines as they provide basic lab/X-ray and theatre facilities without ICU access (48). Community health centres in South Africa have limited staffing as they have Primary Healthcare (PHC) nurses and doctors that perform basic lab/X-ray services as well as a casualty ward (48). Clinics are only staffed by PHC nurses, and they do not have lab/X-ray services (48)

Study population

HCWs were defined as anyone working in a healthcare facility e.g., Nurses, Doctors, Cleaners, Porters and admin. The study population for this study is consenting HCWs employed at the selected hospitals and CHCs who participated in the primary study.

Ethics approval

Ethics approval for the secondary data analysis was obtained from the University of the Witwatersrand human research ethics committee (medical) (ethics clearance certificate no: M220269)

Problem statement

Exposure to a novel virus with high morbidity and mortality, that most HCWs have not been trained for, while working in a hospital or clinic can be a trigger to mental health issues and work stress (5). The lack of resources, information and high patient loads associated with an infectious disease pandemic along with the wearing of confining PPE and the change in workloads can cause stress. Unmitigated stress may result in long term mental health impacts. There is a gap in the information available on the mental health and wellbeing of health care workers in South Africa and the factors associated with psychosocial wellbeing. Ignoring mental health and the work stress experienced by HCWs within healthcare facilities could lead to an increase in poor healthcare delivery thus increasing the burden on the healthcare system and patients.

Justification

The long-term effects of the COVID-19 pandemic could prove to be detrimental to the mental health and job performance of some HCWs. Identification and lowering or eliminating factors that may lead to work-related stress experienced by HCWs during a pandemic or any public health emergency may help strengthen healthcare systems in South Africa and the African continent. HCWs suffering from emotional exhaustion, fatigue and poor concentration are likely to be prone to errors when performing their duties thus weakening healthcare delivery (37). Outcomes from my research are aimed at assisting employers in the South African healthcare sector to identify and support mental health problems that may result from the work environment. Identification of the factors related to mental distress would allow for better interventions in the future.

Research question

What is the relationship between work stress and mental health among HCWs working in public hospitals and community health centers (CHCs) in Gauteng during the COVID-19 pandemic in 2020?

Research aim

To investigate the relationship between work stress and mental health in HCWs working in public hospitals and CHCs during COVID-19 in Gauteng in 2020.

Research objectives

1. To describe mental wellbeing among HCWs in Gauteng during the COVID-19 pandemic in 2020 using GHQ-12 and association with demographic factors.
2. To describe work stress among HCWs in Gauteng during the COVID-19 pandemic in 2020 using JRTI and association with demographic factors.
3. To describe whether there is an adjusted association between JRTI and GHQ-12 scores among HCWs, as a result of the COVID-19 pandemic in 2020.

Measurements and Calculations

Sampling and sample size determination

Clustered sampling was used for the main study, 700 respondents were obtained.

Sample size calculation: Sample size = $\frac{Z\alpha \times Z\alpha \times p \times q}{d \times d}$, Probability (p) of a mental disorder occurring among adults in the general population = 0.303 (49), probability of a mental disorder not occurring (q) = 0.697, d = 0.05, Zα for Confidence Interval of 95% = 1.96, N = (1.96^2 * 0.303 * 0.697) / 0.05^2 = 324.5 ≈ 325. The study population is small therefore a correction is required; n = n_0 / [1 + (n_0-1)/N]; where n_0 = sample size calculated and N = size of the population. n = 325/[1 + (325 – 1)/700] = 222.17 ≅ 223. A sample size of 223 will be required for this study.

Data management and analysis

Permission to access and use the primary study data was sought from the data owner at the NIOH a division of the NHLS.

Data was entered into REDCap by participants themselves and those with no access a trained data capturer captured the responses and STATA® version 16 (StataCorp, College Station, Texas, USA) was used to clean the data. Dataset was kept on a password protected laptop and a password protected cloud backup is being used as a secondary backup for the dataset.

Data cleaning and coding

Procedure	Variables
De-identification	First name, last name, email and telephone dropped from dataset
Dropping data	HCWs without gender, age, job title and facility name are dropped from the dataset
Generating new variable	i) Department: various department names (Department 0-Department 7) were merged into a single variable. ii) GHQ-12, JRTI, COVID-19 perceptions, Appreciation, Social support, and Training received were combined into an aggregated score. This score is obtained by adding the Likert score values from the individual questions and a total score obtained for each participant
De-stringing	Length worked
Categorising	Continuous variables for GHQ-12, JRTI, and COVID-19 perceptions were categorised using 2 as the threshold for the mean GHQ-12 score, 2.5 for the mean JRTI and 3 for the mean COVID-19 score. Age was categorised into different age groups of ease in descriptive analysis. Length worked by the HCWs was categorised for ease in descriptive analysis.
Labelling	Gender, Occupation, Department, Training, COVID contact, GHQ-12 scores, JRTI scores, COVID perceptions, social support, Appreciation, previous illness, stress workshops

Variables

The instruments used in the data collection stage of the study gathered more data than what was used in the analysis. The outcome variables of interest in the study were the GHQ-12 scores and the JRTI scores. The GHQ-12 and JRTI scores were obtained by aggregating the 4-Likert scale scores for each participant and the total of these scores is what was used at the GHQ-12 and JRTI score for each participant. The GHQ-12 and JRTI scores were then categorized, with 2 being used as the threshold as this was one of the most common thresholds for the GHQ-12 4-Likert scale (50). The table below gives a breakdown of the

variables used in the data analysis. For the GHQ-12 variable, the questions were coded as follows; 1 = Not at all/more than usual, 2 = a little, 3 = fairly often, 4 = Almost always. The aggregated score had a minimum score of 1 and a maximum of 4 for each participant. A threshold of 2 (50) was used to categorically signify absence of mental disorders (low GHQ-12 = 0) and a score above 2 signified presence of a mental disorder (high GHQ-12 = 1). For the JRTI variable, aggregated results for each participant from 15 questions with a Likert scale ranging from 1 to 5 for each question. The questions were coded as follows; 1 = Never, 2 = Sometimes, 3 = rarely, 4 = often, 5 = Nearly all the time. A threshold of 2.5 was used to categorically signify absence of job tension if the aggregated value was less than 2.5 (No work-stress = 0) and an aggregated value greater than or equal to 2.5 signified presence of job tension (work-stress = 1).

Exposure variable		
Variable	Type	code
Occupation	Categorical	0 - 19
Social support	Continuous	
Department	Categorical	0 - 7
Covid-19 perceptions	Continuous and Categorical	0 = Negative, 1 = Reasonable An aggregated score was obtained from responses on each question. A threshold of 3 was used. Values equal to or less than 3 represented reasonable perceptions and those above 3 represented negative perceptions.
Covid-19 training received	Categorical	0 = No, 1 = yes
Confounders		
Variable	**Type**	
Age	Continuous and Categorical	0 =18-24yrs, 1 = 25-34yrs, 2 = 35-44yrs, 3 = 45-54yrs, 4 = >55yrs
Gender	Categorical	0 = female, 1 = male

Descriptive analysis

At first, a descriptive analysis of the demographic data was conducted using STATA® 16 to obtain the number and percentage of HCWs in each category so that a clear distribution of the data is obtained. This analysis was then followed by a descriptive analysis using mean, standard deviation, minimum and maximum values for the variables of interest i.e., GHQ-12, JRTI, and COVID-19 perceptions. An analysis of the GHQ-12 and JRTI categorical variables was also be conducted. These categorical variables were obtained by splitting the continuous variable output using a threshold for the respective variable (see variables table). An analysis of the responses given in the questionnaires was done to observe average scores for each question. The final descriptive analysis was that of the mean GHQ-12 and JRTI scores plotted against the demographic variables i.e., Age group, Gender, Occupation and Department.

Regression analysis

A correlation test was first carried out between the GHQ-12 and Physical stress variable to determine if there was any linear relationship between the two variables. A linear regression analysis was then conducted to assess and describe the relationship between GHQ-12 and explanatory variables in the study. The analysis was carried out with an adjustment for clustering within the facilities. Interaction factors between occupation and department, and between age category and length worked were also introduced into the model. A similar regression analysis was conducted for the JRTI score. Akaike's information criterion (AIC) and Bayesian information criterion (BIC) were used for model selection and assessing impact of interaction factors in the model; the lower the AIC and BIC scores, the better the model fit. The Ramsey (1969) regression specification-error test (RESET) was conducted as a post-estimation test to determine if there was a misspecification of the linear regression models. The variance inflation factors (VIF) test was also conducted to rule out multi-collinearity within the model. A logistic regression was also conducted for the categorical variables in the model with the GHQ-12 categorical variable as the output variable. This was carried out in order to observe factors associated with developing a mental health disorder in the study.

Structural equation modelling (SEM)

Assumptions for the use of SEM must be met first before carrying out the analyses, these assumptions are i) large sample size, ii) multivariate normality and iii) correct model specification. The first assumption was met as the dataset had over 200 HCWs. Tests to determine if the variables of interest (GHQ-12, JRTI and COVID-19 perceptions) were normally distributed were conducted using Shapiro-Wilk W tests in STATA® version 16 (StataCorp, College Station, Texas, USA). If the data was not normally distributed, the data was transformed using the Tukey ladder of powers test. After the model was run, a post-estimation analysis was done do compare different model fits and these included Akaike's Information criterion (AIC), Bayesian Information Criterion (BIC), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and a Tucker-Lewis Index (TLI). Previous studies have shown that a good model–data fit can be indicated by a RMSEA score of less than 0.06 (90% CI), a CFI score greater than 0.95, and a TLI score greater than 0.95 (51). The significance level was set at 0.05.

Chapter 3: Results

The data that was collected in the primary study was then cleaned and coded for the analysis to take place. This chapter gives a brief description of the data, and the results of the various analyses will be reported according to the different objectives that were set out in the methodology. The data from the GHQ-12 and JRTI tools will be summarised, together with that from the COVID-19 perceptions questionnaire. This data was then used for the regression analysis and SEM.

Descriptive analysis

The data that was collected in the primary study was able to provide clear summary statistics when analysed using STATA version 16 (StataCorp, College Station, Texas, USA). Table 1 below shows the demographic characteristics of the study participants. The data showed there was a higher percentage of HCWs from the 25-34yr (28.06%) age group followed by the age group 35-44yr (27.76%). Females also constituted a higher percentage (80.00%) compared to males in the study. Of the occupations that could be identified, Professional nurses made up the highest percentage of HCWs (19.11%). Facility F provided the highest percentage of HCWs (25.07), and of the departments, Other department had the highest percentage of HCWs (43.88%) this covered outpatient clinics and non-patient facing areas. The COVID-19 isolation wards covered the largest proportion of inpatient wards represented (8.06%)

Table 1. Demographic characteristics of the study

Demographic characteristic		Number	Percentage
Age	18-24	69	(20.60%)
	25-34	94	(28.06%)
	35-44	93	(27.76%)
	45-54	58	(17.31%)
	>55	21	(6.27%)
Gender	Female	268	(80.00%)
	Male	67	(20.00%)
Occupation	Head of unit	9	(2.69%)
	Comm-service MO &Interns	18	(5.37%)
	Medical officer	11	(3.28%)
	Registrar	3	(0.90%)

	Consultant	4	(1.19%)
	Professional Nurse	64	(19.11%)
	Enrolled assistant nurse	40	(11.94%)
	Enrolled/Staff nurse	28	(8.36%)
	Physiotherapist	8	(2.39%)
	Pharmacist	7	(2.09%)
	Janitor	13	(3.88%)
	Clerk	39	(11.64%)
	Delivery	3	(0.90%)
	Other	88	(26.27%)
Facility	A	81	(24.18%)
	B	47	(14.03%)
	C	77	(22.99%)
	D	28	(8.36%)
	E	18	(5.37%)
	F	84	(25.07%)
Department	Theatre	8	(2.39%)
	General ward	4	(1.19%)
	Emergency	12	(3.58%)
	ICU	2	(0.60%)
	COVID-19 Isolation	27	(8.06%)
	OBS & Gynae	2	(0.60%)
	Other	147	(43.88%)
	Unknown	131	(39.10%)

The output presented in table 2 shows the majority of male HCWs in the study were between the ages of 25 and 44. Females made up majority of the HCWs and they had representation within all age groups except for the >55 age group.

Table 2. Bi-variate analysis of the confounding variables

Age group	**Gender**		**Total**
	Female	Male	
18-24	59 (%)	10	69

25-34	74	20	94
35-44	70	23	93
45-54	50	8	58
>55	15	6	21
Total	268	67	335

Table 3. GHQ-12 questionnaire outcomes

General Health Questionnaire-12 question	**Obs**	**Mean**	**Std. Dev. (±)**
1. Been able to concentrate on what you are doing?	320	2.34	0.90
2. Lost much sleep over worry?	320	2.24	1.07
3. Felt that you are playing a useful part in things?	315	1.93	0.96
4. Felt capable of making decisions about things?	318	2.21	0.97
5. Felt constantly under strain?	318	2.53	1.04
6. Felt that you could not overcome your difficulties?	312	2.21	1.02
7. Been able to enjoy your normal day-to-day activities?	306	2.61	0.99
8. Been able to face up to your problems?	317	2.29	0.91
9. Been feeling unhappy and depressed?	320	2.34	1.11
10. Been losing confidence in yourself?	319	1.89	1.05
11. Been thinking of yourself as a worthless person?	321	1.79	1.07
12. Been feeling reasonably happy all things considered?	310	2.32	0.98

Table 3 shows the mean scores of each question in the GHQ-12 questionnaire. The higher the score the more stress felt. The responses show that most HCWs ‘felt like they were playing a useful part in things’ at work during the pandemic with more so than usual equal to a score of 1.93. They also had positive views about their worth and were confident in themselves.

However, the responses highlight that most of the HCWs had negative feelings due to the pandemic with the highest negative scores coming from the HCWs not enjoying their day-to-day activities, and constantly feeling under strain. Other areas with increased scores were feeling unhappy or depressed and a difficulty concentrating.

Table 4. Job Related Tension Index questionnaire outcomes

Job Related Tension Index question	Obs	Mean	Std. Dev. (±)
1.You have too little authority to carry out the responsibilities assigned to you	309	2.40	1.24
2. Unclear on just what the scope and responsibilities of your job are	309	2.07	1.27
3. How often are you unsure what opportunities for advancement of promotion exist for you	299	2.53	1.42
4. Feel that you have too heavy a workload, one that you cannot possibly finish during an ordinary working day	315	2.54	1.39
5. Think that you will not be able to satisfy the conflicting demands of the various people over you	308	2.63	1.23
6. How often do you feel that you are not fully experienced to handle your job	317	1.65	1.08
7. Not knowing what your immediate supervisor thinks of you and how he or she evaluates your performance	312	2.37	1.30
8. Not being able to get the necessary information to carry out your job	315	2.06	1.21
9. Having to decide things that affect the lives of individuals, people that you know	309	2.72	1.28
10. Feeling that you may not be liked or accepted by the people that you work with	313	2.17	1.22
11. Feeling unable to influence your immediate supervisor’s decisions that affect you	313	2.35	1.22
12. Not knowing what the people that you work with expect of you	316	2.27	1.15

13. Thinking that amount of work that you have to do may interfere with how well it gets done	315	2.51	1.28
14. Feeling that you have to do things on the job that go against your better judgement	317	2.36	1.26
15. Feeling that your job tends to interfere with your family life	323	2.51	1.46

Table 4 shows the mean scores of each question in the JRTI questionnaire, the higher the score the more dissatisfaction. The responses show that the HCWs felt they had too heavy a workload and this would interfere with how well the work was done. They also felt that they would not be able to satisfy the conflicting demands of the various people. HCWs also had negative feelings towards having to decide things that affect the lives of people they knew. HCWs however felt that they were fully experienced to handle their job, and that they had access to necessary information they needed to carry out their job. HCWs in the study also felt that they had clarity on the scope and responsibilities of their job.

Table 5. COVID-19 perception questionnaire outcomes

Perceptions of COVID-19 at work question	**Obs**	**Mean**	**Std. Dev. (±)**
1. I believe that my job is putting me at great risk	320	4.96	1.27
2. I feel extra stress at work since COVID-19	324	4.21	1.64
3. I am afraid of falling ill with COVID-19	324	4.92	1.51
4. I feel I have little control over whether I get infected or not	324	4.43	1.60
5. I feel I may be unlikely to survive if I get COVID-19	324	3.07	1.79
6. I have thought about resigning because of COVID-19	323	2.29	1.84
7. I am afraid I will pass COVID-19 on to others	324	4.57	1.69
8. My family is worried they might get COVID-19 through me	327	4.85	1.58
9. I feel altruistic working with COVID-19	301	3.95	1.75

Table 5 the outcome of the responses to the COVID-19 perceptions questionnaire, it highlights the mean scores as well as the number of responses to each question. Most HCWs did not think about resigning because of the COVID-19 pandemic, however they felt that their job was putting them at great risk of infection. HCWs were also afraid of falling ill with COVID-19 and they were worried that their family would get COVID-19 through them.

. Table 6. Descriptive statistics among the study variables of interest

Variable	Obs	Median	25th percentile	75th percentile
GHQ-12 score	335	24	20	30
JRTI score	335	24	32	41
COVID-19 perceptions	335	29	37	43

Table 6 shows that the mean of the total GHQ-12 score among the HCWs was 25.20 with a standard deviation of ±8.27. The mean of the total JRTI score was 32.78 with a standard deviation of ±13.79. The mean of the total COVID-19 perception score from the questionnaire was 35.74 with a standard deviation of ±11.09. The demographic characteristics of the data are shown below in table 7, these were tabulated using the mean score of the COVID-19 perceptions, GHQ-12 and JRTI questionnaires and described according to each demographic category. Female HCWs showed a significantly higher COVID-19 score indicating a negative outlook, the GHQ-12 was also significantly higher while the JRTI mean score was non-significantly higher compared to the male HCWs. The data also shows that those that were between the ages of 45 and 54 years had high GHQ-12 scores compared to the other age groups, whilst those that were between the ages of 35 and 44 years had higher JRTI scores compared to the other age groups. Matrons in the facilities reported higher COVID-19 and JRTI scores, whilst Registrars reported higher GHQ-12 mean scores. HCWs at hospital B reported higher COVID-19 perceptions, GHQ-12 and JRTI mean scores compared to HCWs from other facilities.

Table 7. Demographic exposure, COVID-19 perceptions, GHQ-12 scores and JRTI scores

Demographic characteristic		COVID-19 perceptions	GHQ-12 score	JRTI score
		Mean (p-value)	Mean (p-value)	Mean (p-value)
*Age group	18-24	4.03 (0.34)	2.21 (0.08)	2.33 (0.70)
	25-34	4.00 (0.34)	2.12 (0.08)	2.32 (0.70)
	35-44	4.29 (0.34)	2.26 (0.08)	2.39 (0.70)
	45-54	4.27 (0.34)	2.38 (0.08)	2.34 (0.70)
	>55	4.01 (0.34)	2.04 (0.08)	2.22 (0.70)
αGender	Female	4.25 (0.00)	2.25 (0.07)	2.37 (0.23)
	Male	3.69 (0.00)	2.10 (0.07)	2.23 (0.23)
*Occupation	Head of unit	4.10 (0.03)	2.19 (0.34)	2.53 (0.04)
	Intern	3.22 (0.03)	2.33 (0.34)	2.47 (0.04)
	Community service MO	4.10 (0.03)	2.06 (0.34)	2.30 (0.04)
	Medical officer	3.72 (0.03)	2.11 (0.34)	2.54 (0.04)
	Registrar	4.63 (0.03)	2.90 (0.34)	3.17 (0.04)
	Consultant	4.17 (0.03)	2.31 (0.34)	2.73 (0.04)
	Matron	4.75 (0.03)	2.83 (0.34)	4.20 (0.04)
	Professional Nurse	4.36 (0.03)	2.33 (0.34)	2.40 (0.04)
	Enrolled assistant nurse	4.62 (0.03)	2.37 (0.34)	2.32 (0.04)
	Enrolled/Staff Nurse	4.57 (0.03)	2.39 (0.34)	2.29 (0.04)
	Physiotherapist	3.64 (0.03)	1.96 (0.34)	1.84 (0.04)
	Pharmacist	4.46 (0.03)	2.35 (0.34)	2.70 (0.04)
	Janitor	4.23 (0.03)	2.57 (0.34)	2.83 (0.04)
	Clerk	3.90 (0.03)	2.05 (0.34)	2.16 (0.04)
	Delivery	3.63 (0.03)	2.14 (0.34)	2.51 (0.04)
	Phlebotomist	3.44 (0.03)	1.67 (0.34)	1.27 (0.04)
	Other	3.79 (0.03)	2.08 (0.34)	2.34 (0.04)
*Facility	A	4.05 (0.11)	2.30 (0.03)	2.34 (0.43)
	B	4.45 (0.11)	2.35 (0.03)	2.50 (0.43)
	C	4.20 (0.11)	2.25 (0.03)	2.35 (0.43)
	D	4.01 (0.11)	2.07 (0.03)	2.21 (0.43)
	E	3.73 (0.11)	1.92 (0.03)	2.04 (0.43)
	F	4.11 (0.11)	2.16 (0.03)	2.34 (0.43)

*Kruskal-Wallis test conducted for p-values. αANOVA test conducted for p-values

The Shapiro-Wilk W test (table 8) showed that the variables of interest were not normally distributed, however the Tukey ladder test of powers test showed no evidence of non-normality in the identity variable after the skewness-kurtosis test was conducted and thus no transformation needed to be performed.

Table 8. Shapiro-Wilk W test for normal data for the variables of interest (GHQ-12, JRTI and COVID-19 perceptions)

Variable	Obs	W	V	z	Prob>z
GHQ12	335	0.98648	3.177	2.728	0.00319
JRTI	335	0.98499	3.528	2.975	0.00147
COVID-19 perceptions	335	0.96956	7.153	4.643	0.00000

Identification of factors associated with mental wellbeing

The Spearman correlations between GHQ-12 and Physical stress showed the presence of a positive correlation between the two variables, but the magnitude of correlation was small (0.48; p< .001).

Table 9. Linear regression model of GHQ-12 and explanatory variables adjusted for clustering within facilities (n = 202)

Variable	Mental wellbeing (GHQ-12)						
	Category	Coef.	Robust Std. Err.	t	p-value	95% CI	
COVID-19 perceptions	Negative	6.12	0.96	6.36	0.001	3.64	8.59
Length worked	10yrs & above	2.02	1.20	1.69	0.153	-1.06	5.10
Age	25-34	-4.18	1.39	-3.00	0.030	-7.77	-0.60
	35-44	-3.59	1.89	-1.90	0.115	-8.44	1.26
	45-54	-1.84	2.02	-0.91	0.402	-7.02	3.34
	>55	-2.68	1.97	-1.36	0.233	-7.75	2.40
Gender	Male	-0.01	1.45	-0.00	0.996	-3.73	3.72
Occupation*	Intern	8.48	2.31	3.67	0.014	2.54	14.42
	Comm-serve MO	-1.21	1.15	-1.05	0.341	-4.17	1.75
	Medical officer	8.78	1.79	4.91	0.004	4.18	13.37
	Registrar	7.66	2.51	3.06	0.028	1.22	14.11
	Consultant	3.72	1.88	1.97	0.105	-1.12	8.55
	Professional nurse	0.79	2.05	0.38	0.718	-4.49	6.07
	Enrolled assistant nurse	-0.42	2.98	-0.14	0.893	-8.08	7.24
	Enrolled/staff nurse	-1.91	0.80	-2.40	0.062	-3.96	0.14

	Physiotherapist	1.40	4.90	0.29	0.786	-11.20	14.00
	Pharmacist	0.97	0.96	1.01	0.359	-1.50	3.45
	Janitor	11.49	2.91	3.95	0.011	4.01	18.98
	Clerk	-0.08	1.83	-0.04	0.967	-4.80	4.64
	Delivery	3.54	1.24	2.86	0.035	0.36	6.72
	Phlebotomist	0.31	1.89	0.16	0.876	-4.54	5.16
Department[α]	Theatre	-2.03	1.93	-2.08	0.092	-8.96	0.94
	Radiology	-6.02	0.79	-7.59	0.001	-8.05	-3.98
	General med-ward	5.18	1.10	4.72	0.005	2.36	8.01
	Emergency	-10.08	1.30	-7.76	0.001	-13.42	-6.74
	ICU	2.36	2.78	0.85	0.435	-4.79	9.51
	COVID-19 Isolation	-11.00	2.33	-4.72	0.005	-16.99	-5.01
	OBS & Gynea	0.46	3.26	0.14	0.894	-7.92	8.84
Occupation and Department interaction[β]	Comm-serve MO#Theatre	-0.58	2.52	-0.23	0.827	-7.06	5.90
	Comm-serve MO#Unkown	13.21	2.88	4.59	0.006	5.80	20.61
	MO#Theatre	-1.96	1.25	-1.56	0.179	-5.18	1.27
	Registrar#Theatre	-1.25	2.60	-0.48	0.651	-7.94	5.44
	Professional nurse#unknown	-0.48	4.48	-0.11	0.918	-11.99	11.02
	Professional nurse#General med-ward	1.90	2.58	0.74	0.494	-4.73	8.53
	Professional Nurse#COVID-19 Isolation	6.71	5.00	1.34	0.237	-6.14	19.55
	Enrolled assistant Nurse#Unknown	-3.31	2.15	-1.54	0.184	-8.84	2.21
	Enrolled assistant Nurse#COVID-19 Isolation	12.08	5.84	2.07	0.093	-2.92	27.08

	Enrolled/staff Nurse#Unknown	7.66	4.71	1.63	0.165	-4.44	19.77
	Enrolled/staff Nurse#Emergency	6.75	1.43	4.71	0.005	3.07	10.44
	Enrolled/staff Nurse#COVID-19 Isolation	18.82	4.44	4.24	0.008	7.41	30.22
	Physio#COVID-19 Isolation	7.89	2.62	3.01	0.030	1.14	14.64
	Pharmacist#Unknown	1.08	2.33	0.46	0.663	-4.90	7.05
	Janitor#Unknown	6.52	1.45	4.49	0.006	2.78	10.25
	Janitor#ICU	-15.87	0.30	-52.20	0.000	-16.65	-15.09
	Janitor#COVID-19 Isolation	-3.67	6.88	-0.53	0.617	-21.36	14.03
	Clerk#Unknown	2.60	3.29	0.79	0.466	-5.86	11.05
	Other#COVID-19 Isolation	5.24	1.43	3.66	0.015	1.56	8.92
_cons		18.00	3.18	5.66	0.002	9.82	26.18

*****Head of unit (jobtitle = 1) set as the baseline. $^{\alpha}$ Outpatient (Department = 9) set as the baseline. $^{\beta}$ ANCOVA approach used.

The regression output of the analysis (table 9) showed that GHQ-12 scores were associated with some of the explanatory variables in the model. The analysis shows that GHQ-12 scores for HCWs that exhibited negative COVID-19 perceptions were 6.12 units higher compared to GHQ-12 scores in HCWs that exhibited reasonable COVID-19 perceptions (p = 0.001; CI: 3.64, 8.59), adjusting for other explanatory variables in the model. The analysis also shows that GHQ-12 scores for HCWs that were between the ages of 25 and 34 years, were 4.18 units lower compared to GHQ-12 scores in HCWs that were between the ages of 18 and 24 years (p = 0.030; CI: -7.77, -0.60), adjusting for other explanatory variables in the model.

GHQ-12 scores by Occupation

The regression also shows that the GHQ-12 scores for HCWs that worked as Interns were 8.48 units higher than GHQ-12 scores of HCWs that worked as the head of unit (p = 0.014, CI: 2.54, 7.52), adjusting for other variables. Medical officers had GHQ-12 scores that were 14.43 units higher than GHQ-12 scores of HCWs that worked as the head of unit (p = 0.001,

CI: 9.13, 19.73). GHQ-12 scores for HCWs that worked as Registrars were 7.66 units higher than GHQ-12 scores of HCWs that worked as the head of unit (p = 0.028, CI: 1.22, 14.11). The GHQ-12 score for Janitors were 11.49 units higher than GHQ-12 scores of HCWs that worked as the head of unit, adjusting for other variables (p = 0.011, CI: 4.01, 18.98). Delivery personnel had GHQ-12 scores that were 3.54 units higher than GHQ-12 scores of HCWs that worked as the head of unit (p = 0.035, CI: 0.36, 6.72).

GHQ-12 scores by Department

HCWs that worked in the radiology department had GHQ-12 scores that were 6.01 units lower than GHQ-12 scores of HCWs working in the outpatient department, adjusting for other variables (p = 0.019, CI: -3.90, -0.54). HCWs that worked in the general medical ward reported GHQ-12 scores that were 5.18 units higher than GHQ-12 scores of HCWs working in the outpatient department, adjusting for other variables (p = 0.005, CI: 2.36, 8.01). HCWs that worked in the emergency department reported GHQ-12 scores that were 10.08 units lower than GHQ-12 scores of HCWs working in the outpatient department, adjusting for other variables (p = 0.001, CI: -13.42, -6.74). HCWs that worked in the COVID-19 isolation department reported GHQ-12 scores that were 11.00 units lower than GHQ-12 scores of HCWs working in the outpatient department, adjusting for other variables (p = 0.001, CI: -16.99, -5.01).

GHQ-12 scores by occupation and department

HCWs that worked as an enrolled assistant nurse in the emergency department reported GHQ-12 scores that were 9.43 units higher than GHQ-12 scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.049, CI: 0.08, 18.78). HCWs that worked as an enrolled/staff nurse in the emergency department reported GHQ-12 scores that were 6.75 units higher than GHQ-12 scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.005, CI: 3.07, 10.44). HCWs that worked as an enrolled/nurse in the COVID-19 isolation department reported GHQ-12 scores that were 18.82 units higher than GHQ-12 scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.008, CI: 7.41, 30.22). HCWs that worked as a physiotherapist in the COVID-19 isolation department reported GHQ-12 scores that were 7.89 units higher than GHQ-12 scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.030, CI: 1.14, 14.64). HCWs that worked as a janitor in the ICU department

reported GHQ-12 scores that were 17.56 units lower than GHQ-12 scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.007, CI: -27.89, -7.24).

The post-estimation tests for the mental wellbeing analysis showed that there were no variables omitted (F(3, 157) = 1.50, p = 0.2172). The test for multi-collinearity also showed absence of multi-collinearity (mean VIF = 6.68), and the AIC and BIC also showed a strong model (appendix).

Identification of factors associated with work-stress

Table 10. Linear regression model of JRTI and explanatory variables adjusted for clustering within facilities (n = 202)

Variable	**Work-stress (JRTI)**						
	Category	**Coef.**	**Robust Std. Err.**	**t**	**p-value**	**95% CI**	
COVID-19 perceptions	Negative	6.37	1.79	3.57	0.016	1.78	10.96
Gender	Male	2.05	1.24	1.65	0.160	-1.15	5.24
Age group	25-34	-5.34	4.07	-1.31	0.246	-15.80	5.12
	35-44	-2.64	4.08	-0.65	0.547	-13.14	7.86
	45-54	-6.84	2.97	-2.30	0.070	-14.48	0.80
	>55	-14.20	5.26	-2.70	0.043	-27.73	-0.67
Length worked	10yrs & above	5.01	2.34	2.14	0.085	-1.00	11.02
Physical stress		0.36	0.12	2.92	0.033	0.04	0.68
Previous illness	Yes	7.69	3.17	2.43	0.060	-0.45	15.84
Occupation*	Intern	21.62	7.83	2.76	0.040	1.51	14.73
	Comm-serve MO	4.37	4.37	2.89	0.034	1.41	23.85
	Medical officer	41.01	4.86	8.43	<0.001	28.51	53.51
	Registrar	29.79	5.98	4.98	0.004	14.40	45.17
	Consultant	10.51	6.06	1.73	0.143	-5.07	26.09
	Professional nurse	12.92	4.38	2.95	0.032	1.66	24.18
	Enrolled assistant nurse	2.85	8.72	0.33	0.757	-19.57	25.28

	Enrolled/staff nurse	4.54	4.61	0.99	0.369	-7.30	16.39
	Physiotherapist	6.15	8.41	0.73	0.498	-15.47	27.77
	Pharmacist	21.14	4.20	5.04	0.004	10.35	31.92
	Janitor	14.39	3.96	3.63	0.015	4.21	24.57
	Clerk	9.18	4.49	2.04	0.097	-2.37	20.72
	Delivery	10.84	2.34	4.64	0.006	4.83	16.85
	Phlebotomist	-21.09	8.11	-2.60	0.048	-41.94	-0.25
Department[α]	Theatre	7.33	5.36	1.37	0.230	-6.46	21.11
	Radiology	-12.04	3.09	-3.90	0.011	-19.97	-4.10
	General med-ward	19.56	7.82	2.50	0.054	-0.55	39.66
	Emergency	-23.42	3.78	-6.19	0.002	-33.15	-13.69
	ICU	17.05	6.14	2.77	0.039	1.25	32.84
	COVID-19 isolation	12.66	3.24	3.91	0.011	4.34	20.98
	OBS & Gynea	7.70	4.34	1.77	0.137	-3.47	18.86
[β]Occupation and Department	Comm-serve MO#Theatre	-8.74	5.11	-1.71	0.148	-21.87	4.40
	MO#Theatre	-35.15	6.30	-5.58	0.003	-51.35	-18.95
	Registrar#Theatre	-39.27	5.02	-7.82	0.001	-52.17	-26.37
	Prof. Nurse#Gen. Med-ward	-12.24	9.25	-1.32	0.243	-36.03	11.54
	Enrolled assist. nurse#Emergency	37.06	5.66	6.55	0.001	22.51	51.61
	Enrolled/staff nurse#Emergency	20.44	5.32	3.84	0.012	6.77	34.12
	Enrolled/staff nurse#COVID-19 Isolation	4.87	5.97	0.82	0.452	-10.47	20.21
	Physiotherapist# COVID-19 isolation	-12.78	6.27	-2.04	0.097	-28.89	3.34

	Janitor#ICU	-19.06	6.56	-2.91	0.034	-35.91	-2.20
	Janitor#COVID-19 isolation	-15.89	14.93	-1.06	0.336	-54.26	22.48
_cons		15.77	12.96	1.22	0.278	-17.56	49.09

*****Head of unit (jobtitle = 1) set as the baseline. $^{\alpha}$ Outpatient (Department = 9) set as the baseline. $^{\beta}$head of unit and outpatient department interaction set as baseline. $^{\beta}$ ANCOVA approach used.

The regression output of the analysis (table 10) showed that JRTI scores were associated with some of the explanatory variables in the model. The analysis shows that JRTI scores for HCWs that exhibited negative COVID-19 perceptions were 6.37 units higher compared to JRTI scores in HCWs that exhibited reasonable COVID-19 perceptions (p = 0.016; CI: 1.78, 10.96), adjusting for other explanatory variables in the model. JRTI scores in HCWs that had experienced physical stress were 0.36 units higher than GHQ-12 scores for HCWs who had not experienced physical stress, while adjusting for other variables (p = 0.033, CI: 0.04, 0.68).

JRTI scores by Occupation

The regression also shows that the JRTI scores for HCWs that worked as Interns were 21.62 units higher than JRTI scores of HCWs that worked as the head of unit (p = 0.040, CI: 1.51, 41.73), adjusting for other variables. JRTI scores for HCWs that worked as community service medical officers were 12.63 units higher than JRTI scores of HCWs that worked as the head of unit (p = 0.034, CI: 1.41, 23.85), adjusting for other variables. The JRTI score for HCWs that worked as Medical officers were 41.01 units higher than JRTI scores of HCWs that worked as the head of unit, adjusting for other variables (p < .001, CI: 28.51, 53.51), adjusting for other variables. JRTI scores for HCWs that worked as Registrars were 29.79 units higher than JRTI scores of HCWs that worked as the head of unit (p = 0.004, CI: 14.40, 45.17), adjusting for other variables. JRTI scores for HCWs that worked as professional nurses were 12.92 units higher than JRTI scores of HCWs that worked as the head of unit (p = 0.032, CI: 1.66, 24.18), adjusting for other variables. JRTI scores for HCWs that worked as pharmacists were 21.14 units higher than JRTI scores of HCWs that worked as the head of unit (p = 0.004, CI: 10.35, 31.92), adjusting for other variables. JRTI scores for HCWs that worked as janitors were 14.39 units higher than JRTI scores of HCWs that worked as the head of unit (p = 0.015, CI: 4.21, 24.57), adjusting for other variables. JRTI scores for HCWs that worked as delivery personnel were 24.34 units higher than JRTI scores of HCWs that

worked as the head of unit (p = 0.005, CI: 11.49, 37.19), adjusting for other variables. JRTI scores for HCWs that worked as phlebotomists were 21.09 units lower than JRTI scores of HCWs that worked as the head of unit (p = 0.048, CI: -41.94, -0.25), adjusting for other variables.

JRTI scores by Department

HCWs that worked in the radiology department had JRTI scores that were 12.04 units lower than those of HCWs working in the outpatient department, adjusting for other variables (p = 0.011, CI: -19.97, -4.10). HCWs that worked in the emergency department reported JRTI scores that were 23.42 units lower than JRTI scores of HCWs working in the outpatient department, adjusting for other variables (p = 0.002, CI: -33.15, -13.69). HCWs that worked in the ICU department reported JRTI scores that were 17.05 units higher than those of HCWs working in the outpatient department, adjusting for other variables (p = 0.039, CI: 1.25, 32.84). HCWs that worked in the COVID-19 isolation department reported JRTI scores that were 12.66 units higher than those of HCWs working in the outpatient department, adjusting for other variables (p = 0.011, CI: 4.34, 20.98).

JRTI scores by occupation and department

HCWs that worked as a medical officer in the theatre department reported JRTI scores that were 35.15 units lower than JRTI scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.002, CI: -51.35, -18.95). HCWs that worked as a registrar in the radiology department reported JRTI scores that were 39.27 units lower than JRTI scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.001, CI: -52.17, -26.37). HCWs that worked as an enrolled assistant nurse in the emergency department reported JRTI scores that were 37.06 units higher than JRTI scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.001, CI: 22.51, 51.61). HCWs that worked as an enrolled/staff nurse in the emergency department reported JRTI scores that were 20.44 units higher than JRTI scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.012, CI: 6.77, 34.12). HCWs that worked as a janitor in the ICU department reported JRTI scores that were 19.06 units lower than JRTI scores of HCWs that worked as a head of unit in the outpatient department, adjusting for other variables (p = 0.034, CI: -35.91, -2.20).

The post-estimation tests for the work stress analysis showed that there were no variables omitted (F(3, 141) = 0.45, p = 0.7143). The test for multi-collinearity also showed absence of multi-collinearity (mean VIF = 6.23), and the AIC and BIC also showed a strong model (appendix).

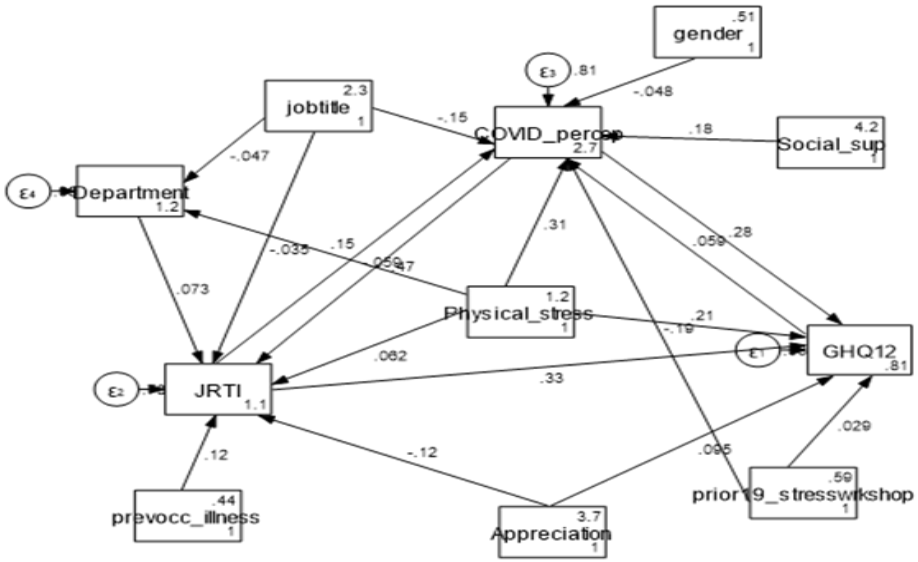
Identification of an adjusted association between work stress and mental wellbeing

Table 11. Structural equation model of GHQ-12, JRTI and COVID-19 perceptions adjusted for clustering within facilities (n = 224)

Factor		**Mental wellbeing**						
		Unstandardized coefficients		**Standardized**				
Structural		**Coef.**	**Std. Err.**	**Coef.**	**Z**	**p-value**	**95% CI**	
GHQ	JRTI	0.19	0.03	0.33	6.73	<0.001	0.14	0.25
	COVID-19 perceptions	0.21	0.09	0.28	2.24	0.025	0.03	0.39
	Physical stress	0.28	0.05	0.21	6.15	< 0.001	0.19	0.37
	Prior stress workshop	0.53	0.80	0.03	0.67	0.504	-1.03	2.10
	Appreciation	0.18	0.26	0.09	0.71	0.479	-0.33	0.70
	_Cons	6.46	3.09	0.81	2.09	0.037	0.40	12.51
COVID perception	GHQ-12	0.08	0.30	0.06	0.26	0.792	-0.51	0.67
	JRTI	-0.05	0.27	-0.06	-0.17	0.863	-0.57	0.48
	Physical stress	0.56	0.21	0.31	2.61	0.009	0.14	0.98
	Gender	-1.27	0.94	-0.05	-1.36	0.175	-3.10	0.57
	Prior stress workshop	-4.57	1.29	-0.19	-3.56	<0.001	-7.09	-2.05
	Social support	0.51	0.20	0.18	2.53	0.011	0.12	0.91
	jobtitle	-0.29	0.14	-0.15	-2.09	0.037	-0.56	-0.02
	_Cons	28.60	10.37	2.69	2.76	0.006	8.27	48.93

A SEM was also conducted as an analysis method to assist in describing whether there was an adjusted association between JRTI and GHQ-12 scores among HCWs, as a result of the COVID-19 pandemic in 2020. The output of the analysis is shown in table 11. The results of the SEM showed that a unit increase in the JRTI score was associated with a 19% increase in the GHQ-12 score ($p < .001$, CI: 0.14, 0.25) adjusting for other variables. A unit increase in the COVID-19 perception score was associated with a 21% increase in the GHQ-12 score ($p = 0.025$, CI: 0.03, 0.39) adjusting for other variables. The model also shows that HCWs that had experienced physical stress were associated with a 28% increase in their GHQ-12 scores. The post-estimation output (appendix) for the model shows good model fit with a CFI = 1.000, TLI = 1.027, RMSEA = 0.000, pclose = 0.965, and likelihood ratio (chi2 ms(19) = 10.927, $p = 0.692$).

Figure 3. Structural Equation Model of mental wellbeing, work-stress and covid-19 perceptions.



Prevalence

The outcome variables of interest (GHQ-12 and JRTI) were categorised according to the thresholds and tabulated, table 12 shows the number of HCWs that either experienced mental disorders or work-related stress during the COVID-19 pandemic in Gauteng, 2020. 55.22% and 54.33% HCWs experienced mental disorders and work stress respectively.

Table 12. *Categorical descriptive statistics of the study outcome variables of interest.*

Variable	Category	Frequency	Percentage
GHQ-12	Good mental wellbeing observed	150	44.78%
	Poor mental wellbeing observed	185	55.22%
JRTI	No work stress observed	153	45.67%
	Work stress observed	182	54.33%

A two-by-two table analysing the GHQ-12 scores and the JRTI scores (table 13) showed that the prevalence of mental health disorders and work stress in HCWs in Gauteng during the COVID-19 pandemic was 39.10%. Contrary to that, 29.55% of the HCWs did not experience mental health disorders and work-related stress, however 15.22% of the participant experienced work-related stress only and 16.12% experience mental health disorders only during the COVID-19 pandemic in Gauteng, 2020. The analysis had a Pearson chi-square value of 45.24 (P<.001). The analysis showed the odds of experiencing psychological distress with work stress to be 4.71 (p value 0.00001).

Table 13. *two-by-two table of the outcome variables of interest*

Variables		**JRTI**		**Total**
	Category	No work stress	Work stress	
GHQ-12	No mental disorder	99 (29.55%)	51 (15.22%)	150 (44.78%)
	Mental disorder	54 (16.12%)	131 (39.10%)	185 (55.22%)
Total		153 (45.67%)	182 (54.33%)	335 (100%)

Pearson chi2(1) = 45.24 Pr = 0.000

A logistic regression analysis (table 14) was also conducted to determine the factors that are associated with developing mental health disorders among the HCWs. The logistic regression output for the GHQ-12 categorical variable shows that the odds of developing mental health

disorders among HCWs who were experiencing work-stress in Gauteng, 2020, were 7.51 times the odds of developing mental health disorders among HCWs not experiencing work-stress in Gauteng, 2020 (p <.001, CI: 2.99, 18.85). The output also showed that the odds of developing mental health disorders among HCWs who had negative COVID-19 perceptions in Gauteng, 2020, was 6.09 times the odds of developing mental health disorders in HCWs who did not have negative COVID-19 perceptions in Gauteng, 2020 (p < .001, CI: 3.57, 10.40).

Table 14. *Multivariable logistic regression of the GHQ-12 categorical variable adjusting for clusters within facilities (n =188)*

Variable	**Factor**	**Presence of mental health disorder (GHQ-12 = 1)**					
		Odds ratio	**Robust Std. Err.**	**z**	**p-value**	**95% CI**	
JRTI	Work-stress present	3.80	0.81	6.25	<0.001	2.50	5.78
COVID-19 perceptions	Negative	3.22	0.61	6.13	<0.001	2.21	4.67
Age group	25-34	0.41	0.09	-4.14	<0.001	0.27	0.63
	35-44	0.62	0.31	-0.96	0.338	0.24	1.64
	45-54	0.59	0.30	-1.05	0.294	0.22	1.58
	>55	0.40	0.32	-1.15	0.249	0.09	1.88
Gender	Male	1.07	0.55	0.13	0.895	0.39	2.94
Occupation	Comm-serve MO	0.09	0.11	-2.04	0.042	0.01	0.91
	Medical officer	1.60	1.27	0.59	0.558	0.33	7.61
	Consultant	0.40	0.29	-1.25	0.212	0.10	1.68
	Professional nurse	0.24	0.15	-2.27	0.023	0.07	0.82
	Enrolled assistant nurse	0.68	0.35	-0.74	0.457	0.25	1.86
	Enrolled/staff nurse	0.59	0.41	-0.76	0.448	0.15	2.30
	Physiotherapist	0.39	0.32	-1.13	0.258	0.07	2.01
	Pharmacist	0.59	0.94	-0.33	0.741	0.03	13.59
	Janitor	2.51	4.91	0.47	0.638	0.05	115.78
	Clerk	0.23	0.10	-3.25	0.001	0.10	0.56
	Delivery	0.31	0.25	-1.46	0.145	0.06	1.50
*Department	General med-ward	0.10	0.07	-3.59	<0.001	0.01	1.44

	COVID-19 isolation	0.58	1.02	-0.31	0.758	0.02	18.04
Social support	present	3.23	2.53	1.49	0.135	0.69	15.03
Physical stress		1.07	0.03	2.12	0.034	1.01	1.14
Occupation and Department	Professional nurse#COVID-19 isolation	0.41	0.95	-0.39	0.699	0.00	39.41
	Enrolled assistant nurse#COVID-19 isolation	2.47	5.83	0.38	0.703	0.02	254.43
	Enrolled/staff nurse#COVID-19 isolation	1.88	3.34	0.36	0.723	0.06	61.41
	Janitor#COVID-19 isolation	0.30	1.04	-0.35	0.729	0.00	254.52
_Cons		0.25	0.30	-1.14	0.253	0.02	2.67

*****other departments were omitted by the model.

Chapter 4: Discussion and Conclusion

This study sought to describe the relationship between work stress and mental health among HCWs working in public hospitals and CHCs in Gauteng during the COVID-19 pandemic in 2020. In this chapter, the results of the study will be discussed in detail, and the outcome of the data analysis will show that pandemics do affect the mental health of HCWs as well as increase the level of stress they face while performing their various duties within healthcare facilities.

The research findings showed that there was a significant positive relationship between work stress and mental health among HCWs working in public hospitals and CHCs in Gauteng during the COVID-19 pandemic in 2020. The findings also showed that in workers reporting higher work-stress levels, there was a similar increase in poor mental wellbeing. The outcome of that analysis showed that HCWs that had negative perceptions of COVID-19 were associated with increased mental health disorder levels and work-stress levels.

There was an observed prevalence (55.22%) of poor mental wellbeing and work-stress (54.33%) among HCWs during the COVID-19 pandemic. These results corroborate a previous review that was conducted that showed that rates for any depression among HCWs in South Africa ranged from 8.9% to 50.4%, and the rates for any anxiety among HCWs ranged from 10.4% to 44.6% (37). Findings from this study also corroborate mental health and work-stress outcomes observed in Italy during the COVID-19 pandemic (52). HCWs in China reported physical symptoms due to working in healthcare facilities during the COVID-19 pandemic; these included lethargy (26.6%), headaches (31.9%) and insomnia (21%) (53). This study showed that individuals that were experiencing physical stress had a 36% increase in the JRTI score compared to those that were not experiencing physical symptoms, signifying a higher perceived work-stress experience.

Mental wellbeing among HCWs in Gauteng during the COVID-19 pandemic in 2020

HCWs in Gauteng, South Africa, reported not being able to enjoy their day-to-day activities and felt under strain, but they also reported having less of a desire to resign from their job because of COVID-19. These conflicting sentiments may have been due to broader issue in South Africa, and in most African countries currently face, the issue of unemployment.

Research has shown that approximately 18 million people in South Africa make up 80% of the poorest households, and of these households 45% have an employed member (54). South Africa's current unemployment rate in the first quarter of 2022 was 34.5% (60), this is one of the highest unemployment rates in the world. HCWs may have had to endure poor working conditions that may have led to work-stress and mental health disorders rather than leaving their job. This conundrum that HCWs faced could have been worsened by the closure of non-essential services, and the cessation of healthcare services that were deemed not urgent. HCWs also reported feeling unhappy and depressed during the COVID-19 pandemic. These feelings could have also arisen from their work as a result of the pandemic as they reported feeling constantly under strain and having a heavy workload that they could not finish during an ordinary working day. These outcomes corroborate the outcomes observed in Brazil as changes to their work environment are thought to have increased the anxiety and depression of HCWs (29).

Most HCWs were afraid of passing the COVID-19 virus to their family members (73.77%) and believed that their job was putting them at risk of contracting COVID-19 (89.06%). Fear is a phenomenon that was also observed during the 2003 SARS pandemic in Canada (21), and its recurrence during the COVID-19 pandemic highlights the importance of protecting the mental health of HCWs during pandemics. South Africa faced a PPE supply issue in the healthcare sector (55) and this could have worsened the fear of transmitting the virus to their family members that HCWs were experiencing. Previous studies showed that being a parent was associated with psychological distress (21). HCWs during the COVID-19 pandemic did show that they felt their work was interfering with their family life and this may have also fuelled the fear of transmitting the virus to their family members.

Our study also showed that those that were in the 25-34-year age-group were less likely to develop mental health disorders during the COVID-19 pandemic compared to the other age groups in the study. This outcome is also supported by a study conducted by Hayat et. Al which showed that HCWs between the ages of 20 to 29 had less depressive symptoms compared to the other age groups (56). A study conducted in China during the COVID-19 pandemic showed that HCWs that had experienced the SARS pandemic and other epidemic prevention experiences had more psychological pressure (57). South Africa experienced the world's largest HIV/AIDS epidemic as it had the highest number of HIV infected people (58). Some HCWs that worked during that epidemic are reported to have experienced high

workloads, exposure to HIV infection and stress (58) and these HCWs might still make up part of the current healthcare workforce in the public hospitals. This may explain the outcome that those in the younger age groups were less likely to have developed/experienced mental health disorders during the COVID-19 pandemic.

Certain occupations also showed an association with mental health, with a greater effect among medical officers and janitors. Previous studies showed that nurses and HCWs working in the front line had experienced high psychological distress compared to other HCWs (21, 26), our study corroborates this observation with nurses working in the COVID-19 isolation wards having a higher association with poor mental health disorders. In South Africa, nurses are usually exposed to a lot of tasks and roles, this is as a result of fewer medical doctors available in most public sector facilities such as community healthcare centres that are usually the first point of access for many people. This exposure may have enabled nurses working in other departments in Gauteng to not have been negatively affected by the COVID-19 pandemic in 2020. Janitors may have been exposed to work conditions they were not used to, which may have involved keeping certain wards in a higher sanitary condition and thus being in contact with COVID-19 infected patients. However, janitors working in the ICU department had a negative association with mental health disorders, this may have been due to reduced ICU cases during the lockdown period in Gauteng in 2020.

Work stress among HCWs in Gauteng during the COVID-19 pandemic in 2020

The study also showed that work-stress levels differed by a HCW's specific occupation in the facility. Medical officers and registrars were associated with the highest work-stress levels compared to head of units, this outcome is different from those observed in previous studies. Kuo et al (4) showed that medical technicians experienced the highest levels of burn-out during the SARS pandemic. HCWs work-stress levels also varied according to their department and occupation similar to HCW experiences in Saudi Arabia which showed that HCWs in the COVID-19 wards and paediatric ER experience more anxiety compared to their colleagues in other departments (59). Enrolled assistant nurses working in the emergency department in this study showed higher levels of work-stress, and this may have been due to role ambiguity as HCWs were expected to perform duties they were not used to. More work might have been assigned to assistant nurses during the pandemic as a way to counter the HCW staff shortage. Contrary to this, registrars in the theatre department experienced lower

stress levels as there were fewer surgical procedures being performed during the lockdown period. Our data also showed that majority of the HCWs that participated in the study were female (80%), and assumptions can be made that most of them may have experienced the double shift scenario (3) as they were expected to take care of their family's needs after work.

Strengths

Our study contributes to existing literature about the effects of the COVID-19 pandemic on the mental wellbeing of HCWs but from a South African, and poorly resourced environment experience. This study used validated tools found in many other studies so provides comparable findings. Our study also takes a look at other workers in medical facilities that are not often taken into consideration when studies focusing on HCWs are conducted. Our study was able to give a broader view of HCWs in different facilities, i.e. well-resourced and poorly-resourced facilities. The combination of both a mental health tool and work stress tool in the same questionnaire allows us to demonstrate the association between work stress and mental health while adjusting for factors known to affect both. This allows a clear demonstration of the role of work stress in mental health of health care workers. This is able to provide evidence for employers to include mental health in their wellness programs.

Limitations

The study had limitations, the questionnaires that were used to collect the data were self-reported and thus participants might not have been fully transparent or honest in their responses, and thus might have led to reporter bias. Another limitation to the study was the presence of antecedent-consequence bias as it is difficult to determine whether mental health issues preceded the COVID-19 pandemic as questions on previous mental health issues were not included in order to encourage participation and to remove any idea of blame for mental health conditions. The dataset had some missing data where respondents chose not to answer certain questions or missed them unintentionally. This may have also led to bias when the data was analysed. There was also poor response from HCWs in the different facilities and this might affect generalizability of the study outcomes.

Conclusion

This study demonstrated that work-stress significantly affected mental health among HCWs working in public hospitals and community health centres (CHCs) in Gauteng during the

early COVID-19 pandemic. This finding illustrates the role of workplace mental health support as a necessary part of pandemic preparedness. It also shows that pandemics such as the COVID-19 pandemic can lead to a high proportion of work-stress as well as mental health disorders in HCWs. A negative perception of COVID-19 played a significant role in work stress and mental wellbeing of HCWs. This study demonstrates the need for work place psychosocial support for all HCWs during a pandemic to keep the workers healthy and productive.

Recommendations

Results from the study show that HCWs are at risk of developing work-stress and mental health disorders during disease outbreaks and this may lead to poor service delivery and staff shortages as some employees may take more sick leave. Decision makers at the district and provincial level should aim to provide constant counselling services even during periods of less work-stress. Sufficient outbreak response training should be provided as part of HCWs Continual Professional Development (CPD) courses so that there is better readiness for future pandemics. The national department of health (NDoH) in partnership with the private sector should develop a national PPE stockpile for future pandemics, including ventilators and sanitizers used to curb the spread of infections. There should permanent policy changes that reduce the number of hours worked by HCWs, and more effort staff retention in the public sector as this is what majority of the country uses for seeking healthcare services. Smaller healthcare facilities should also be better equipped with not just only professional HCWs but equipment, including training and storage of such equipment, and regularly checked as preparation for future outbreaks. Lessons learned from the COVID-19 pandemic should form a large part of policy changes in the South African healthcare system. As we observed from this study, certain professionals in certain wards are more prone to work-stress and mental health disorders, therefore all HCWs should constantly receive training for the different wards and better rotation of supporting staff be implemented so that role ambiguity may not exist when such employees are required to assist in wards that they are not normally stationed in.

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Appendix

Results Extended

Post-estimation

Objective 1.

Ramsey RESET test using powers of the fitted values of GHQ12

Ho: model has no omitted variables

F(3, 170) = 1.50

Prob > F = 0.2172

Mean VIF = 6.68

Model	N	11(null)	11(model)	df	AIC	BIC
.	214	-751.196	-700.230	5	1410.46	1427.29

Objective 2.

Model	N	11(null)	11(model)	df	AIC	BIC
.	202	-808.08	-755.07	5	1520.14	1536.68

Ramsey RESET test using powers of the fitted values of GHQ12

Ho: model has no omitted variables

F(3, 141) = 0.45

Prob > F = 0.7143

Mean VIF = 6.23

Objective 3. Post-estimation statistics

Fit statistic		Value	Description
Likelihood ratio	Chi2_ms(19)	10.927	Model vs. saturated
	P > chi2	0.692	
	Chi2_bs(30)	312.198	Baseline vs. saturated
	P > chi2	0.000	
Population error	RMSEA	0.000	Root mean squared error of approximation
90% CI,	lower bound	0.000	
	Upper bound	0.046	
	pclose	0.965	Probability RMSEA <= 0.05
Information criteria	AIC	14585.399	Akaike's information criterion
	BIC	14686.464	Bayesian information criterion
Baseline comparison	CFI	1.000	Comparative fit index
	TLI	1.027	Tucker-Lewis index
Size of residuals	SRMR	0.021	Standardized root mean square residual
	CD	0.300	Coefficient of determination

Post-estimation statistics. *Specificity error test for GHQ-12 logistic regression*

Factor	Mental wellbeing categorical variable (GHQ12_cat)					
	Coef.	Std. Err.	z	p-value	95% CI	
_hat	0.997	0.123	8.12	0.000	0.756	1.238
_hatsq	0.040	0.078	0.52	0.605	-0.113	0.194
_cons	-0.051	0.171	-0.30	0.764	-0.386	0.283

LR chi2(2) = 61.23 Prob > chi2 = 0.0000 Pseudo R2 = 0.2539

Post-estimation statistics. *Logistic model for GHQ12_cat, goodness-of-fit test*

Number of observations =	306
Number of covariate patterns =	292
Pearson chi2(8) =	287.87
Prob > chi2 =	0.083

Model	N	11(null)	11(model)	df	AIC	BIC
.	306	-210.63	-158.71	5	327.42	346.04

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Mr Themba Butao

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M220269

NAME: (Principal Investigator)	Mr Themba Butao
DEPARTMENT:	School of Public Health
PROJECT TITLE:	The Relationship between Mental Health and Work Stress in Healthcare Workers during COVID-19 in Gauteng, South Africa (2020)
DATE CONSIDERED:	25/02/2022
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr K. Wilson
APPROVED BY:	CB Penny Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	23/03/2022

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions.Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **February** and will therefore be due in the month of **February** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

24/03/2022
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

DECLARATION:

Adherence to HREC (Medical) Ethics Application Terms and Conditions

I, the undersigned, hereby declare that I have not collected data/ done secondary data analysis or any other form of research, prior to obtaining clearance certificate from the HREC (Medical) for study no: M220269.

I have read and understood the terms and conditions on section 9 of HREC (Medical) application form. I confirm that it is my responsibility to ensure that I have received final HREC (Medical) Clearance before commencing any research.

THEMBA BUTHO

Name, Surname and Signature

Student/~~Staff~~ no if applicable: 1385032

Date: 24/03/2022

Name, Surname and Signature

Supervisor (if applicable)

Date: